FINAL DRAFT

The United Republic of Tanzania

Ministry of Water and Irrigation

SITE HANDBOOK

for
Construction Management & Supervision
of
Small Scale Irrigation Scheme Development

October 2017

National Irrigation Commission (NIRC)

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for
Construction Management & Supervision
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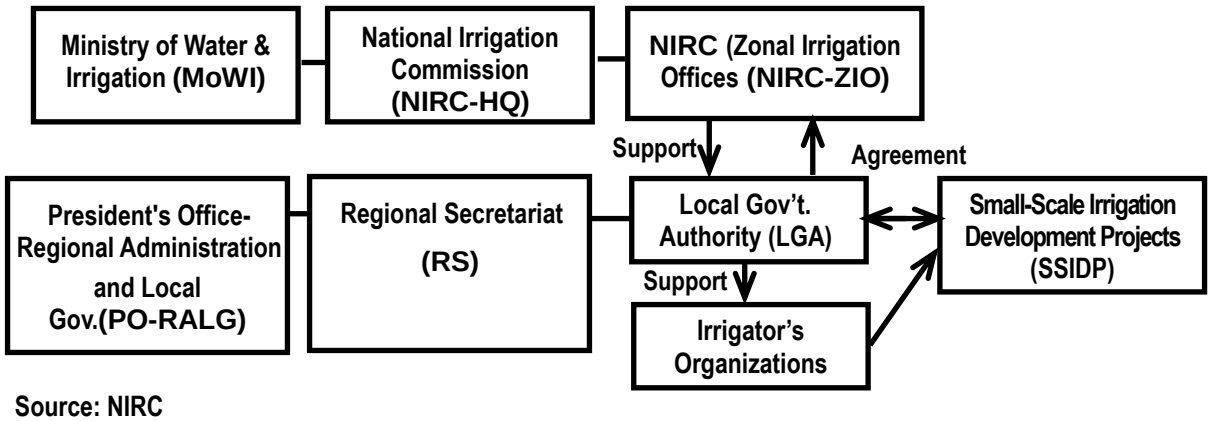
SITE HANDBOOK FOR CONSTRUCTION MANAGEMENT & SUPERVISION OF SMALL SCALE IRRIGATION SCHEME DEVELOPMENT

1 INTRODUCTION

(1) Authority

This <FINAL Draft> Site Handbook of Construction Supervision was prepared in accordance with the Technical cooperation "Project for Capacity Development for the Promotion of Irrigation Scheme Development Under the District Agricultural Development Plans Phase 2 (TANCAID-2) ", under Japan International Cooperation Agency (JICA), for the implementation of Small scale irrigation development projects under Ministry of Water and Irrigation (MoWI) in the United Republic of Tanzania on October 12, 2017.

The overall administrative organization chart for the implementation of Small-Scale Irrigation Development Projects in Tanzania is shown as below:



Source: NIRC

(2) Objective

The objective of the <Draft> Site Handbook is to provide the staffs of Zonal Irrigation Offices (ZIOs) and LGAs with how to make construction management and supervision properly and effectively for the Project. Thus, the site handbook is prepared in user-friendly manner for construction management and supervision by the Project Managers/ Technicians of ZIOs and LGAs, in accordance with/ referring to the "Comprehensive Guideline (CGL)" as well as the "Manual for Construction Supervision for Small Scale Irrigation Development Project for District Agricultural Development Plans (Nippon Koei Co. Ltd., June 2014)", which was prepared under the SSIDP.

(3) Composition of Site Handbook

The Site Handbook consists of the following contents, especially focusing on the irrigation canal lining works:

- Contract Documents for Civil Works
- Work Management
- Progress Control
- Quality Control
- Safety Control
- Environmental Control

These further include (i) field instructions, (ii) works requests, (iii) record of daily construction activities, (iv) field and laboratory tests, (v) record of monthly work schedule, (vi) weekly and monthly work schedule, (vii) site measurement, (viii) approval of performed work, (ix) acceptance of materials, (x) monthly statement of accomplishment for billing, (xi) receipt of monthly/ interim payment, (xii) change order, (xiii) extra or emergency work order and (xiv) certification of completion.

It is noted that the Site Handbook shall be used as a guidance document for an effective and efficient construction management/ supervision based on the Contract documents, especially along with the Technical specifications, and the CGL.

(4) Role and Responsibility of Stakeholders

The Role & Responsibility of Stakeholders, the Project Manager, technical staff of the relevant Zonal Irrigation Office and LGA, the Contractor as well as the Project Committee (PC) in implementation of Small Scale Irrigation Projects under Ministry of Water and Irrigation (MoWI) are tabulated as follows:

(a) Project Manager (the PM)

To ensure quality control, progress control, safety control, cost control of irrigation and drainage Infrastructure development in collaboration with the relevant LGA Council. The Project Manager shall be provided either by the Zonal Irrigation Office or the relevant LGA, by the appointment letter issued by the Zonal Irrigation Office.

(b) The Relevant LGA Council

The relevant LGA Council will ensure supervision during the Contract period in collaboration of zonal office, Project Committee (PC)/ Irrigator's Organization (IO) of the target irrigation scheme. If requested and appointed by the Zonal Irrigation Office, the LGA Council provide the Project Manager, in addition to technical staff.

(c) The Contractor

The Contractor will ensure the followings:

To construct quality Irrigation Infrastructure, as per specified in the Contract document;

To receive advice and instruction from the PM as per the Contract document;

To follow and accept the PPRA regulation;

To provide report regularly as requested by the PM.

(d) Project Committee (PC)/ Irrigator's Organization (IO)

Project Committee (PC) will supervise the Construction work according to instruction from the PM.

The PC i) has opened a bank account for the payment to the Contractor; ii) will assist the construction supervision in collaboration with the PM and LGA staff and report to the PM; iii) through the acknowledgment of the PM, interim payment will be done by the PC.

Only if the agreed work is specified in the BoQ of the Contractors Work, Irrigators Organization (IO) will mobilise their agreed work under supervision of PC as instructed by the PM.

2 CONTRACT DOCUMENTS FOR CIVIL WORKS

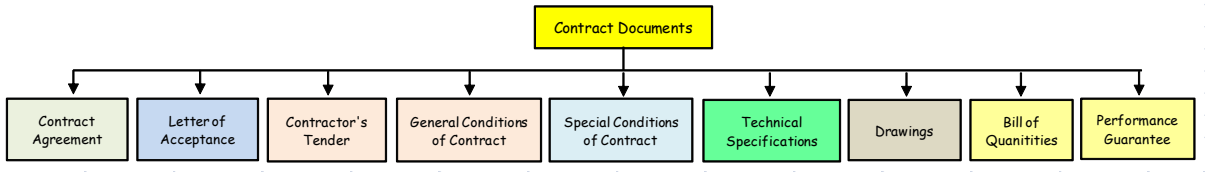
(1) General

The contract documents are the common basics for the Client, the Employer and the Contractor to fulfill the works.

【Explanation】

The contract documents are generally composed of contract agreement, letter of acceptance, contractor's tender, general conditions of contract, special conditions of contract, technical specifications, drawings, bill of quantities and performance guarantee.

Figure 2.1 Composition of Contract Documents



The construction activities should be duly carried out in accordance with the contract documents. Thus, the Client/ the Employer, the Engineer (the Project Manager) and the Contractor should always observe the contract documents during the construction period.

【Output】

The works fulfilled in line with the contract documents.

It is noted that the **Site Handbook** shall be used as a **guidance document for an effective and efficient construction management/ supervision** based on the Contract documents.

(2) Priority of Documents

There are priorities in the contract documents forming various documents.

【Explanation】

The documents composing the contract should be treated as mutually explanatory one another. For the purposes of interpretation, the documents shall be given in the following sequence:

- the Contract agreement
- the Letter of Acceptance
- the Special Conditions of Contract
- the General Conditions of Contract
- the Specifications/ the Technical Specifications
- the Drawings and
- the Bill of Quantities (BoQ)
- the Schedules and any other documents forming part of the contract

If an ambiguity or discrepancy is found in the documents, the Project Manager shall issue

any necessary clarification or instruction.

【Output】

Priority in the documents forming the contract

(3) General Conditions of Contract (GCC)

General Conditions of Contract indicate the common stipulations on rights and obligations of the Client, the Employer and the Contractor.

【Explanation】

General Conditions clearly mention the rights and obligations of the Client, the Employer and the Contractor which are indispensable for successful execution of the works. Thus, it is expected that the responsible staffs of ZIOs and LGAs, especially the Project Manager should scrutinize and understand them. Whenever any problems occur at the works, the responsible staffs of ZIOs and LGAs should keenly check the relevant clauses of General Conditions of Contract.

【Output】

Construction activities coincided with General Conditions

(4) Special Conditions of Contract (SCC)

Special Conditions of Contract have a role of complementing General Conditions of Contract in consideration of the project conditions.

【Explanation】

Special Conditions of Contract are prepared for the following reasons:

- Needs of additional information to supplement the words and expressions employed in General Condition of Contract;
- Needs of additional information on type and location of the works and environmental conditions; and
- Needs of modification of General Conditions in the light of the laws of the country concerned and in view of particular environmental conditions.

Special Conditions of Contract should therefore keep the consistency with General Conditions of Contract.

【Output】

Special Conditions of Contract completely supplementing General Conditions of Contract

(5) Technical Specifications/ Specifications

Technical Specifications of Contract are prepared aiming to complete the works technically sound.

【Explanation】

Technical specifications are so important for keeping the good quality of the works. When supervising the construction works, the corresponding technical specifications and drawings should be checked in advance by the responsible staffs of ZIOs and LGAs, if necessary carried at the site, to examine whether the works are carried out as specified in technical specifications.

Technical Specifications generally cover the following:

- extent of the works the Contractor has to carry out;
- methods the Contractor may or may not use in order to construct the works;
- type and quality of materials and workmanship that will prove acceptable.

The achievement of the first and third items is straightforward, but there are some dangers attached to the second item. For instance, the Project Manager specifies the exact measures to be used; then if the Contractor follows these measures and damage follows, liability for the damage lies squarely upon the Project Manager. Thus, the Project Manager and also staffs of ZIOs and LGAs in charge of construction supervision should carefully assimilate the technical specifications of contract in order to tread upon such dangerous ground.

The third purpose of the specification-to specify the type and quality of materials and workmanship that will prove acceptable- appears to call upon an engineer for an immensely wide range of specialized knowledge. It is not surprising that one of the common ways of writing a specification is for an engineer to gather all other specifications he can find that have been written on the same subject (regardless of their date) and, by a process of editing, combine relevant portions of these specifications.

【Output】

Technical Specifications well-fitted to proper construction works

(6) Drawings

Drawings related to construction works consist of Working Drawings and As-built Drawings.

【Explanation】

(a) Working Drawings

The Contractor shall submit to the Project Manager Working Drawings, where so required by the Contract or as requested by the Project Manager, for all temporary and permanent works to be constructed by or supplied and installed by the Contractor or his sub-contractor or supplies.

The term of "Working Drawings" shall be understood to include the Contract Drawings, Construction Drawings and Shop Drawings.

Working drawings shall be prepared based on the LGAs' Contract Drawings and Specification requirements, and shall contain sufficient details to show or include:

- General arrangement and dimensions of each and every part of the Works to be constructed and/ or fabricated;
- Topographic data and ground surface level obtained through the site survey stipulated in Technical Specifications as necessity arises or as directed by the Project Manager;
- All relevant calculations;
- Nature of the materials from which the various parts are to be made, and

- Construction details including fixings, cast-in items and the like.

The Contractor shall submit three (3) sets in a form approved by the Project Manager, for the Project Manager's review and approval not less than thirty (30) calendar days or the stipulated calendar days in the Special Conditions of Contract, prior to he plans to start construction of any particular item of the Works. Of the Working Drawings approved by the Project Manager, two (2) sets shall be retained by the Project Manager, and the remaining one (1) set shall be returned to the Contractor for construction work.

The Contractor shall keep one copy of each approved Working Drawings on site for the reference of the Project Manager's staff and to mark. For later use in preparation of As-built Drawings, ant amendments due to all site changes, variations and instructions. These drawings shall be subject to the Project Manager's regular inspection, and if not found to incorporate all amendments, the Contractor shall update the Drawings within three (3) working days or as directed by the Project Manager.

Working Drawings prepared by sub-contractors, manufactures, supplies or the like shall be thoroughly reviewed by the Contractor before submittal to the Project Manager. Such review by the Contractor shall include a study of all technical and dimensional aspects together with a review for co-ordination purposes to ensure that the work indicated on the Shop Drawings is correctly coordinated according to the constraints of all other related works.

The Project Manager's review, comments or approval of Working Drawings shall not relieve the Contractor from any responsibility under the Contract, or from the necessity of furnishing materials or performing works required by the Contract Drawings and Technical Specifications that shall, in the event of any dispute, take precedence over Working Drawings.

Fabrication, manufacture or construction of any part of the Works shall not commence until Working Drawings have been approved in writing by the Project Manager, and after approval by the Project Manager, any changes shall not be made to the relevant Working Drawings without the permission of the Project Manager.

(b) As-built Drawings

Before substantial completion and Taking-over of the Works, the Contractor shall carry out an As-built survey of the Works, and shall prepare As-built Drawings based on the results of this survey and the any amendments noted on the site record Working Drawings. And then, the Contractor shall submit As-built Drawings to the Project Manager for his approval.

GCC 61. Operating and Maintenance Manuals	**61.1If "as built" Drawings and/ or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the SCC.** **61.2If the Contractor does not supply the Drawings and/ or manuals by the dates stated in the SCC, or they do not receive the Project Manager's approval, the Project Manager shall withhold the amount stated in the SCC from the payments due to the Contractor**

SCC Clause	GCC Clause	Description
		D. Cost Control
27.	61.1	As built drawings shall be supplied by the Contractor by ___ days after completion of the works.
28.	61.2	The amount to be withheld by the Project Manager in the case the Contractor does not submit as built drawings is: _____ /=.

Note: _____ values shall be determined by the Employer with consensus of the Project manager.

As-built Drawings shall accurately represent the Works as constructed and show all dimensions and construction details, incorporating the effect of all site changes, variations and instructions. The **Joint Inspection results** shall be compiled as **dimension table(s)** by the Contractor and be effectively used as a part of As-build drawings, especially for **typical section of canals/ dyke embankment and division structures.**

The Contractor shall prepare and submit two (2) sets of draft As-built Drawings to the Project Manager for his review and approval as soon as possible after any part or section of the Works has been completed. The Contractor shall ensure that a minimum of twenty eight (28) calendar days for each submittal is allowed for the Project Manager's review or comments or approval. The Contractor shall be allowed for sufficient time for modification, correction and re-submittal where so required.

After making revision instructed by the Project Manager and getting approval from him, the Contractor shall prepare and submit to the Project Manager two (2) sets of copy and one (1) set of original of As-built Drawings in A3 size unless otherwise indicated in the Contract documents. Should the preceding two (2) draft Drawings submitted for the Project Manager's review be approved without any comments from him, these two (2) preceding Drawings can be deemed to be as the final copy of the relevant As-built Drawings.

The Contractor is requested to convert the all As-built Drawings to electronic document files, and to submit three (3) sets of the files in CD Rom (s) unless otherwise directed in the Contract documents.

The Works shall not be considered to be complete for the purpose of Taking-over until such As-built Drawings have been submitted to and approved by the Project Manager.

(c) No Preparation of Working Drawings and As-Built Drawings by the Contractor

If the Contractor could not prepare and submit Working Drawings nor As-built Drawings, the Project Manager shall withhold the amount stated in the Special Conditions of Contract **Clause 28** from the payment to the Contractor.

【Output】

Working Drawings and As-built Drawings approved by the Project Manager. The **Joint Inspection results** shall be compiled as **dimension table(s)** by the Contractor and be effectively used as a part of As-build drawings.

(7) Bill of Quantities

Bill of Quantities should accurately represent the quantities as measured from the drawings to certain specific and clearly stated limits.

【Explanation】

The limits mentioned above, should be marked on the drawings as "Line showing depth (or width) to which quantities have been measured for the purpose of the bill of quantities". If below or beyond such boundaries the Project Manager thinks that further work might possibly be required, he can enter a further provisional quantity under items in the bill which are labeled provisional.

It has been sometimes stated that "civil engineering work is normally based on an approximate bill or schedule of prices". This is not true. The quantities given in the bill must accurately reflect the amount of work shown on the drawings. If this were not so, no reliance could be placed on the tendered prices as a proper estimate of the cost of the works, and untold confusion result. The confusion may arise because the quantities are not fixed; this is an entirely different matter from their being inaccurate. If, as does happen occasionally, the whole works are constructed exactly as shown on the drawings, then the amount paid to the Contractor should be exactly the tendered (contracted) sum.

【Output】

The accurate Bill of Quantities measured/ computed from the drawings.

(8) Variation/ Additional Work

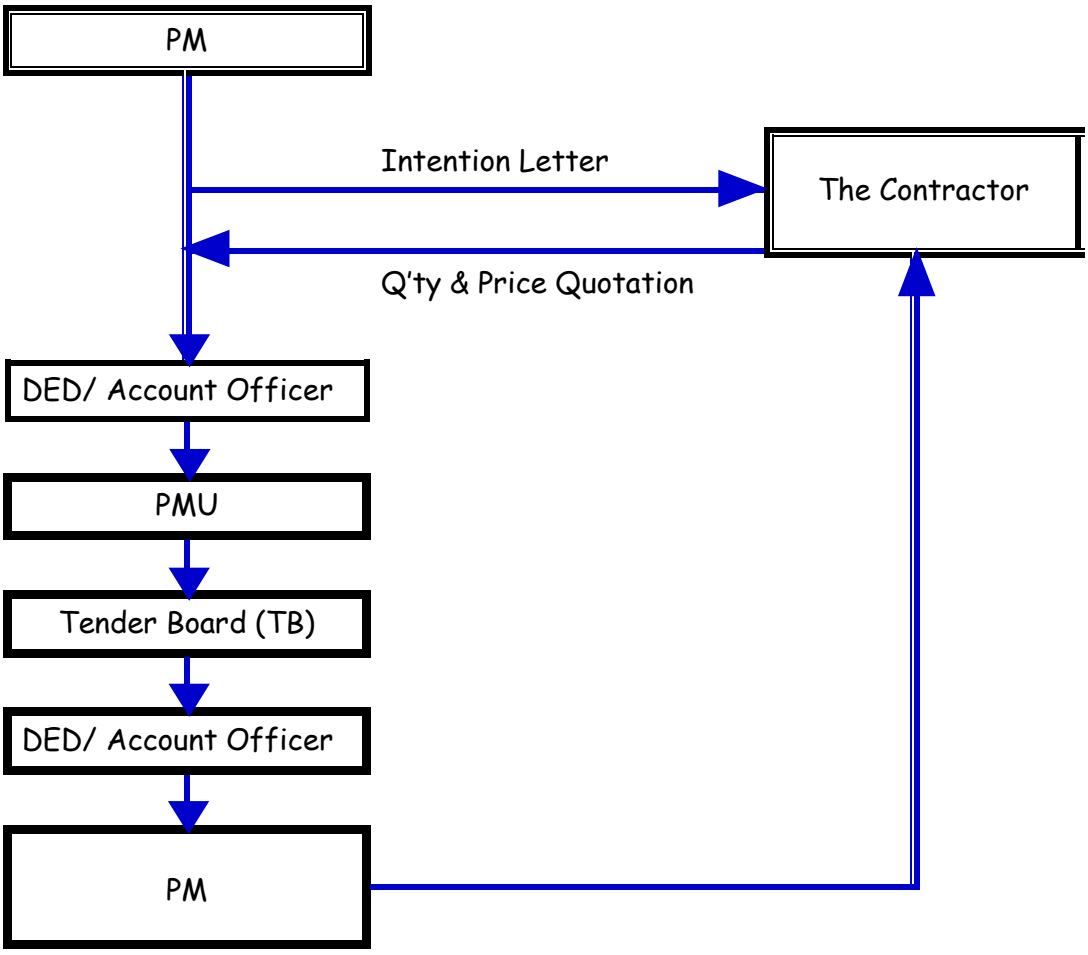
The contract documents are the common basics for the Client, the Employer and the Contractor to fulfill the works.

【Explanation】

The contract documents are generally composed of contract agreement, letter of acceptance, contractor's tender, general conditions of contract, special conditions of contract, technical specifications, drawings, bill of quantities and performance guarantee.

【Flow chart for Variation/ Additional Works】

Variation Order Steps



3 Construction Supervision

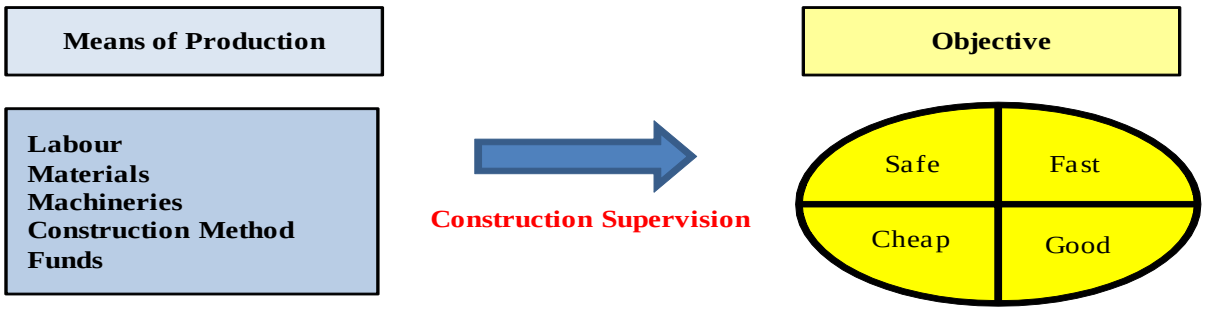
(1) Objective

The construction supervision aims to execute the construction works in fast, good, cheap and safe manners by appropriate combination of means of production.

【Explanation】

In construction of civil works, a construction plan will be prepared firstly. Based on this plan, the Project Manager or staffs of ZIOs or LGAs will monitor whether the works progress as planned or not on the way. If there find that the works do not progress as planned, the Project Manager or staffs of ZIOs or LGAs will seek for causes in delay and take necessary improvement actions immediately, so that the works could be completed with the required quality in the most economical and safe manners within the planned period. Namely, construction supervision is to fulfill the construction works in fast, good, cheap and safety manners by appropriately combining the means of production for construction.

Figure 3.1 Relation between Means of Production and Objective



【Output】

The completed works with the required quality in the most economical and safe manners within the planned period, using the Site Handbook as a guidance document.

(2) Main Activities

Construction supervision mainly consists of four activities such as progress control, quality control, cost control and safety control.

【Explanation】

Although there are various activities in the construction supervision, it can be said that main activities are progress control, quality control, cost control and safety control as shown in the right figure, and then other activities are directly related to these ones. In the construction supervision, thus the Project Manager or staffs of ZIOs or LGAs will focus on these activities by observing the contract documents, especially

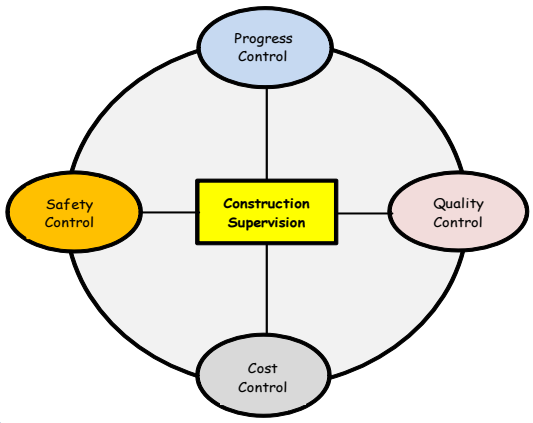


Figure 3.2 Main Activities in Construction Supervision

technical specifications since the quality control is the main pillar among them. The right figure shows the purposes of these four activities such as progress control, quality control, cost control and safety control, which are "Fast", "Good", "Cheap" and "Safe", respectively.

Figure 3.3 Purposes of Four Activities

【Output】

Main activities necessary for construction management/ supervision.

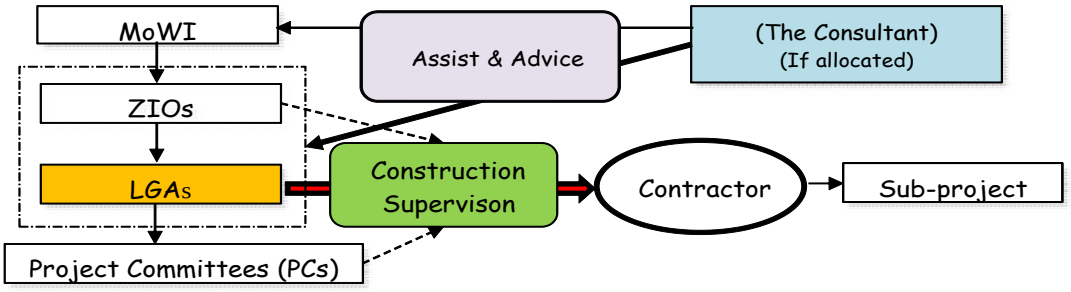
(3) Organization

The employer for construction is either LGAs or PCs depending on contract amount.

【Explanation】

Either LGAs or Project Committees (PCs) make a construction contract with the Contractor for the construction works depending on the contract amount. In case that the contract amount is more than or equal to four (4) hundred million Tsh, a contract is made by LGAs, while in case of a contract amount less than four (4) hundred million Tsh, it is made by PCs. ZIOs provide support for both LGAs and PCs in any cases. Figure 3.4 shows the organization chart among relevant agencies and the Consultant at construction stage.

Figure 3.4 Organization Chart (the Employer:LGAs)



【Output】

Definite organization chart for construction supervision

(4) Major Work Items of Construction Supervision

Construction supervision covers different work items at each stage.

【Explanation】

The construction supervision can be divided into the following stages: (i) preparatory works, (ii) commencement of construction, (iii) construction, and (iv) post-construction. The major work items of construction supervision are as follows:

(a) Preparatory Works
➢ Setting-up of design review team ➢ Examination of the Contract documents ➢ Check of land acquisition program

- Setting-up of site organization (i.e. the Project Manager, LGA staff, PC)
- Preparation of sample construction drawings
- Project coordination with the authorities concerned
- Pre-Kick-off Meeting with the Employer, the Project Manager and the Contractor (Preferably be held on the Contract signing day. Notify the Contractor roles & responsibility of each stakeholders and what should be prepared for the "Kick-off Meeting")

(b) Commencement of Construction Works

- Kick-off meeting (Pre-construction meeting) with the Contractor
- Check and approval of submittals, Work plan, temporary works including temporary roads, aggregate production plan, concrete plant, water and electricity supply system, telecommunication system, and other facilities needed for the Contractor
- Mutual check of survey, design and quantity of works
- Layout survey of works
- Progress meetings
- Safety at work sites
- Concrete mix proportion, cube tests

(c) Construction

- Check of arrangement/ setting-out made by the Contractor during early construction stage
- Construction supervision and quality control of major construction components such as excavation, foundation treatment, earth and concrete works including field and laboratory tests
- Planning and supervision of additional investigations during construction, if any
- Check and approval of Working Drawings together with As-built Drawings
- Check and approval of construction program and method prepared by the Contractor from time to time
- Inspection and witness of tests of manufactures equipment at the factory for mechanical works before shipment, and issuance of necessary certificates on inspection
- Check and approval of the Contractor's progress billings
- Quantity survey of completed works
- Interim measures of partially completed works compiled as "measurement sheets" and "photo documentation" as an evidence for interim payment certificates, if any
- Progress monitoring and reports (daily, weekly and monthly)
- Acceptance of completed works in accordance with construction practices and civil engineering standards
- Final inspection and completion tests of completed works
- Continuous records and documentation

(d) Post-construction (Maintenance period=Defect Liability Period)

- Mutual check for defect check & correction
- Checking for Handing-over of completed works
- Checking for commissioning of completed works
- Checking for final payment and release of retention money
- Evaluation of works and methods carried out by the Contractor
- Preparation of reports (Project Completion Reports, attachments, etc.)

【Output】

Clarified works items at each stage in construction supervision

(5) Basic Forms for Construction Management and Supervision

The following forms shall be used for construction management and supervision during construction period, in order to fulfill the works successfully.

【Explanation】

(a) List of Forms

DAILY REPORT (for the Contractor)

DAILY REPORT (the Project Manager/ Technical staff)

REQUEST FOR INSPECTION/ APPROVAL (Contractor => PM => Contractor)

SITE INSTRUCTION (PM => Contractor)

REQUEST FOR INFORMATION (PM => Contractor) (Contractor => PM)

MEASUREMENT SHEET (Contractor => PM)

WEATHER INFORMATION (Contractor => PM, with assistance of TMA for instruments)

(b) Usage of Forms

Refer to Work flow of each construction stages (succeeding pages i.e. 3-8, 3-V, 3-W, 3-X, 3-Y, and 3-Z)

【Output】

Clarified works items at each stage in construction supervision

(6) Contractor's Submittals

The Contractor shall submit various statements and reports during construction period, in order to fulfill the works successfully.

【Explanation】

(a) Quality Control

The Contractor shall implement a quality control and assurance system in compliance with the requirements of the Contract. Details of all procedures and compliance documents shall be submitted to the Project Manager prior to commencement of design and execution stage.

The detailed statement of a quality control and assurance system shall show the organizations, resources and mechanism that the Contractor proposes to provide quality control of the Works, including the quality of his suppliers and sub-contractors if any. The detailed statement of a quality control and assurance system shall also contain the number of staff responsible for quality control at the site and their qualification duties, a training program of his personnel, working format and form, and procedure of quality control activities related to the daily construction work at the site in collaboration with the Project Manager and staffs of ZIOs and LGAs.

In preparation of the detailed statement of a quality control and assurance system, the quality control sequences, forms and checklist presented herein shall be duly taken into account.

(b) Work Method Statement

Before the Contractor starts work on any permanent or temporary works, he shall submit to the Project Manager for review, comment and approval, the detailed construction method statements. The statements shall contain the following information at least:

- Location and type of construction or installation activity
- Temporary works to be used
- Materials to be used
- Contractor's equipment to be used
- Sequence of operations (with drawings or sketches if required)
- Quality control and testing procedures
- Safety measures to be used and enforced

To make it clear the specification requirements for all necessary inspections and tests to be carried out during construction activity by the Project Manager and the Contractor, the forms and checklists presented herein are prepared.

(c) Monthly, Weekly and Daily Reports

The Contractor shall submit to the Project Manager five (5) sets unless otherwise specified in the Contract, of the monthly, weekly and daily reports at regular intervals and in a form to be agreed with the Project Manager.

1) Monthly Report

The monthly report will contain the following:

- Physical progress of the Works, in detailed form, up to the preceding month and estimated progress for the current month
- Rate of progress based on the Working Programme
- An estimate of payment from the Employer to the Contractor for the current month
- A tabulation of the Contractor's staff at the site, technicians, skilled and unskilled labor employed for the Works in the preceding month
- A tabulation of the Contractor's construction machinery used for the Works, which presents type and specifications, operation hours of each equipment in the preceding month, current situation of each equipment
- Quantities of major items of materials and plant supplied and consumed in the preceding month with inventory of such materials
- Details of all material tests and their results
- Progress photographs
- Safety report
- Weather report (weather details for daily temperature and rainfall are to be obtained from the adjacent meteorological station)
- Information required by the Contractor

2) Weekly Report

The Contractor shall prepare and submit to the Project Manager a weekly report in a format agreed with the Project Manager, covering the following items:

- A detailed list of work proposed for following week
- A summary of progress for the preceding week against the planned
- Records of the Contractor's equipment and labor

3) Daily Report

The Contractor shall prepare and submit to the Project Manager a daily report in a format agreed with the Project Manager and shall contain the following

- A list of work including its measurable progress
- A list of actual daily activities of each work against the schedule
- Record of the Contractor's equipment manpower material and working hours of the day

(d) Photographs

The Contractor shall prepare photo documentation with digital photographs and description showing the monthly progress of the Works and submit them to the Project Manager as part of the Contractor's monthly report.

- At 0%, 50% progress and at substantial completion of the Works, the Contractor shall make arrangements to have photographs taken (from the same location on each occasion) of each section of the Works for submittal to the Project Manager
- Each set of photographs with description/ explanation of works submitted shall contain one photograph at every kilometer along all canals, drains and roads and one photograph of every structure.
- Prints of photographs shall be at least 12cm x 8cm in size, suitably referred and bound in albums of at least A4 size which shall have the date and names of the Works (or sections), the Employer, the Project Manger and the Contractor printed on the cover

- One (1) set of negatives/ electronic photo data and three (3) sets of prints in albums unless otherwise specified in the Contract, shall be submitted to the Project Manager within thirty (30) calendar days at 0%, 50% progress and substantial completion of the Works.

【Output】

Clarified progress conditions of the Works in photo documentation

(7) Testing Operation

The Contractor shall execute quality control test in the manner satisfying the specifications of the Contract, in order to keep the Works in good quality.

【Explanation】

Under the direction of the Project Manager or the designated staff of ZIOs and LGAs, the testing expert of the Contractor shall perform the quality control test in a proper manner and analyze and evaluate the results. His evaluation shall include the suitability of material used, adaptability of earthfill and concrete process and accuracy of the test. The testing apparatus on its frequency shall be also made by the testing expert of the Contractor.

Testing expert of the Contractor shall make sampling of the test materials using labor in accordance with the Technical Specifications of the Contract or as directed by the Project Manager. The Contractor shall record the test results statistically and report to the Project Engineer in weekly and monthly forms to be approved by the Project Manager.

The quality control shall be implemented by applying control standard designated in the specifications. The Project Manager or his staff shall review the results of tests and measurements. If any extraordinary condition if found, appropriate actions shall be ordered to the Contractor.

【Output】

Maintenance of good quality of the Works through testing operation

(8) Basic Workflow (Canal Network Construction)

The basic workflow of construction supervision & management is depicted as follows:

Basic Workflow of Construction Supervision & Management

A-1. Pre-Kick-off Meeting (soon after Signing)
A-2. Kick-off Meeting (soon after Mobilization)

A-3. Establishment of Contractors Base Camp (after Approval)
A-4. Preparation of Project Sign Board(s), Erection after Approval

A-5.Clarification of Bench Marks (BM), Canal Routes, etc. at Site

A-6. Material/ Equipment Approval
A-7. Trial Mix Proportion Calculation

B-1. Site Clearing
B-2. Setting-out of additional BM
B-3. Setting-out of Canal Routes, etc

A-8. Concrete Cube Test Preparation (for crushing test)
A-9. Template/ Formwork Preparation

B-4. Preliminary Excavation
B-5. Setting-Canal Templates
B-6. Pegging & Leveling of Canal Bed EL
B-7. Final Excavation (as specified depth & shape)
B-8. Foundation Treatment, Blinding

A-10. Concrete Cube Test (Crushing) (7 days, 28 days)
Repeat until obtaining specified strength for each concrete type
A-11. Material Approval and Fabrication of Gates, other equipment, if any

Canal Lining

C-0. R-bar / Formwork arrangement
C-1. Base Concrete
C-2. Joint Inspection of Canal Bed EL
C-3. Walling
C-4. Joint finishing
C-5. Backfill w/ Compaction

Related Structures

D-1. R-bar / Formwork arrangement
D-2. Base Concrete
D-3. Joint Inspection of Bed EL
D-4. Walling/ Grooves/ Top slab, etc.
D-5. Transitional Section Works
D-6. Backfill w/ Compaction

E-1. Final Inspection (Dimension & EL., Function)/ E-2. Running Test

E-3. Substantial Take Over/ E-4. Preparation of As-Built Drawings/ E-5. Substantial Completion Certificate
E-6. Demobilization (Removal of base camp & Restoration)

E-7. Defect Liability Period (Correction as per required)
E-8. Final Completion Certificate (Incl. Defect Liability Certificate)

(9) Preparatory Works Stage

The basic approach and workflow of Preparatory Works Stage is depicted as follows:

1) Basic approach

- Confirmation will be made among the PM, ZIO, LGA staff and the local implementation organization (IO/ PC) on the Scope of Works of construction works, design features and basic dimension of the facilities as well as the basic interpretation method of the design drawings and specifications;
- Inspection will be conducted on construction work plan and its contents, scope of works which the contractors and his personnel should be engaged until completion on the basis of the design drawings;
- Confirmation will be made such as on quality assurance methods over construction materials and equipments, the role and responsibility of each organization in the construction management and the document format to secure them;
- Clarification on the approval flow and the personnel responsible for construction implementation; and
- Guidance will be made to both PCs and the Contractor on "safety Management plan" and possibility risk of flooding in the rainy season & typical examples of accidents take place during construction (e.g. the possibility of serious injury of workers due to standing around/ behind heavy equipments) and its prevention measures, so that PCs are to recognize the need for proper safety management on their own. In addition, the guidance will be made to PCs to check the safety plans prepared by contractors adequately.

2) Basic Workflow

A-1. Pre-Kick-off Meeting (after Signing of the Contract, preferably on the same day)

i) Confirmation shall be done on i) the Scope of Works, ii) Role & Responsibility of Zonal Irrigation Office (ZIO), LGA, the Contractor, PC (I/O) during the Construction; Reference clauses from the Contract Doc./ Tender Doc.

Sec V-1 (SCC clause 1, GCC clause 1.1),
Sec III-1 (BDS clause 4, ITB clause 2.1),
Sec IV-4 (GCC clause 5,6,7,8,9,10 and 19),
(Technical Specification clause 111)

ii) The Contractor is requested to submit the following documents on the 1st Site meeting ("Kick-off" meeting)", to be held as soon as their site mobilization:

a) Unconditional letter of acceptance, issued within seven days after offer;
b) Contract performance security;
c) Signed Contract Agreement between the Contractor and LGA Executive Director;
d) Work Plan & Schedule of awarded Works;
e) Quality Control plan; and

f) Safety Control/ Management Plan.

For work plan and schedule: it should consider the nature of the Works and rainy season; including the timing of regular official site meeting, procurement and mobilization of material, labors & heavy equipment (type, nos.), etc.;

Reference clauses from the Contract Doc./ Tender Doc.

Sec V-1 (SCC clause 1, GCC clause 1.1),
Sec V-3 (SCC clause 14),
Sec IV-10 (GCC clause 30),
Sec III-3 (BDS clause13,ITB clause12.3 a) to d)

For Quality Control plan of the Contractor, it should also include procurement of proper & adequate construction materials (based on the Technical Specification, etc.), checked by both the Project Manager & PC members.

The timing of "Request for Inspection/ Approval" from the Contractor to the PM on the major works should be done on regular basis, using the flow chart of Construction.

Reference clauses from the Contract Doc./ Tender Doc.

Sec IV-7,
Sec IV-12,
Sec IV-13 (GCC clause 19,36 to 39and Clause 43.1 and 43.2)

For Safety Control/ Management Plan, it should consider the safety of both the Contractor and Community , especially taking care of schooling hours by avoiding operation of heavy equipments and lorries; and also avoiding any conflict among the villagers and the Contractor;

(Discuss & Confirm will be done among LGA Tender Committee/ Village Executives/ PC members on "Base Camp")

Reference clauses from the Contract Doc./ Tender Doc.

Sec IV-7(GCC clause 22) and Technical Specifications 112)

A-2. Kick-off Meeting (after Mobilization)

Before the Contractor starts work on any permanent or temporary works, he shall submit to the Project Manager for review, comment and approval, the detailed construction method statements. The statements shall contain the following information at least:

- Unconditional letter of acceptance
- Contract performance security
- Materials to be used
- Signed Contract Agreement between the Contractor and LGA Executive Director

- Work Plan & Schedule of awarded Works.
- Quality control and testing procedures; and
- Safety Control/ Management Plan to be used and enforced.

The basic work flow and the timings of "Request for Inspection/ Approval (RFA)" and checklist of required document(s)/ action, from the Contractor to the PM on the major work items at Preparatory Stage is shown below:

	General Flow of Request for Approval (RFA) at Preparatory Works Stage	Check list (**V**: required doc./ Action)			
		A	**B**	**C**	**D**
A-2.	**Kick-off Meeting (after Mobilization)**	V		V	
	⇩ (Spec.)				
A-3.	**Establishment of Contractors Base Camp**	V			V
	(Spec.)				
A-4.	**Preparation of Project Sign Board(s), Erection**	V		V	(V)
	⇩ (Spec.)				
A-5.	**Clarification of Bench Marks (BM), Canal Routes, etc. at Site**			V	
	⇩ (Spec.)				
A-6.	**Material/ Equipment Inspection and Approval**	V		V	
	⇩ (Spec.)				
A-7.	**Trial Mix Proportion Calculation**	V		V	
	⇩ (Spec.)				
A-8.	**Concrete Cube Test Preparation**	V		V	
	⇩ (Spec.)				
A-9.	**Template/ Formwork Preparation**	V		V	
	⇩ (Spec.)				
A-10.	**Concrete Cube Test (Crushing)**	V	V	V	
	(Spec.)				

A: Supporting Doc, (Work Plan/ Spec); **B**: Test Results; **C:**Joint Inspect. **D**: Measure. Sheet w/ Photo Doc. for Payment;

To make it clear the specification requirements for all necessary inspections and tests to be carried out during construction activity by the Project Manager and the Contractor, the forms and checklists presented herein are prepared.

- Location and type of construction or installation activity
- Temporary works to be used
- Materials to be used
- Contractor's equipment to be used
- Work plan/ schedule and Sequence of operations (with drawings or sketches if required)
- Quality control and testing procedures, including Site Management chart (names

and qualification, contacts of the Contractor's Project Manager, the Site Agent and key staff)

- Safety measures to be used and enforced, including the Emergency contact flow chart and checklist

For work plan/ schedule and Sequence of operation, it should consider the nature of the Works and rainy season; including the timing of regular official site meeting, procurement and mobilization of material, labors & heavy equipment (type, nos.), work execution and its procedure, etc.;

For Quality Control plan of the Contractor, it should also include procurement of proper & adequate construction materials (based on the Technical Specification, etc.), checked by both the Project Manager & PC members.

Confirmation on the timings of "Request for Inspection/ Approval" from the Contractor to the PM on the major work items should be done on regular basis, using the flow chart of Construction (table on the previous page and on the following pages).

For Safety Control/ Management Plan, it should consider the safety of both the Contractor and Community, especially taking care of schooling hours by avoiding operation of heavy equipments and lorries; and also avoiding any conflict among the villagers and the Contractor;

(Discussion & Confirmation will be made among LGA Tender Committee/ Village Executives/ PC members on the location of "Base Camp", in prior to the contract signing)

For the detailed inspection and checkpoints of the above documents, also refer to the previous section of "(6) Contractor's Submittals"

Further confirmation will be made on the Official Procedure for design Change, if any, after commencement of the work, in case either the Contractor/ the PM understood some changes need to be considered due to actual site condition, etc.

Reference clauses from the Contract Doc./ Tender Doc.

Sec IV-13(GCC clause 43.1 ad 43.2),
Sec V-3(SCC cluse17, GCC clause 38.1),
Technical Specifications 104 (1to2)

Confirmation will be also made on the "Initial Site Setting-Out" to be conducted by the Contractor, based on Technical Specifications, Drawing, BoQ and instruction by the Project Manager as soon as commencement & in prior to the actual construction.

Reference clauses from the Contract Doc./ Tender Doc.

Sec IV-8 (GCC clause 24),
Sec V-1 (SCC clause 1,GCC clause 1.1)

A-3. Establishment of Contractors Base Camp (after Approval)

Based on a prior agreement between the Project Committee (PC) and the Contractor, under guidance by the Project Manager and technical staff of the LGA, the Contractor shall submit to the Project Manager a Request for Approval (RFA) with attaching a sketch layout of i) their base camp, ii) heavy equipments parking area and iii) stock piling area, etc., including the area of clearing with dimensions. After the approval by the Project Manager, the Contractor shall establish his base camp, etc. at specified location and condition.

A-4. Preparation of Project Sign Board(s), Erection after Approval

Based on the Contract Drawing, the Contractor shall submit to the Project Manager a Request for Approval (RFA) with attaching the Contract drawing of the signboard and its photo(s) showing the sizes and board contents, together with the location of erection. After the approval by the Project Manager, the Contractor shall erect the signboard(s) at specified location. Instead of attaching photo(s), joint inspection shall be conducted.

A-5. Clarification of Bench Marks (BM), Canal Routes, etc. at Site

Based on the request from the Contractor, a joint inspection shall be carried out among the Project Manager, technical staff of the LGA and the Contractor on the existing bench marks (BM), canal routes, etc. at the Site for a smooth implementation of the Works. It is also noted if any gap(s) are identified between the Contract Drawings and the Site condition, the Project Manager shall prepare an instruction/ additional documents for a countermeasure.

A-6. Material/ Equipment Inspection and Approval

The Contractor shall submit to the Project Manager RFA on the approval of the materials/ equipment promptly, before execution of the Works at site.

(a) Concrete Materials

Quality of concrete is highly affected by characteristics and quality of coarse and fine aggregates, thus laboratory tests are essential.

【Explanation】

There are five (5) kinds of materials for concrete, i.e., cement, coarse aggregate, fine aggregate, water, and sometimes admixtures. In case the ordinal Portland cement is used for the construction works, the specific test for the cement would not be required usually. The quality of the concrete would be much affected by the characteristics and quality of coarse and fine aggregate, and hence laboratory tests for the aggregates are recommended. The minimum requirements for those concrete materials are described as follows:

1) Minimum Requirement

a) Water

- Free from impurities such as oil, salts, and organic matter
- If the Project area has salinity problems, "Salinity test result" shall be required for inspection and approval. Test can be done at laboratory of the relevant "Water Basin Office"

b) Fine and Coarse Aggregates

- Well-graded
- Free from impurities such as clay, silt, organic matter and trash
- Having appropriate specific gravity
- Having sufficient durability

2) Recommendable Aggregates for Concrete

The following types of stones are preferable as the concrete aggregates:

- Granite
- Andesite
- Basalt
- Hard sandstone
- Hard lime stone
- gneiss

3) Required Tests for Aggregates

At least the following physical tests for the concrete aggregates are recommended. Its evaluation criteria are also given below as reference:

a) Fine Aggregates

- Specific gravity test (specified range : 2.50 ~ 2.65, material which has a small specific gravity is not suitable)
- Grading analysis (fineness modules : 2.3 ~ 3.1)
- Soundness of aggregate (maximum loss weight due to soundness test using sulfate of natrium : less than 10%)

b) Coarse Aggregates

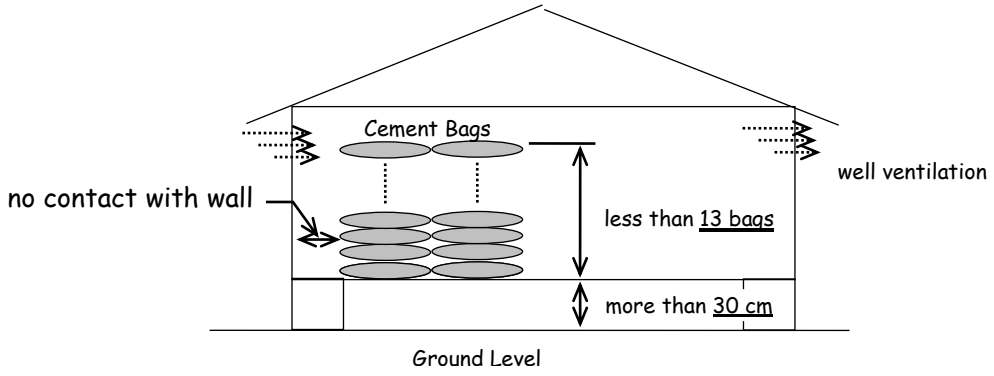
- Specific gravity test (specified range : 2.55 ~ 2.65, material which has a small specific gravity is not suitable)
- Grading analysis (fineness modules : 6 ~ 8)
- Soundness of aggregate (maximum loss weight due to soundness test using sulfate of natrium : less than 12%)

4) Storage of Materials

a) Cement

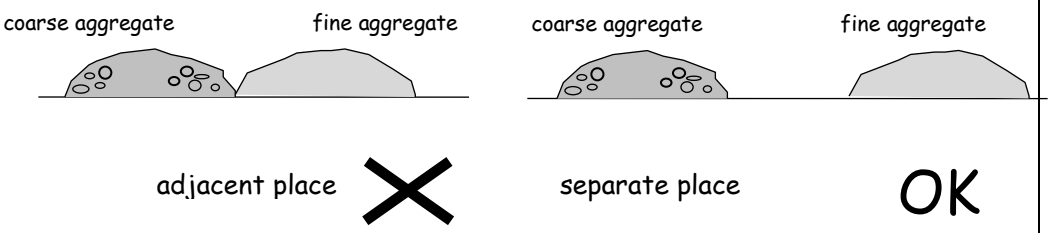
- Cement which was stored for more than 3 months shall not be used;
- Cement bags shall be stored in the well ventilated ware-house having more than 30 cm floor height from the ground;
- Cement bags shall be stored not so as to contact with the walls;
- Cement bags shall not be stocked more than 1.5 m or 13 bags; and

- Cement bags shall be well arranged so as to easily recognize its purchased date.



b) Aggregates

- Aggregate shall be stored separately according to kind, size and grading;

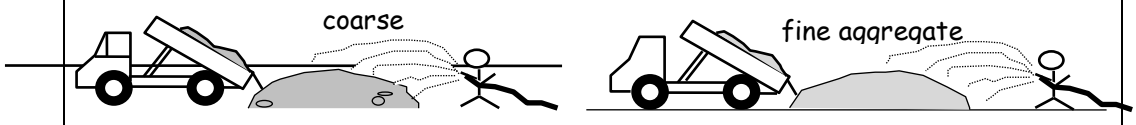


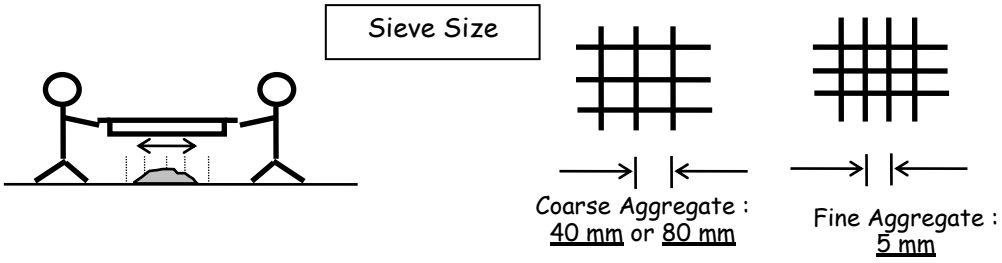
- Aggregate shall be used in a manner to avoid excessive segregation, breakage and contamination with other materials;

- Aggregate shall be stored under a shelter or cover so that the aggregate would not be influenced by the direct sun and/or rainfall;

- Coarse aggregate shall be washed and stored at least 48 hours before use and be allowed to drain to ensure a relative uniform moisture; and

- Fine aggregate shall be washed and stored at least 72 hours before use at a free draining base.



		➢ Aggregate shall be sieved before its use in order to remove a large size aggregate deviated from the specified range. 

【Output】

Good quality concrete by properly controlling materials of concrete

After approval of the Project Manager, the Contractor shall transport and unloaded equipments and materials at the Site at the specified locations and spaces. The inspection method on site after mobilization is also tabulated as follows:

Stage	Inspection Methods (Actual/ Visual)
Material loaded	
Submission of the Specification documents of equipments with certification	-Actual Inspection Method ➢ The specification documents and certificates of all equipments shall be submitted by the Contractor to the PM before they transport the equipments to the site. The PM is responsible for inspection and approval of these documents.
Submission of the Specification documents of materials	-Actual Inspection Method ➢ The specification documents of all materials shall be submitted by the Contractor to the PM before they transport the materials to the site. The PM is responsible for inspection and approval of these documents.
(a) Water	- Actual Inspection Method ➢ Free from impurities such as oil, salts, and organic matter
(b) Cement	- Actual Inspection Method ➢ Inspection: Manufacturer, expiration date, date of manufacture, state (like wheat powder), TBS mark for quality authorization, Storage condition at the Site.
(c) Fine Aggregates	- Actual Inspection Method ➢ Visual: Good: Fine aggregates shall be **Clean**, **Uniform** and **Durable** and shall be natural sand, crushed gravel sand or crushed rock sand, with a maximum diameter of Less than 5mm. Bad: Mica, shale, coal or other laminar, soft or porous materials. Also bad if it contains iron pyrites and/ or iron oxides. ➢ Squeezing: Squeeze the moistened sand by hand. When you open the hand, it is not good sand if the sand adhere to the hand.
(d) Coarse Aggregates	- Actual Inspection Method ➢ Visual: Good : Hard & durable crushed rock, crushed gravel and/ or natural gravel. Bad: coals, other soft or porous material, and/ or contains organic matter ➢ Make sure small holes/ voids and or cracks are Not observed on stone surface ().
(e) Steel Reinforcement	- Actual Inspection Method ➢ Visual : Clean, and no corrosion/ rust nor oil

No. (Namba)		Check Items (Kuangalia Vifaa)		Evaluation (Tathmini)	
(1)	**Construction Materials Check**				
	(a)	Water is free from impurities and not contaminated (Maji kwa ajili ya uchanganyaji wa zege ni masafi)		OK (Ndio)	NO (Hapana)
	(b)	Cement are Portland cements, with "tbs" mark		OK (Ndio)	NO (Hapana)
	(c)	Sand is **Clean and Uniform** made of natural sand or crushed rock sand, with a maximum diameter of Less than 5mm		OK (Ndio)	NO (Hapana)
	(d)	Coarse Aggregate is Hard & durable crushed rock, crushed gravel and/ or natural gravel, maximum size of 40mm	 	OK (Ndio)	NO (Hapana)
	(e)	Reinforcement Steel is Clean, and no corrosion/ rust nor oil with specified size & shape, attached with certificate from supplier(s)		OK (Ndio)	NO (Hapana)
	(f)	Stones are free from crack/seam with size of 30 - 40cm for Gabion, 10 – 20 cm for Stone masonry work (less than 2/3 of wall thickness)		OK (Ndio)	NO (Hapana)

A-7. Trial Mix Proportion Calculation

Prior to commencement of the concrete works, the design of concrete mixes shall be carried out by the Contractor laboratory team. For small scale irrigation projects with relatively small structures, it can be jointly done with the Contractor, the Project Manager and the technical staff of LGA. A general procedure of concrete mix design is as follows (Reference Manual of Construction Supervision for Small Scale Irrigation

Development Project (referred to as "Manual"), June 2014, SSIDP, pp 5-22 ~ 5-25):

No. | **Items to be Determined** | **Standard Value/Reference**

1 — Determination of W/C (water-cement ratio) → the standard value is as follows:

2 — Determination of Maximum Size of Aggregate → the standard value is as follows:

Type of Concrete	Compressive Strength (28 days) (kg/cm2)	Specified Maximum Size of Aggregates (mm)	Specified Maximum Water/Cement ratio (%)	Approx. Cement Content (kg/m3)
AA (Reinforced Concrete)	255	12	50	350
A (Reinforced Concrete)	255	20	50	300
B (Mass Concrete)	204	40	50	225
C (Mass Concrete)	153	40	55	200
D (Blinding Concrete)	-	40	60	150

3 — Determination of Slump Height

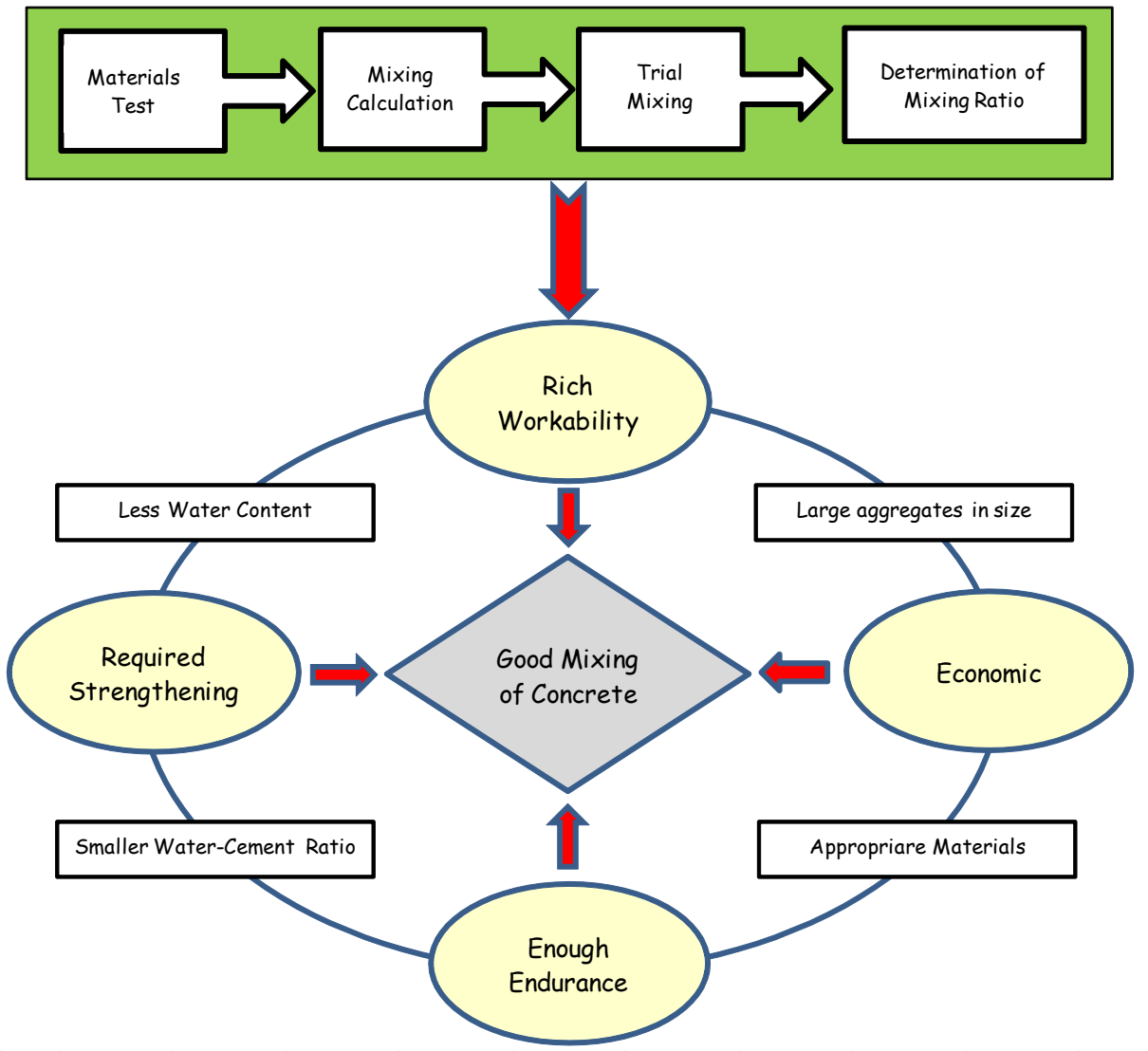
Type of Concrete	Slump (cm)	
AA	10.0	
A	10.0	
B	8.0	
C	6.0	
D	6.0	

4 ~ 6 — Assumption of Fine aggregate, Air content and Unit Water wight → see the following table **(to be adjusted by mixing test)**

Type of Concrete	Fine Aggregate Content	Air Content	Unit Water Weight (kg/ m^3-Concrete)	Remarks (Reference: Irrigation Manual Module 13, FAO, 2001)
AA (Reinforced Concrete)	35 %	1.0 %	175	Grade 25; Nominal C. Ag: Size. 10
A (Reinforced Concrete)	35 %	1.0 %	150	Grade 25; Nominal C. Ag: Size .20
B (Mass Concrete)	36 %	1.0 %	113	Grade 20; Nominal C. Ag: Size: 40
C (Mass Concrete)	36 %	1.0 %	100	Grade 15; Nominal C. Ag: Size: 40
D (Blinding Concrete)	36 %	1.0 %	75	Grade 10; Nominal C. Ag: Size: 40

Adjustment based on the fineness modules : standard = **2.75**

See "Manual" pp.5-23 ~ 5-25 for details, especially for relatively large structures such as headworks



1) Example Calculation at site level:

a) Standard used Bucket Size (full):

Average inner diameter (top & bottom): (25.4+23.0)/2=24.2 cm = 0.242 m, R=0.121m

Average Area: $A = \pi R^2 = 0.121 \times 0.121 \times 3.1416 = 0.046\ m^2$

Inner Height: H = 27.5 cm = 0.275 m

Inner Volume: $V = A \times H = 0.046 \times 0.275 = 0.01265\ m^3 = 12.65$ litre

b) Trial mix proportion design for small mixer at site:

Based on FAO Grade 25 and nominal aggregate size 40, with Hand compaction

$$c/w = \frac{\text{mass of cement (kg)}}{\text{mass of water (kg)}}$$

NOTE: For conversion to W/C, 1/ (c/w)

Concrete mix proportions by volume batching for different concrete grades

Grade	Nominal stone size (m)	Compac -tion	c/w ratio	Mix proportions per bag of cement			Materials per m³ of concrete			Yield per bag
				Sand (m³)	Stone (m³)	Water (litres)	Cement (bags)	Sand (m³)	Stone (m³)	(litres)
25	40	H	1.85	0.06	0.12	21.5	7.6	0.50	0.89	130
		V	1.80	0.06	0.14	21.5	6.8	0.48	0.95	145
	20	H	1.85	0.07	0.10	21.0	8.0	0.59	0.76	125
		V	1.80	0.07	0.11	21.5	7.4	0.57	0.82	135
	10	H	1.85	0.07	0.07	21.0	8.9	0.71	0.58	110
		V	1.80	0.08	0.08	21.0	8.3	0.72	0.62	120

H = compaction by hand (rodding and tamping).

V = compaction by vibration (internal pokers).

Source: FAO Irrigation manual 13 Construction of Irrigation Schemes, 2001 pp. 21

W/C = 1/ 1.85 = 0.54

Assume density of cement: 50kg-bag = 40 Litre; 50 ÷ 40 = 1.25 kg/ Litre

1 bucket of Cement in weight: 12.65 Litre x 1.25 kg/ Litre = 15.81 kg

Required Water in weight: 15.81 kg x 0.54 = 8.539 kg,

In volume: 8.539 Litre or 0.008539 m^3

Determining the trial water depth (d) in standard bucket:

d = 0.008539 ÷ 0.046 (Average area of bucket) = 0.185 m or 18.5 cm

Determining the number of buckets for Sand & C. aggregates versus 1 bucket of Cement:

Mix proportion per bag of Cement For Grade 25, Nominal Ag. Size 40 in m^3 of material:

Cement: 1 bags = 1 x 40 Litre/ 1000 = 0.04 m3

Sand: 0.06 m3; Proportion to Cement = 0.06 ÷0.04 = 1.5, say 1.5 bucket

C. Aggregates: 0.12 m3; Proportion to Cement = 0.12 ÷0.04 = 3.0, say 3 bucket

Therefore, trial mix can be done at site, together with checking the slump test result

For Example (for the above standard bucket is used): Slump to be 5 to 15 cm (average 10 cm) for Grade 25-40

W/C	Cement (Bucket)	Water (Bucket-depth)	Sand	C. Aggregate	Remarks Water (Litre)
0.54	1	18.5 cm	1.5	3	8.54 Litre
0.53	1	18.2 cm	1.5	3	8.38 Litre
0.52	1	17.8 cm	1.5	3	8.22 Litre
0.51	1	17.5 cm	1.5	3	8.06 Litre
0.50	1	17.2 cm	1.5	3	7.91 Litre
0.49	1	16.8 cm	1.5	3	7.75 Litre

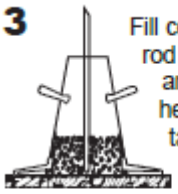
Slump Test Procedure (to be conducted within 2 and 1/2 minutes): Source http://gatesconcreteforms.com/wp-content/uploads/2014/10/slumpTest1.pdf

Gates CONCRETE FORMING SYSTEMS

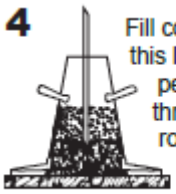
SLUMP TEST PROCEDURE
(FIELD TESTING)

1 To obtain a representative sample, take samples from two or more regular intervals throughout the discharge of the mixer or truck. DO NOT take samples at the beginning or the end of the discharge.

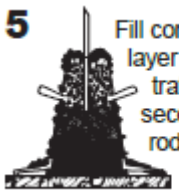
2 Dampen inside of cone and place it on a smooth, moist, non-absorbent, level surface large enough to accommodate both the slumped concrete and the slump cone. Stand or, foot pieces throughout the test procedure to hold the cone firmly in place.

3 

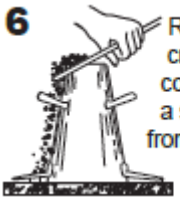
Fill cone 1/3 full by volume and rod 25 times with 5/8-inch-diameter x 24-inch-long hemispherical tip steel tamping rod. (This is a specification requirement which will produce non-standard results unless followed exactly.) Distribute rodding evenly over the entire cross section of the sample.

4 

Fill cone 2/3 full by volume. Rod this layer 25 times with rod penetrating into, but not through first layer. Distribute rodding evenly over the entire cross section of the layer.

5 

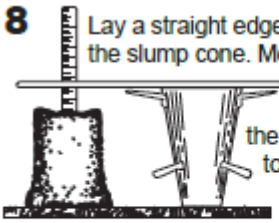
Fill cone to overflowing. Rod this layer 25 times with rod penetrating into but not through, second layer. Distribute rodding evenly over the entire cross section of this layer.

6 

Remove the excess concrete from the top of the cone, using tamping rod as a screed. Clean overflow from base of cone.

7 

Immediately lift cone vertically with slow, even motion. Do not jar the concrete or tilt the cone during this process. Invert the withdrawn cone, and place next to, but not touching the slumped concrete. (Perform in 5-10 seconds with no lateral or torsional motion.)

8 

Lay a straight edge across the top of the slump cone. Measure the amount of slump in inches from the bottom of the straight edge to the top of the slumped concrete at a point over the original center of the base. The slump operation shall be completed in a maximum elapsed time of 2 1/2 minutes. Discard concrete. DO NOT use in any other tests.

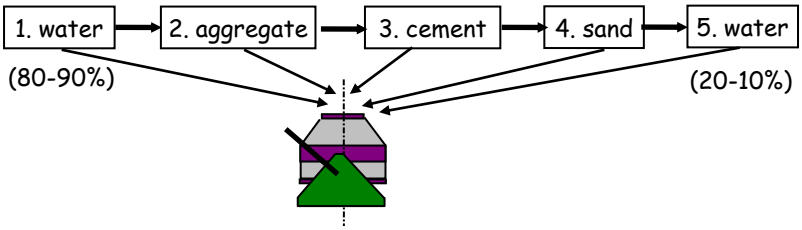
Source: Gates Concrete form system

Remarks: Based on ISO 4109 1980

After the calculation, the trial mix test using mixer and slump test equipment can be started from the upper water content to lower. The standard mixing procedure is as shown below. If the slump is too big, reduce the w/c and redo the next trial. If good result have been obtained, go to next sub-step "**G-8 Concrete Cube Test Preparation**"

Reference for commonly used type of concrete (source: FAO)

- Filling : 3 minutes
- Mixing : 2 minutes
- Unloading : 3 minutes
- Extra : 2 minutes



Concrete mix proportions by volume batching for different concrete grades

Grade	Nominal stone size (m)	Compac -tion	c/w ratio	Mix proportions per bag of cement			Materials per m^3 of concrete			Yield per bag
				Sand (m^3)	Stone (m^3)	Water (litres)	Cement (bags)	Sand (m^3)	Stone (m^3)	(litres)
15	40	H	1.45	0.09	0.15	26.5	5.9	0.55	0.88	170
		V	1.42	0.09	0.18	27.0	5.4	0.52	0.91	185
	20	H	1.45	0.09	0.12	26.5	6.2	0.65	0.75	160
		V	1.42	0.10	0.14	27.0	5.8	0.62	0.82	170
20	40	H	1.72	0.07	0.13	23.0	7.0	0.51	0.88	140
		V	1.67	0.07	0.15	23.0	6.3	0.49	0.95	160
	20	H	1.72	0.08	0.10	22.5	7.4	0.61	0.76	135
		V	1.67	0.08	0.12	23.0	6.8	0.58	0.82	145
	10	H	1.72	0.08	0.07	22.5	8.2	0.73	0.58	120
		V	1.67	0.09	0.08	23.0	7.7	0.74	0.62	130
25	40	H	1.85	0.06	0.12	21.5	7.6	0.50	0.89	130
		V	1.80	0.06	0.14	21.5	6.8	0.48	0.95	145
	20	H	1.85	0.07	0.10	21.0	8.0	0.59	0.76	125
		V	1.80	0.07	0.11	21.5	7.4	0.57	0.82	135
	10	H	1.85	0.07	0.07	21.0	8.9	0.71	0.58	110
		V	1.80	0.08	0.08	21.0	8.3	0.72	0.62	120

H = compaction by hand (rodding and tamping).

V = compaction by vibration (internal pokers).

Source: FAO Irrigation manual 13 Construction of Irrigation Schemes, 2001 pp. 21 Table 7.

Description of the various concrete grades

Grade	Description	Purpose
15	Unreinforced concrete	Large foundations for non-vibrating machinery; dams and weirs; bridge piers abutments and wing walls. Floors in domestic buildings to receive light toppings with surface finishing
20	Standard structural-grade concrete	General reinforced concrete construction in buildings; small bridges, culverts and silos; machine foundations; unrendered walls above ground; single course domestic and office floors on the ground; base course of light-loaded floors on ground to receive toppings
25	High-grade structural concrete	Precast concrete fence posts and panels; machine foundations subject to vibration or shock; minimum for water-tight concrete and domestic driveways; light duty single course floors on ground (no trucking)

Source: FAO Irrigation manual 13 Construction of Irrigation Schemes, 2001 pp. 21 Table 8.

A-8. Concrete Cube Test Preparation

After approval of trial mix proportion by the Project Manager, the Contractor shall start the casting of test cubes based on the approved trial mix proportion to verify the specified strength of the concrete for each concrete type as per drawings and BoQ. A set of standard steel casts with dimensions of B:15cm x L:15cm x H:15cm shall be used

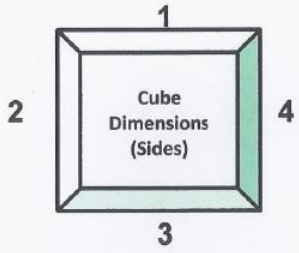
for casting. For each concrete type, at least 6 (six) pieces will be casted i.e., 3 (three) for 7 days strength test, another 3 (three) for the 28 days strength test. Another 3 (three) is added for 14 days strength test as per instruction by the PM.

Cast prepared by wooden frame (9 pieces)

If handmade, all dimension are to be inspected

CUBES DIMENSION CONTROL

Date: 21.11.2016



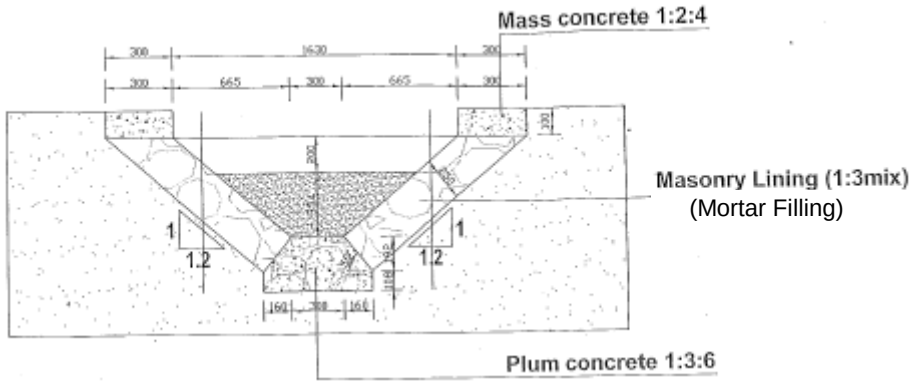
Due to lack of squareness of the Timber Mould Cubes, below is the table Showing the average size of the cubes with average surface area for reference

Cube No.	Side 1 (mm)	Side 3 (mm)	Average Side Length (mm)	Side 2 (mm)	Side 4 (mm)	Average Side Length (mm)	Surface Area(mm^2)
01	153.4	154.3	**153.85**	150.5	152.4	**151.45**	**23300.58**
02	152.4	155.2	**153.80**	150.2	151.6	**150.90**	**23208.42**

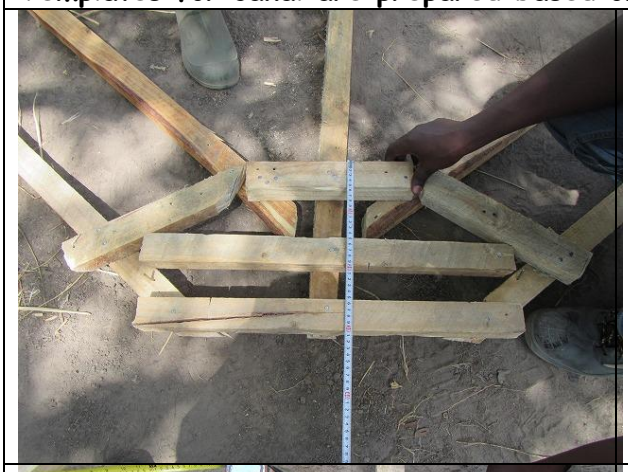
Example of dimension inspection result to calculate the surface area of casted concrete if the Contractor be allowed to use other type of casts under the approval of the PM.

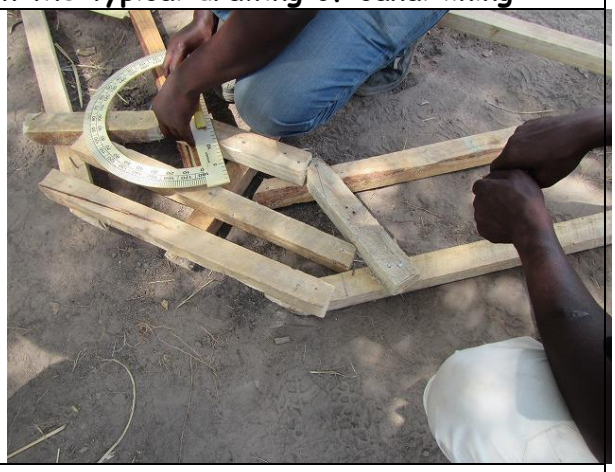
A-9. Template/ Formwork Preparation

Based on the drawing, the Contractor shall prepare the templates for canal excavation and lining works, as well as side formworks for concrete works. The number of templates and formworks should be carefully discussed and determined among the Contractor, based on the daily progress of the work, but at least 6 (six) sets of templates (4 for excavation of 3 advancing sections, 2 for concreting and walling) and 6 to 12 pairs of side formworks if the length of 4 m long are used (6 pairs covers about 25 m). It is also noted that 2 (two) to 4 (four) pairs of "end stopper formwork" shall be prepared for properly stopping the end of concrete sections to avoid flowing out/ segregation of concrete. A joint inspection shall be made on the dimension and the numbers of templates/ formworks based on RFA from the Contractor, along with the proposed schedule/ progress of the daily excavation/ concreting/ walling. After the approved by the Project Manager, those templates and formworks can be used for the canal Works.



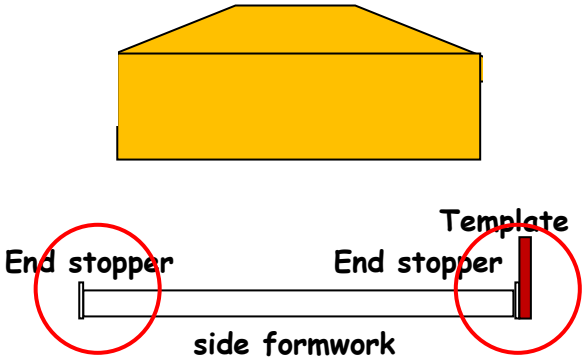
Templates for canal are prepared based on the typical drawing of canal lining





Correction is made after inspection

Sample of "end stopper" based on the shape of base concrete



Introduction of "end stopper"

Sample of failure w/out stopper (thin base concrete (left), thick (right))

A-10. Concrete Cube Test (Crushing)

The test pieces of the casted concrete cubes shall be cured right after hardened by soaking into water and the crushing test shall be conducted at the specified/ agreed test laboratory, such as regional TANROAD, on the specified date of crushing. The test result shall be submitted by the Contractor to the Project Manager for his approval.

309 Concrete Classes

(1) The classes of concrete to be used in the Works shall be as shown on the Drawings, Bills of Quantities or as directed by the Project Manager. For each class of concrete the characteristic 28-day crushing strengths, when tested in accordance with the following clauses, shall be as set out in the table below, the 7-day strengths, and minimum cement content shall be used only as a guide.

Class of Concrete	Max Aggregate Size (mm)	Characteristic Strength N/mm²		Minimum cement content	Minimum strength for trial mix
		28 day	7 day	kg/m³	N/mm²
AA (reinforced concrete)	12	25	18	350	32.5
A (reinforced concrete)	20	25	18	300	32.5
B (mass concrete)	40	20	14	225	27.5
C (mass concrete)	40	15	10	200	20
D (blinding concrete)	40	-	-	150	-

(2) The term characteristic strength means the value of the strength of concrete below which not more than five per cent (5%) of the test results fall.

(10) Site Setting & Foundation Works Stage

The basic approach and workflow of Site Setting & Foundation Works Stage is depicted as follows:

1) Basic approach

- Confirmation will be made on leveling, elevation setting-out at the structure foundation, appropriate setting and installation procedures of formwork; and
- Since it is difficult at the foundation work with a visual confirmation after its completion, confirmation will be made on typical foundation works such as appropriate placement of the foundation concrete and its leveling, inspection method on pilings reaching the specified firm rock foundation/ layer, adequate installation of reinforcement bars and its covers, strength test of the flexible container, etc., including, photo shooting and documentation methods and techniques (showing the dimensions of the invisible side explicitly, introduction of "fixed-point observation method" for photo documentation).

2) Basic Workflow

The basic work flow and the timings of "Request for Inspection/ Approval (RFA)" and checklist of required document(s)/ action, from the Contractor to the PM on the major work items at Site Setting & Foundation Works Stage is shown below:

	General Flow of Request for Approval (RFA) at Site Setting & Foundation Works Stage	Check list (V: required doc./ Action)			
		A	B	C	D
B-1.	**Site Clearing**	V		V	V
	⇩ (Spec.)				
B-2.	**Setting-out of additional BM**	V		V	
	⇩ (Spec.)				
B-3.	**Setting-out of Canal Routes, etc**	V		V	V
	⇩ (Spec.)				
B-4.	**Preliminary Excavation** (RFA Not required)				
	⇩ (Spec.)				
B-5.	**Pegging & Leveling of Canal Bed EL**	V		V	V
	⇩ (Spec.)				
B-6.	**Setting of Canal Templates**	V		V	
	⇩ (Spec.)				
B-7.	**Final Excavation**	V		V	V
	⇩ (Spec.)				
B-8.	**Foundation Treatment** (filling with specified stones, if required), **before placing blinding concrete, esp. Structure base& its D/S**	V	V	V	V
	(Spec.)				

A: Supporting Doc, (Work Plan/ Spec); **B**:Test Results; **C**:Joint Inspect. **D**: Measure. Sheet w/ Photo Doc. for Payment;

B-1. Site Clearing

The Contractor shall implement site checking, especially the routes of canal, farm road, drainage, etc., as specified in the drawings and BoQ, if necessary together with the Project Manager and LGA technicians, PC members (RFA will be sent). After the

confirmation of the routes and specified width, the Contractor submit the RFA for clearing, with attachment of the measurements & sketches clearing showing quantities of the Works. Through approval of the Project Manager, the site clearing shall be conducted.

B-2. Setting-out of additional BM

The Contractor shall provide and install additional bench marks in accordance with the technical specification at a interval of 50m. It is noted that the bench marks should be installed along the canal routes, not interfering by the road, i.e., avoid any damage by vehicles and motorbikes, heavy equipments during the construction. The elevation of each bench mark shall be determined by the joint survey work, with the Project manager, based on the authorized existing bench mark which is the basis of the contract drawings.

<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Authorized Bench Mark</td><td>Damaged Bench Mark due to improper location (Never use any more)</td></tr>
<tr><td> 
</td><td>STANDARD DIMENSION OF BM CONCRETE STAKE

SHAPE: Rectangular or cylindar
Vertical length: 250-300mm
x Horizontal length: 250-300mm
x Height: 300-400mm; or
Dia. 300mm x Height: 300-400mm
R-Bar size & length: R-10, L=250mm</td></tr>
</table>

B-3. Setting-out of Canal Routes, etc

Setting-out of the canal routes, etc., shall be conducted along the center line of the canal, farm road, etc., by pegging and leveling of the ground elevation. The result shall be compared with the profiles of canal (bed elevation), road (road top elevation), etc. for determination of the excavation/ embankment volume. The Contractor shall submit the

RFA with measurement/ calculation sheets to the Project Manager for his/ her approval, in prior to the Works.

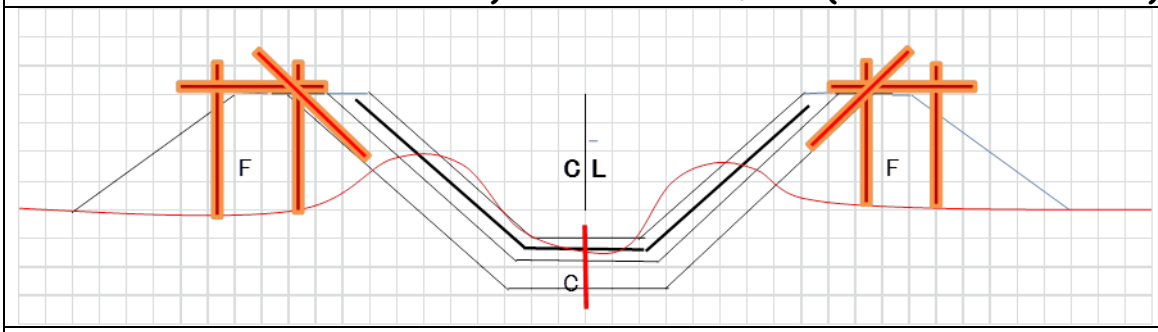

B-4. Preliminary Excavation

The Contractor shall start preliminary excavation, deep enough for setting the approved templates along the canal route(s).

B-5. Pegging & Leveling of Canal Bed EL & B-6. Setting-Canal Templates

The Contractor shall implement setting-out using the templates along the canal route(s), for both inspection of i) excavation works and ii) canal lining works, so that the top of base concrete (canal bed) shall be set at the specified elevation as per the drawings (canal profile). It is noted that when setting the template, it should be set at specified chainages and inter-sectional points (IPs) where canal route changes direction, then set at up-right using a level gauge. Joint inspection shall be carried out with pegging for setting at correct position and elevations. After two consecutive templates are set correctly, strings will be set between two consecutive templates at proper location, such as top of excavation levels, top of base concrete levels, and the bottom and top of the wall, etc. The final excavation shall be carried out based on the above condition.


Two consecutive Templates shall be installed at specified chainages and IPs. They have been also set together with 6 – 8 strings, showing lines of lining faces (correct canal bed ELs. And wall lines) and excavation faces (avoid over-excavation)



Alternative setting-out by installation of a pair of hinges/ batter boards showing slanted excavation lines and elevation of the embankment (earth-filling)/ canal top

EXTENSION OF USSOKE MLIMANI IRRIGATION SCHEME

CONTRACT NO.: LGA/122/2016/2017/W/20

REQUEST FOR INSPECTION OR APPROVAL

REQUEST NO.: 02 (DATE: 09.11.2016)

ITEM: SC2 CANAL JOINT SURVEY CONDUCTING

DESCRIPTION (Briefly)

– REQUEST FOR CONDUCTING THE JOINT SURVEY ~~FOR~~ FOR CHECKING THE ELEVATION OF CANAL BED LEVELS VERSUS THE DESIGN IN THE CONTRACT SO THAT PLUM CONCRETE CAN START TO BE CASTED ASAP.

LOCATION: SC2 CANAL AREA, USSOKE PROJECT

DATE & TIME READY: 11/11/2016, AT 0800 AM.

SIGNATURE OF CONTRACTOR:

RECEIVED BY ENGINEER ON:

[illegible] LTD.
Civil - Building Contractors
11 NOV 2016
P.O. Box 1182, SHINYANGA
TIN: [illegible]
VRN: [illegible]

EXTENSION OF USSOKE MLIMANI IRRIGATION SCHEME

CONTRACT NO.: LGA/122/2016/2017/W/20

MEASUREMENT FORM

Sheet No. 02

ITEM NO.	CALCULATIONS	UNIT	OUTPUT	TOTAL OUTPUT

DATA PRESENTATION SC2(0+300-475)

CHG	DESIGN LEVEL	CURRENT PEG LEVEL	DEVIATION
300	1166.07	1166.07	0
325	1166.07	1166.05	-0.02
350	1166.07	1166.03	-0.04
375	1166.06	1166.01	-0.05
400	1164.86	1165.99	+1.13
425	1164.86	1165.97	+1.11
450	1164.86	1165.95	+1.09
475	1164.85	1165.93	+1.08

REMARKS:

1. There is a change of slope from 0.07% to 0.08%.
2. Omission of Drop structure at chg 0+400 as a result of changing the slope.
3. These changes are awaiting the PMs approval because they were Verbally instructed ie, Canal slope change & omission of drop str.
4. Attachment to Instruction No. 02

OUTPUT CARRED FORWARD OR PAGE TOTAL

SIGNED BY: MARWA GORDON

M and A ENGINEERING LTD

FOR CONTRACTING CONTRACTORS

JOSEPH BAHATI

SIGNED BY:

PROJECT MANAGER / ENGINEER

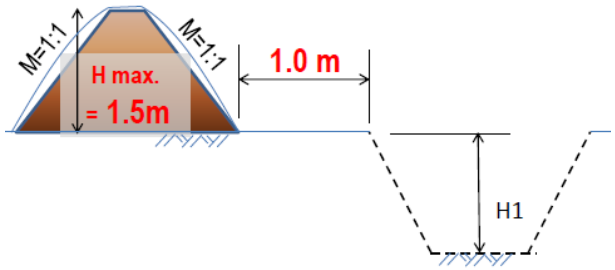
Reinforcement bars (D12mm, 40cm length) are installed at an interval of 20m/ 25m

B-7. Final Excavation

(a) canal Excavation

The Contractor shall conduct the final excavation guided by the consecutive templates and strings as guide.

Final excavation been carried out. Excavated material shall be stock piled as above



Excavated material shall be pushed aside from the excavated trench in accordance with trench depth, to maintain a safety distance to avoid i) slope failure due to additional load on the trench shoulder (sliding angle may be 60 – 45 degree); ii) return of soil back to trench (esp. due to rainfall); and allow workers to move along the canal safely and efficiently.

The standard slope gradient of excavation is indicated in the following table and if the soil condition in the site is different with the design condition, an application of this standard value or another counter measure such as slope protection and/or lining shall be considered for the excavation slope:

Table 5.1 Standard Slope Gradient based on Soil Type

Soil Type		Cutting Height	Standard Slope Gradient
Hard Rock			1 : 0.3 ~ 1 : 0.8
Soft Rock			1 : 0.5 ~ 1 : 1.2
Sand	not dense and poorly graded		1 : 1.5 ~
Sandy Soil	dense	less than 5 m	1 : 0.8 ~ 1 : 1.0
		5 m ~ 10 m	1 : 1.0 ~ 1 : 1.2
	not dense	less than 5 m	1 : 1.0 ~ 1 : 1.2
		5 m ~ 10 m	1 : 1.2 ~ 1 : 1.5
Sandy Soil mixed with Gravel and/or	dense or well graded	less than 10 m	1 : 0.8 ~ 1 : 1.0
Cobblestone		10 ~ 15 m	1 : 1.0 ~ 1 : 1.2
	not dense or poorly graded	less than 10 m	1 : 1.0 ~ 1 : 1.2
		10 ~ 15 m	1 : 1.2 ~ 1 : 1.5
Clayey Soil		less than 10 m	1 : 0.8 ~ 1 : 1.2
Sandy Soil mixed		less than 5 m	1 : 1.0 ~ 1 : 1.2
with Gravel and/or Cobblestone		5 ~ 10 m	1 : 1.2 ~ 1 : 1.5

【Output】

Excavation works properly executed in accordance with the excavation line shown on the drawings

B-8. Foundation Treatment, Blinding Concrete (if applicable)

During the final excavation works, if any weak/ soft foundation section is identified, the Contractor shall report to the Project Manager for joint inspection and foundation

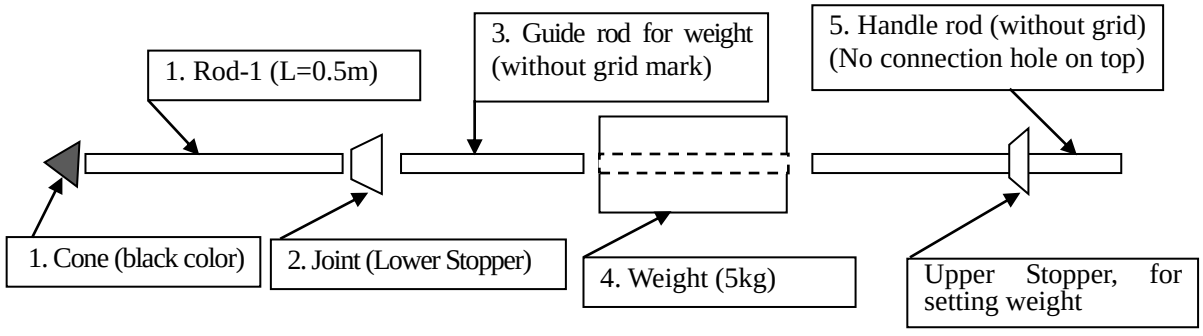
treatment, as per necessity.

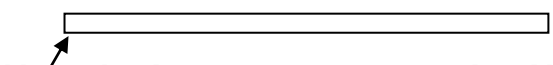
A cone penetration device (cone penetrometer) can be used for the instant check of the bearing capacity of the foundation. Foundation treatment necessity as well as method will be determined by the Project Manager and instruction shall be issued to the Contractor.

	
Damaged section due to soft foundation	**Due to sinking of foundation base concrete deformed and**

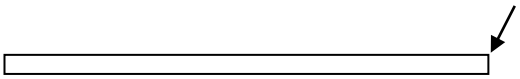
For the confirmation of Foundation condition of the Soil, one of the method is using "Simple Dynamic Cone penetration test device (Nd, number of hitting to penetrate 0.1m)", then convert to "N value" which normally obtained through the Standard Penetration Test (SPT). It will be used to determine the bearing capacity of foundation layer of a structure, trafficability of construction equipment over the foundation layer and structure basis for houses.

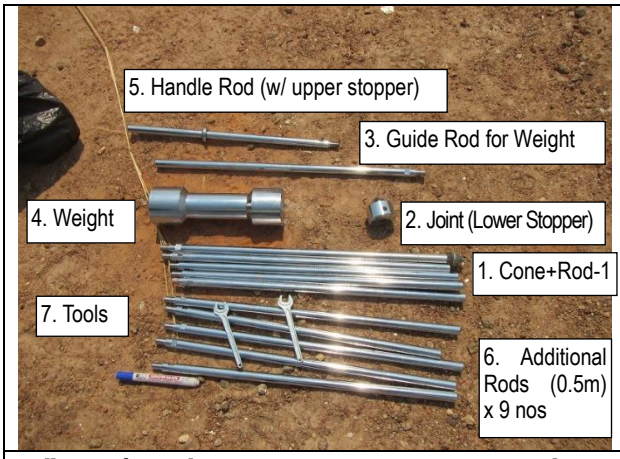
1. Initial Assemble: Set the cone at the lower end of the Rod-1 (L=0.5m), then fix the joint (lower stopper) at the upper end of Rod-1. Set the Guide rod, followed by weight (drive hummer), then connected with handle-rod.





6. Additional rods (L=0.5m) x 9 nos., each rod has 10 grids at an interval of 0.05m





Full Set of Simple Dynamic Cone Penetration Test device for Soil Foundation Test upto 5.0m deep, consists of:
1. Cone + Rod-1 (0.5m); 2. Joint; 3. Guide Rod for Weight;
4. Weight; 5. Handle Rod (items 1-5, One each);
6. Additional Rods (0.5m) x 9 nos., 7. Tools (2 spanners)

The rod length is set from the joint of "cone" and Rod-1 (Not from the tip of cone)
For each rod, marking is set at every 5.0cm
(so, for penetrating 10.0cm means "two marks"

2. Set the device at the selected test point vertically, with cone buried (zero position); Lift- up the drive hummer up to 500mm height (upper stopper). The acceptable error of lifting height is +/- 10mm;
3. Let the drive hummer free fall by gravity and count the number of hitting times (Nd) until it penetrates 100mm (0.1m, two markings of grids);
4. The number of hitting, as Nd value, is recoded to the data sheet;
5. If through driving of hummer penetrated over 100mm (0.1m), following formula shall be used;

   Nd = 100 x (The number of hitting) / (Actual Penetration Depth)

   If Actual Penetration Depth is at 100mm, simply Nd = the number of hitting
6. If the test device penetrates 100mm (0.1m) or more by its own weight without hitting the hummer, wait until it stops and record the penetration depth. In this case, the Nd shall be recorded as "0".

Caution (When to Stop the TEST):

- If it appears that with 10 hitting (Nd=10), the penetration depth is less than 20mm, then stop the operation. This means that the test is not suitable to that soil condition.
- While if the penetration depth is less than 100mm (0.1m) with 50 hitting (Nd=50), the test shall be also stopped by recording the final penetration depth. This also indicates the soil condition is not suitable for the further test (too hard).

NOTE:

a) For an effective driving of the hummer by hitting, make sure that the rod is set vertical with the ground;

b) The maximum penetration depth shall be 5m and stopped since the friction between the rod and the soil layer will lead into miscalculation/ over or under estimate;

c) For the test of a hard clay soil layer, a tri-pod with pulley and chain-block shall be prepared in prior to the test for pulling out the rods against friction;

d) This machine can be used for a simple soil test;

e) For **an accurate investigation/ estimation of bearing capacity** of **the foundation layer**, the **soil types shall be checked by test pit in prior to/ during the test**.

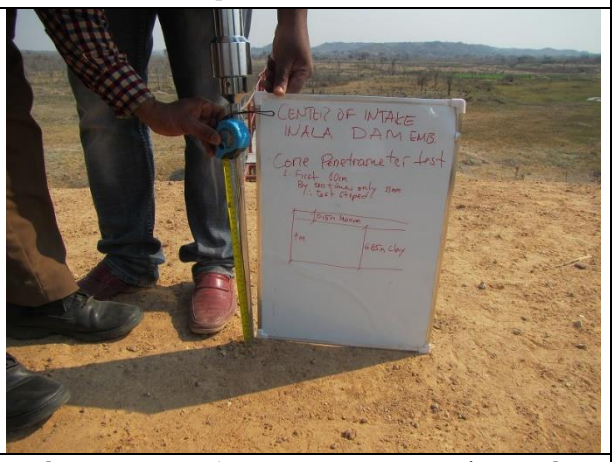
f) **Disadvantage of the test**

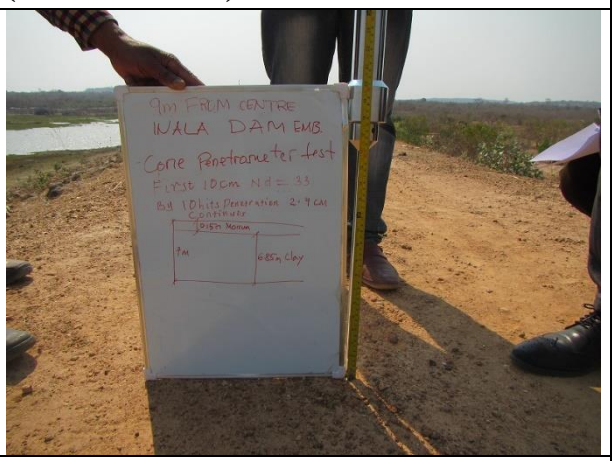
The test is reliable for granular soils such as sand granular/ gravel while Silts and Clays exhibit different driving resistance when dry and moist.

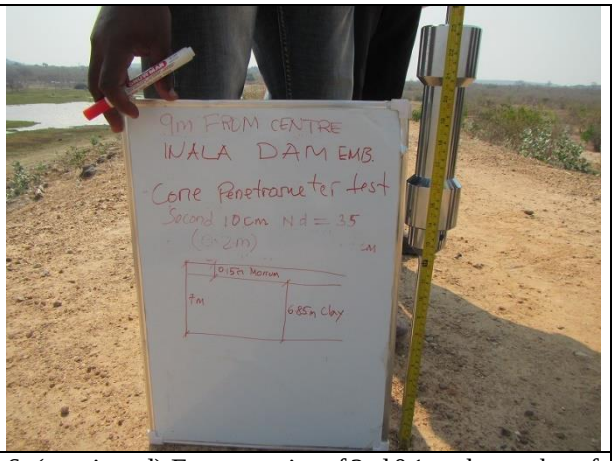
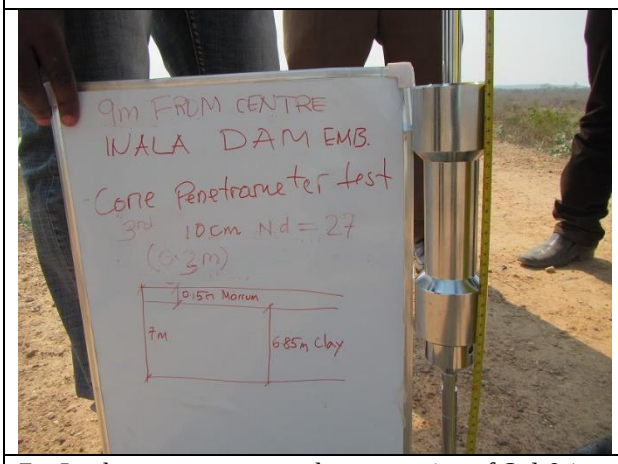
The small diameter of cone penetrometer instrument sometimes cannot give the realistic results, especially for a large scaled structure (use as a preliminary geological sounding).

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Initially, the device is assembled with order of 1 -> 2 -> 3 -> 4 -> 5, using tools for tightening the devices and rods, for accurate test, without losing any parts when device pulled-up after test.</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Make sure each part connected and tightened at joints using tool</td><td>After initial assembly is ready, Bring the device to testing site location
Test Site-1 has been set at the Center of Intake</td></tr>
</table>

Photo Documentation of Trial Test (sample) using Simple Dynamic Cone Penetration device

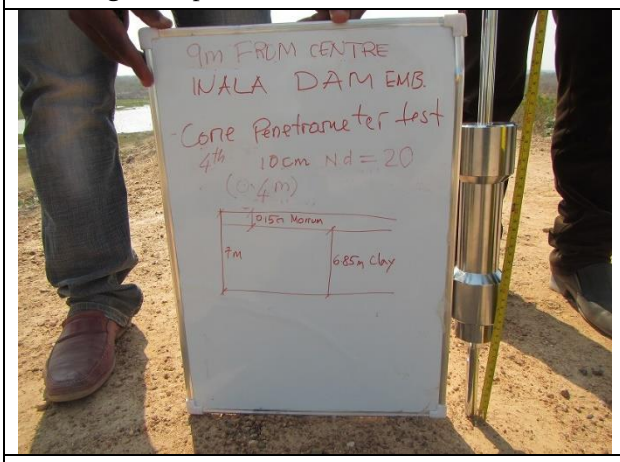
<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>0. Starting position: Prepare the testing foundation surface to be flat and smooth, then Cone shall be stuck into the surface of testing foundation, as “Position “0”” (2210)</td><td>1. Device is held “up-right”, using both hand by holding “Handle”, by Staff-1, then
2. Lift the Weight slowly by Staff-2, up to the lower end of the Handle (stopper) (2227)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>2. (continued) Weight is lifted up to “stopper” of Handle, gently by Staff-2 (DO NOT lift like “hitting up” the stopper) (2229)</td><td>3. Staff-2 Free drop the weight Just releasing it, now “one hit (Nd = 1)” is completed (2228)
Count the number of hitting as Nd, Check the Penetration depth with each hit</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>4. If with “10 hits (Nd=10)”, the penetration depth is less than 2.0 cm, “STOP” the test, since the test layer is NOT Suitable for this Test(2211)</td><td>Trial Test at Site-1 was “STOPPED”, since Nd=10 penetrated only 1.1cm < 2.0cm (2212)
Note: While IF the device sinks 10cm without hitting, evaluate as Nd=0</td></tr>
</table>

	
Trial Test Site has been shifted to Site-2 (2214) (Left 9.0m from the Center of Intake)	Setting up the Device at Test Site-2 (2215)
	
Checking the 1st "10 hits (Nd=10)" at Site-2 (2218) for test suitability, checking penetration depth by each hit	At Site-2, Penetration depth with Nd=10 found to be about 3 cm (more than 2.0 cm), Test continued (suitable to the Test) (2217)
	
4. For Site-2, Record that Nd=10 penetrated 2.9 cm and continue hitting until the first 0.1m penetration depth is achieved (2219)	5. For penetration of first 0.1 m, the number of hitting was 33, thus recorded as Nd=33, for Layer "0 – 0.1m" of the recording sheet (2217)

	
6. After recorded, continue for next 0.1m penetration (2nd 0.1m or 0.1m – 0.2m) (2228)	6. (continued) For penetration of 2nd 0.1 m, the number of hitting was 35, thus recorded as Nd=35 for layer "0.1m – 0.2m" (2232)
	
7. In the same manner the penetration of 3rd 0.1 m conducted, the number of hitting was 27, thus recorded as Nd=35 for layer "0.2m – 0.3m" (2234)	8. After the 3rd layer test, Handle, Weight, Rod for weight and joint shall be removed, remaining Cone+ Rod-1 still, using tools, then one additional rod to be added to Rod-1 (2238)
	
8. (continued) After one rod is added to Rod-1, confirm rod and other parts are tightened firm using tools (2240)	8. (continued) By adding one rod to Rod-1, enable for testing up to 1.0m depth (2240)

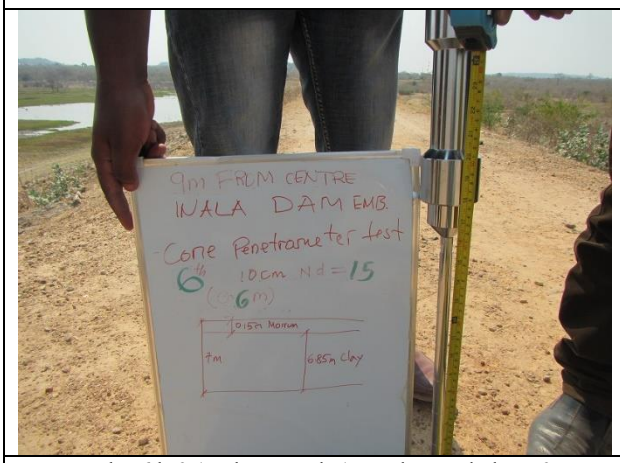
8. (continued) After one rod is added to Rod-1, confirm rod and other parts are tightened firm using tool up to handle (2241)

9. After step-8 is complete, Hold the device up-right then continued for the 4th 0.1m layer "0.3m – 0.4m" (2239)



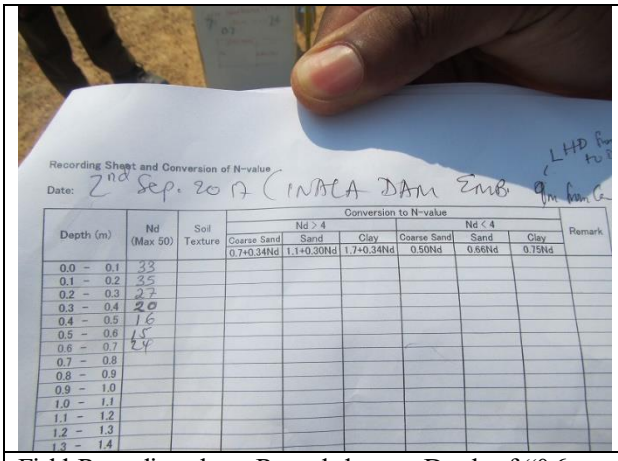
9. (continued) For the 4th 0.1m layer, Nd=20 and recorded to "0.3m – 0.4m" (2243)

10. For the 5th 0.1m layer, Nd=16 and recorded to "0.4m – 0.5m" (2243)



11. For the 6th 0.1m layer, Nd=15 and recorded to "0.5m – 0.6m" (2237)

12. For the 7th 0.1m layer, Nd=24 and recorded to "0.6m – 0.7m" (2245)


Recording Sheet and Conversion of N-value

Date: 2nd Sep. 2017 (INALA DAM Emb. 9m from C

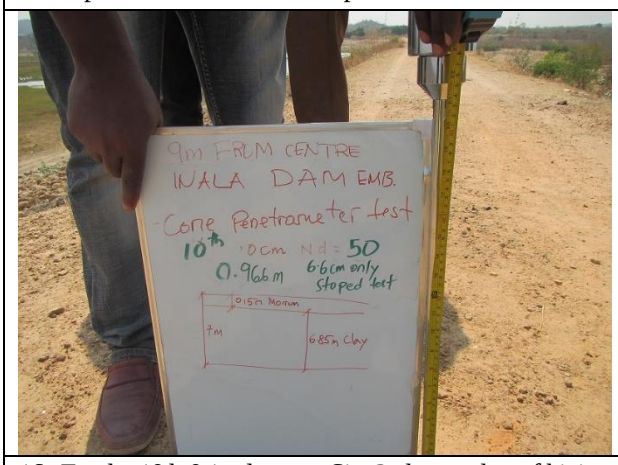
Depth (m)	Nd (Max 50)	Soil Texture	Conversion to N-value						Remark
			Nd > 4			Nd < 4			
			Coarse Sand 0.7+0.34Nd	Sand 1.1+0.30Nd	Clay 1.7+0.34Nd	Coarse Sand 0.50Nd	Sand 0.66Nd	Clay 0.75Nd	
0.0 – 0.1	33								
0.1 – 0.2	35								
0.2 – 0.3	27								
0.3 – 0.4	20								
0.4 – 0.5	16								
0.5 – 0.6	15								
0.6 – 0.7	24								
0.7 – 0.8									
0.8 – 0.9									
0.9 – 1.0									
1.0 – 1.1									
1.1 – 1.2									
1.2 – 1.3									
1.3 – 1.4									

Field Recording sheet. Recorded up to Depth of "0.6m – 0.7m"

13. For the 8th 0.1m layer, Nd=17 and recorded to "0.7m – 0.8m" (2523)

14. After completion of the 8th 0.1m layer, another additional rod to be added, enable for testing up to 1.5m depth, as same manner as Step-8 (2345)

15. For the 9th 0.1m layer, Nd=15 and recorded to "0.8m – 0.9m" (2556)



16. For the 10th 0.1m layer, at Site-2, the number of hitting reached to Nd=50. And recorded Nd=50 for "0.9m – 1.0m". The Test shall be STOPPED if Nd=50 is reached. (2460) - SC1(2561)

16. (continued) Penetrated depth by Nd=50 was measured as 6.6cm and also recorded for Layer "0.9m – 1.0m" (2558)
Test can be continued, if Nd=50 NOT reached.

	
17. If Test is STOPPED and necessary records are made, the device shall be removed by hitting the "Handle Stopper" upward. If penetrated depth is deep, remove the additional rods and re-tightened for easy remove (2361)	17. (continued) If penetrated depth is very deep and removal of device by hitting upward is difficult, a tripod with hook, rope and pully shall be used for as an aid (2363)
	
18. After removal of device completely, the hole should be repaired by filling the hole with surrounding soil and pouring water with compaction (2363))	18. (continued) Completion of Restoration of the hole. If it is important to mark clearly for the future works, use pegs (if no traffic), or supplement pegs (to avoid traffic disturbance) (2361)
	
20. Re-Packing of device (Weight, joint tools)	20. Rod-1 w/ cone, Handle, Rod for weight and additional rod, removing soil completely, then pack (2368)

Evaluation of TEST Result:

OUTPUT/ RESULTS AND INTERPRETATION

The results obtained after the test was shown below:

Nd = 100x (The number of hitting times) / (Actual Settlement Depth)

Simply Use "Nd" = the number of Hitting to penetrate 100mm (= 0.1 m)

Recording Sheet and Conversion of N-value

Date: Sep. 2, 2017 Location: Inala Dam Embankment, 9.0m left from the center of intake

Depth (m)	Nd (Max 50)	Soil Texture	Conversion to N-value						Remark
			Nd > 4			Nd ≤ 4			
			Coarse Sand	Sand	Clay	Coarse Sand	Sand	Clay	
			0.7+0.34Nd	1.1+0.30Nd	1.7+0.34Nd	0.50Nd	0.66Nd	0.75Nd	
0.0 – 0.1	33	Clay			12.9				2.9cm by Nd=10
0.1 – 0.2	35	Clay			13.6				
0.2 – 0.3	27	Clay			10.9				
0.3 – 0.4	20	Clay			8.5				
0.4 – 0.5	16	Clay			7.1				
0.5 – 0.6	15	Clay			6.8				
0.6 – 0.7	24	Clay			9.9				
0.7 – 0.8	17	Clay			7.5				
0.8 – 0.9	15	Clay			6.8				
0.9 – 1.0	50	Clay			18.7				6.6cm by Nd=50
1.0 – 1.1									Test STOPPED
1.1 – 1.2									
1.2 – 1.3									
1.3 – 1.4									
1.4 – 1.5									
1.5 – 1.6									
1.6 – 1.7									
1.7 – 1.8									
1.8 – 1.9									
1.9 – 2.0									
2.0 – 2.1									
2.1 – 2.2									
2.2 – 2.3									

Sub-Step-1a: Conversion to "N value"

Based on the soil type, and Number of Hitting

For Nd > 4:

Coarse sand:
N = 0.70 + 0.34 Nd

Sand:
N = 1.10 + 0.30 Nd

Clay:
N = 1.70 + 0.34 Nd

Depth (m)	Nd (Max 50)	Soil Texture	Conversion		
			Nd > 4		
			Coarse Sand	Sand	Clay
			0.7+0.34Nd	1.1+0.30Nd	1.7+0.34Nd
0.0 – 0.1	33	Clay			12.9
0.1 – 0.2	35	Clay			13.6
0.2 – 0.3	27	Clay			10.9
0.3 – 0.4	20	Clay			8.5
0.4 – 0.5	16	Clay			7.1
0.5 – 0.6	15	Clay			6.8
0.6 – 0.7	24	Clay			9.9
0.7 – 0.8	17	Clay			7.5
0.8 – 0.9	15	Clay			6.8
0.9 – 1.0	50	Clay			18.7

Sub-Step-1b: Conversion to "N value" (continued)

For Nd ≦ 4:

Coarse sand:
N = 0.50 Nd

Sand:
N = 0.66 Nd

Clay:
N = 0.75 Nd

to N-value			Remark
Nd ≦ 4			
Coarse Sand	Sand	Clay	
0.50Nd	0.66Nd	0.75Nd	
			2.9cm by Nd=10

Sub-Step-2: Evaluation of Bearing capacity by N-value - Effective Use method -

CONCEPT:	**The Standard Penetration test (SPT) is a common in situ testing method used to determine the geotechnical engineering properties of subsurface soils;** **It is a simple and inexpensive test to estimate the relative density of soils and approximate shear strength parameters.**
DESCRIPTION AND PROCEDURE (1)	**Standard Penetration Test, SPT, involves driving a standard thick-walled sample tube into the ground at the bottom of a borehole by blows from a slide hammer with standard weight and falling distance.**
DESCRIPTION AND PROCEDURE (2)	**The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 150 mm (6 in) up to a depth of 450 mm (18 in) is recorded.**
DESCRIPTION AND PROCEDURE (3)	**The sum of the number of blows required for the second and third 6 in. of penetration is reported as SPT blow-count value, commonly termed "standard penetration resistance" or the "N-value".**

Correlation between SPT-N value, friction angle, and relative density (Meyerhoff 1956)

SPT N_3 [Blows/0.3 m - 1 ft]	Soil packing	Relative Density [%]	Friction angle [°]
< 4	Very loose	< 20	< 30
4 -10	Loose	20 - 40	30 - 35
10 - 30	Compact	40 - 60	35 - 40
30 - 50	Dense	60 - 80	40 - 45
> 50	Very Dense	> 80	> 45

Note that soil characteristic is different between "sandy soil" and "clayey soil" as shown table below:

Difference of Capacity by Soil Types			
N-value	**Sand**	**Clay**	**Remarks**
0-2	**Very Loose**	**Very Loose**	
2-4		Soft	
4-8	**Loose**	**Medium**	
8-10		Hard	
10-30	Medium		
31-50	**Rather Hard**	**Very hard**	
more	Very Hard		

N-value	Cohesion (t/m²) in case Clay soil	Condition (interpretation by body)
0 - 2	**0 – 1.25**	Possible to **enter** the **Fist**
2 - 4	1.25 – 2.5	Possible to **enter** the **Index Finger**
4 - 8	2.5 - 5	Possible to **enter** the **Thumb**
8 - 15	5 - 10	Possible to **dent** by the **Thump**
15 - 30	10 - 20	Possible to **scratch** with the **Nail of Thumb**

Relation between Structure Type and Required N-value/ Bearing Capacity			
Case/ Structure Type	**Necessary N-value as foundation**		**Recovery Method - If not satisfy the necessary N-value -**
	Sand/ Sandy	Clay	
1. If less than (Necessary to remove)	0 - 2	0 - 1	Excavate & Replace by good soil/ soil cement
2. Foundation of embankment for Small Farm Road (Motor bike)	2	1	Excavate & Replace by good soil/ soil cement + Compaction
3. Foundation of embankment for Trunk Farm Road (Vehicle/ trucks)	10	8	Excavate & Replace by good soil/ soil cement + Compaction
4. Foundation of small structure	10	8	Excavate & Replace by good soil/ soil cement + Compaction
5. Foundation of large structure (necessary to have continuous layer of minimum 3 meters in depth with N-values equal or higher than the value in right column)	20	10	Excavate or use Piling if deeper than 3m (No replacement)
6. Foundation of Small Reservoir Dam (necessary to have continuous layer of minimum 3 meters in depth with N-values equal or higher than the value in right column)	30	20	Excavate or grouting (No replacement, since too deep and large scale)

Note: For "soil cement", 50kg (1 bag) of cement mixed with 1 m^3 of soil.

Explanation on Trial Embankment and Compaction Test are shown in Attachment 13.

B-9. Soil Replacement/ Embankment Works in Earthworks

Embankment works shall be performed using proper materials and equipment in technically appropriate construction method.

【Explanation】

(a) Soil Replacement/ Embankment Material

1) Minimum requirement of materials

The minimum requirements for the soil as embankment/ earthfilling work materials are as follows

- easy to handle for construction: low cost
- having a large shearing capacity: stability of embankment slope
- having low permeability: low conveyance loss or leakage from embankment/dike
- having a small compressibility: less risk for cracking

2) Recommendable soil material

The recommendable soil materials for embankment/earthfilling works are:

- (most suitable): well-graded sand or gravel mixed with clay as a cement material; and
- (2nd suitable) : sand mixed with clay having low plasticity, or mixed with silt

The unsuitable soil materials for earthfilling works are:

- soil having high water absorption and/or having high compressibility; and
- soil containing much humus and/or organic matter

3) Required tests and evaluation criteria

It is proposed to conduct the following physical tests in order to check an appropriateness of soil material for embankment/earthfilling works. Main purposes of these tests are: i) to classify the soil type and ii) to clarify the optimum moisture content for compaction. The evaluation criteria of soil shown below can be used for checking an appropriateness of each soil as embankment/earthfilling materials:

- specific gravity test;
- grading analysis;
- moisture content test;
- liquid limit test (LL);
- plastic limit test(PL); and
- compaction test.

Table 5.2 Criteria for Evaluation of Embankment/Earthfilling Materials

Classification of Soils based on Standard Soil Classification	Kinds of Material	Applicability for Earthfilling Materials*
-	Rocks	-
-	Boulders	-
GW,GP	Gravels	6
GM.GC	Silty/Clayey, Gravels	1
SW, SP	Sands	5
SM, Sc	Silty/Clayey Sands	2
ML,CL,OL	Clayey Soils	3
MH,CH,OH	Clay	4
PT	Organic Soils	7

*Note: * Applicability of soil is indicated by the number in ascending order, viz., a small figure indicates more suitability as the material for embankment/earthfilling works*

4) Trial Embankment

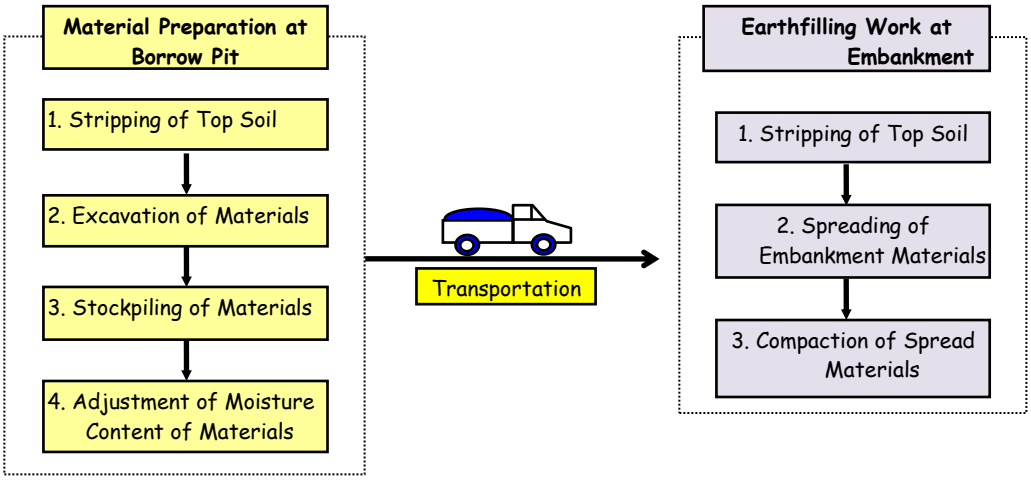
The trial embankment should be carried out for the selected embankment materials before a commencement of the embankment works. A method for the trial embankment should follow the actual construction method applied in the works sites and should be carried out in accordance with the following manners:

- a size of trial embankment yard is (width > 3 m) x (length > 5 m) x (height 0.30 cm) for one compactor;
- a compaction equipment which will be employed in the actual construction works shall be used;
- moisture content, density of compacted soil and cone index should be measured for respective compactor passage times of 0, 1, 2, 3, 5, 10 and 15 times; and
- the most suitable compaction manner should be employed for the actual construction works based on the above test results

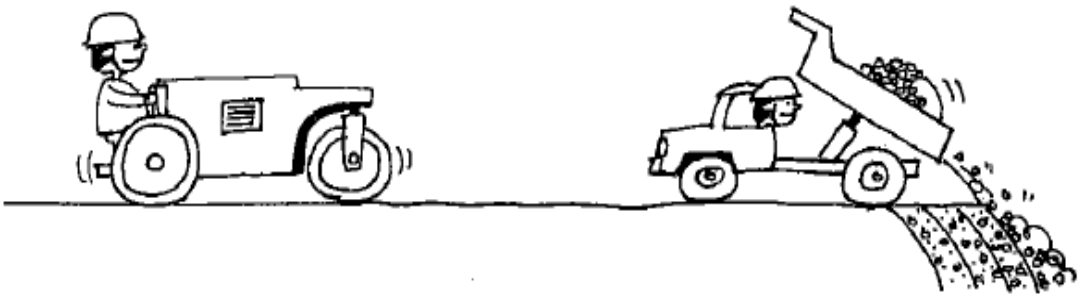
(b) Embankment Works

The embankment works consist of two major work elements of: i) material preparation works at the borrow pit and ii) earthfilling works at the embankment site. The each element further consists of several work items as illustrated on the next page:

Explanations and illustrations of the respective work items and its key points for securing a good quality of the earthfilling works are described in the following table for the respective cases of equipment works and manual works, and some sample checking forms for those works are attached in **Attachments** of this manual:



Further Elements of Two Major Work Elements

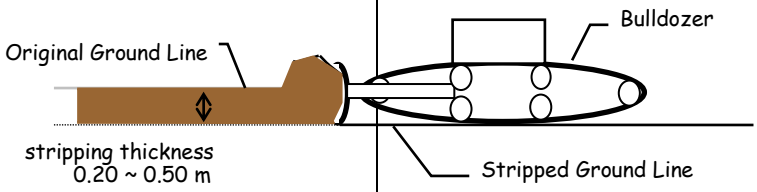


Classification	Construction Time	Characteristics Of Quality	Type of Test
Physical Characteristics	Before	Grading	Grading Analysis
		Water Content	Moisture Content Test
		Liquid Limit	Liquid Limit Test
		Plastic Limit	Plastic Limit Test
Mechanical Characteristic	Middle	Max. Dry Density	Compaction Test
		Optimum Moisture Content	Compaction Test
		Compaction	Dry Density Test
Bearing Capacity Characteristics	After	Penetration Index	Penetration Tests
		C.B.R in Water	C.B.R Test
		Bearing Capacity Coefficient	Plane Table Loading Test

1) Equipment Works

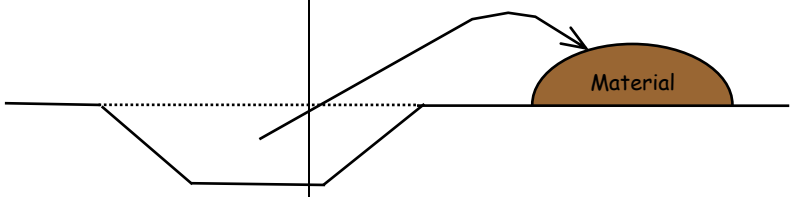
a) Material Excavation and Stockpiling at Borrow Pit

<table>
<tr><th>No.</th><th>Work Item</th><th>Explanation</th></tr>
<tr><td>1</td><td>Stripping of Top Soil

 
</td><td>(i) All obstacles such as sod, debris, organic soil, blocks, stumps, puddle, etc. shall be removed by bulldozer, etc.
(ii) Stripped soil shall be properly disposed to the spoil bank or disposal yard
(ii) Depth of stripping shall be carefully checked (0.20m ~ 0.50 m)

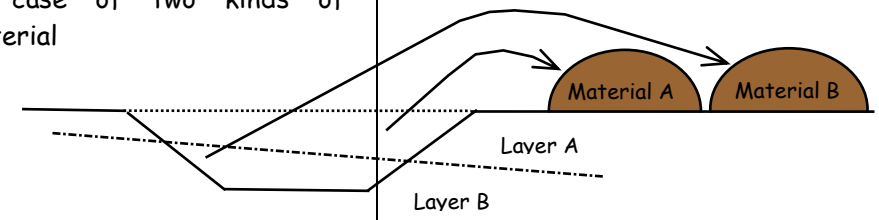
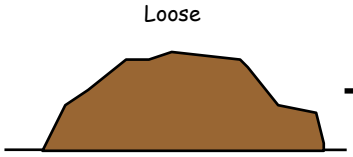
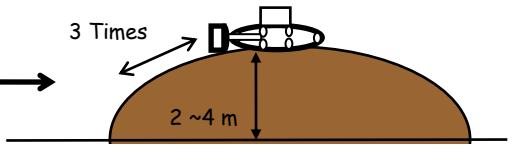
(see illustration below)</td></tr>
<tr><td>2</td><td>Excavation of Soil Material at Borrow Pit

➢ In case of homogeneous materials

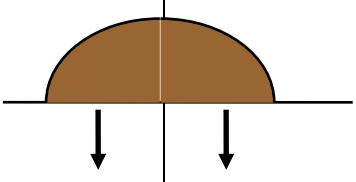
 
</td><td>➢ If excavated material consists of more than 2 kinds of the different type of soil, those materials shall be stocked separately.
➢ Usability of materials shall be checked referring to the previous laboratory test results or construction record.
➢ If the characteristics are unclear, the laboratory test shall be conducted.
➢ The natural moisture content of soil shall be checked.

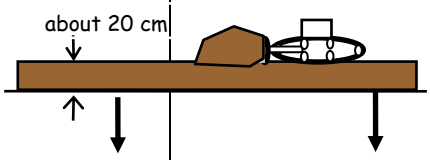
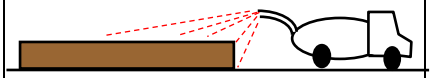
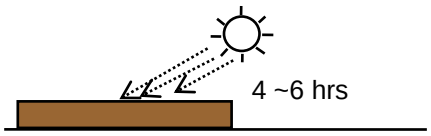
Measuring method : refer to Attachment 1

(see the following illustrations)</td></tr>
</table>

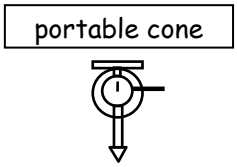
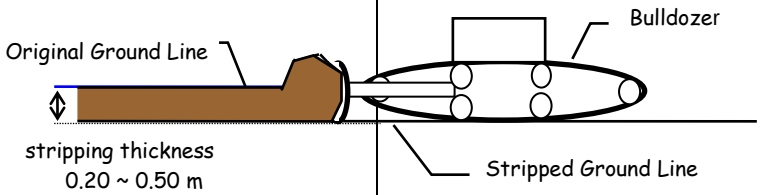
No.	Work Item	Explanation
	➢ In case of two kinds of material 	
3	Stocking and Moisture Adjustment  **not acceptable** ✕	- Moisture content shall be adjusted so as to be in the specified range (±5 %) of the optimum moisture content) before hauling materials to embankment site. - Surface of stockpile shall be compacted by the bulldozer or covered by the plastic/covering sheet, etc. to avoid infiltration of rain into the material and/or loss of moisture of the materials.  **OK**

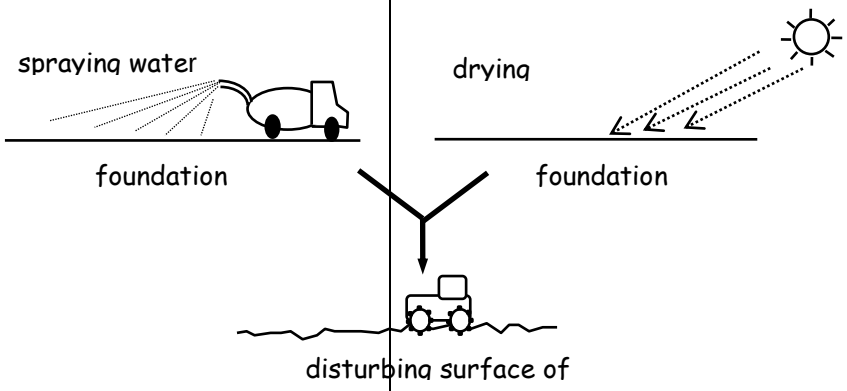
b) Adjustment of Moisture Content of Stockpiled Material at Borrow Pit

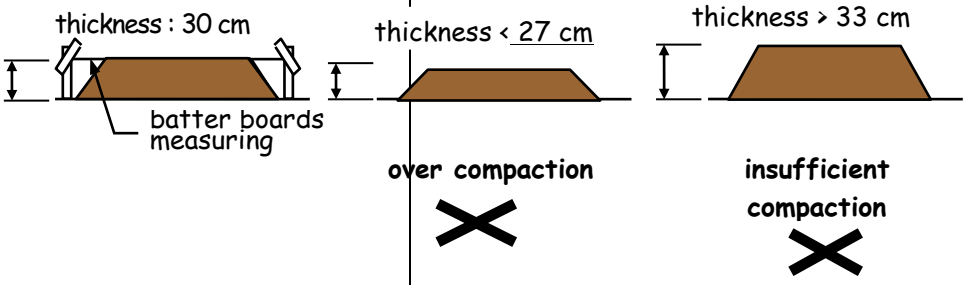
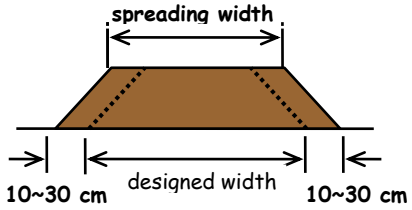
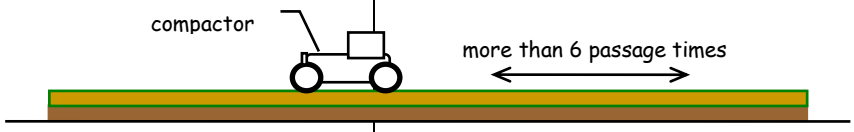
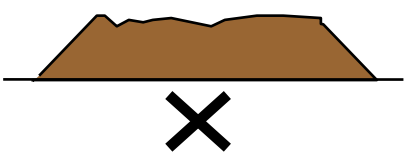
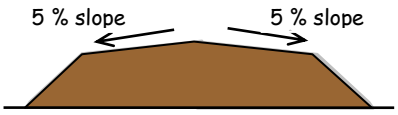
	Moisture Content : Drier than Specified Range the material shall be moistened	**Moisture Content : Wetter than Specified Range** the material shall be dried
1	stockpile 	

2	spreading stockpile	
3	water spraying 	drying material 
4	mixing material and check of moisture content **if not ok**	
5	**hauling to Soil Replacement/ embankment site**	

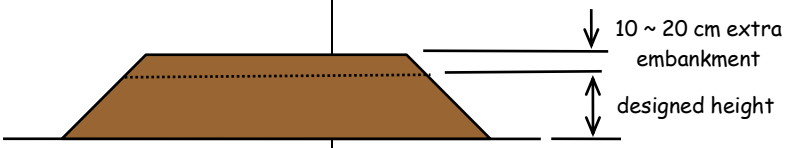
c) Material Embankment

No.	Work Item	Explanation
1	Stripping of Top Soil  	➢ All obstacles such as sod, debris, organic soil and puddle shall be removed by the bulldozer, etc. ➢ Stripped soil shall be properly disposed to the spoil bank or disposal yard. ➢ Depth of stripping shall be carefully checked (0.20m ~ 0.50 m). ➢ Stripping shall be made up to the foundation with sufficient bearing capacity (around 5 to 7 kgf/cm2 -- to be checked by portable cone, or dynamic cone penetration test device). (see the following illustration)

No.	Work Item	Explanation
2	Treatment of Foundation	➢ Foundation is too dry, water shall be sprayed. ➢ Foundation is too wet, drying or stripping shall be made for the part. ➢ Foundation surface shall be disturbed for securing a sufficient contact with embankment material. Dry Foundation 
3	Spreading Embankment Material refer to the illustration for the above Treatment of Foundation	➢ The foundation or the last layer's treatment shall be conducted before spreading embankment material as the following manners: i) foundation/last layer is too dry : spraying water. ii) foundation/last layer is too wet : drying last layer. ➢ The last layer's surface shall be disturbed.
	Spreading Thickness	➢ Spreading thickness shall be 40 cm then compaction shall be made normally to 30 cm, however, this thickness depends on target soil density, material and equipment to be used. Therefore, a compaction thickness shall be determined based on the trial embankment (see the following illustrations).

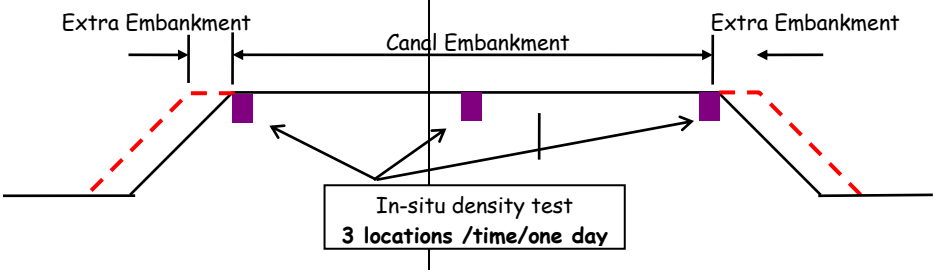
No.	Work Item	Explanation
	Starting from 40cm,  	
	Spreading Width	➢ Spreading width shall be 10 ~30 cm wider than the designed width. 
4	Compaction of Embankment Materials No. of Passage Times  	➢ Passage time of the compactor is more than 6 passage times (to be confirmed by the trial embankment). **This no. of passage times shall be carefully checked by the supervisor.**
	Provision of 5 % Slope 	➢ **For the case of embankment**, before rain and at the end of everyday work, 5 % slope shall be provided to the embankment surface. 

No.	Work Item	Explanation
		➢ **For the case of Embankment**, Extra embankment of about 10 ~ 20 cm or 5 ~ 10 % of total height shall be provided on the last layer for considering future settlement. However, an application of this extra embankment shall be done duly considering the technical specifications and unit prices or agreement with the contractor.

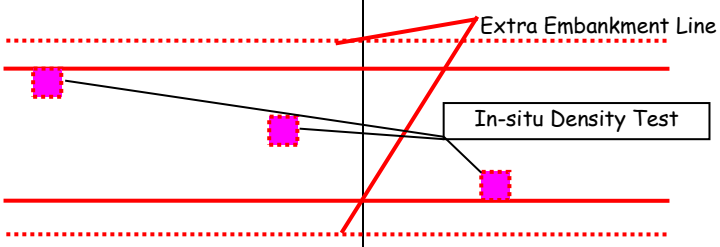


d) In-situ Density Test

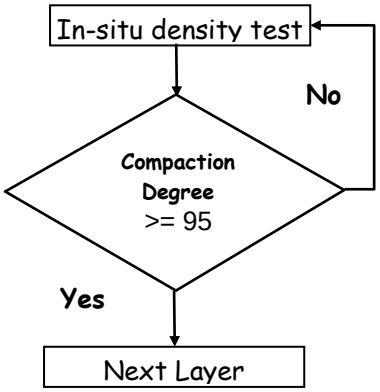
No.	Work Item	Explanation
1	In-situ Density Test	➢ In-situ density test shall be undertaken to confirm compaction degree of the compacted materials by the density at the embankment site. ➢ In-situ density test shall be performed by the sand replacement method. If the other method is applied calibration of both methods shall be made.



CROSS SECTION



PLAN

No.	Work Item	Explanation
		➢ The above test shall be carried out about every 200m of every compaction layer or every 200 to 500 cum of embankment works.
2	Evaluation of Compaction  	➢ Specified range of the compaction degree of the compacted embankment is more than 95 % of the maximum dry density, based on Technical Specifications especially for Embankment, including Dam. ➢ If the test results do not satisfy the specified range: i) A further compaction shall be made until the compaction degree exceeds 95 %*. ii) If the compaction degree is much lower than the specified range, the compaction method such as spreading thickness and no. of passage times shall be changed. Note: * For backfilling of small structures, compaction degree to be 90% or more. ➢ If the test results satisfy the specified range, the next layer may be embanked. **Detailed photo documentation on density test is shown in the Attachment.**

(11) Construction Works Stage

The basic approach and workflow of Construction Works Stage is depicted as follows:

1) Basic approach

- In addition/ parallel to the work items explained on ii) above, critical construction stages such as placing concrete at walls and slabs of the structures after casting, etc., "witness" will be done for each of such event in accordance with the manual and carry out "inspection" as needed. It should be noted that, depending on the test contents, discussion over the future necessary action will be conducted

2) Basic Workflow

Related Structures	General Flow of Request for Approval (RFA) at Construction Works Stage	Check list (V: required doc./ Action)			
		A	B	C	D
(A-6)	Material (Coarse & Fine Agg., Cement, Steel, etc.)	V	V	V	
	⇩ (Spec.)				
(A-7 & 10)	Trial Mix for all Concrete Types	V	V		
	⇩ (Spec.)				
(B-7)	Excavation of Canal(s)/ Structures (bed condition (material & compaction)) and Invert Levels	V		V	V
	⇩ (Spec.)				
(B-8)	Foundation Treatment (filling with specified stones, if required), before placing blinding concrete, esp. Structure base & its D/S	V	V	V	V
	⇩ (Spec.)				
(B-8)	Placing Blinding Concrete/ Level Concrete for Division Structure/ Drops and EL check	V		V	V
	⇩ (Spec.)				
D-1.	Arrangement of steel reinforcement for Division Structure/ Drops (if applicable)	V		V	V
	⇩ (Spec.)				
D-1.	Arrangement of formwork for Division Structures/ Drops (base concrete & wall)	V		V	V
	⇩ (Spec.)				
D-2.	Placing Base Concrete for Division Structures/ Drops (base concrete & wall) w/ EL Check; and/ or	V			V
	⇩ (Spec.)				
D-3.	Placing of Concrete Wall or Stone Masonry Wall for Division Structures/ Drops w/ EL Check	V		V	V
	⇩ (Spec.)				
D-4.	Backfilling of transitional section betw/ Division Structure/ Drops and Canals w/ Compaction	V		V	V
	⇩ (Spec.)				
D-5.	Installation of Gate guide frame & Gate leaves/ Stoplogs	V		V	V
	⇩ (Spec.)				

	General Flow of Request for Approval (RFA) at Construction Works Stage	Check list (V: required doc./ Action)			
Canal Lining Works					
C-0.	<If designed> Placing Blinding Concrete/ Level concrete for Canal(s) & EL Check, then Placing	V		V	V
	⇩ (Spec.)				
C-1.	Placing of Canal Base concrete w/ EL Check	V		V	V
	⇩ (Spec.)				
C-2.	Joint Inspection of Canal(s) Bed EL	V		V	V
	⇩ (Spec.)				
C-3.	Placing of Stone Masonry Wall for Canal(s)	V			V
	⇩ (Spec.)				
C-4.	Joint finishing along Canal(s)	V			V
	⇩ (Spec.)				
C-5.	Backfilling of Canal(s), Division Structures/ Drops	V			V
	⇩ (Spec.)				
D-5A.	Fabrication of Gate guide frame & Gate leaves	V		V	V
	⇩ (Spec.)				
D-5B.	Joint Inspection of Gate guide frame & Gate leaves/ Stoplogs, etc.	V		V	V
	⇩ (Spec.)				
D-5C.	Installation of Gate guide frame & Gate leaves/ Stoplogs	V		V	V
	⇩ (Spec.)				
D-5D.	Placing of top slab for Bridges/ Foot Bridges	V		V	V
	⇩ (Spec.)				
E-1.	Final Inspection (Dimension Elevation)	V	V	V	V
	⇩ (Spec.)				
E-2.	Inspection for Running test	V	V	V	V
	⇩ (Spec.)				
E-3.	Measurement of Completed/ semi-completed Canal/ Related Structures (for Statement)	V	V	V	V
	⇩ (Spec.)				

A: Supporting Doc, (Work Plan/ Spec); **B**:Test Results; **C:**Joint Inspect. **D**: Measure. Sheet w/ Photo Doc. for Payment;

For the small scale irrigation scheme, It is recommended to construct division box (D) first, then followed by canal lining works (C), since the joint/ transition between canal lining and the structure becomes easy to compact and water tight by simply connecting the lining works to the edge of structure(s).

C Canal Lining Works

The basic workflow of construction supervision & management is depicted as follows:.

C-1a. Base Concrete (for Stone masonry wall type)

Concreting works of the base concrete can be started after the "concrete compressive test" results for a specified trial mix proportion have been approved by the Project manager.

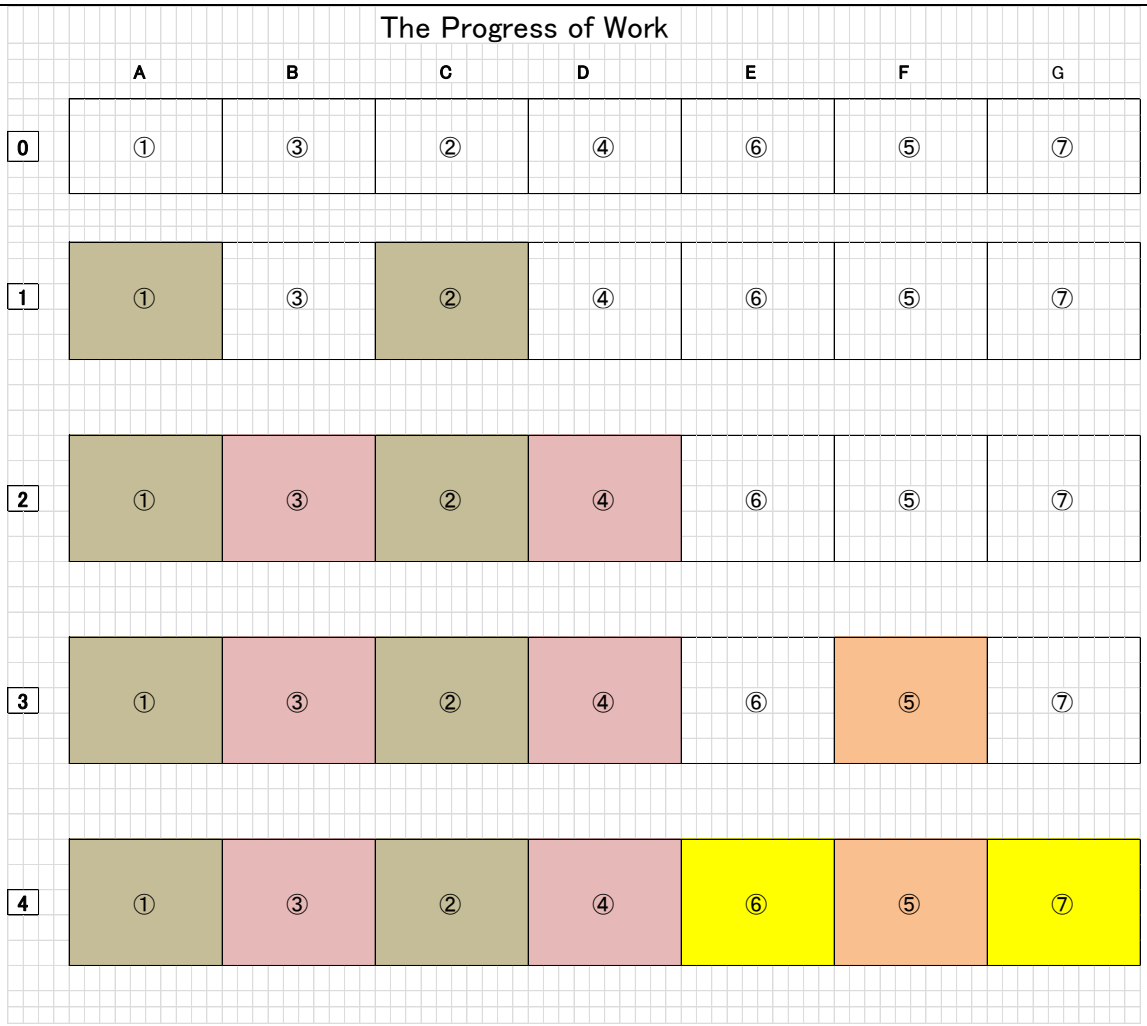
Material (2 units of cement) should be ready and placed near the concrete mixer

After Mixed properly chute near canal

Concrete has mixed and carried to section

First concrete layer of plum concrete (5-10 cm)
2 units x 2 batch for L=4m

	
Stones placed on top of 1st layer	**2nd layer of concrete has been placed 2 units x 3 batches for L=4m of 2nd L**
	
Hand compaction of 2nd layer using rod/ stick	**Stones placed on top of 2nd layer and hand compacted, then filed with 3rd (final) layer and compacted & smoothed**
	
Smoothed surface of concrete 3 units x 1 batch for L = 4m of final layer (NB (Left photo): no "end stopper" installed near template)	
Concrete requirement for 4m: 2 units x (2+3) batches and 3 units x 1 batch	



Formation (order) of Base Concrete Placement

Considering "joint" and saving of Templates, the base concrete placement will be conducted "every other barrel" (in order of barrel ①, barrel ②), then in between barrel ③, so that joint can be filled in prior to place barrel ③ , continued as shown above

After hardening (2-3 hours), cured by sand and water for at least 36 hours. Formwork will be removed after 2-3 days

Photo of Bad Sample (Base Concrete Placement)	
	
Joint between template (no end stopper)	**Wooden support was found inside the formwork and left holes after removing support**

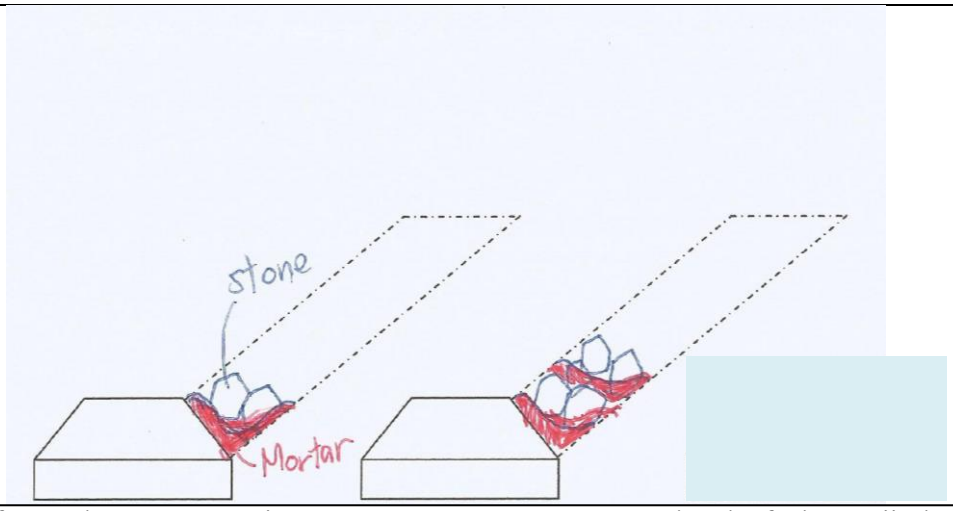
The Contractor shall implement a quality control and assurance system in compliance with the requirements of the Contract. Details of all procedures and compliance documents shall be submitted to the Project Manager prior to commencement of design and execution stage.

C-2. Joint Inspection of Canal Bed EL

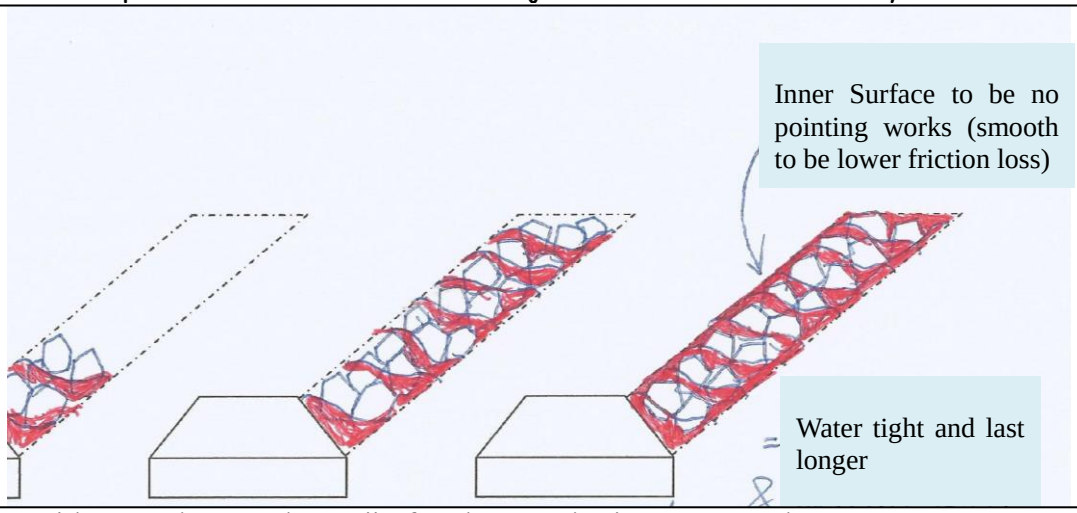
The Contractor, together with the Project Manager shall conduct joint inspection of canal bed elevation based on the contract drawings along the targeted canal(s) for approval of the base concrete result by the Project Manager.

C-3. Walling

The Contractor shall conduct walling of the canal lining as per contract drawings, especially for the case of small scale irrigation systems. For a large cross sectional canal, the order may be starting with wall, in prior to the base concrete. It is noted that if stone masonry wall has been adopted, the procedure for walling shall be in accordance with "Good Practice" as shown below.

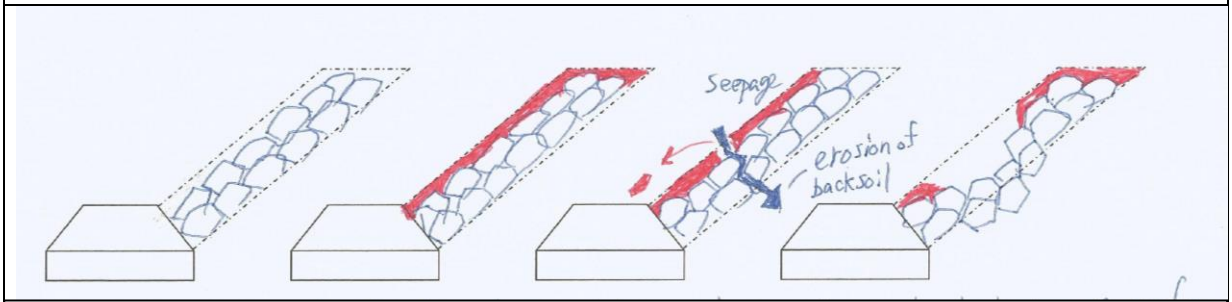


Starting from the Bottom, placing mortar at bottom & behind of the wall then put stones on top to make sure mortar is well jointed with stones near by



then build toward upward. Finally finishing with plastering without pointing
This is Water-Tight and good smooth surface lower the roughness coefficient

Above: Good Practice of Walling by Stone Masonry (Mortar 1st ! then Stone)



Placing stones only first without any joint mortar between and around stones. Then only plastering on the surface.
This is NOT Water-Tight, especially any small crack occurred on the mortar plastering, it causes NOT ONLY LEAKAGE BUT ERODE/ WASH OUT the Soil behind the wall
⇨ Cause of Fatal Collapse since no soil support behind the wall

Bad Practice of Walling by Stone Masonry (Stone placed 1st then only plastering)


Walling based on "Good practice (well mixing of Mortar then Stone, from Bottom)


Inspection of Thickness of the masonry wall (30cm or more, as specified)


Advancing of walling along guide string	**Make sure before walling start curing is done and sand/ soil will be removed to avoid mixing with walling mortar**

Considering "joint" and saving of Templates, the similar method shall be employed for stone masonry wall construction, as seen in that for base concrete; i.e. "every other barrel" (in order of barrel ①, barrel ②), then in between barrel ③, so that joint can be filled in prior to place barrel ③.

Note: Stone Masonry Works

(a) General

The wet stone masonry works are also one of the most important components for the construction works of irrigation facilities and other major works. The quality control for these works, however, is rather difficult comparing to those of earth and concrete works. The main reason is due to difficulty in laboratory check of strength of wet stone masonry, and furthermore that an evaluation of quality much depends on the supervisor's subjective. Especially the mix proportion of sand and cement should be carefully checked during the wet masonry placement work for securing an acceptable quality.

In this chapter the important matters to be cared for the execution of the masonry works are explained with some illustrations, in particular of the following works:

- Material;
- Placement Manner; and
- Construction of Lining and Structural Masonry Works.

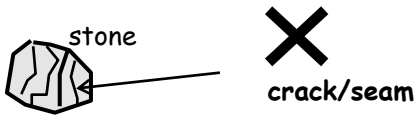
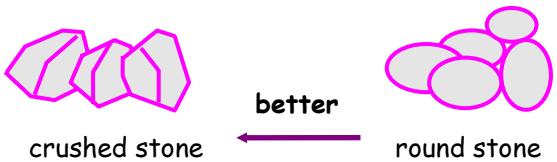
In **Attachment 5** a sample checking form for the masonry works is attached for the field supervisory use.

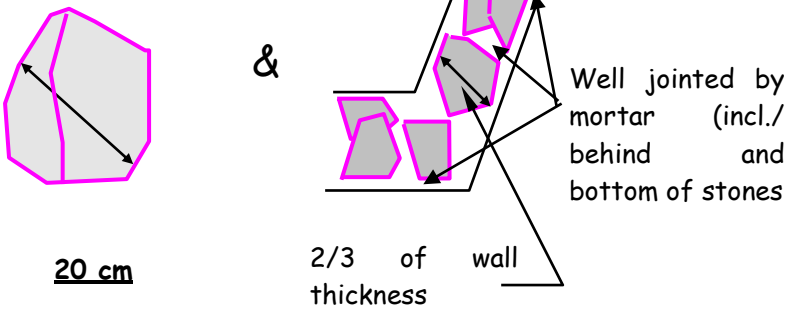
(b) Material for Wet Stone Masonry Works

Wet stone masonry works shall be made paying attention upon use of suitable mortar and sound stones.

【Explanation】

Wet stone masonry is composed of the four major materials such as water, cement, sand stones. The minimum requirements for respective materials are as follows:

No.	Material	Minimum Requirement
1	Water	➢ Need of the equivalent quality with that of concrete works
2	Cement	➢ Need of the equivalent quality with that of concrete works
3	Sand	➢ Need of the equivalent quality with that of concrete works
4	Stone Stone	➢ free from crack/seam (see the following illustrations)  ➢ crushed stone is preferable 

No.	Material	Minimum Requirement
		➢ specific gravity not less than 2.5
	Max. Stone Size	➢ specific gravity not less than 2.5 ➢ maximum stone size is 2/3 (two thirds) of wall thickness; i.e. less than 20 (twenty) centimeters for wall thickness of 30cm. 

【Output】

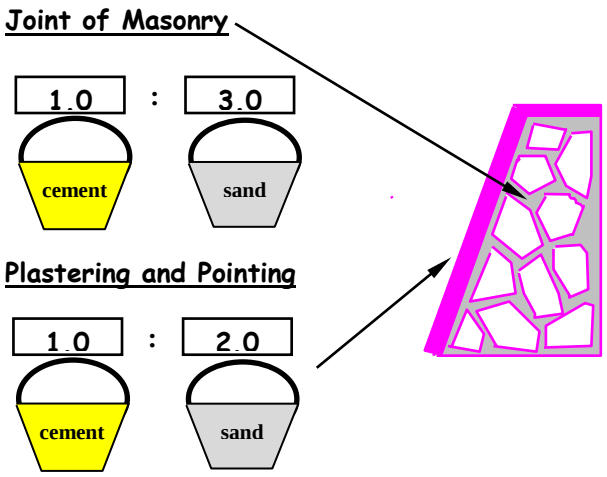
High quality of masonry works using proper mortar and solid stones

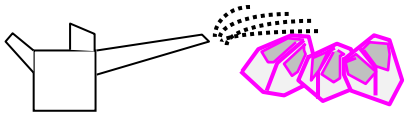
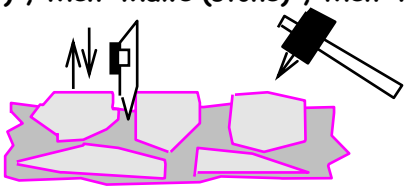
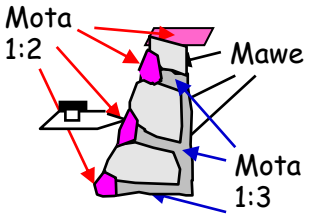
(b) Placement of Wet Stone Masonry Works

Stones and mortal shall be placed in a proper position in order to make strong wet stone masonry works.

【Explanation】

The wet stone masonry shall be placed in accordance with the following manner:

No.	Work Item	Explanation
1	Mixing of Mortar	➢ The mortar shall be mixed with the following volume proportion of cement and sand: 

No.	Work Item	Explanation
2	Moistening Stone	➢ The stone shall be moistened before placing. 
3	Filling Mortar & then Placing Stone	➢ The joint mortar shall be sufficiently compacted by the trowel and the stone shall be struck and consolidated by steel hammer. **Always:** **"Mota (mortar)", then "Mawe (stone)", then "Mota", then "Mawe"** 
4	Surface Joint	➢ A width of the joints in face stone shall not exceed 3 cm.  If the mortar for plastering is specified by 1:3, mix proportion of 1:3 can be used

【Output】

High quality wet stone masonry works constructed in a proper way

(c) Wet Stone Masonry Works for Lining and Structures

1) General

Wet stone masonry is generally used for two major construction works i.e., i) canal lining works and ii) structural works. An explanation on the method of quality control for wet stone masonry works is given for those two major work items in this section.

2) Masonry Lining Works

Masonry lining works for canals requires the careful supervision, especially for quality, thickness, and leakage.

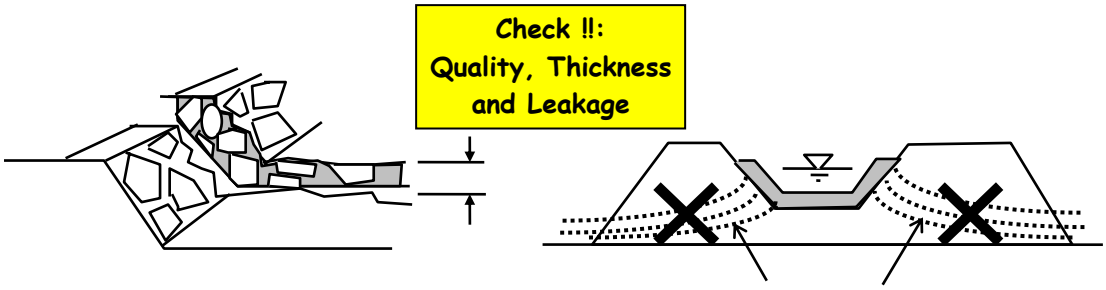
【Explanation】

In the case of the masonry canal lining, it is rather difficult to control a quality during the construction works because generally the quality test like a compression test for concrete is not carried out, and this makes hard to obtain quantitative standard in quality control. Therefore it is needed to carry out a strict post-construction check for the masonry lining works.

In order to secure the good quality of the masonry lining, the following points should be carefully checked after construction works.

- Quality of joint mortar;
- Thickness of lining; and
- Water leakage.

For checking the above first two points, it is needed to dismantle a part of lining wall at an interval of every 100 m or 200 m and check the masonry quality and wall thickness. In addition a water leakage should be checked during the running test, which implies lower quality of masonry works. Principally if such lining defects are found out, the lining shall be once demolished and re-constructed.



【Output】

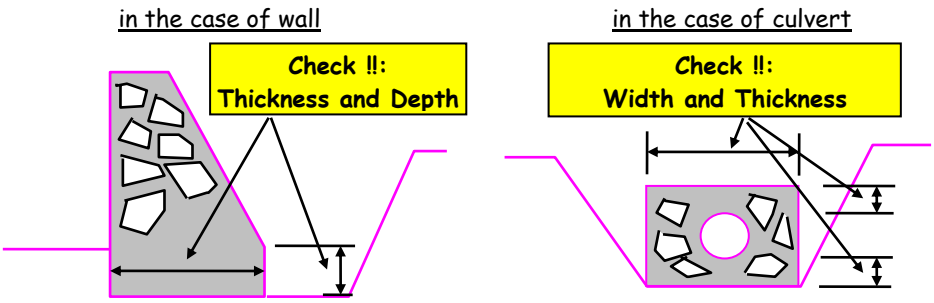
Stone masonry lining without leakage

3) Masonry Structural Works

Masonry structure works should be constructed with proper dimensions since their stability is ensured by gravity.

【Explanation】

As already described in the masonry lining works, a quality of the structural masonry works is rather difficult to control strictly without any continuous supervising in the field. Therefore it is recommended for the project field supervisor to undertake the frequent inspection for the masonry works, in particular of the mix proportion of cement and sand, and of structural dimension of the backfilled portion. Regarding the backfilled portion, a condition of every structure shall be checked before the commencement of backfilling through site checking and/or photograph.



【Output】

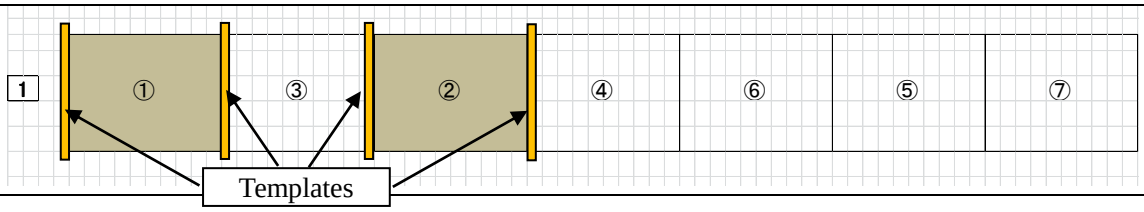
Masonry structure works stable against sliding, overturning and sinking

C-4. Joint finishing

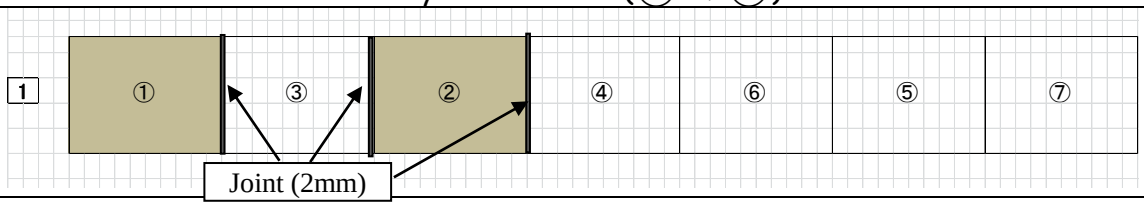
Joints (contraction/ expansion joints) shall be filled with "joint filler" such as bitumen, after treatment of concrete/ wall correction. As an alternative method, the following method can be adopted only for small scale irigtion system, if bitumen is difficult to use, agreed with and instructed by the Project Manager.

Photo of Bad Sample (Joint arrangement & placement)	
	
Joint will be made at Template locations	**The gap shall be minimized by concreting and the joint should be 20mm-25mm**

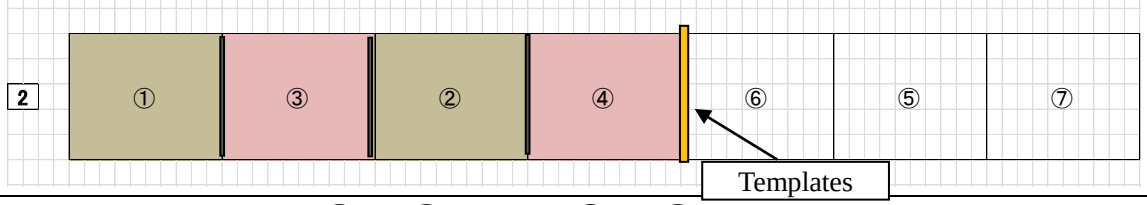
Improved procedure for base concrete/ stone masonry walling and Joint placement



Sub-step-1: Set templates on both side then Place base concrete/ stone masonry walling every other barrel (① & ②)



Sub-step-2: Remove templates and Place joint (bitminus material/ paint 2mm), before placing barrel ③



Sub-step-3: Place barrels ③ & ④. Barrels ① & ② can be used as "templates" for ③ (just need one template for ④). Saving number of templates with good joint finishing

Reference: Alternative procedure for Joint placement (if thicker joint is required)	
	Necessary Materials · tarmac · sand · pan · form work timbers · Sand bag · Sisal Strings · Compaction tool
Filling of gaps can be done in two ways. One is filling gap part directly by tarmac sand.	

Filling tarmac sand

② Excavate and Clear around the targeted part.

② Formwork around the targeted part to receive tarmac sand filling materials.

③ Heat tarmac in pan and mix with sand (ratio 1:1), after the tarmac heated and liquidized.

④ Fill the gap with tarmac sand with stick and tapping forms so that the gap will be filled well.

C-5. Backfill w/ Compaction

Backfilling of the Structural excavations shall be carried out with excavated material selected or approved by the Project Manager. The material shall be placed in layers not exceeding 150mm compacted thickness or such other thickness as the Project Manager at regular intervals and in a form to be agreed with the Project Manager may approve or directed and shall be compacted as specified in Clause 216 of the Technical Specifications (to obtain a dry density of not less than ninety five percent (95%)). The gap between the backfill and the stone masonry wall shall be filled with mortar (1:2).

Gap shall be filled by mortar

Beam concrete will be placed after filling mortar on the top of the wall

The transition between related structure is also weak point, so that backfill with well compaction is very important

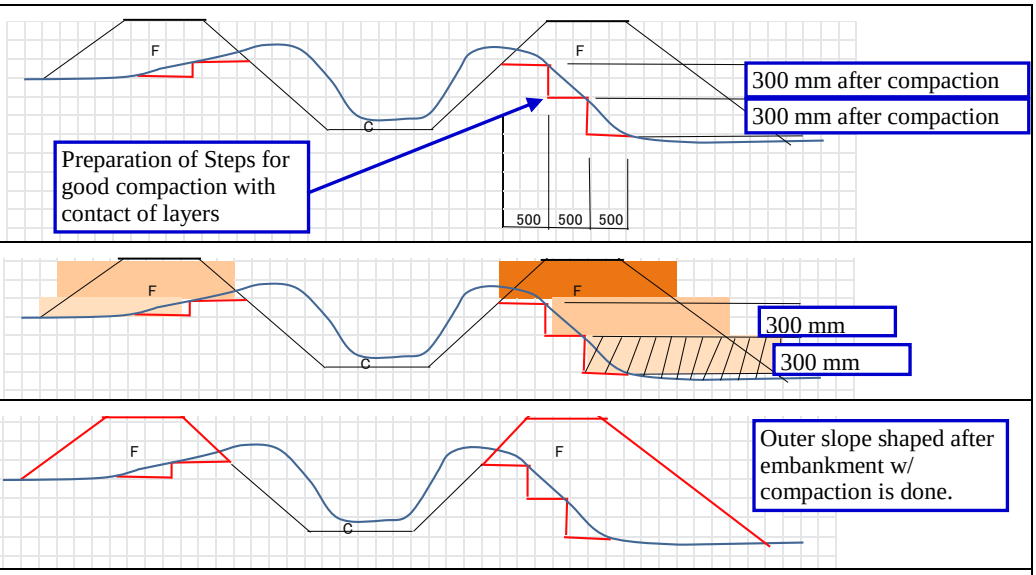
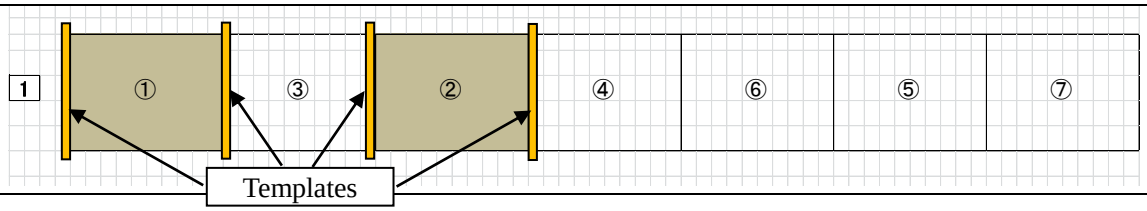


Image sketch for backfilling with compaction, using excavated material.
Steps are prepare for good compaction and contact of soil layers, based on Clause 216 of Technical Specifications.

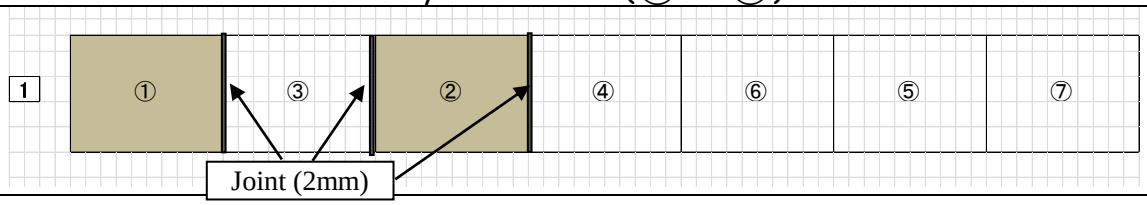
C-1b. Base Concrete (for Concrete Lining type, using BRC)

Concreting lining works shall be carried out after the "concrete compressive test" results for a specified trial mix proportion have been approved by the Project Manager. The improved procedure is applied as shown below as barrel-wise, i.e. considering good finishing of joint and saving of the number of templates with proper dimension control using pre-placed barrels.

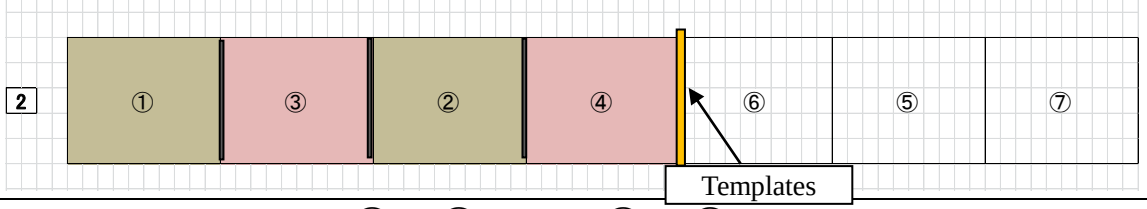
Improved procedure for Concrete lining canal and Joint placement (barrel-wise)



Sub-step-1: Set templates on both side then Place base concrete/ concrete walling every other barrel (① & ②)

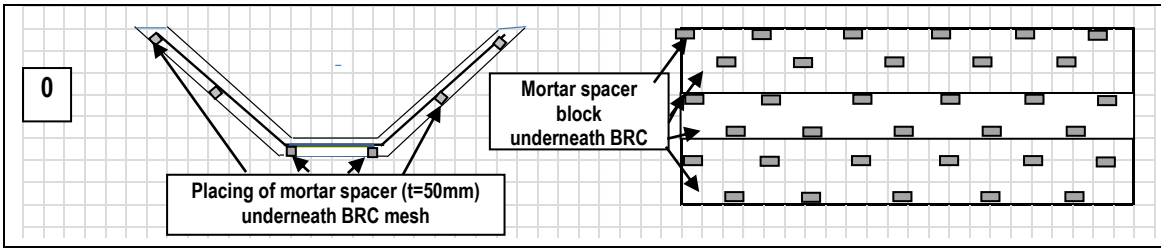


Sub-step-2: Remove templates and Place joint (bitminus material/ paint 2mm), before placing barrel ③

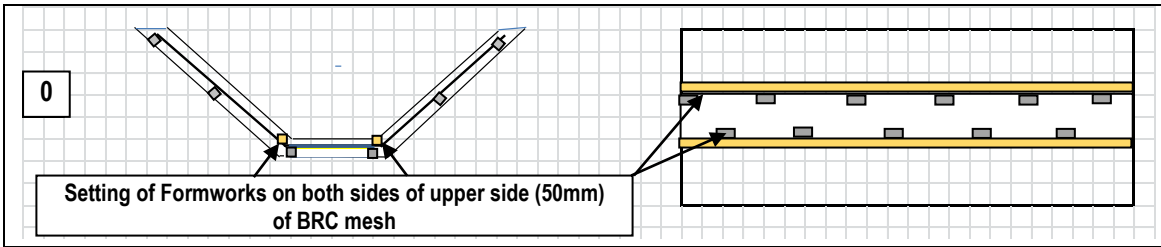


Sub-step-3: Place barrels ③ & ④. Barrels ① & ② can be used as "templates" for ③ (just need one template for ④). Saving number of templates with good joint finishing

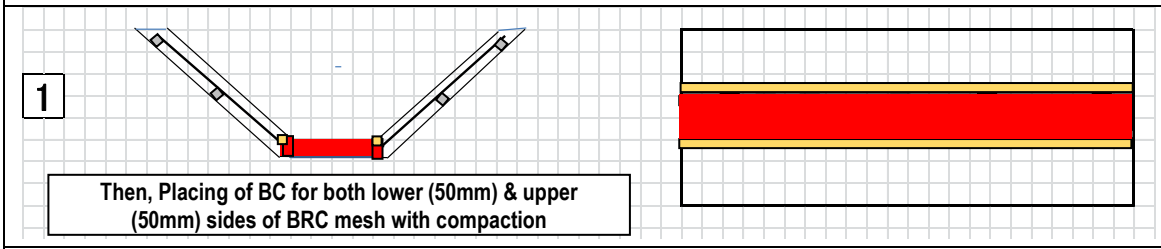
Especially for a small scale canal with concrete lining (Bottom width ≤ 1.0m), in cross-sectional wise the following procedure shall be applied for each barrel as shown on next page, i.e. placing BRC (R6 x 150 x 150), using mortar spacer block (50mm x 50mm x 100mm, Cement: Sand ratio = 1:2, spacing of 1 block/ m^2, tied with BRC by wire) for keeping specified cover underneath the BRC mesh, and as a part of formwork for the base concrete.



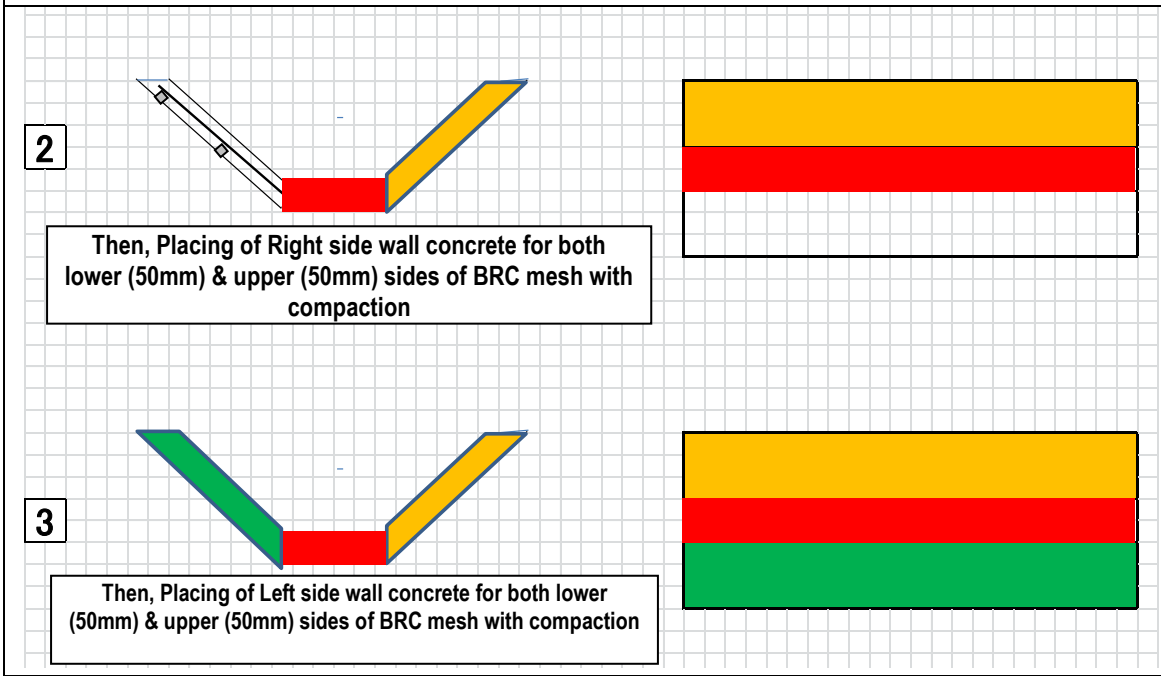
Placing of Mortar Spacer blocks



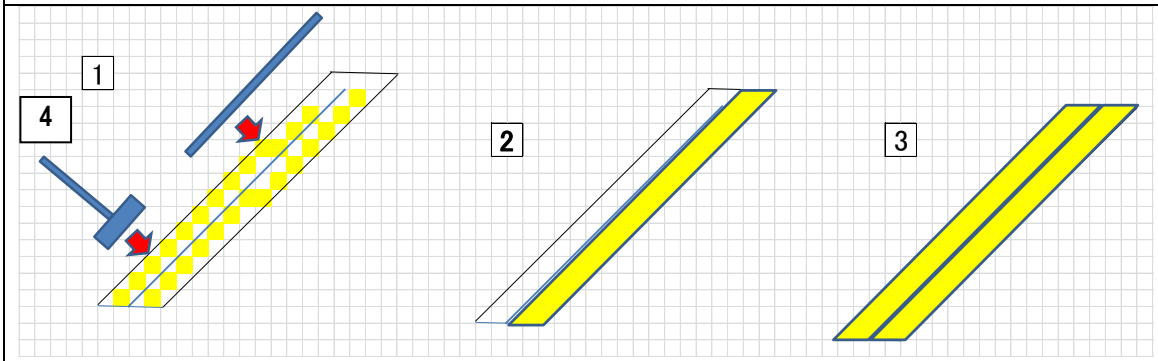
Setting of Formwork for Base Concrete (BC)



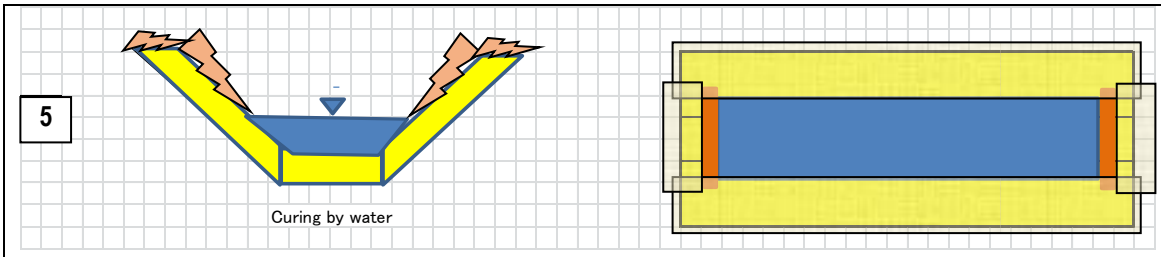
Placing of Base Concrete (BC) with compaction



Placing of Side-walls Concrete with good compaction



For Good compaction of Side-wall, Wooden compacting tools are used instead of vibrator. Concrete hit hard 3 times per location by tools to release air. Sub-step 2 and 3 shall be done in short time for a good quality of concrete wall/ base.



Curing of Base and Side-walls Concrete with ponding water and wet jute bags/ sheet. The placed concrete shall be cured after 2-3 hrs by means of moist curing and /or equivalent method for at least 36 hours

Preparation of Mortar spacer blocks (1:2)

C1 Base murum casting (if required)

C2 BRC preparation

C3 Concrete pouring

C4 Joint painting

C5 Iron trowel finishing

C1-C. In-situ Concrete Canal Lining Works (for Medium to Large Scale)

In-situ concrete canal lining should be carried out with suitable interval in proper procedure.

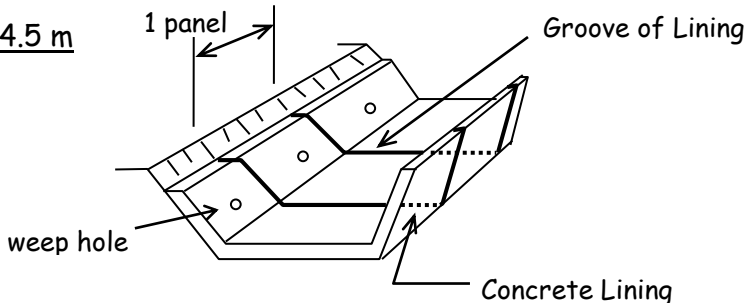
【Explanation】

1) Basic Matters

Basic Requirement for Concrete

- Type of Concrete : Type A
- Slump of Concrete : 5 cm
- Max. Size of Concrete Aggregate : 40 mm or 1/2 of lining thickness
- Water/Cement Ratio : 50 ~ 55 %

Length of One Panel: 3.0 m ~ 4.5 m



Dimension of Groove: as follows

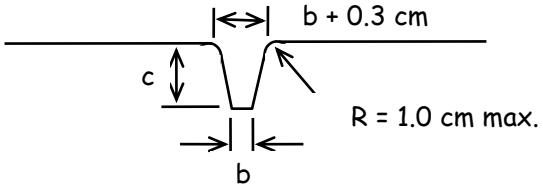


Table 5.5 Dimension of Lining Groove

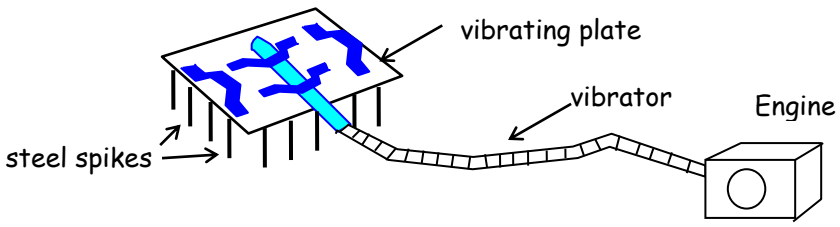
t (cm)	b (cm)	c (cm)	Approx. Groove Spacing center to center (cm)
5	0.6 ~ 1.0	1.5 ~ 1.9	3.0
6.3	0.6 ~ 1.0	1.9 ~ 2.2	3.5
7.5	1.0 ~ 1.3	2.5 ~ 2.8	3.6 ~4.5
8.8	1.0 ~ 1.3	2.8 ~ 3.1	3.6 ~ 4.5
10	1.0 ~ 1.3	3.1 ~ 3.5	3.6 ~ 4.5

Weep Hole

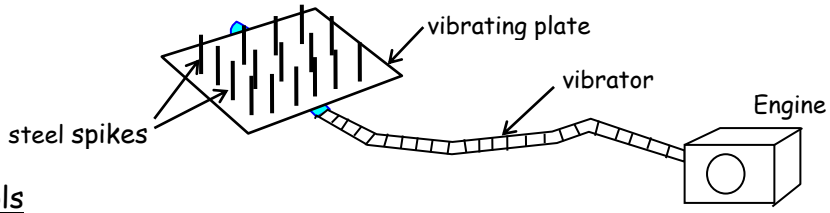
PVC pipe equipped **with valve, which prevents a reverse flow,** shall be used.

Vibrating Tools

(Upper Side View)

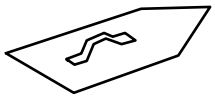


(Lower Side View)

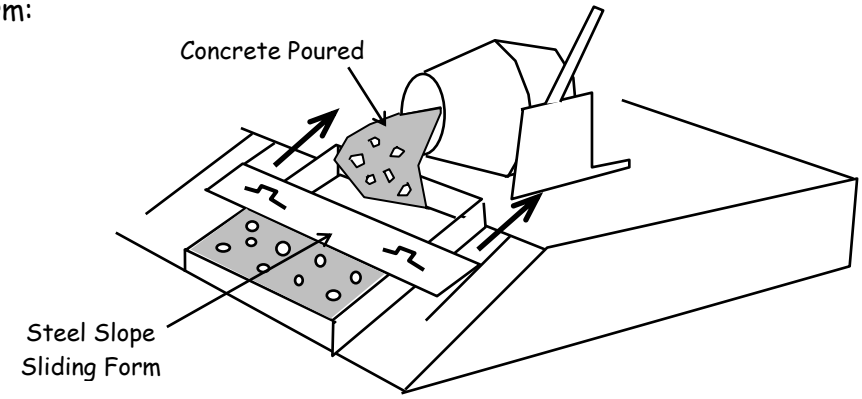


Other Small Tools

- Trowel:



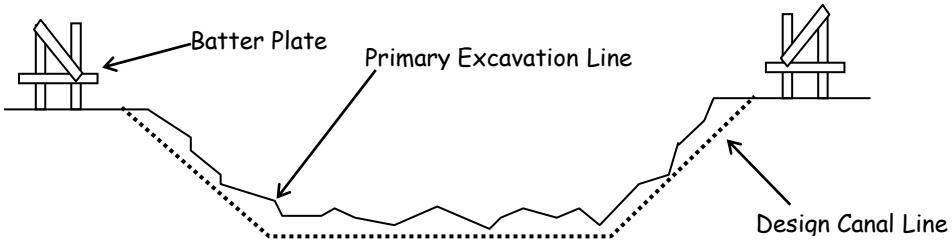
- Sliding Form:



2) Lining Concrete Placing Method

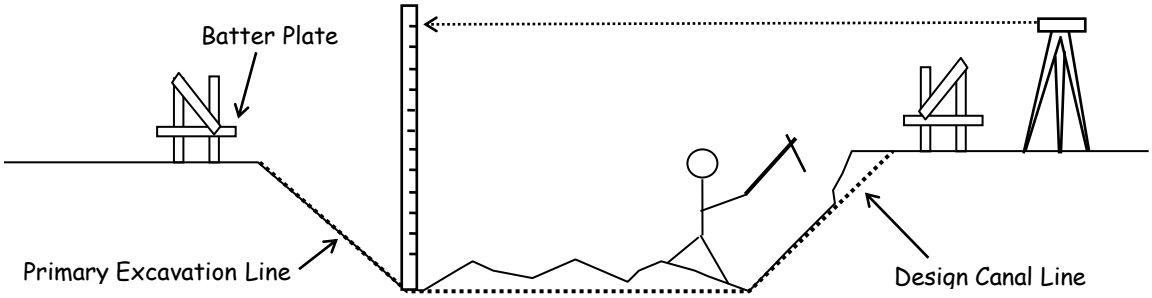
For Slope Concrete

- Primary canal excavation for lining foundation and setting of batter board :

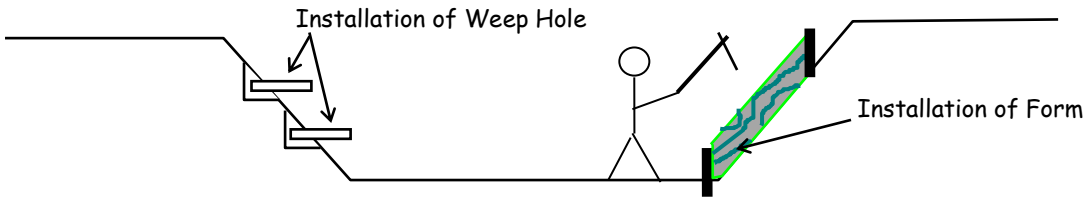


- Trimming Canal Slope :

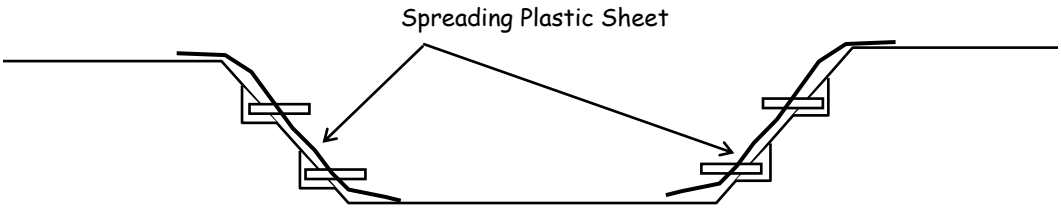
  Trimming of roughly excavated slope with a careful check of the canal elevation and dimensions as shown below.



- Placing the weep hole and form work.

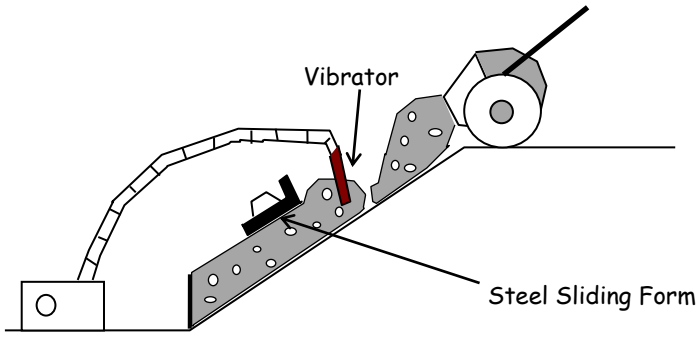


- Placing thin plastic sheet is recommended to prevent the leakage of canal water or the welling of ground water.

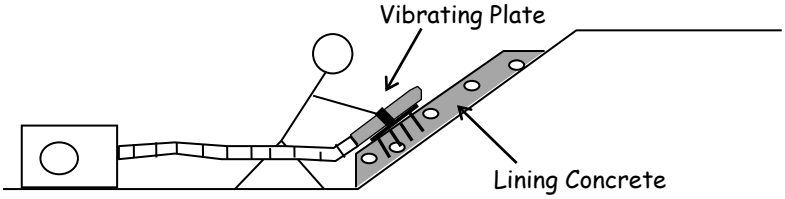


Note: In case of using the plastic sheet, filling joint sealer to the groove is not necessary to the lining joint groove.

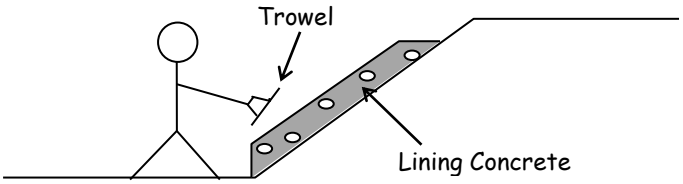
- Placing lining concrete on the canal slope using the steel sliding form:



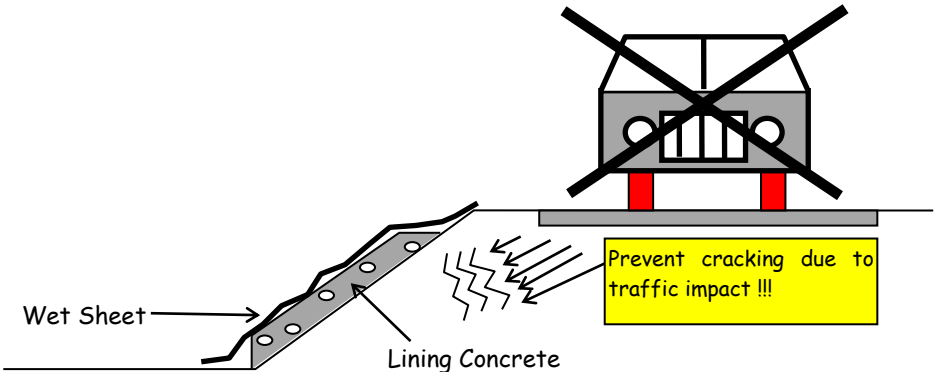
- Compaction of Concrete using Steel Vibrating Plate with Spikes :



- Finishing using Trowel on the flesh concrete surface :

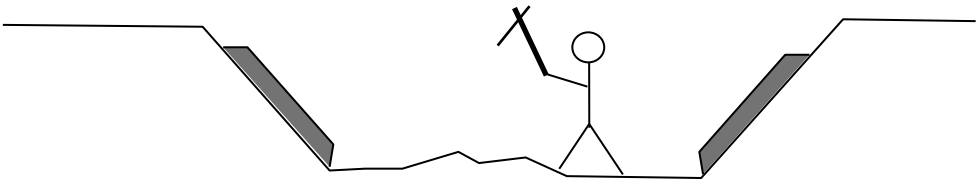


- Curing using Wet Sheet and No Heavy Traffic passing on the side Inspection Road for 7 days:

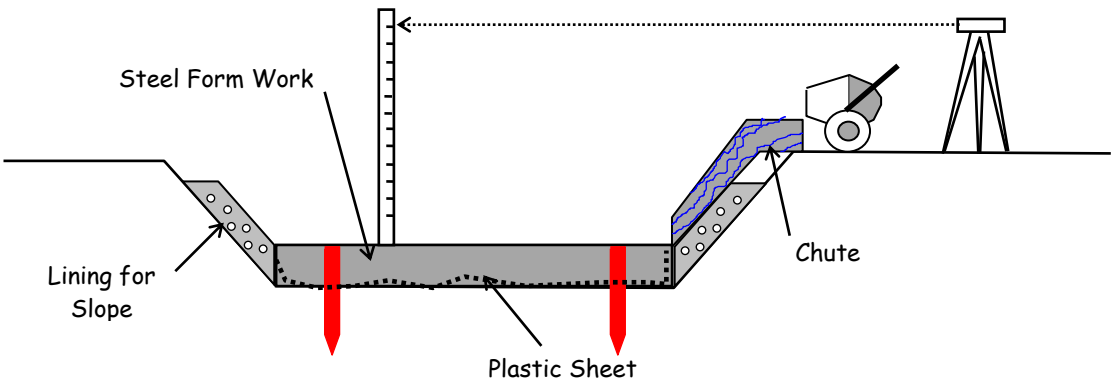


For Bottom Concrete

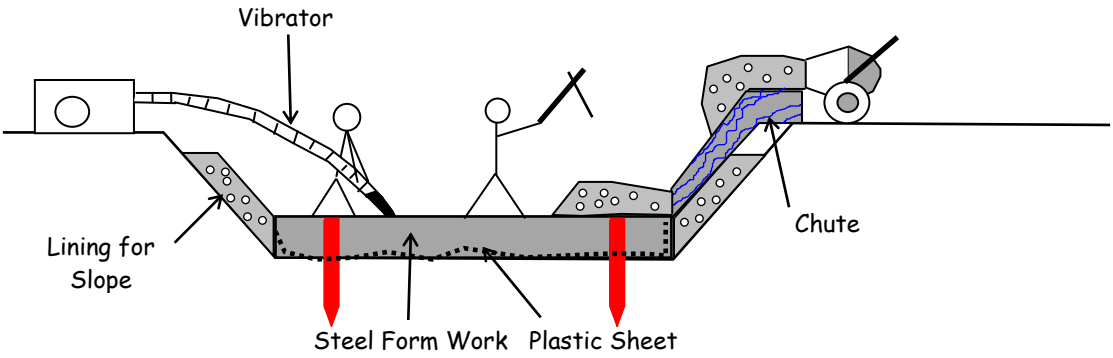
- Trimming of Canal Bottom



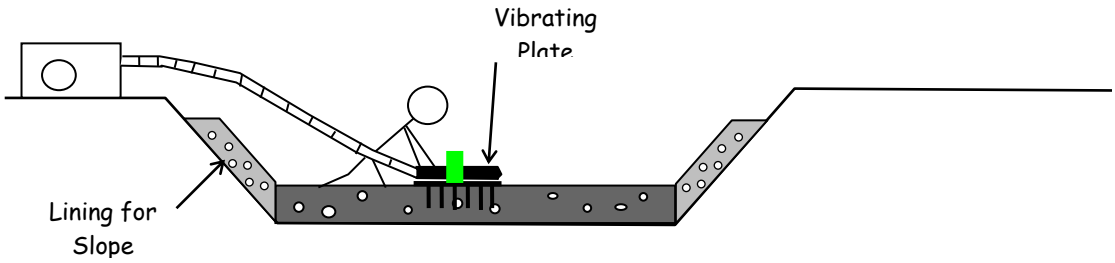
- Spreading Plastic Sheet and Installing Steel Form Work with Check of Elevations and Dimensions :



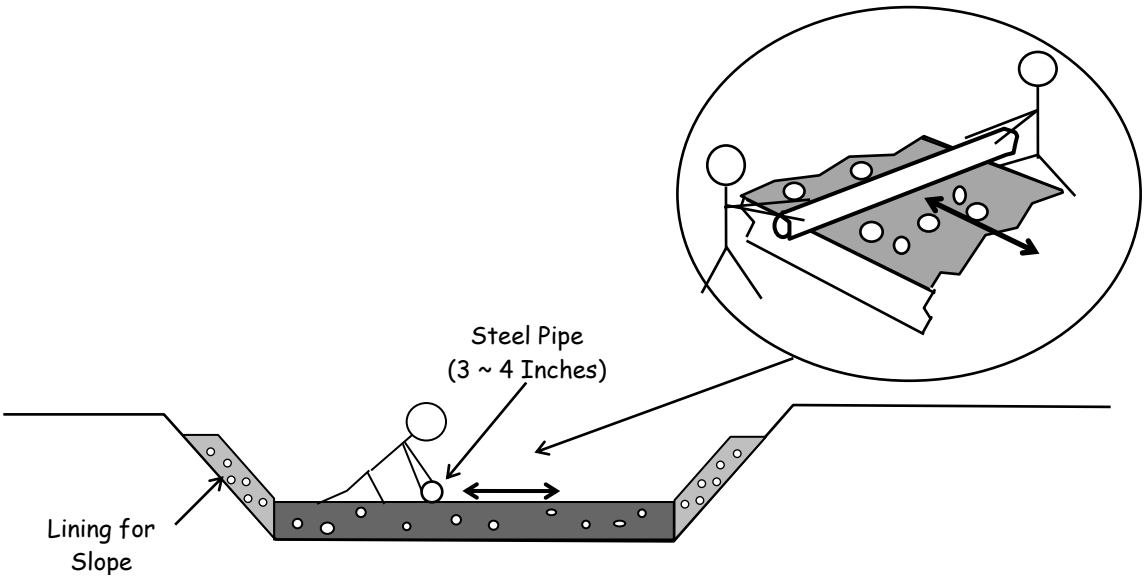
- Placing Lining Concrete:



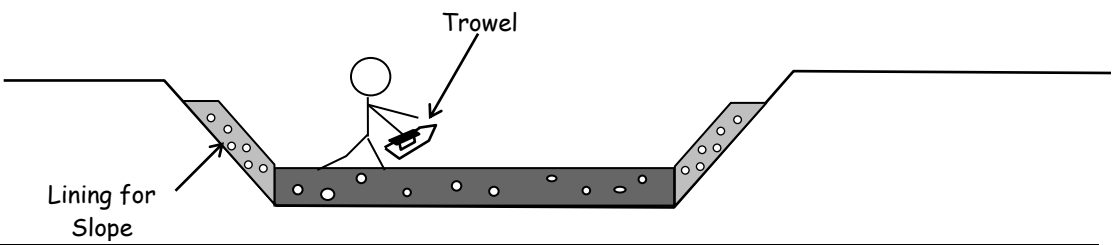
- Compacting Lining Concrete using Vibrating Plate with Spikes:



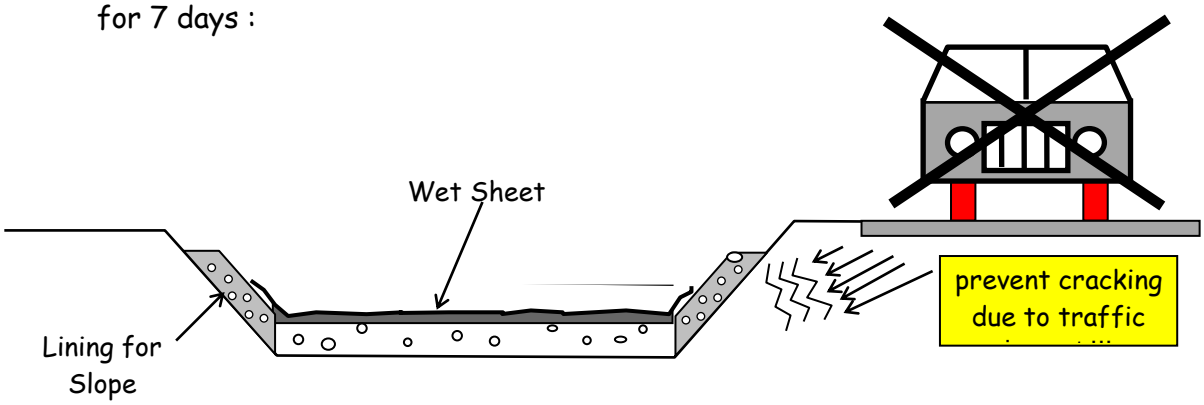
- Leveling Concrete Surface using Steel Pipe :



- Finishing using Trowel on the Flesh Concrete Surface:

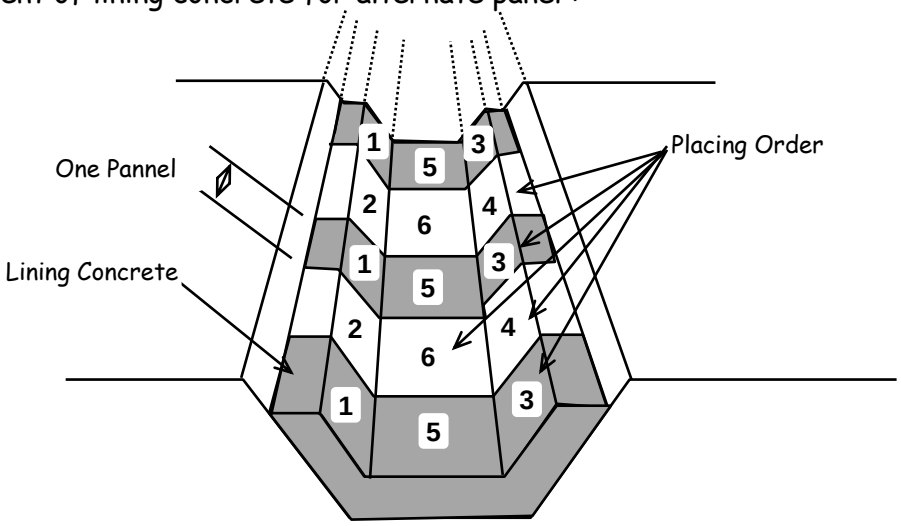


- Curing using Wet Sheet and No Heavy Trafic passing on the side Inspection Road for 7 days :



Concrete Placing Order

- Placement of lining concrete for alternate panel :



- Placing order of the concrete for the respective panels is as follows:

	Curing of Concrete Lining: In general, the placed concrete shall be cured after 2-3 hours* by means of moist curing and /or equivalent method for at least 36 hours. Note*: For night/ very clouded condition, it can be 6-12 hours

D Related Structures Works

The basic workflow of construction supervision & management is depicted as follows:.

In prior to start construction of related structures,

B-7. Final Excavation shall be checked (Depth & Elevation) and

B-8. Foundation Treatment (if necessary) and/ or Blinding/ Levelling Concrete shall be done. For Blinding/ Levelling concrete (checking "Top Elevation" is important),

D-1. R-bar/ Formwork arrangement

See Photo and "1. Pre-Placement Works" below for details as a common work procedure.

D-2. Base Concrete

See Photo documentation and "1. Pre-Placement Works" below for details as a common work procedure.

D-3. Joint Inspection of Bed EL

The Contractor shall implement setting-out along the canal route, identifying the right position of the structure, then carry out inspection of i) excavation works **(B-7)** ii) top elevation of blinding/ leveling concrete **(B-8)** and iii) top elevation of structure base **(D-3)**, so that the top of base concrete shall be set at the specified elevation as per the drawings (See Photo documentation below). **These inspection result in photo documentation (especially D-3) shall be used as "proof/ evidence" for a smooth IPC payment together with Measurement sheets.**

D-4. Walling/ Grooving/ Top Slab, etc.

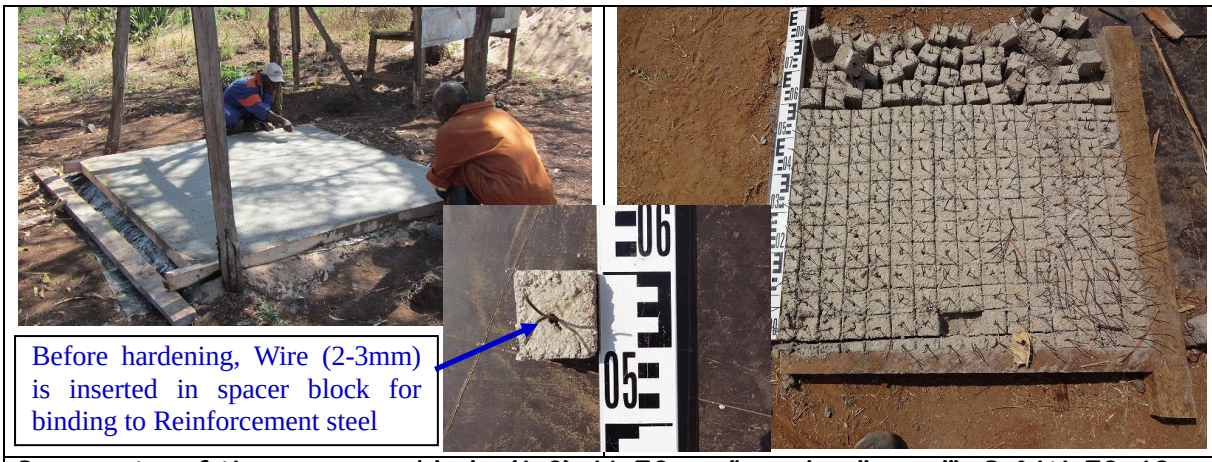
See Photo documentation "1. Pre-Placement Works" below for details as a common work procedure for walling.

D-5. Transitional Section Works

See page 3-85 "(d) Structural Works, 2) Structural Transition ".

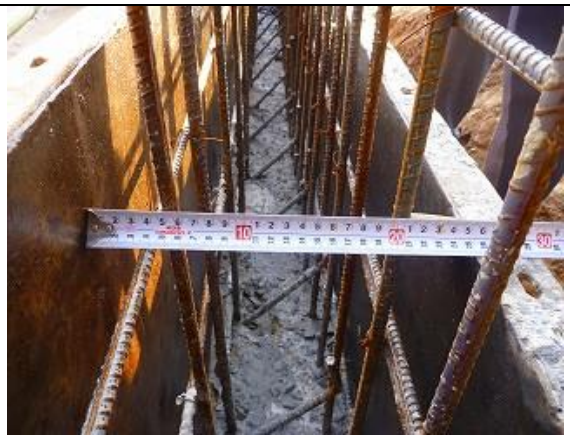
D-6. Backfill w/ Compaction

See C-5 as common works.



Preparation of Mortar spacer blocks (1:2), H=50mm (based on "cover"), B & W=50-60mm

	
B-7 Final excavation (depth & EL is checked)	Blinding Concrete placed first, then R-bar
	
D-1 Placing of R-bar with spacer block is set on top of blinding concrete	D-1 Placing of R-bars, setting specified spacing with formwork (footing)
	
D-1 Checking of R-bar spacing before placing base concrete/ footing concrete for wall	D-2 Placing of base concrete

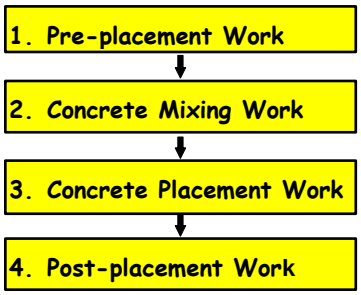
	
D-3 Joint Inspection of dimension, EL of base concrete/ footing before walling	**D-1, D-3 Inspection of R-bars spacing before placing formwork**
	
D-1 Preparation of formwork	**D-1 Placing of formwork around R-bar for walling**
	
D-1, D-3 Joint Inspection of spacing between R-bar and formwork before placing concrete wall	**D-4 Placing concrete for walling**

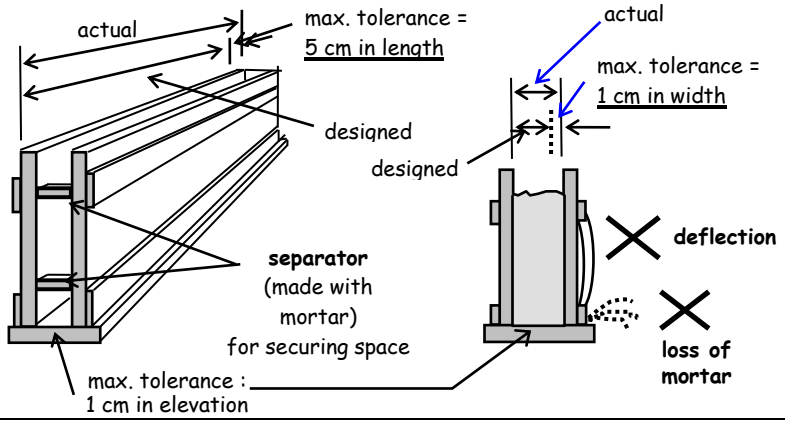
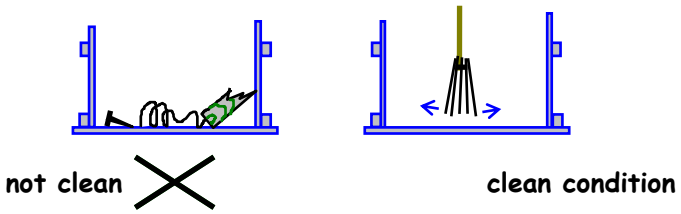
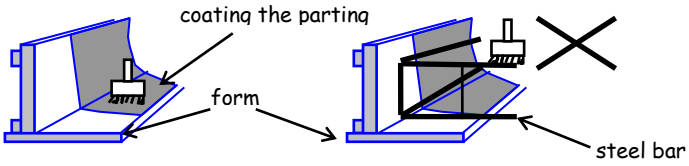
	
Curing of structure after placing concrete. Timing and duration is referred to "Curing" See below	**Preparation of formwork for Grooves**
	
Concrete Wall with Grooves must be placed before placement of concrete for transition section	**Wall of division structure with groove (before placing leaning concrete of transition section)**
	
A pair of Grooves shall be parallel to each other for a smooth operation of gate/ stoplog	**Transitional section between structure (vertical) and Canal lining (slanting/ leaning)**

1) Concrete Mixing and Placement Works

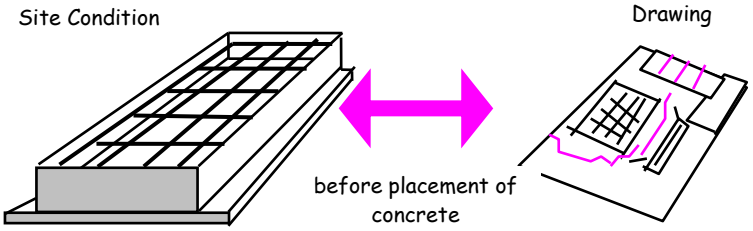
The concrete mixing works consist of the four major work components as illustrated in the right figure:

The details of the respective works and requirements for securing a good quality are as follows:



No.	Work Item	Explanation
1	Pre-placement Works **Form Work**	- The form shall be sufficient tight and properly braced. The max. tolerance is 1 cm in width and elevation, and 5 cm in length. - Spacers must be made of mortar and placed 2nos/m^2 for 4nos/m^2 
		➢ The inside of form shall be clean before placement of concrete. 
		➢ The release agent shall be coated on the form and such material shall not be painted on the reinforcement bar. 
		➢ The water stop shall be properly furnished and its joints shall be fastened together.
		➢ The form shall be wetted before a placement of concrete. 

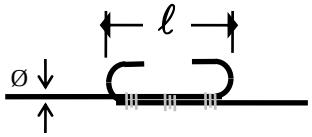
No.	Work Item	Explanation
	Reinforcement Bar Placing	Reinforcement bar shall be placed in accordance with the drawings.



check !!

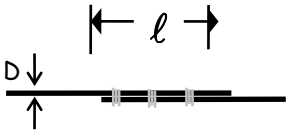
A length of the lap joint shall satisfy the specified length.

ℓ = **30 times of diameter** for **the case of with U hook**



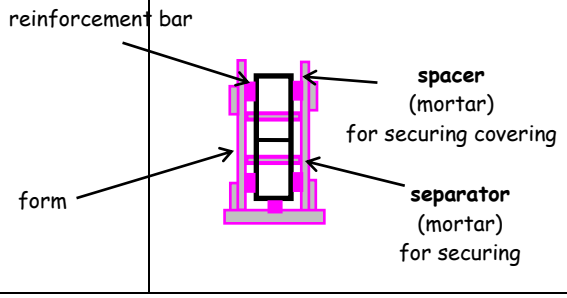
Diameter of Steel Bar (Ø)	Lap Joint (= ℓ)	
6	180	
8	240	
10	300	
12	360	
14	420	
16	480	
19	570	
22	660	
25	750	

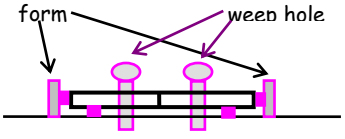
ℓ = **50 times of diameter** for **the case of without hooks**



Diameter of Steel Bar (D)	Lap Joint (= ℓ)	
6	300	
8	400	
10	500	
12	600	
14	700	
16	800	
19	950	
22	1100	
25	1250	

- Reinforcement bar shall be fastened together properly.
- Reinforcement bar shall free from mud, oil, grease and/or other contaminant.
- All embedded material shall be properly placed.



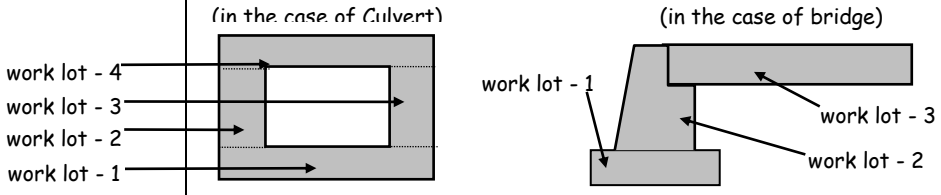


No.	Work Item	Explanation

The respective concrete tests shall be performed in accordance with the following frequency:

Concrete Test	Frequency	Remarks
Grading Test	once a lot	
Surface Moisture Test	twice a day	morning & afternoon
Slump Test	twice a day	morning & afternoon
Sampling for	3 specimens each	see following
Compression Test	for respective	illustration
	work lots or structural member	

Example of Work Lot



- A deviation of each test shall be as follows:

Slump Test

refer to the previous page.

Grading Test

- Fine Aggregate

Fineness modulus : 2.3 ~ 3.1

Grading : refer to the following table.

Sieve Size (mm)	Percentage (%)
0.15	2 ~ 10
0.3	10 ~ 30
0.6	25 ~ 60
1.2	50 ~ 85
2.5	80 ~ 100
5	95 ~ 100
10	100

- Coarse Aggregate

Fineness modulus : 6 ~8

Grading : refer to the following table.

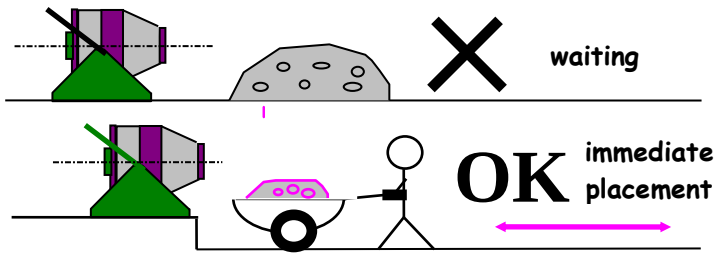
Size of Aggregate

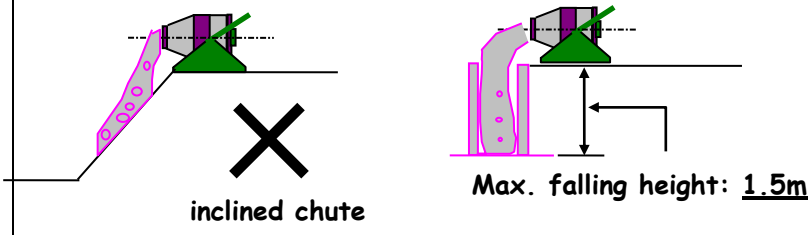
(40 ~ 5 mm)

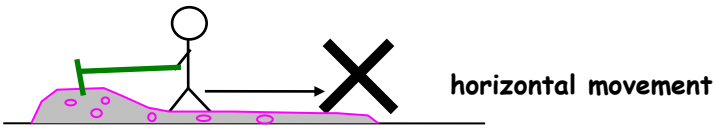
Sieve Size (mm)	Percentage (%)
5	0 ~ 5
10	10 ~ 30
20	35 ~ 70
40	95 ~ 100
50	100

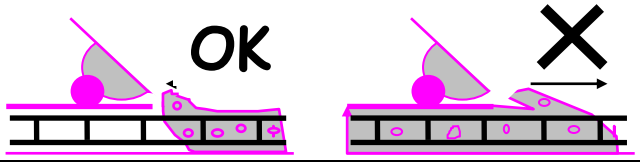
(40 ~ 80 mm)

Sieve Size (mm)	Percentage (%)
20	0 ~ 5
40	0 ~ 15
60	45 ~ 70
80	90 ~ 100
100	100

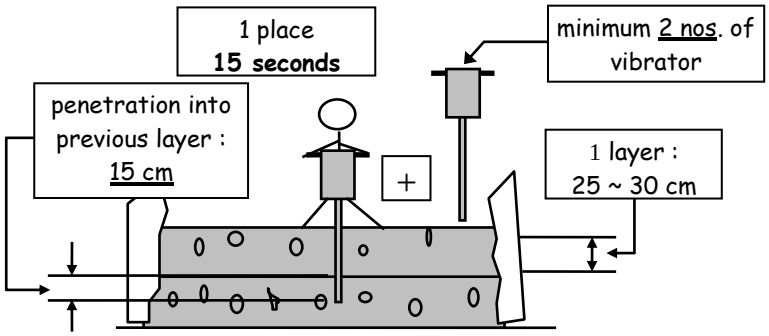
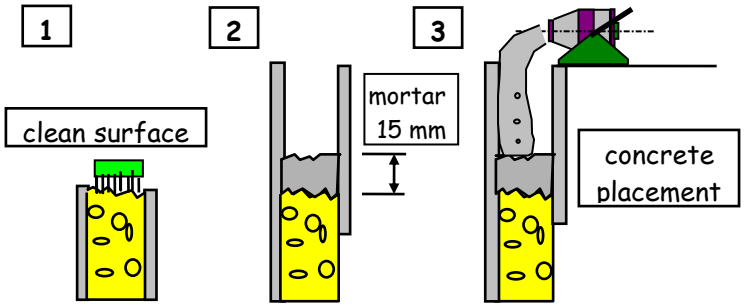
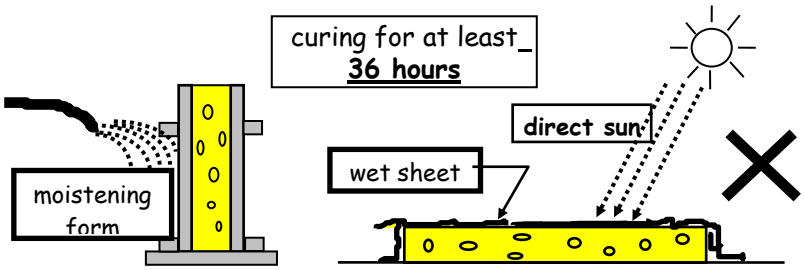
<table>
<tr><th>No.</th><th>Work Item</th><th>Explanation</th></tr>
<tr><td></td><td></td><td>
<u>Compression Test</u>
The minimum average compressive strength shall be equal to or more than the strength given by the following formula:
fcr = f'c/(1 -0.883 V)
where;
fcr = required minimum average compressive strength
f'c = design compressive strength
V = coefficient of variation expressed as a decimal
<table>
<tr><th rowspan="2">Type of Concrete</th><th colspan="3">Compressive Strength (kgf/cm2)</th><th rowspan="2">Coefficient of Variation (V)</th></tr>
<tr><th>Design (f'c)</th><th>Target (fcr)
Cube</th><th>Cylinder</th></tr>
<tr><td>AA</td><td>255</td><td>300</td><td>260</td><td>0.18</td></tr>
<tr><td>A</td><td>255</td><td>300</td><td>260</td><td>0.18</td></tr>
<tr><td>B</td><td>204</td><td>240</td><td>200</td><td>0.18</td></tr>
<tr><td>C</td><td>153</td><td>180</td><td>150</td><td>0.18</td></tr>
<tr><td>D</td><td>153</td><td>180</td><td>150</td><td>0.18</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Concrete Placement Work
Placing</td><td>
➢ The concrete shall be placed <u>immediately after mixing</u>.


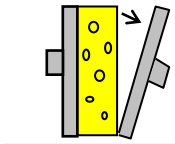
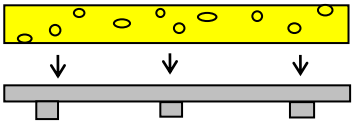
</td></tr>
<tr><td></td><td></td><td>
➢ A use of inclined chute shall be avoided as much as possible.
➢ The maximum falling height is <u>1.5 m</u> at maximum.


</td></tr>
<tr><td></td><td></td><td>
➢ The concrete shall not be moved to horizontal direction.


</td></tr>
<tr><td></td><td></td><td>
➢ The concrete shall be placed to the backward but not to the forward.


</td></tr>
</table>

No.	Work Item	Explanation
		➢ A thickness of one layer for vibrating compaction of concrete is around 25 ~ 30 cm. ➢ The vibrator shall be penetrated into the previous layer by 15 cm. ➢ The vibrating at one position shall not over 15 sec. ➢ A back-up vibrator shall be prepared on site. 
		➢ The maximum interval time of concrete placement at the construction joint shall be 2 hours and the surface of the previous concrete shall be free from laitance.. ➢ If the above interval is more than 2 hours, the cement mortar with a slump height of about 15 cm (1:3, w/c = 0.5) shall be put on the construction joint with a thickness of about 15 – 20 mm and the new concrete shall be immediately placed on it. In this case also the surface of the construction joint shall be **cleaned and thoroughly roughened or scrabbled by a stiff brush such as a wire brush (no smooth skin of concrete)** before placement of concrete. 
4	Post Placement Work **Curing**	➢ The placed concrete shall be cured after 2-3 hours* by means of moist curing and /or equivalent method for at least **36 hours**. Note*: For night/ very clouded condition, it can be 6-12 hours 

No.	Work Item	Explanation
	Removal of Forms	➢ The form shall not be removed at least for 2-4 days for side support (thick/ mass concrete – thin members) and 7 to 17 days for bottom support after a concrete placement. **removal of form**  side support : 2-4 days  Removal of props to slab: 9 days Beam soffits with props left under: 7days Removal of props to beam: 17 days TIPS: It is important concrete to achieve the following reference compressive strength before removal of the formworks Thick/ mass concrete members such as footings: 3.5 (N/mm^2) Thin concrete members such as column, wall beam: 5.0 (N/mm^2) Bottom of Slab, beams: 14.0 (N/mm^2)

The sample checking forms for the concrete works are attached in **Attachment 4.**

3) Minimum Requirements for Quality Control of Concrete Works

In order to secure the minimum quality of the concrete works, the Project Manager or staff of ZIOs and LGAs should pay a careful attention to the following checking points even in the very minor works:

- check of the reinforcement bar placement before placing concrete;
- check of dimensions and elevations, especially of elevations of the form work, before placement of concrete;
- careful check of proportion of concrete materials during the mixing work of concrete by weight or volume;
- check of the concrete slump;
- check of the preparation of at least 2 sets of vibrator;
- check of moistening of forms or provision of wet sheet during the curing period and removal time of forms.

【Output】

High quality concrete obtained by applying appropriate concrete mixing and placing

Schmidt Hammer Test for Concrete: Shown in the Attachment

Tolerance from Designed Dimension and Elevation

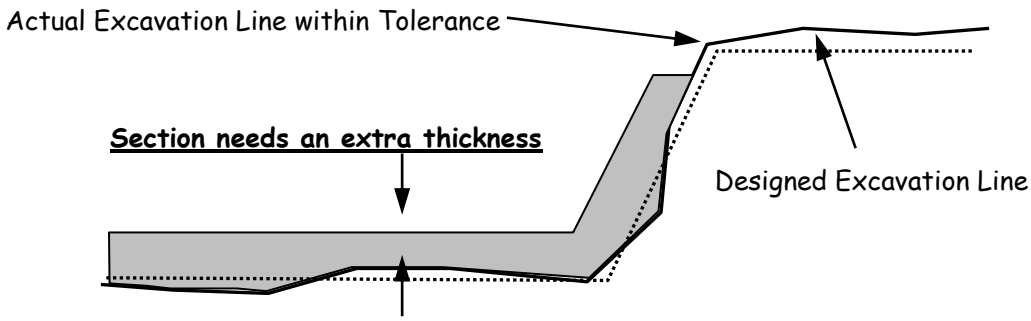
A general tolerance of dimension and elevation of the concrete lining is as follows:

Table 3.3 Tolerance of Lining Dimension/Elevation for Concrete lining

Items	Tolerance
Longitudinal Direction	**+ 2.5 cm/ -1.0 cm**
Elevation	**± 0.5 cm (± 1.5cm for 10m gradual)**
Thickness of Lining	**+ 2.5 cm/ -1.0 cm**

For Stone masonry works, + 10cm/- 2.5cm in dimension, same as above for elevation

In the case of the concrete canal lining, a thickness of concrete slab is very thin. In case the above tolerance is applied for the construction works under this condition, some parts of the lining thickness will become about **2.5 cm in the case of 10 cm thick lining works**, which would be easily damaged due to the uplift pressure and/or the water leakage. Such deviation usually caused by the minor undulation of the excavated soil surface of the lining foundation. Therefore, it is proposed to provide some centimeters of the extra thickness to the designed one as illustrated below:



【Output】

High quality in-situ concrete canal lining constructed in appropriate working procedure

(d) Structural Works

Structural works should be carried out focusing on elevations, dimensions and quality.

【Explanation】

1) Check of Structural Works

The important checking points in quality control of structural works are as follows:

- Elevation of the structure;
- Dimension of the structure; and
- Quality of the structure for securing durability and designed function.

The general tolerance in elevation and dimension for the structural works are as follows:

Table 3.4 Tolerance of Structure Works with Concrete/ Reinforced Concrete

Items	Tolerance	Remarks
Elevation	**± 0.5 cm**	
Dimension	**+ 2.5 cm/ -1.0 cm**	in the case of the gate and the measuring device: **± 1.0 cm**

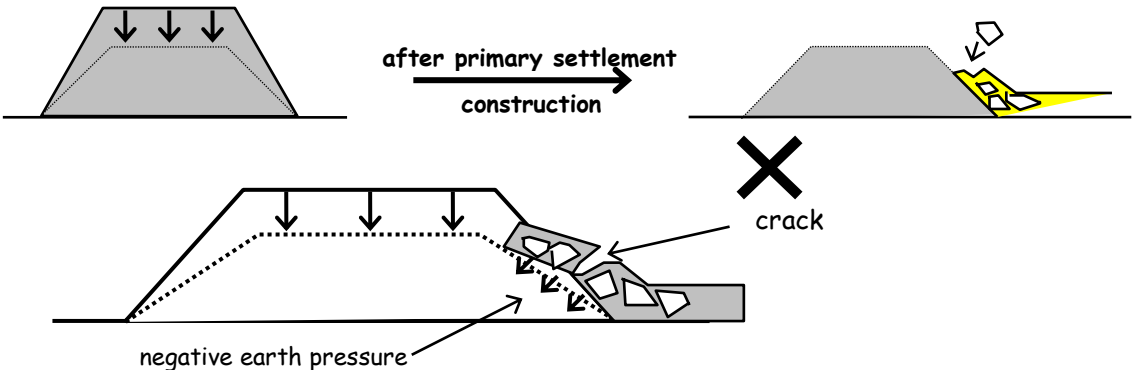
Regarding the function and durability of the structure, it should be checked through the site inspection immediately after a completion of structural works or during the running test. The sample checking forms for the irrigation structures are attached in the **Attachment 8** of this manual for the following structures:

Measuring Device (Broad Crested Weir)	Drop
Turnout	Chute
Check	Aqueduct
Pipe Culvert (1 pipe)	Siphon
Pipe Culvert (2 pipes)	Bridge
Box Culvert	Cross Drain

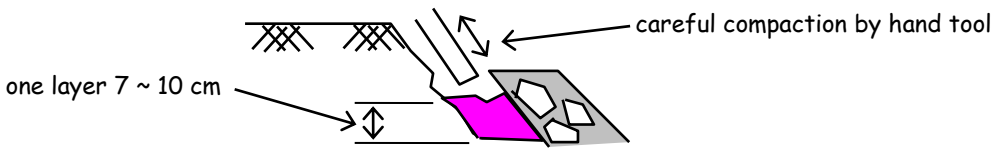
2) Structural Transition

Regarding the construction of the transition portion of the structure, it should be taken care on the following matters:

- Construction of the structural transition should be carried out after 1 to 2 months of a completion of embankment works for avoiding cracking in the transition wall due to the negative earth pressure caused by the primary settlement of the embankment.



- Backfilling for the transition should be placed and compacted in a thin layer with a thickness of 7 ~ 10 cm.
- Compaction of backfilled material should be carefully carried out to avoid a damage to the transition wall, especially compaction adjacent to the transition wall should be carried out by the hand tool.



【Output】

Canal Structures securing durability and designed function

Interim Payment to Contractors

The Project Manager will carry out joint measurement of achieved work quantities with the Contractor and to check the statement submitted by the Contractors. The statement will be recommended by the Project Manager and forwarded to the Employer/ IO for the payment. Joint inspection shall be carried out among the Project Manager, LGA team, the Contractor and the PC. Then the photo documentation shall be compiled by the Contractor under guidance of the Project Manager, as a supporting document to the measurement sheet and Interim Payment Certificate (IPC).

(12) Completion Stage

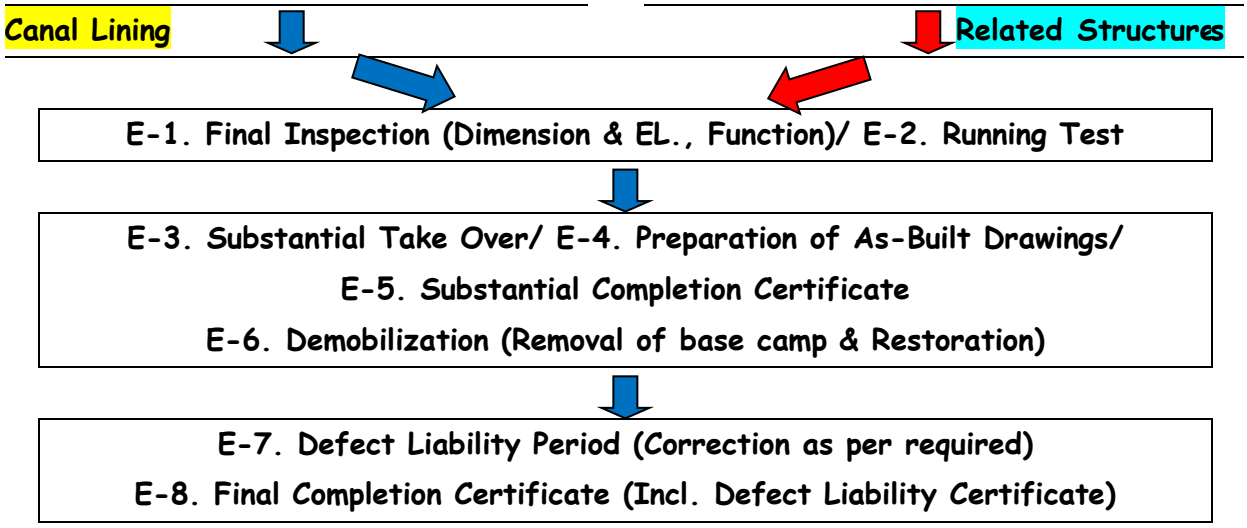
The basic approach and workflow of Completion Stage is depicted as follows:

1) Basic approach

The basic workflow of construction supervision & management is depicted as follows:.

- Through "Final Inspection", position, dimensions and quantity of the constructed structure will be confirmed/ checked as per the design drawings. Then, the "As-built drawing" will be prepared based on the final inspection results. In case as-built drawing is not available nor inadequate, guidance on preparation of as-built drawings technique will be provided;
- A consciousness will be brought up through the inspection that as-built drawings are important to be used for future maintenance as well as repair/ rehabilitation of the constructed structures; and
- It is very important and essential to properly compile and store as-built drawings both at the site and offices in charge, from the view point of the future proper maintenance management of constructed facilities. Therefore, current problems and solutions regarding as-built drawings will be summarized then reflected in the manual as an improvement plan (filing, preparation of pdf, etc.).

2) Basic Workflow



E-1. Final Inspection (Dimension & EL., Function)

Final inspection shall be conducted at the presence of the Employer's Representative, the Project Manager, and representative of the PC so as to confirm if the work is done properly according to the design and the technical specification. The list of outstanding works to be rectified will be prepared to conclude the work successfully.

(a) It is noted that Joint Inspection shall be conducted for detailed walk through, measurement and photo documentation among the Contractor and the Project manager, in prior to the Final inspection.

(b) It is also noted that the Joint inspection results shall be compiled as a dimension table(s), so as to utilized for a part of the As-Built Drawings, especially for long distant structures (e.g. canals, embankment) and structures with typical dimensions (e.g. division boxes, etc.).

E-2. Running Test/ Alternative Test

(a) The Contractor shall consult with the Project Manager, then prepare and submit detailed test procedures and schedules to the Project Manager for consideration and approval, at least one (1) month prior to Running Test/ Alternative Test for Verifications on Completion.

(b) The test procedure shall be determined based on the following condition:

i) Condition of the irrigation system (whether water source, main canal, secondary canals, etc. are connected from the upstream to downstream or partially disconnected);

ii) Condition of water source (whether required amount of water for running test/ alternative test is available at the time of the test, and/ or waiting until succeeding rainy season within the Defect Liability Period);

iii) Other condition such as irrigation method (continuous or rotational, etc.).

See Attachment 14 Sample Implementation of Running Test/ Alternative Test.

E-3. Substantial Take Over

The employer shall take over the Site and the Works within seven days after the Project manager issuing a Certificate of Substantial Completion. The Project Manager will also prepare Substantial Handing over Documents including O&M manuals and submit it to the Employer/ LGA so that the completed facilities can be handed over to the IO. A Completion Report shall be also prepared by the PM, based on the results of "E1 Final Inspection" and "E2 Running Test", respectively, and the concept of the report is as follows:

(a) Concept :

The purpose of any Completion report (or Commissioning report) is to mark the completion of the project and completion of construction pertaining to new or renewal of project and facilities assets by confirming that the essential

contractual and other project closure activities have been completed.

The report transfers the asset, deliverables and all ongoing administrative functions to the Employer and Project End User with the exception of the Defects liability period and its documented defect listing.

(b) Description and Procedure :

The Commissioning Plan may include the Functional Design Brief, Final Design Documentation and Basis of Design (if separate), Project Specifications, Commissioning Meeting minutes, Commissioning Issues log, Construction Checklists, Commissioning Forms, training materials, warranty listings, Post project function reports, lessons learned.

(c) Completion Report (or Commissioning Report) :

The Commissioning Plan may include the Functional Design Brief, Final Design Documentation and Basis of Design (if separate), Project Specifications, Commissioning Meeting minutes, Commissioning Issues log, Construction Checklists, Commissioning Forms, training materials, warranty listings, Post project function reports, lessons learned.

The Report captures the detail and analysis from the commissioning process and activities undertaken, namely outcomes from:

i) Running tests on-site (construction phase, including an alternative tests, when conducted);

ii) Full commissioning tasks at the end of construction (as part of the handover / takeover requirements), with stakeholder involvement;

iii) Project during defects liability;

iv) The Report should include all documentation recording that all project systems are complete, tested and operational. Records of all testing and design changes shall be provided, including material test results, and all unsuccessful tests with details on what was done to correct and finalise each item (eg adjustment of mix ratio,).

E-4. Preparation of As-Built Drawings

(a) The Project Manager may provide electronic data of Tender Drawings and other Drawings, to the Contractor after conclusion of Agreement, if the Contractor wishes those electronic data. If any changes due to the Site condition/ changes, variation and/ or instructions, the revised drawing shall be provided by the Project manager to the Contractor.

(b) Prior to substantial completion and Taking-Over of the Works, the Contractor shall carry out Joint Inspection with the Project Manager as As-built survey of the Works and shall prepare As-built Drawings based on this joint inspection and submit the As-built drawings to the Project Manager for approval.

(c) As-built drawings shall accurately represent the Works as constructed and show all dimensions and construction details, incorporating the effect of all Site changes, variations and instructions.

(d) For the canal/ embankment cross sectional drawings and typical structural drawing such as division structures, the Contractor shall attach the compiled dimension table(s)

See Attachment 17 Sample Project Completion Report.

E-5. Substantial Completion Certificate

Based on a request from the Contractor, the Project Manager will issue a Certificate of Substantial Completion and send its copy to the Employer, in prior to the "Final Completion Certificate". It is also noted that the introduction of the above system shall be comply with PPRA and its adoption and validity shall be clearly written in the Special Condition of Contract (SCC) to avoid any confusion among procurement entity and the Contractor.

E-6. Demobilization (include removal of base camp & restoration)

On completion of the Works, the Contractor shall clear the Site and remove all temporary buildings, equipment and debris. The Contractor shall level off and grade all areas used for haul roads and all building, store and workshop areas. The whole of the Site shall be left in a clean and tidy condition. Subject to any requirement of the Works whereby a permanent change is to be effected, all drains, canals, pipes, channels, water-courses or streams temporarily cut through or disturbed by the excavation of the Works are to be restored so that the water flowing in them may continue to flow in as full and free manner as it did before the disturbance.

E-7. Defect Liability Period

The Project Manager will give the Contractor due notice of intention to carry out any inspection during the defects liability period. The Contractor shall, upon receipt of such notice, arrange for a responsible representative to be present at the times and dates named by the Project Manager. This representative shall render all necessary assistance and shall take note of all matters and things to which his attention is directed by the Project Manager.

See Attachment 18 Sample documentation for Defect Liability Period.

E-8. Final Completion Certificate

Based on a request from the Contractor, the Project Manager will issue a Certificate of Completion and send its copy to the Employer.

The Project Manager will also prepare Handing over Documents including O&M manuals and submit it to the Employer/ LGA so that the completed facilities can be handed over

to the IO.

In order to issue the Completion certificate, following works shall be conducted and confirmed on the final completion of the Works.

(a) Final Account Procedure

i) Site inspection;

ii) Summary –BoQ items;

iii) Remedial procedure/instruction from PM(specify exactly what to be done or what was not done/incomplete and set the time frame for remedial activities;

iv) Issue Final Completion certificate by using *GCC* 58.1, 59.1 and 60.1.

(b) *GCC* E. Finishing the Contract

58.	Completion Certificate	58.1	The Contractor shall request the Project Manager to issue a certificate of Completion of the Works, and the Project Manager will do so upon deciding that the work is completed.
59.	Taking Over	59.1	The Employer shall take over the Site and the Works within seven days of the Project Manager's issuing a certificate of Completion.
60.	Final Account	60.1	The Contractor shall supply the Project Manager with a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Project Manager shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Project Manager shall issue within 56 days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the Project Manager shall decide on the amount payable to the Contractor and issue a payment certificate.

4 Cost Control

(1) Objective

Cost control aims at timely and proper payment to the Contractor.

【Explanation】

Cost control is a material component in construction supervision in order to avoid a delay in construction works by means of timely and proper payment to the Contractor and also to grasp the progress of the works.

Cost control is expected to be made on the monthly basis based on the monthly statement which is prepared and submitted by the Contractor.

The Project Manager or staff of ZIOs and LGAs shall know the actual expenditures at any time during the construction period.

【Output】

Timely and proper payment and clarified actual expenditures

(2) Advance Payment

Advance payment will be provided, if requested by the Contractor for him, with the purpose of paying foe equipment, plant, materials and mobilization required for execution of the Contract.

【Explanation】

The Employer shall make advancement to the Contractor of the amount stated in the Special Conditions of Contract (generally ten (10) % of the contract amount) by the date stated in the Special Conditions of Contract (generally ten (10) % of the contract amount) by the date stated in the Special Conditions of Contract (generally within twenty one (21) days), against provision by the Contractor of un Unconditional Bank Guarantee in an form and by a bank acceptable to the Employer in amount and currencies equal to the advance payment.

The advance payment shall be repaid by deducting proportionate amounts from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis.

Thus, the Project Manager or staff of ZIOs and LGAs should keep this deduction from payments to the Contractor in mind.

【Output】

Need of deduction of proportionate amounts from payments

(3) Retention Money

Retention money will be deducted from each payment due to the Contractor until completion of the whole of the Works.

【Explanation】

The Employer shall retain from each payment due to the Contractor the proportion stated in the Special Condition of Contract (generally ten (10) % of value of works of

payment certificate), until completion of the whole of the Works. On completion of the whole of the Works, the Employer shall repay the half of the total amount retained to the Contractor, and the remaining half when the Defects Liability Period has passed and the Project Manager has certified that all Defects notified by the Project Manager to the Contractor before the end of this period have been corrected.

The Project Manager or staff of ZIOs and LGAs shall pay attention to this deduction from payments to the Contractor.

【Output】

Need of deduction of proportionate amounts from payments

(4) Control by Monthly Statement

Actual expenditures can be known by analysis on the monthly statement from the Contractor.

【Explanation】

As explained in "Progress Control", the monthly statement can be used for cost control of the project. Namely, the progress of each activity (work portion) is plotted on a graph with the completion period on the horizontal axis and the corresponding cost (or % of the total construction cost) on the vertical axis, so as to form a graph on monetary basis. Then, the construction period is divided by calendar month, and the cost corresponding to the works completed in each activity (work portion), say monthly statement, is added up for each month to obtain a planned progress curve for the entire project. From this graph, it can be acknowledged whether the actual expenditures so far are as scheduled or not.

【Output】

Cost control by monetary basis graph

(5) Changes in the Quantities

The Project Manager shall carefully approach to the adjustment of rates by changes in the quantities.

【Explanation】

The General Conditions of Contract clearly state the adjustment of rates by changes in the quantities in the following case:

"If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than 25%, provided the change exceeds 1% of the Initial Contract Price, the Project Manager shall adjust the rate to allow for the change".

However, the adjustment of the rate from changes in quantities shall not be considered if thereby the Initial Contract Price is exceeded by more than 15% except with the prior approval of the Employer.

Thus, the Project Manager or staff of ZIOs and LGAs shall carefully approach to this matter.

【Output】

Proper judgment on adjustment of the rate by changes in the quantities

(6) Price Adjustment

The amount payable to the Contractor shall be adjusted in respect of the rise or fall in the cost of labor, Contractor's equipment, plant, materials, and other inputs to the Works.

【Explanation】

The adjustment to be applied to amount payable to the Contractor as certified in Payment Certificates shall be determined using the formulae for each of the currencies in which the Contract Price is payable. The formulae to be applied are stated in the General Conditions of Contract. The price adjustment factors to be used in the formulae are also specified in the General Conditions of Contract and the Appendix to Tender. The Project Manager or staff of ZIOs and LGAs shall therefore scrutinize the relevant clauses in the General Conditions of Contract and the Appendix to Tender.

【Output】

Proper application of price adjustment

(7) Liquidated Damages

The Contractor shall pay the liquidated damages to the Employer at the rate per day for each day that the Completion Date is later than the Intended Completion Date.

【Explanation】

The liquidated damages will be paid to the Employer at the rate per day as stated in the Special Conditions of Contract (generally 0.1% of the contract price per day) when the Works could not be completed by the Intended Completion Date. The Employer may deduct the liquidated damages from payments due to the Contractor. If the Intended Completion Date is extended after having paid the liquidated damages, the Project Manager shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate.

Therefore, the Project Manager or staff of ZIOs and LGAs shall keenly check the progress of the Works when coming closer to the Intended Completion Date.

【Output】

Proper payment for liquidated damages by the Employer

(8) Dayworks

The Contractor is entitled to be paid for Dayworks subject to obtaining the signed Dayworks forms approved by the Employer.

【Explanation】

The Daywaorks rates in the Contractor's tender shall be used for small additional amounts of work only when the Project Manager has given written instructions in advance for additional work. The Contractor is requested to record all work to be paid for as Dayworks on forms approved by the Project Manager. Each completed form shall be verified and signed by the Project Manager within two (2) days of the works being done.

Therefore, the Project Manager shall carefully keep the payment as Dayworks in mind to make proper cost control.

【Output】

Payment for Dayworks by the Employer in proper procedure

(9) Cash Flow Forecast

Cash flow forecast is useful for timely payment to the Contractor as one of cost control.

【Explanation】

The Contractor shall provide the cash flow forecast to the Project Manager to realize the smooth payment to the Contractor, and to avoid any delay in the Works accordingly. Whenever the Programme is updated the Contractor is requested to submit the updated cash flow forecast to the Project Manager. The cash flow forecast shall include different currencies as defined in the Contract, converted as necessary using the Contract exchange rates.

【Output】

Timely payment to the Contractor by arranging the budget based on the cash flow forecast

5 Safety Control

(1) Objective

Objective of safety control is to promote the comfortable working conditions by ensuring safety and health for labors at working site.

【Explanation】

It is essential to ensure safety and health for labors at working site. If these are neglectful, there is negative possibility that the steady work progress and appropriate work quantity might not be realized thereby. In order to avoid such situations, the following activities should be carried out by the Contractor:

- Provision of good working condition: To create healthy and desirable working condition for labors
- Check of equipment and tools: To make safety check of equipment and tools prior to use of them
- Improvement of working method: To adopt more safety working method
- Use of safeguard tools: To use of safeguard tools whenever dangerous job is executed
- Permeation of safety education: To give the widest possible publicity to the regulations of safety and hygiene

【Output】

Recognition of need of safety and hygiene by the Contractor

(2) Information to the Contractor

The Employer shall inform the Contractor of execution of necessary actions for safety and hygiene of the Contractor staff and labors.

【Explanation】

Prior to commencement of the Works, the Employer shall confirm the Contractor to carry out the following actions on safety and hygiene matters:

- To take all reasonable precautions to maintain the safety and health of his staff and labors at during the construction period
- To ensure that first aid facilities are available at all times at the site and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics
- To notify the Employer details of any accident as soon as practicable after its occurrence
- To maintain records and make reports concerning safety, health, and welfare of persons, and damage to the property
- To conduct an HIV-Aids awareness programme, and to take other necessary measures to reduce the risk of transfer of HIV virus between and among the Contractor personnel, the Employer's staff and the surrounding community.

【Output】

Timely and suitable actions taken by the Contractor on safety and hygiene

Emergency information flow chart shall be prepared by the Contractor, in case of accident occurrence

(3) Monitoring

The Employer shall monitor the Contractor's actions taken for safety and hygiene at the site to remind the Contractor of them at any time.

【Explanation】

The Employer shall remind the Contractor of need of actions for safety and hygiene for his staff and labors, through the weekly and monthly meetings. In the meetings, the Contractor shall report the Project Manager what kinds of activities are taken for safety and hygiene and also the accidents if any.

【Output】

Permeated safety and health recognition through monitoring

Sample forms for safety management are listed in the Attachment

10a_Safety Instruction for the Safety, Sanitary and Environment management to the Contractor

10b_Safety Management Check List

6 Environmental Control

(1) Objective

Objective of environmental control is to make the Contractor recognize the need of consideration to be given to the countermeasures for minimizing the public pollutions by construction work.

【Explanation】

The Contractor shall take all reasonable steps to protect and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations.

Prior to commencement of the Works, it is important that the Contractor shall explain inhabitants about the construction works if necessary, in order to obtain understanding and cooperation of them.

【Output】

Recognition of need of protection of environment by the Contractor

(2) Information to the Contractor

The Employer shall inform the Contractor of execution of necessary actions for protection of environment

【Explanation】

Prior to commencement of the Works, the Employer shall confirm the Contractor to give a care on the following matters in order to protect the environment:

- Noise: Pile driver, Breaker, Compressor, Concrete Plant, Bulldozer, Excavator, Concrete Cutter
- Vibration: Pile driver, Compacter
- Water Contamination: River training works, Headworks, River Crossing Structures
- Drying up of Groundwater: Pump up of groundwater
- Land Subsidence: Pump up of groundwater
- Damage of Houses: Land Subsidence, Falling of Construction Materials, Collapse by falling equipment
- Dust: Passing of Dump Trucks, Earthworks by Equipment

【Output】

Construction works friendly to the environment.

(3) Monitoring

The Employer shall monitor the Contractor's actions taken for protection of environment at the site to remind the Contractor of them at any time.

【Explanation】

The Employer shall remind the Contractor of need of actions for protection of environment, through the weekly and monthly meetings. In the meetings, the Contractor shall report the Project Manager what kinds of measures are taken for protection of environment.

【Output】

Permeated recognition of protection of environment through monitoring

Sample form for environment control/ management is listed in the Attachment

10a_Safety Instruction for the Safety, Sanitary and Environment management to the Contractor

(also used for "safety Management")