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Republika ng Pilipinas

Pambansang Pangasiwaan ng Patubig

(NATIONAL IRRIGATION ADMINISTRATION)

Lungsod ng Quezon

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OUR REFERENCE:

Memorandum Circular No. 17, s. 1998

TO : **THE DEPUTY ADMINISTRATOR; ASSISTANT ADMINISTRATORS; HEADS OF DEPARTMENTS AND STAFFS; REGIONAL IRRIGATION MANAGERS; OPERATION MANAGERS; PROJECT MANAGERS; PROVINCIAL IRRIGATION OFFICERS; IRRIGATION SUPERINTENDENTS; AND ALL OTHER CONCERNED**

SUBJECT : **MANUAL ON CONSTRUCTION METHODOLOGY AND QUALITY CONTROL.**

This Manual on Construction Methodology and Quality Control has been prepared in order to achieve proper and uniform construction methods and to attain the desired quality standards of irrigation structures. This manual shall be given widest dissemination so that the lowest supervisors, such as the construction foremen, shall have access to this publication as their reference and guide.

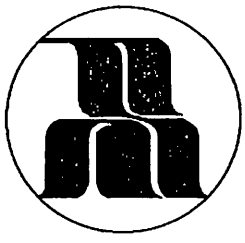
This manual likewise form part of the standard specifications for all Civil Works and shall be so referred to as part of our contract documents.

For guidance and strict compliance.

MANUEL S. AREVALO
Administrator

November 12, 1998

REPUBLIC OF THE PHILIPPINES
National Irrigation Administration



CONSTRUCTION METHODOLOGY AND QUALITY CONTROL MANUAL FOR IRRIGATION CIVIL WORKS

Prepared by:

Project/System Monitoring Team

October 1998

FORWORD

The Project/System Monitoring Team in the course of their inspections of completed and on-going new constructions repair and rehabilitation Projects have seen the need for the vigorous enforcement of Quality Control Specifications. Construction Methology and Quality Control have been paid lip service in the field primarily because NIA lacks the supervisory personnel to enforce our specifications on quality control. The strength and durability of our irrigation structures most often, suffer due to this management deficiencies.

The publication of this Manual on Construction Methods and Quality Control will address the problems on the enforcement of our specifications on these subject matters. The very simple presentation of Work Methods, and the very simple testing procedures in quality control, will enable our lowest field supervisors to understand and fully implement our methodology and Quality Control Specifications. By making this manual available in the field offices will provide our supervisors with ready reference and guide as to our requirements to attain the standards of our construction. The importance of this manual therefore cannot be over emphasized.

B/Gen. PROTACIO L. DEPAKAKIBO
Technical Assistant A
Co-Team Leader, PSMT

ALEJANDRO R. CRUZ
Department Manager
Team Leader, PSMT

Chapter 1

Introduction

Good quality in the construction of irrigation facilities is one of the major concerns of the administration. Improving the quality of work in all aspects of the civil works will result in more savings of scarce resources in the form of longer lasting structures and lesser maintenance.

This manual was prepared as reference material for construction inspectors and supervisors to help achieve the quality works and improve control procedures & techniques in the construction of irrigation and related infrastructure facilities. It provides practical construction methods for quality control in the field. The criteria embodied in this manual are patterned from international standards, however, if some criteria are different from technical specifications, the technical specifications shall be followed to avoid misunderstanding with the contractors.

Based on the above basic concept, this manual emphasizes the following:

1. the use of practical manner in enforcing quality control measures in the field with illustration, especially for embankment and concrete works; and

2. the use of various sample checking forms for field quality control works.

This manual consists of five (5) chapters dealing specially on the above considerations, to wit:

1. Introduction;
2. Objectives of Quality Control;
3. General framework of Quality Control;
4. Organization for Quality Control; and
5. Detailed explanation on the Quality Control Procedures and Techniques for certain works.

The main part of this manual is Chapter 5 which provides the explanation and description of practical quality control procedures and techniques, while Chapters 1 through 4 deal with the general concept of quality control works.

Chapter 2

Objectives

2.1 Objective of and Quality Control

The objective of quality control is to be assured of the designed quality of constructed infrastructure through dedicated field inspection and supervision and rigid laboratory and field control testing. In order to achieve this objective, the execution and enforcement of the various quality control measures is indispensable during construction period.

It is the Agency's experience that in the construction of irrigation facilities, the defects in the head works down to the level of the on-farm facilities affect the delivery of irrigation water to the end-users. These defects reduce project benefits and may induce serious social problems to the farmer-beneficiaries. To avoid these situations, it is important during the construction stage to undertake and enforce an intensive quality control works giving special attention to the following:

1. selection and use of the desired quality of construction materials;
2. employment of appropriate construction methods and procedures;
3. enforcing appropriate construction methods and quality control techniques and procedures; and
4. detecting and correcting construction defects through the conduct of close and rigid field inspection/supervision.

In most cases, the quality of the constructed facilities could be secured at a reasonable level through the strict enforcement of the above measures. However, in the case of irrigation facilities, wherein simultaneous construction activities are on-going for large number of canals and structures scattered within the project's service area, all the defects may not be detected and/or corrected by the enforcement of quality control measures during the construction period. To ensure the final acceptable quality of irrigation facilities, those uncontrolled defects should be improved during the trial operation or during the warranty period. It is therefore necessary that the project supervisor shall carry out carefully the appropriate facility check even after the completion of the construction works in order to correct the construction defects during the transition period prior to the full operation of the irrigation system.

2.2 Scope of this Manual

The field supervisors who are engaged in the daily field quality control works are enjoined to implement the quality control measures embodied in the manual. The main emphasis therefore is for field supervisors/inspectors to put in place in the field, the concept of quality control as illustrated in the sketches or drawings showing the practical quality control procedures and methods. Further explanation on the detailed theories on the quality control is beyond the scope of this manual.

2.3 Applicability of Quality Control Techniques and Procedures

Due to the varying degree of construction works from large scale to a small scale irrigation projects, it is extremely difficult to prepare a quality control manual that is applicable to all types of construction works. It is suggested therefore that each project manager must establish laboratory/field test and/or appropriate field check procedures for quality control taking into account the varying scale of construction activities.

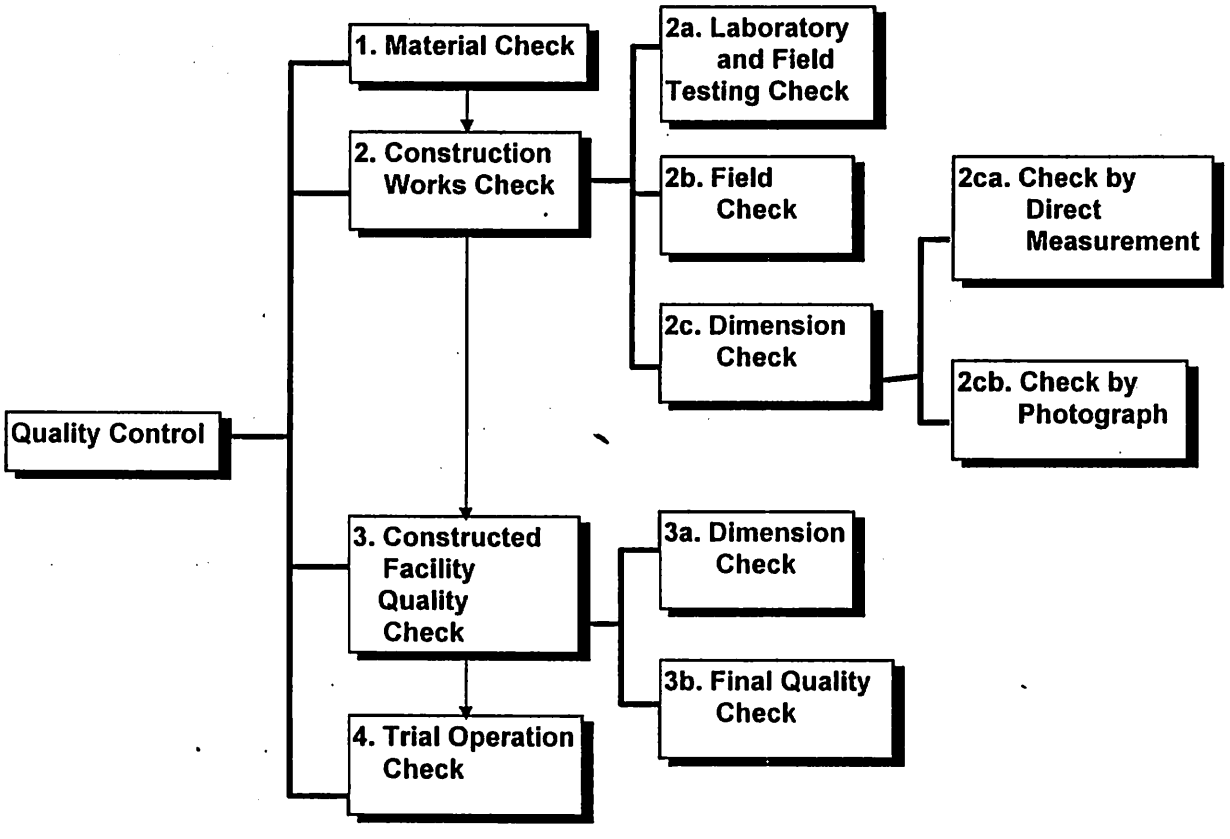
Chapter 3

General Framework of the Quality Control

Quality control consist of the operational techniques procedures and activities that are to be undertaken to achieve the desired quality of the works. These include design checks, tests carried out during construction, sample tests on materials, calibration of machinery and testing equipment or production of required test certificates. Quality control provides indicators at various stages of the project to ensure that the requirements of specifications are being met. It gives feedback and makes possible the early detection of defects which require attention or correction.

3.1 General

The major framework of the quality control is illustrated below:



Among the quality control work items mentioned above, items No. 1 through 3 are conducted during the construction period and item No. 4 is conducted during the warranty or initial operation period.

Item No. 1 and No. 2 are carried out by the combination of field tests/checks and laboratory tests. In most cases, the conduct of such tests may not be possible in timely manner due to lack of testing equipment and facilities near/around the project sites. In such cases, at least the tests for the major work components such as the soil test, checking concrete materials and checking construction methodology should be carried out to attain the minimum requirement for the desired quality of the irrigation facilities.

Basic definitions for the respective quality control work items are explained in the following sub-paragraphs.

3.2 Material Quality Check

Material as used in this manual means the basic material for construction such as soil, fine aggregate, coarse aggregate, cement, etc. These materials shall at least satisfy the conditions and requirements specified in the Technical Specifications. Material control is extremely important for insuring the durability of constructed facilities. For instance, earthfill material with a low shearing capacity would easily induce sliding of the canal slope during water delivery, or poor concrete materials like a poorly-graded aggregates would result to low concrete strength.

It is recommended that a periodic examination and selection of construction materials shall be undertaken before the commencement of the Work and during the actual concreting operations. Selection of materials should be carefully made in accordance with the instructions indicated in Chapter 5.

3.3 Construction Works Check

Construction Works Check includes the following:

- Checking concrete by conducting tests on the fresh and hardened concrete.
- Checking the method of mixing concrete in the field.
- Checking the usage of vibrator for concrete placement.
- Checking water content of earthfill material.

The quality control work under this category consists of the following:

(1) Laboratory Tests;
(2) Site Supervision; and
(3) Checking the dimension of the component parts of the structure:
    - by the Direct Measurement; and
    - by the use of Photograph

Through laboratory tests, the basic quality of construction works can be attained at an acceptable level, while the construction methods and workmanship could be achieved through site supervision in the field. Dimension Check should be undertaken in a timely manner by means of the direct measurement or by the use of photograph to minimize the deviation of canal/structural dimension and elevation from the construction drawing.

In case the checking and/or testing results of some Works do not satisfy the specified criteria, such Works should be demolished and constructed again to ensure that they meet the specifications of the facilities. Without any favorable test/check results no certification should be issued to the contractor.

The following works should be strictly controlled during construction period:

i) earthfilling/embankment works for canals;
ii) concrete placement works for canal lining and structures; and
iii) masonry works.

3.4 Constructed Facility Quality Check

Constructed Facility Check means the quality control to be conducted for constructed facilities in order to check the final quality of works during the actual operation of the structure. This check work is divided into two categories, namely, the Dimension Check and Quality Check.

3.4.1 Dimension Check

The Dimension Check is conducted for the purpose of checking the dimensions/sizes of major parts of the structure and canal to ensure that the constructed structure meet the designed dimensions. It should be kept in mind that every part of the structure/canal is designed considering its stability, durability and function. Strict control to ensure proper dimensions of the constructed structure is indispensable for attaining the designed function and structural safety.

For example, the insufficiency of the thickness of retaining wall may result in an overturn of the wall; and the insufficiency of canal embankment width may cause the leakage of water.

3.4.2 Final Quality Check

The constructed facilities should be checked for its final quality after completion of the structure whether the facilities could function as designed or not. The typical checking items of this work are a check of function of the structures, a check on the finishing works, the leakage test/check for canals and structures, and so on. This final quality check should be conducted for all the structures and canals immediately after completion of construction activities. To finally confirm the functionality of the structure, the test run should be undertaken at the end of the construction period.

Unless major part of canals and structures can pass this check/test, the completion certificate should not be issued to the contractor.

3.5 Trial Operation Check

Latent and some patent defects could not be detected even after the execution of the above mentioned quality control work due to a large number of canals/structures scattered in the large area. These defects should be detected through the operation during the warranty period. This is the final quality check of the constructed facilities, therefore, it is necessary that a careful re-check of facilities should be made during this period. After the repair of all the detected defects during this warranty period, the project office may release all the contractors on their responsibility for the works.

Chapter 4

Organization for Quality Control

4.1 General

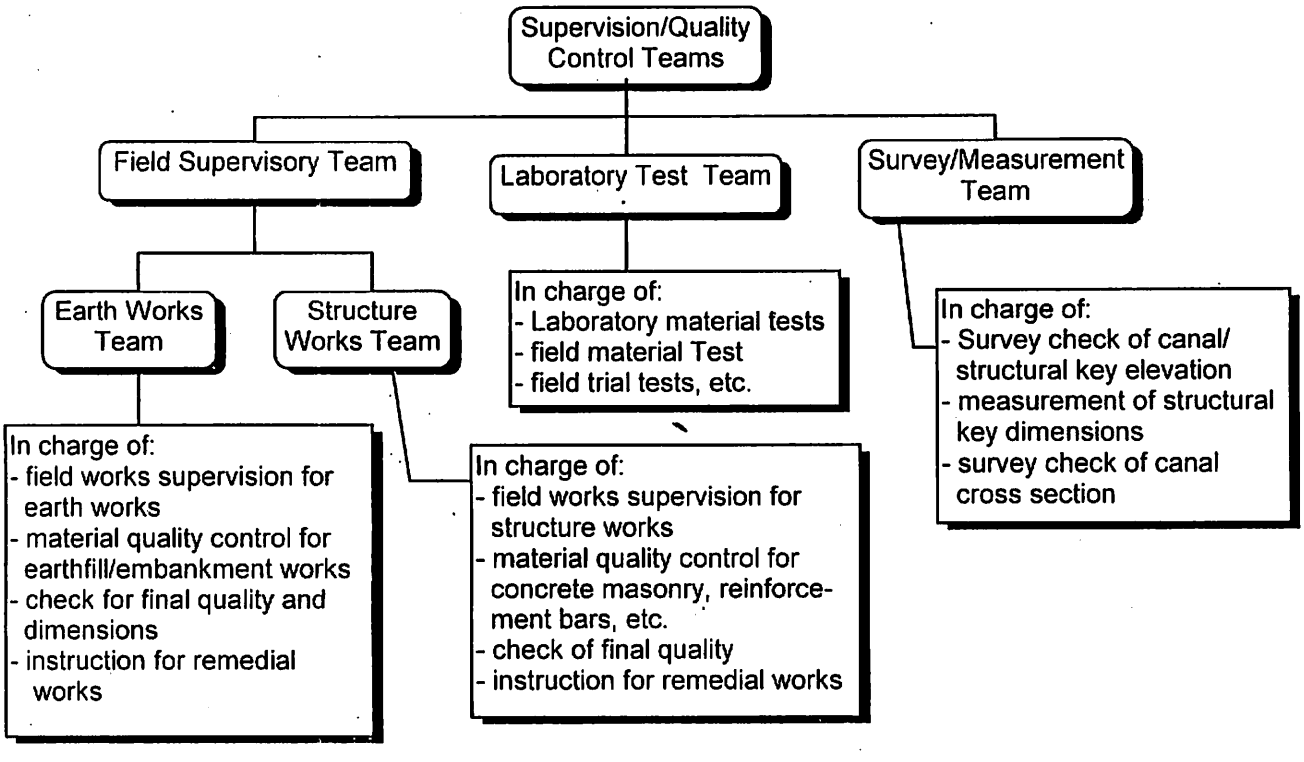
This chapter provides a basic idea for a typical organization and mechanism for execution of the quality control work in the respective field offices. Due to the limited number of available personnel qualified to undertake the quality control function, it would be necessary to establish an effective and efficient organization and system for the quality control work in each project. In this regard, this chapter discusses:

- organization
- number of staff
- timing for staff input

4.2 Organization

The organization of quality control work may be composed of three major working teams, namely; i) Field Supervisory Team; ii) Laboratory Test Team; and iii) Survey/Measurement Team.

An illustration of the above organization and the main duties of the respective teams are illustrated below:



Due to a limited number of supervisory staff personnel, a good arrangement of staff deployment for certain supervisory work would contribute to the realization of good quality control in the field. Ideally, an assignment of at least one supervisor for every construction site is the most effective manner for securing good quality. As it may be

hardly possible to do so for almost all the project, an effective staff deployment plan should be considered.

The following indicates the number of the supervisors to be assigned to the respective work sites for satisfying a standard requirement of quality control:

(Earth Works)

- for embankment works site	1 supervisor for 1 or 2 adjacent work sites;
- borrow pit works	1 supervisor for 1 or 2 adjacent borrow pit sites;
- for excavation works site	1 supervisor for 3 ~ 4 adjacent work sites;

(Structure Works)

for ordinary works	1 supervisor for 3~4 adjacent work sites except for the works which require intensive quality control such as concrete placement work, etc.;
for intensive control works	1 supervisor for 1 work site;

(Field/Laboratory Testing Work)

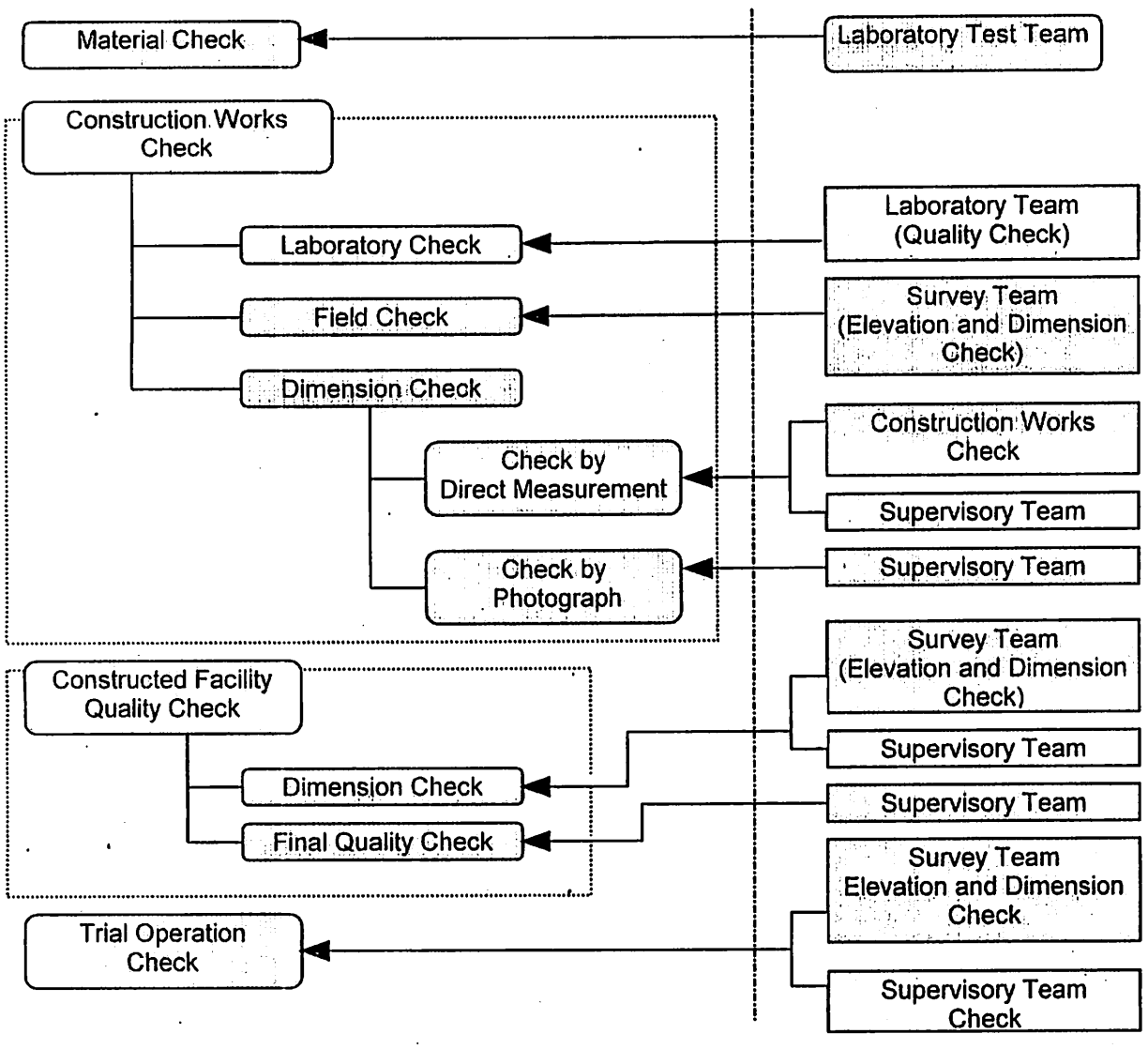
number of staff	1 team with at least 1 expert or junior expert and 2 ~3 supporting staffs,
number of team	subject to number of working sites, at least required 2 teams consisting of 1 team for earth works and 1 team for concrete works;

(Survey Work)

- number of staff	1 team with at least 1 surveyor and 2 ~ 3 supporting staffs
- number of team	subject to number of working sites, at least required 2 teams consisting of 1 team for canal check and 1 team for structural check

4.4 Team Obligation

The duties of the quality control teams at each construction stage are indicated in the following illustration:


Quality Control Item
Quality Control Team
Material Check
Laboratory Test Team
Construction Works Check
Laboratory Check
Laboratory Team (Quality Check)
Field Check
Survey Team (Elevation and Dimension Check)
Dimension Check
Construction Works Check
Check by Direct Measurement
Supervisory Team
Check by Photograph
Supervisory Team
Constructed Facility Quality Check
Survey Team (Elevation and Dimension Check)
Supervisory Team
Dimension Check
Supervisory Team
Final Quality Check
Survey Team Elevation and Dimension Check
Trial Operation Check
Supervisory Team Check

Chapter 5

Quality Control for Construction Works

5.1 General

This chapter presents an explanation of the major points for quality control covering important construction works for irrigation facilities, namely, i) embankment works; ii) concrete works; iii) wet stone masonry works and iv) other construction works. For embankment works, a detailed explanation is made for material preparation works at borrow pit and earthfilling work at embankment works site. For concrete works an explanation is given for concrete material, pre-placement work, mixing work, placement work and post-placement work. For canal and its related structures, main emphasis is given on the provision of sample field checking forms for inspecting the final quality of respective constructed facilities. In addition, sample checking forms are provided in this manual for the embankment works, concrete works and masonry works.

5.2 Earthworks

5.2.1 Embankment Works

(1) **Embankment Material**

(A) Minimum Requirement as Embankment/Earthfill Material

The minimum requirements for the soil as embankment/earthfill work material 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
having a small compressibility	: less possibility for cracking

(B) Recommendable Soil Material for Embankment/Earthfill Works

The recommendable soil materials for embankment/earthfill works are:

(most suitable) : well graded sand or gravel mixed with clay as bonding material

(2nd suitable) : sand mixed with clay having low plasticity, or mixed with silt

The unsuitable soil materials for earthfill works are:

- soil having high water absorption and/or having high compressibility

- soil containing much humus and/or organic matter

(C) Required Tests and Evaluation Criteria

The following physical tests shall be conducted in order to check the suitability of soil material for embankment/earthfill works. The purposes of these tests are: i) to classify the soil type and ii) to determine the optimum moisture content for compaction. The evaluation criteria of soil shown below can be used for checking an suitability of each soil as embankment/earthfill materials:

- specific gravity test

- grading analysis

- moisture content test

- liquid limit test (LL)

- plastic limit test(PL)

- compaction test

Criteria for Evaluation of Embankment/Earthfill Material

Classification of Soils according to Standard Soil Classification	Kind of Material	/1 Suitability for Earthfill Material
-	Rocks	-
-	Boulders	-
GW, GP	Gravel	6
GM, GC	Silty/Clayey Gravel	1
SW, SP	Sand	5
SM, SC	Silty/Clayey Sand	2
ML, CL, OL	Clayey Soils	3

MH, CH, OH	Clays	4
PT	Organic Soils	7

Note: /1 A small figure indicates more suitability for embankment/earthfill material.

(D) Trial Embankment

The trial embankment should be made for the selected embankment materials before the commencement of the embankment works. A method for the trial embankment should follow the actual construction method to be applied in the works site and should be made in accordance with the following manner:

(a) The size of trial embankment yard is (width > 3 m) x (length > 5 m) x (height 0.30 cm) for one compactor;

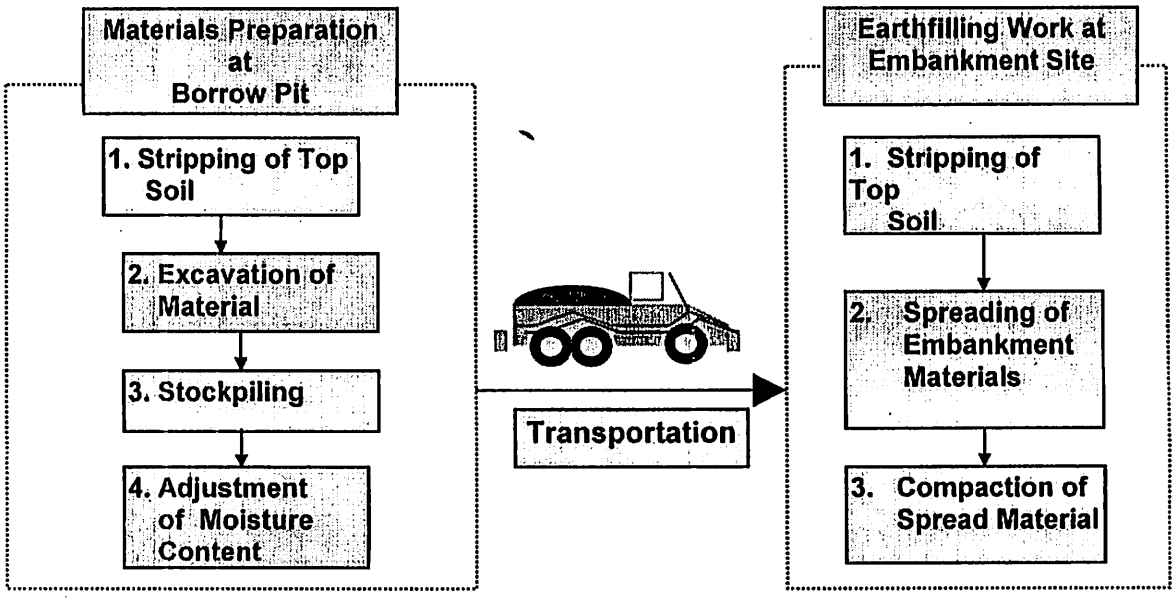
(b) The compaction equipment which will be utilized in the actual construction works shall be used;

(c) moisture content, density of compacted soil and cone index should be measured for respective compactor passage time of 0, 1, 2, 3, 5, 10, 15; and

(d) the most suitable compaction manner should be employed for the actual construction works based on the above test results.

(2) **Embankment Works**

The embankment works consist of two major work components of: i) material preparation works at the borrow pit and ii) earthfill works at the embankment site. The each component further consists of several work items as illustrated below:

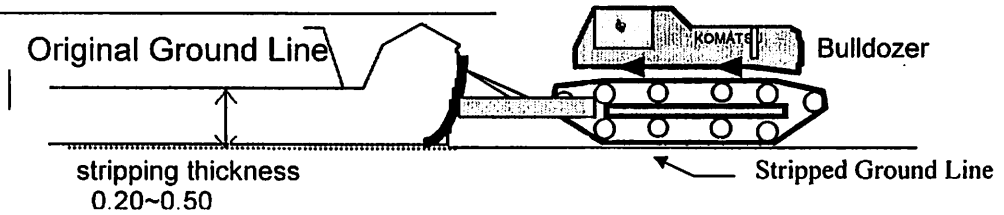


Explanations and illustrations of the certain work items and its key points for securing a good quality are described in the table for the certain equipment works and manual works and sample checking forms for these works are attached in the *APPENDIX-1* of this manual:

(2) - (1) Equipment Works

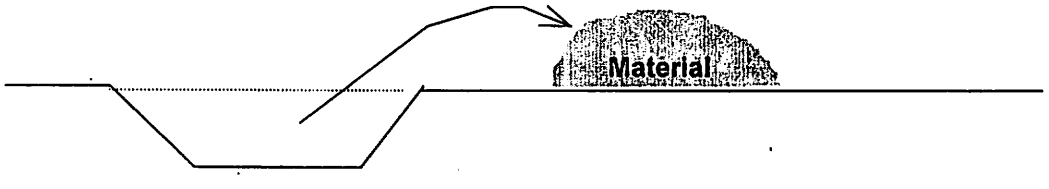
(A-1) Material Excavation and Stockpiling at Borrow Pit

No.	Work Item	Explanation
1	**Stripping of Top Soil**	a. All obstacles such as sod, debris, organic soil and puddle shall be removed by bulldozer, etc. b. Stripped soil shall be properly disposed to the spoil bank c. Depth of stripping shall be carefully checked (0.10 m~0.50 m) d.

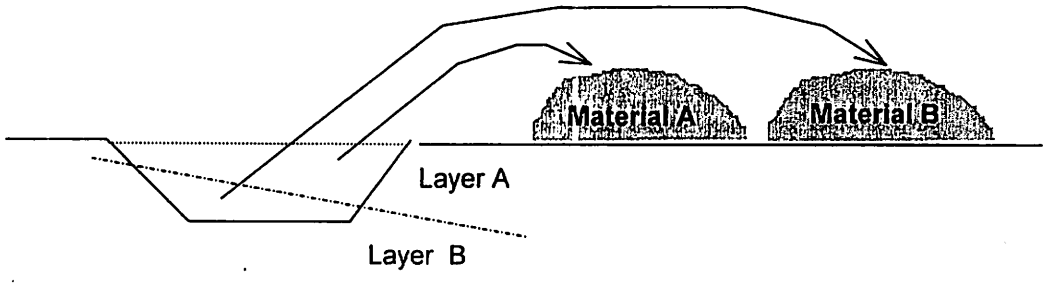


	Excavation of Soil Material at Borrow Pit	- If excavated material consists of more than 2 soil, those materials shall be stocked separately. - Suitability of materials shall be checked, referring to the previous laboratory test results or construction record. If the soil properties are unclear, the laboratory test shall be conducted. - The natural moisture content of soil shall be checked. **measuring method : refer to ATTACHMENT -1**

1. In case of homogeneous material

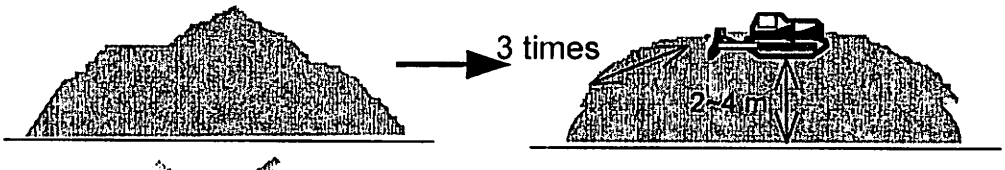


2. In case of two kinds of material



3 **Stockpiling and Moisture Adjustment**

- Moisture content shall be adjusted to the specified range (± 5%) of the optimum moisture content) before hauling the material to embankment site.
- Surface of stockpile shall be compacted to avoid infiltration of rain or loss of moisture in the material.



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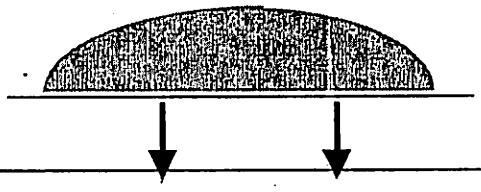
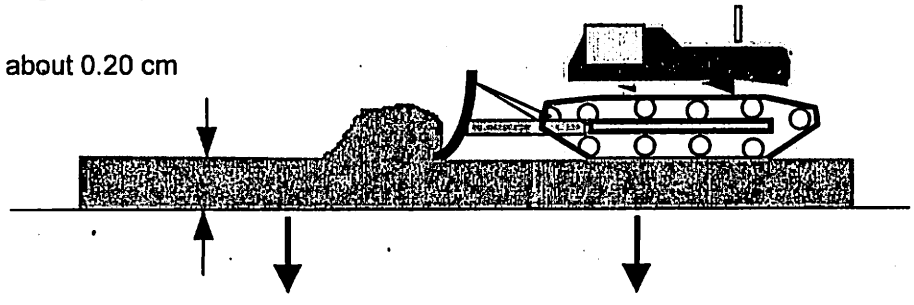
(A-2) Adjustment of Moisture Content of Stockpiled Material at Borrow Pit

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

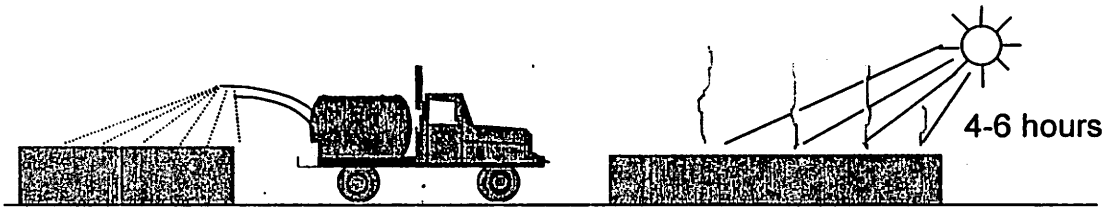
1 stockpile



2 spreading stockpile

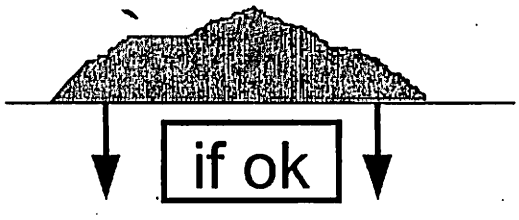


3 water spraying drying material



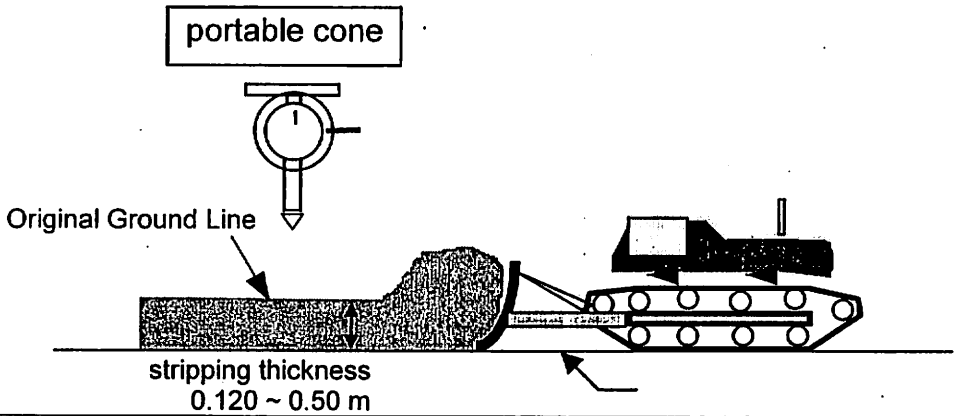
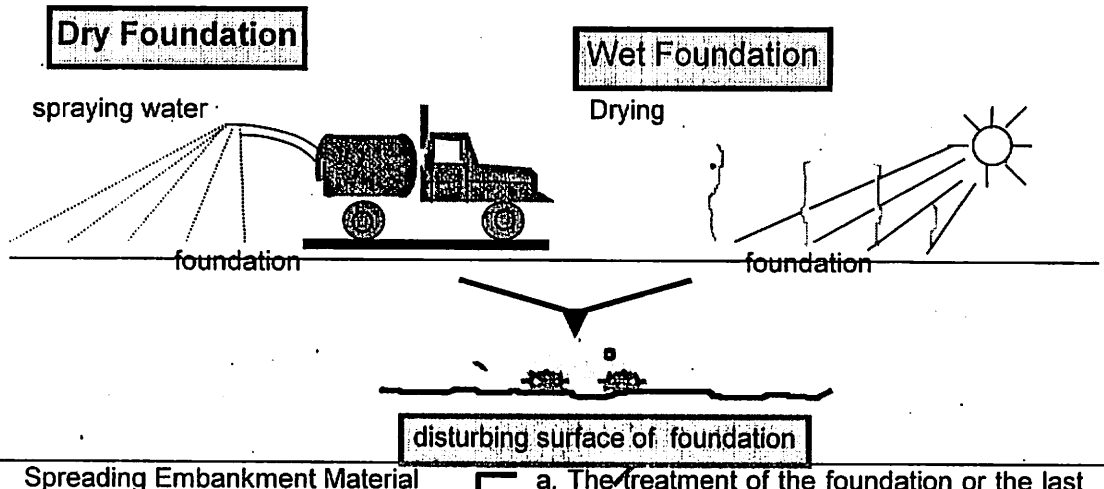
4 mixing material and checking of moisture content

if not ok



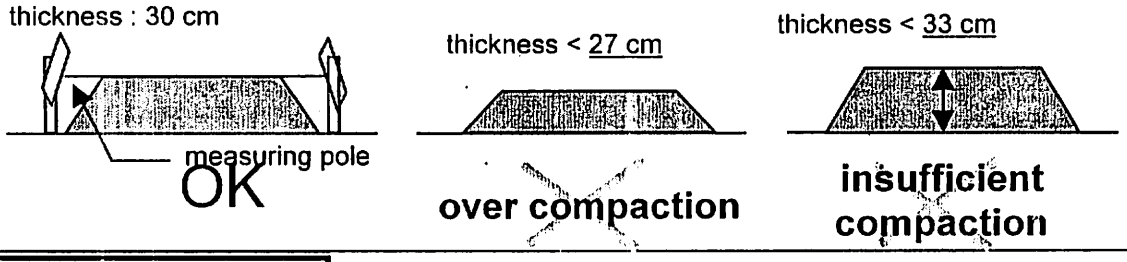
5 hauling to embankment site

B-1) Material Embankment

No.	Work Item	Explanation
1	**Stripping of Top Soil**	
2	**Treatment of foundation**	a. Foundation is too dry, water shall be sprayed. b. Foundation is too wet, drying or stripping of the wet portion shall be made. c. Foundation surface shall be disturbed to secure sufficient contact with embankment material. 
3	Spreading Embankment Material refer to the illustration for the above Treatment of Foundation	a. The treatment of the foundation or the last layer shall be conducted before spreading embankment material in the following manner: i) foundation/last layer is too dry: *spraying water* ii) foundation/last layer is too wet: *drying last layer* b. The surface of the last layer shall be scarified.

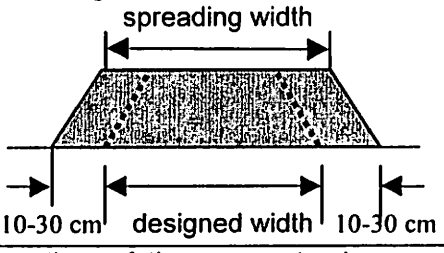
Spreading Thickness

c. Spreading thickness for compaction shall be 30 cm.



Spreading Width

d. Spreading width shall be 10 ~ 30 cm wider than the designed width.

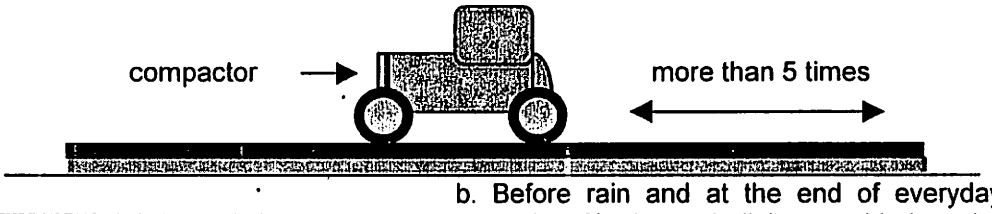


4

Compaction of Embankment Material

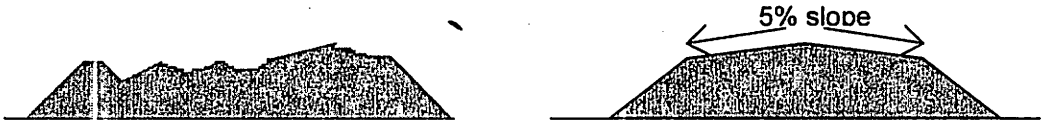
Passage Time

a. Passage time of the compactor is more than 5 times (to be confirmed by the trial embankment).
This passage time shall be carefully checked by the supervisor.

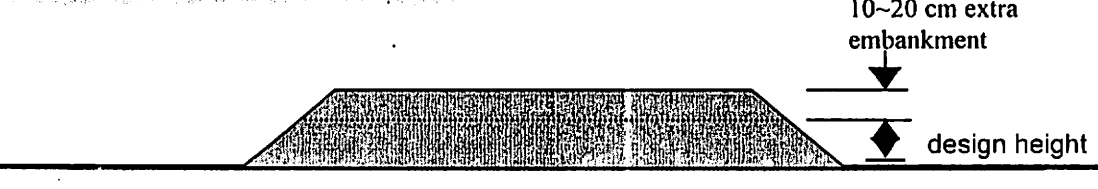


Provision of 5% Slope

b. Before rain and at the end of everyday work, 5% slope shall be provided to the embankment surface.

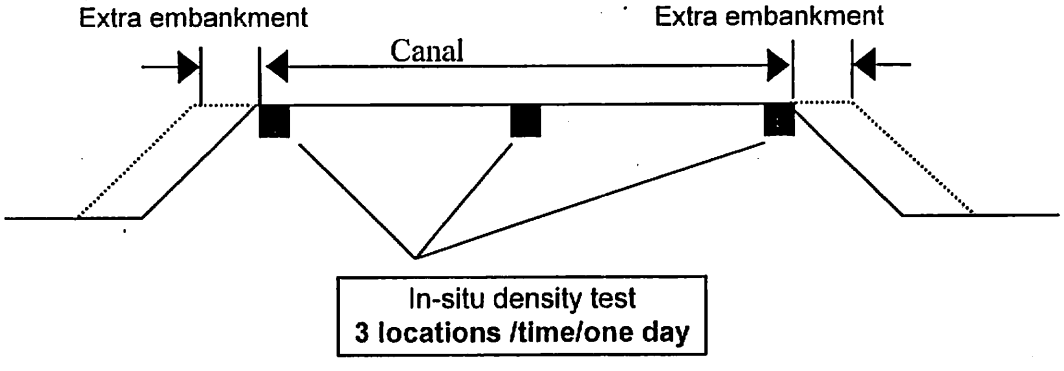


c. Extra embankment of about 10~20 cm or 5~ 10 % of total height shall be provided on the last layer as allowance for future settlement.

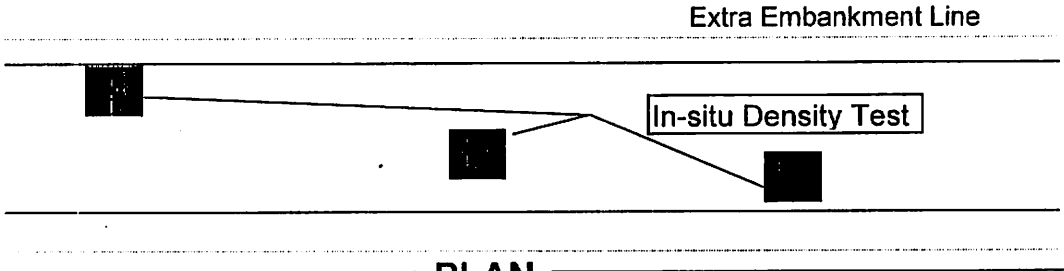


(B-2) In-situ Density Test

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

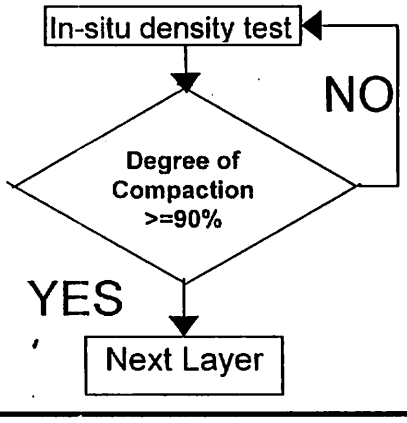


CROSS SECTION



PLAN

Evaluation of the Compaction



a. Specified range of the degree of compaction of the compacted embankment is more than 90% of the maximum dry density.

b. If the test results do not satisfy the specified range.

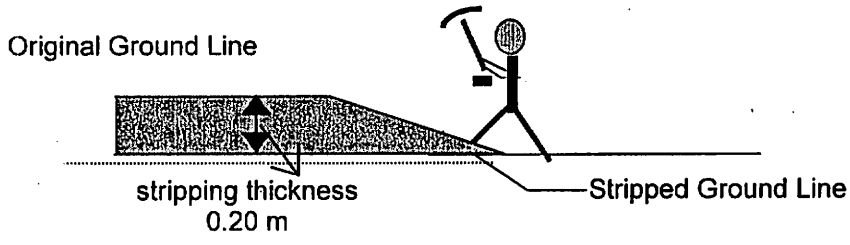
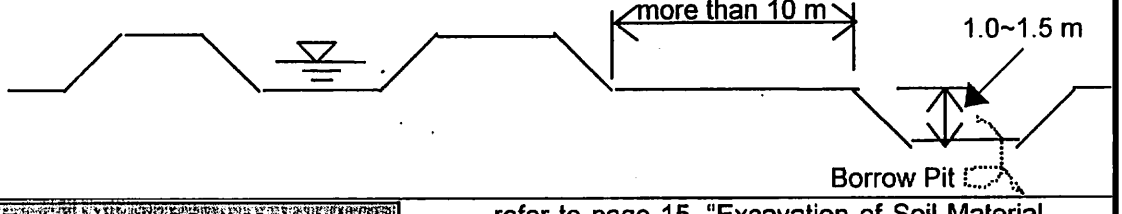
i) A further compaction shall be made until the degree of compaction exceeds 90%.

ii) If the degree of compaction is lower than the specified range, the compaction method such as spreading thickness and passage times shall be changed.

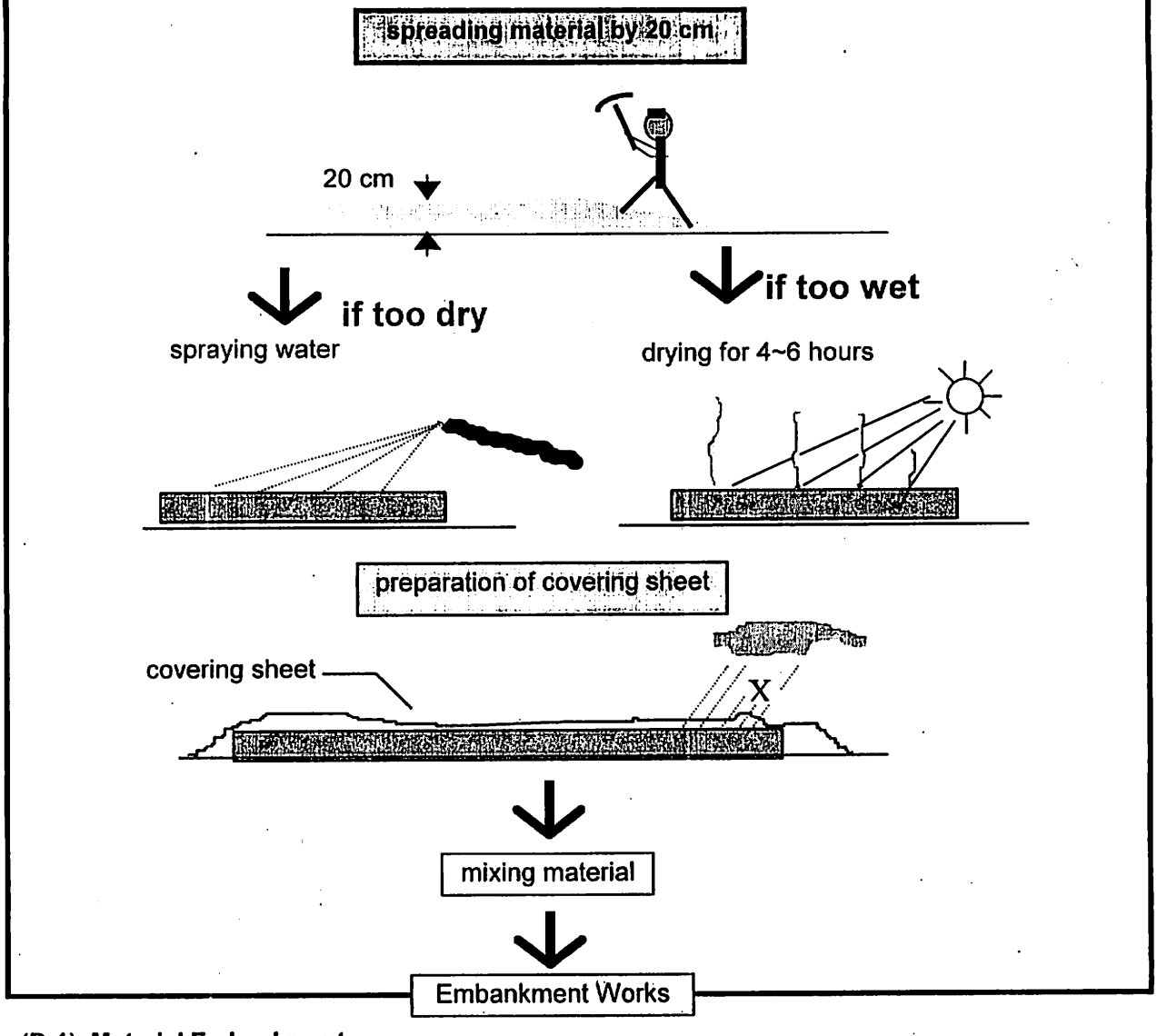
c. If the test results satisfy the specified range, the next layer may be embanked.

(2) - (2) Manual Works

(C-1) Material Excavation and Stockpiling at Borrow Pit

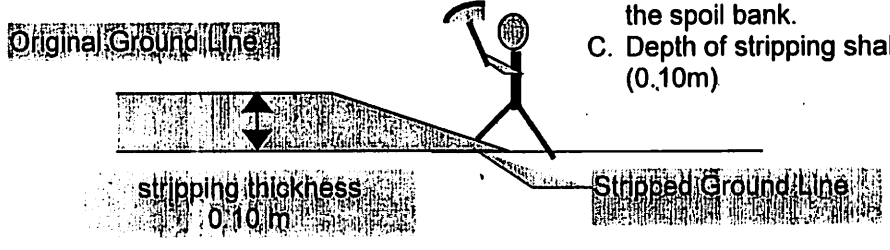
No.	Work Item	Explanation
1	Material Excavation	
	Stripping of Top Soil	a. All obstacles such as sod, debris, organic soil and puddle shall be removed. b. Stripped soil shall be properly disposed of to the spoil bank. c. Depth of stripping shall be carefully checked (0.10m). 
	Location of Borrow Pit	d. In case the borrow pit is selected along the canal, the distance between the canal and borrow pit edges shall be more than 10 m and the depth of borrow pit shall not exceed 1.0 m ~ 1.5 m. Such borrow pit hole shall be backfilled properly after completion of the works. 
2	**Excavation of Soil Material at Borrow Pit**	refer to page 15, "Excavation of Soil Material at Borrow Pit" for equipment work
3	**Stockpiling and Material Adjustment**	a. In case the excavated material is too dry, the material shall be spread at 20 cm thick and moistened by spraying water. b. In case the excavated materials are too wet, the material shall be spread at 20 cm thick and dried for 4 ~ 6 hours. c. In order to avoid an infiltration of the rainfall, a covering sheet shall be prepared for the stockpiled soil. d. If the measurement of soil moisture can be carried out in a timely manner, the moisture content of soil shall be checked.

No.	Work Item	Explanation



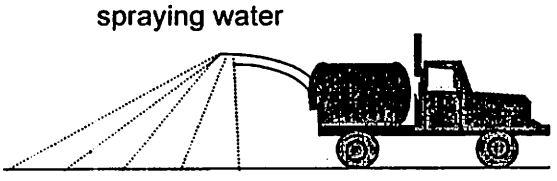
(D-1) Material Embankment

No.	Work Item	Explanation
1	Stripping of Top Soil	A. All obstacles such as sod, debris, organic soil and puddle shall be removed. B. Stripped soil shall be properly disposed of to the spoil bank. C. Depth of stripping shall be carefully checked (0.10m)

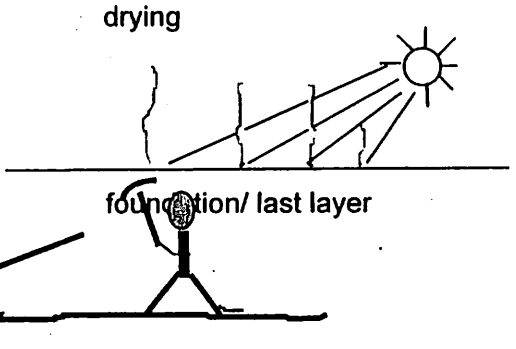


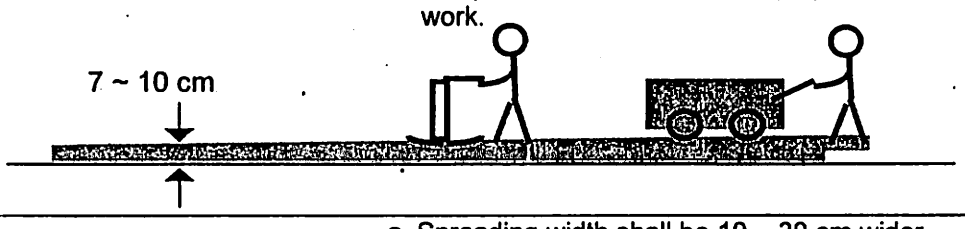
No.	Work Item	Explanation
2	**Treatment of Foundation and Last Layer**	a. Foundation/Last layer is too dry, water shall be sprayed. b. Foundation/Last layer is too wet, drying or stripping shall be made for the part. c. Foundation surface shall be disturbed for securing a sufficient contact with embankment material.
3	**Spreading Thickness**	a. Spreading thickness for compaction shall be 7 ~ 10 cm if the small compactor or manual compaction tool will be employed for the work.
4	**Spreading Width**	a. Spreading width shall be 10 ~ 30 cm wider than the designed width.

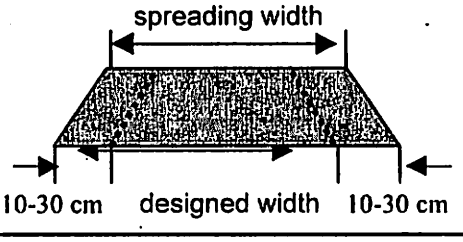
Wet Foundation/ Last Layer

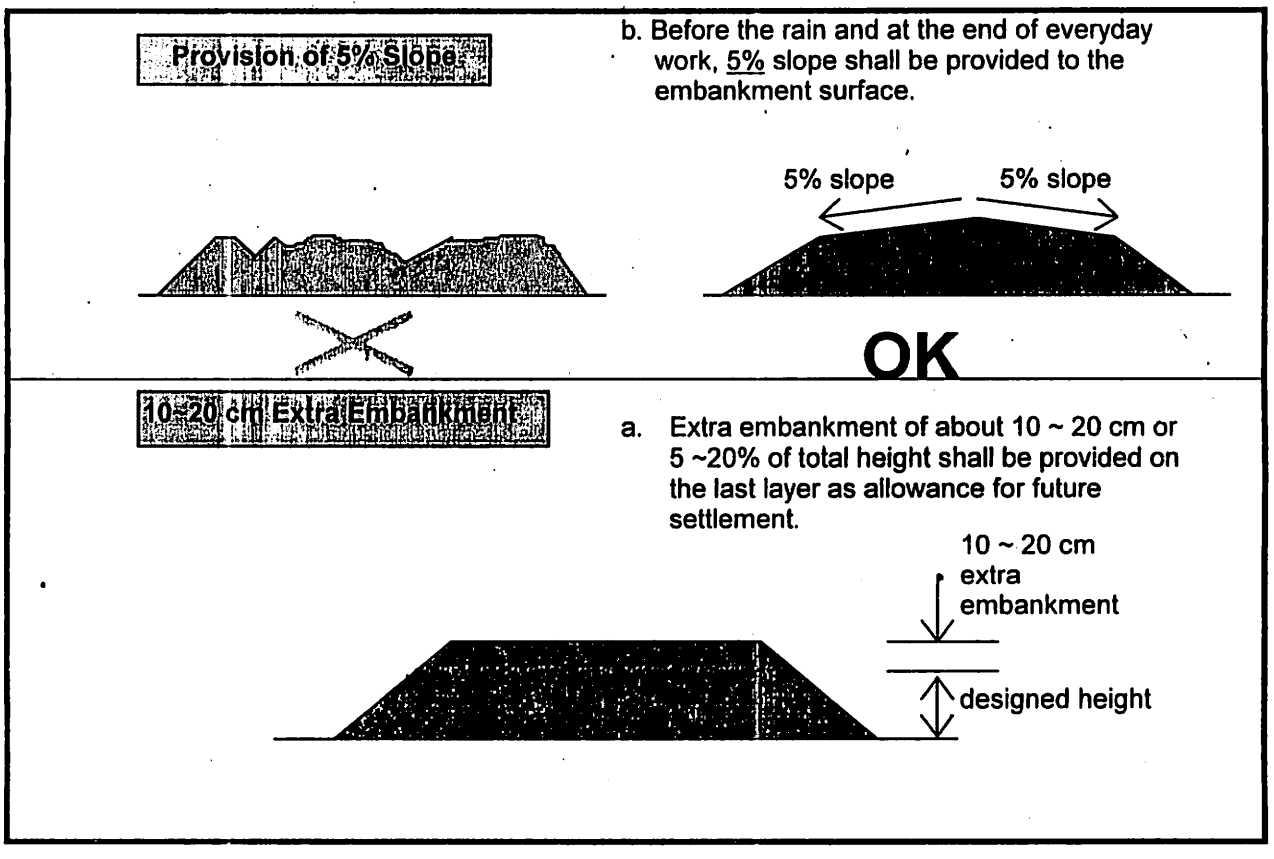


Dry Foundation/ Last Layer









(3) Minimum Requirement for the Embankment Works

In order to attain the minimum quality of the embankment works, the supervisor should check the following:

- Material for embankment shall be carefully selected and checked in accordance with the instructions described in the Section 5.2.1 at page 11 of this manual;

- Moisture content of the soil shall be carefully and frequently checked by the supervisor by means of the moisture content test or check of condition of the compacted material; and

- Spreading thickness of the material and passage time of the compactor shall be carefully checked by the supervisor.

5.2.2 Excavation Works

In the case of excavation works, due attention should be given to the following:

(a) Selection of an appropriate excavation method and/or equipment considering soil characteristics and volume of excavation;

(b) Consideration and provision of appropriate drainage method for excavated portion before commencement of the works;

(c) Use of leading frame to clearly indicate excavation line to prevent over excavation that would weaken the foundation of the structure and canal lining;

(d) Removal of obstacles such as sod, debris, organic matter, root and stump before commencement of excavation as the excavated material can be used for earthfill material; and

(e) Provision of appropriate drainage at the end of everyday work.

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

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 Cobblestone	dense or well graded	less than 10 m	1 : 0.8 ~ 1 : 1.0
		10 m ~ 15 m	1 : 1.0 ~ 1 : 1.2
	not dense or poorly graded	less than 10 m	1 : 1.0 ~ 1 : 1.2
		10 m ~ 15 m	1 : 1.2 ~ 1 : 1.5
Clayey Soil		less than 10 m	1 : 0.8 ~ 1 : 1.2
Sandy Soil mixed with Gravel and/or Cobblestone		less than 5 m 5 ~ 10 m	1 : 1.0 ~ 1 : 1.2 1 : 1.2 ~ 1 : 1.5

5.3 Concrete Works

5.3.1 Concrete Materials

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

(A) Minimum Requirement

(Aa) water

- free from impurities such as oil, salts, organic matter, etc.

(Ab) fine and coarse aggregate

- well graded;
- free from impurities such as clay, silt, organic matter, trash, etc.;
- having appropriate specific gravity; and
- having sufficient durability.

(B) **Recommended Aggregates for Concrete**

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

- granite;
- andesite;
- basalt;
- hard sandstone;
- hard limestone; and
- gneiss.

(C) **Required Tests for the Aggregate**

The following physical tests for the concrete aggregates are required. Its evaluation criteria are also given below as reference:

(Ca) Fine aggregate

- specific gravity test (specified range: 2.50 ~ 2.65, material which has a small specific gravity is not suitable)
- grading analysis (fineness modulus :2.3 ~ 3.0)

- soundness of aggregate (maximum loss weight due to soundness test using sodium sulfate: less than 18%)

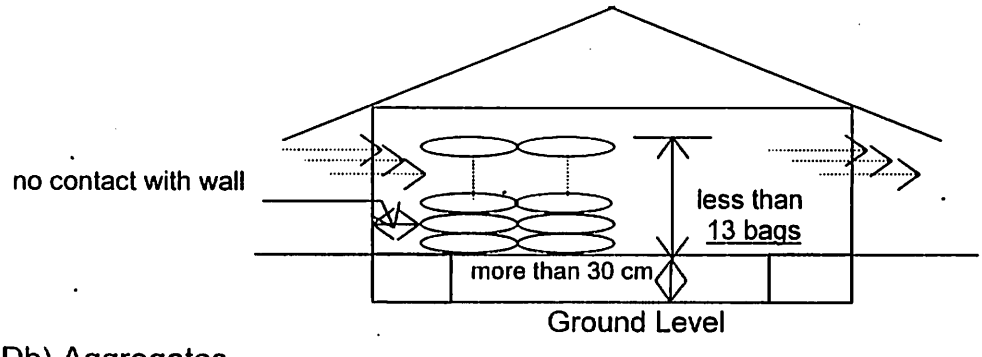
(Cb) Coarse aggregate

- specific gravity test (specified range: 2.55 ~ 2.65, material which has a small specific gravity is not suitable)
- grading analysis (fineness modulus: 6 ~ 8)
- soundness of aggregate (maximum loss weight due to soundness test using sodium sulfate: less than 10%)

(D) Storage of Materials

(Da) Cement

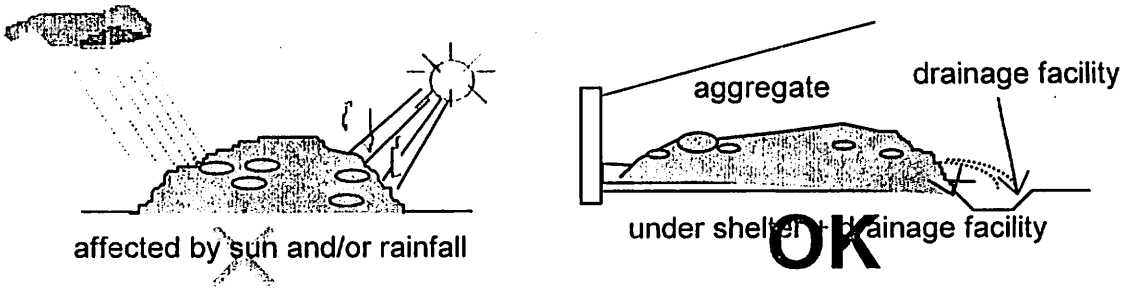
- cement which was stored for more than 3 months shall not be used;
- cement bags shall be stored in the well ventilated warehouse having more than 30 cm floor height from the ground;
- cement bags shall be stored without contact with the walls;
- cement bags shall not be stacked more than 1.5 m or 13 bags in height; and
- cement bags shall be well arranged so as to easily recognize its purchased date.



(Db) Aggregates

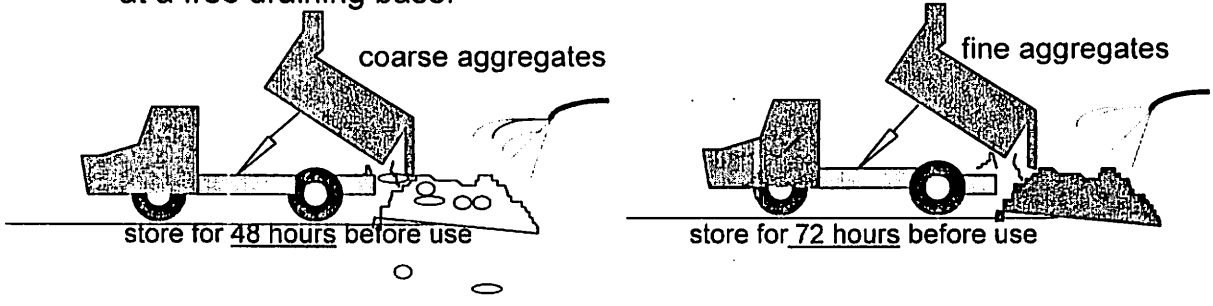
- aggregate shall be stored separately according to kind, size and grading;

- 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 affected by the direct sun and/or rainfall;

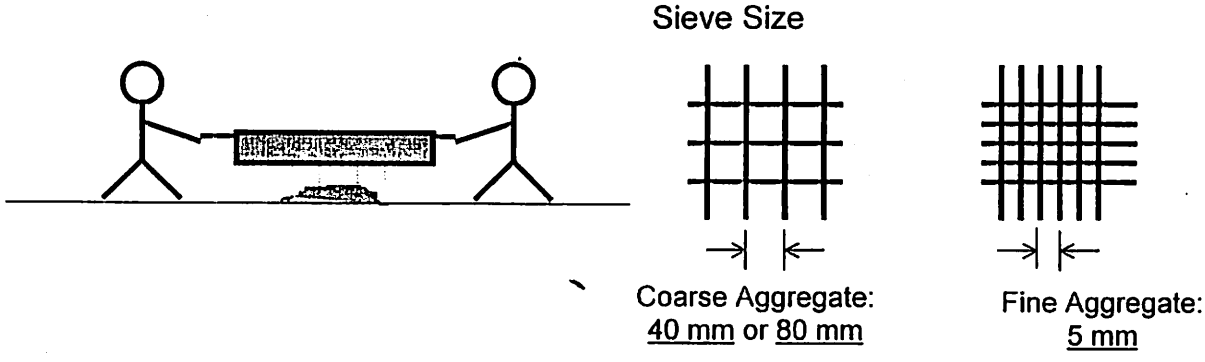


- dirty coarse aggregate shall be washed and stored at least 48 hours before use and be allowed to drain to ensure a relative uniform moisture; and

- dirty 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 the large size aggregate that are outside the specified range.



5.3.2 Concrete Mixing Works

(1) Concrete Mix Design

Before commencement of concreting works, the design of concrete mixes shall be carried out by the laboratory team. A general procedure for concrete mix design is as follows:

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

1 Determination of W/C (water cement ratio)

2 Determination of Maximum Size of Aggregates — the standard value is as follows

Type of Concrete	Compressive Strength (28 days)	Specified Maximum Size of Aggregates	Specified Maximum Water/ Cement Ratio	Approx. Cement Content	Usage
	(kg/cm^2)	(mm)	(%)	(kg/m^3)	
A (K-225)	225	40	50	330	Reinforced concrete for bridge superstructure, pre-cast concrete, pile, etc.
B (K-175)	175	40	50	300	Reinforced concrete for structures and concrete lining
C (K-125)	125	80 or 40	55	250	Plain concrete for mass concrete
D (K-100)	100	20	60	200	Plain concrete for foundation and filling purposes

3 Determination of Slump Height (See Table 5.1)

Type of Concrete	Slump (cm)
A (K-225)	10.0 cm
B (K-175)	8.0 cm
C (K-125)	5.0 cm
D (K-100)	6.0 cm

4 Assumption of Fine aggregate content — see the following table **(to be adjusted by mixing test)**

Type of Concrete	Fine Aggregate (%)	Remarks
A (K-225)	35%	
B (K-175)	35%	
C (K-125)	36% 35%	Maximum size of Aggregate =40 mm Maximum size of aggregate = 80 mm
D (K-100)	36%	

Adjustment based on fineness modulus : Standard = **2.75** (see Table 5.1)

Assumption of Air Content (see Table 5.1) — see the following table **(to be adjusted by mixing test)**

5

Type of Concrete	Air Content (%)	Remarks
A (K-225)	1.0%	
B (K-175)	1.0%	
C (K-125)	1.0% 0.3%	Maximum size of Aggregate =40 mm Maximum size of aggregate = 80 mm
D (K-100)	1.0%	

6 Assumption of Unit Water Weight for 1 m^3 concrete

see the following table **(to be adjusted by mixing test)**

Type of Concrete	Unit Water Weight (kg/cm^3)
A (K-225)	165 kg
B (K-175)	150 kg
C (K-125)	138 kg
D (K-100)	120 kg

7 Calculation of Unit Cement Weight for 1 m^3 concrete :

= [unit weight] x $\frac{1}{\text{[Water/Cement Ratio]}}$

see the sample calculation **(to be adjusted by mixing test)**

8 Calculation of Unit Weight of Fine Aggregate for 1 m^3 concrete :

= [1.0 m^3 - {volume of (water + cement + air)}]x [fine aggregate content]

see the sample calculation **(to be adjusted by mixing test)**

9 Calculation of Unit Weight of Coarse Aggregate for 1 m^3 concrete :

= [1.0 m^3 - {volume of (water + cement + air)}] x [1- coarse aggregate content]

see sample calculation **(to be adjusted by mixing test)**

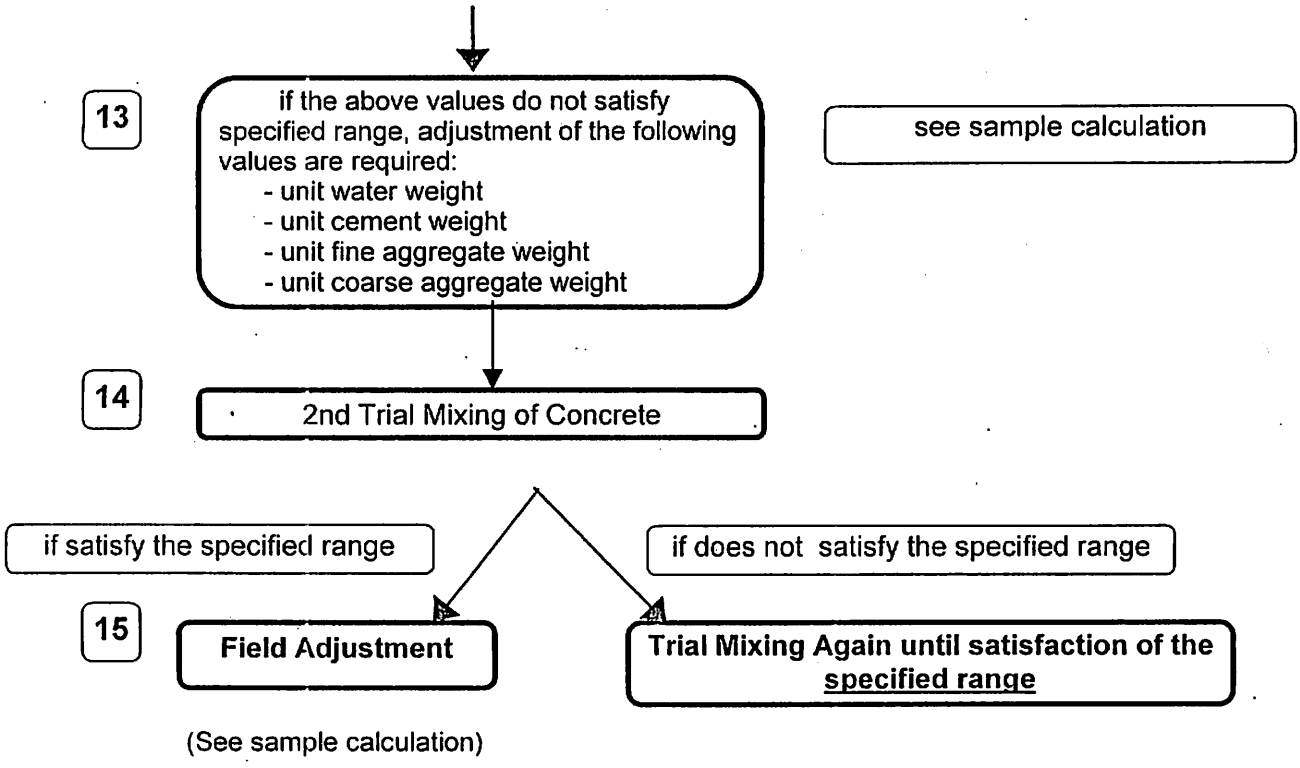
10 Adjustment of Unit Water Weight considering Surface Water Content of Aggregates

Condition of Aggregate	Surface (range)	Water (%) (average)
Wet Gravel	0 ~ 1%	0.5%
A little Wet Sand	0 - 2%	1.0%
Wet Sand	2 ~ 5%	2.5%
Very Wet Sand	5 ~ 9%	7.0%

11 Trial Mixing of Concrete

see sample calculation

12 Measurement of the Following Values:
- slump
- air content
- unit weight of concrete



(See sample calculation)

If the actual condition or the specified condition is different from the standard value shown above, the content of fine aggregate and the unit water weight shall be adjusted based on the following adjustment factors:

Table 5.1 Table for Adjustment for Material Volume

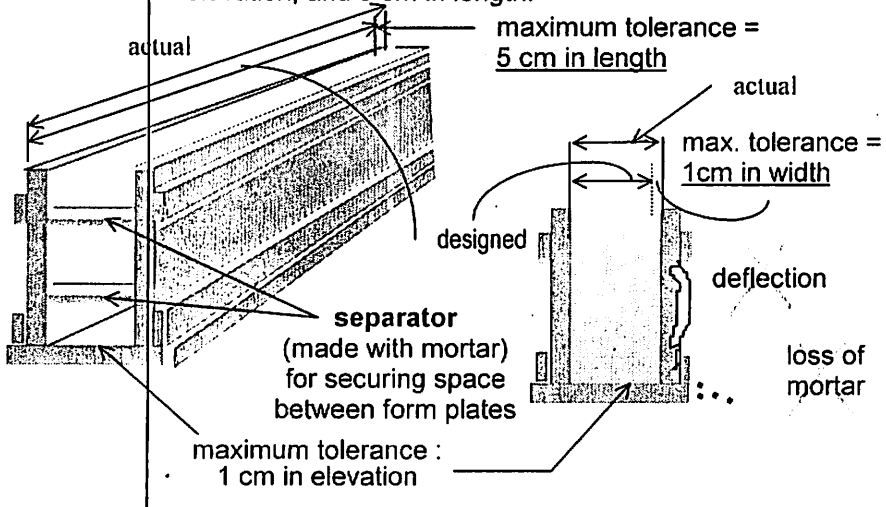
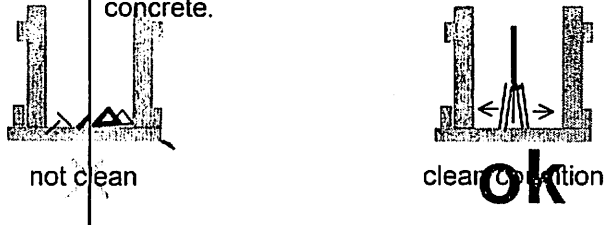
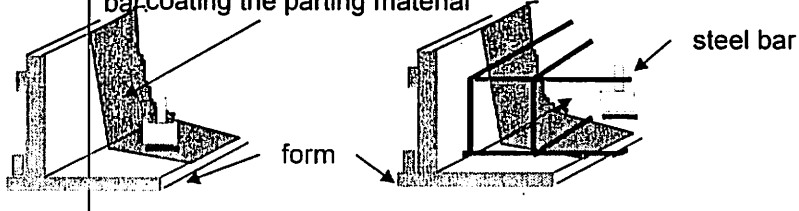
Condition		Adjustment for Content of Fine Aggregate (s/a)	Adjustment for Unit Water Weight	Remarks
Fineness Modulus:	+ 0.1 %	+ 0.5 %	no adjustment	-
	- 0.1 %	- 0.5 %	no adjustment	-
Slump:	+ 1 cm	no adjustment	+ 1.2 %	-
	- 1 cm	no adjustment	- 1.2 %	-
Air Content	+ 1.0 %	- 0.3 %	- 3.0 %	slump: +2.5cm
	-1.0 %	+ 0.3 %	+ 3.0 %	slump: -2.5 cm
in case of crushed coarse aggregate		+ 4 %	+ 12.0 kg	-
in case of crushed fine aggregate		+ 2.5 %	+ 7.5 kg	-

(2) **Concrete Mixing and Placement Works**

The concrete mixing works consist of the four major work components as illustrated below:

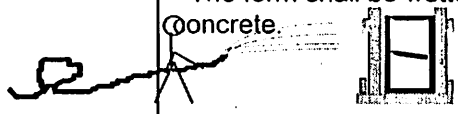
1. Pre-placement Work
2. Concrete Mixing Work
3. Concrete Placement Work
4. Post-Placement Work

The details of the 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 sufficiently tight and properly braced. The maximum tolerance is 1 cm in width and elevation, and 5 cm in length. 
		- The inside of form shall be clean before placement of concrete. 
		- The parting material shall be coated on the form and such material shall not be painted on the reinforcing bar.coating the parting material 

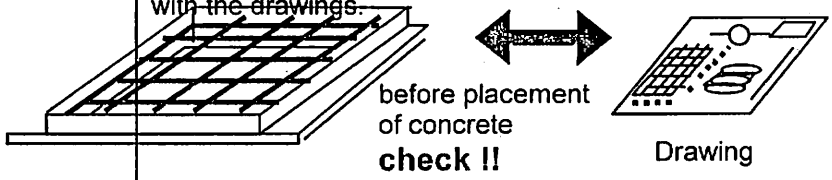
- The water stop shall be properly installed and its joints shall be fastened together.

- The form shall be wetted before placement of concrete.



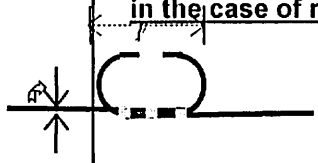
Reinforcement Bar Placing

- Reinforcement bar shall be placed in accordance with the drawings.



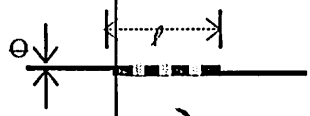
- A length of the lap joint shall satisfy the specified length.

in the case of round bar



Diameter of Steel Bar (ø)	Lap Joint (= ℓ) (U22)	(U24)
6	180	180
8	240	240
10	300	300
12	360	350
14	420	410
16	480	470
19	570	560
22	660	650
25	750	730

in case of deformed bar



Diameter of Steel Bar (ø)	Lap Joint (= ℓ) (U22)	(U24)
6	140	140
8	180	180
10	230	220
12	270	270
14	320	310
16	360	350
19	430	420
22	550	490
25	560	550

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

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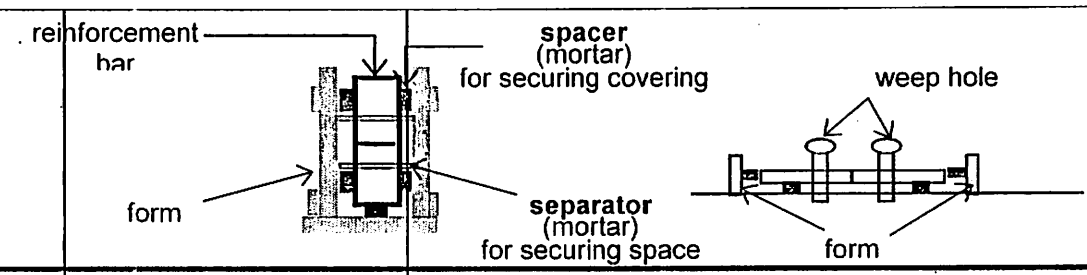


</td></tr>
<tr><td>2</td><td>Concrete Mixing Work

Preparation</td><td>- The concrete mix proportion shall be adjusted before commencement of mixing work taking into consideration the surface moisture of aggregates (refer to the site adjustment in the sample calculation shown in the ATTACHMENT-2).
- The concrete material shall be measured by its weight. If the weighing machine is not available, the material may be measured by volume. The standard mix proportion is illustrated as follows (to be adjusted by the trial mixing results).
<u>Type-A (K-225)</u>
Weight : 0.5 1.0 2.0 3.7
Volume : 1.6 1.0 2.4 4.5
water cement sand gravel

<u>Type-B (K-175)</u>
Weight : 0.5 1.0 2.3 4.3
Volume : 1.6 1.0 2.7 5.1
water cement sand gravel

<u>Type-C (K-125) Max. Aggregate = 40 mm</u>
Weight : 0.6 1.0 2.9 5.2
Volume : 1.7 1.0 3.5 6.3
water cement sand gravel

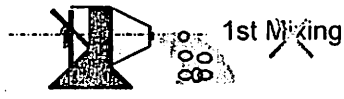
<u>Type-C (K-125) Max. Aggregate = 80 mm</u>
Weight : 0.6 1.0 2.9 5.4
Volume : 1.7 1.0 3.5 6.4
water cement sand gravel</td></tr>
</table>

		Type-D (K-100)			
		Weight	0.6	1.0	3.8	6.8
		Volume :	1.9	1.0	4.6	
			water	cement	sand	gravel

Mixing Work

- The inside of mixer shall be clean.
- The 1st mixing batch shall not be used for concrete placement.

inside: **clean !!**

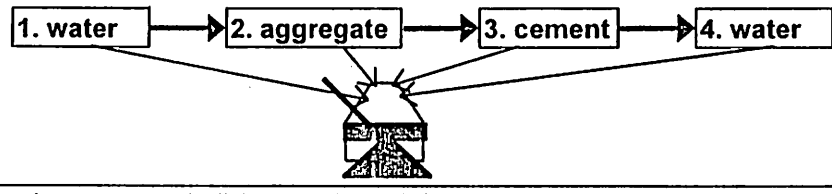


1st Mixing :do **not use !!**

- The standard mixing time is as follows:

Capacity of Mixer (m3)	Standard Mixing Time (minutes)
< 1.5	1.5
1.5 ~ 2.0	2.0
2.0 ~ 3.0	2.5

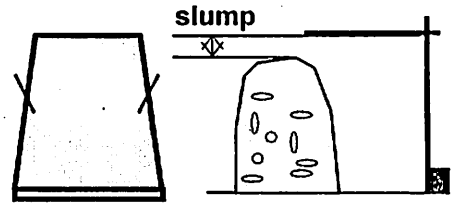
- An order of putting materials to the mixing machine shall follow the following sequence:



Concrete Test

- The slump tests shall be conducted for the 2nd mixing batch and if such result does not satisfy the specified range of the slump height, a volume of water shall be adjusted until satisfying specified range. The specified range of the slump is as follows:

Specified Slump (cm)	Type of Concrete
10 ± 2.5 cm	A (K-225)
8 ± 2.5 cm	B (K-175)
5 ± 2.5 cm	C (K-125)
10 ± 1.0 cm	D (K-100)



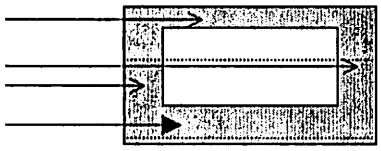
- The respective concrete tests shall be performed in accordance with the following frequency:

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 Compression Test	4 specimens each for respective work lots or structural member	see following illustration

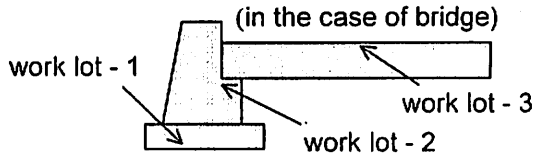
Example of Work Lot

(in the case of culvert)

work lot - 4
work lot - 3
work lot - 2
work lot - 1



(in the case of bridge)



- the allowable deviation for each test shall be as follows:

Slump Test

refer to the previous page

Grading Test

(1) Fine Aggregate

Fineness modulus : 2.3 ~ 3.0
Grading : refer to the following table

Sieve Size (mm)	Percentage (%)
0.15	2 ~ 10
0.3	10 ~ 30
0.6	25 ~ 60
1.18	60 ~ 85
2.36	80 ~ 95
4.75	95 ~ 100
9.5	100

2) Coarse Aggregate
Fineness modulus : 6 ~ 8
Grading : refer to the following table

Size of Aggregate (40 ~50 mm)

Sieve Size (mm)	Percentage (%)
5	0 ~ 5
10	10 ~ 30
20	35 ~70
37.5	90 ~ 100
50	100

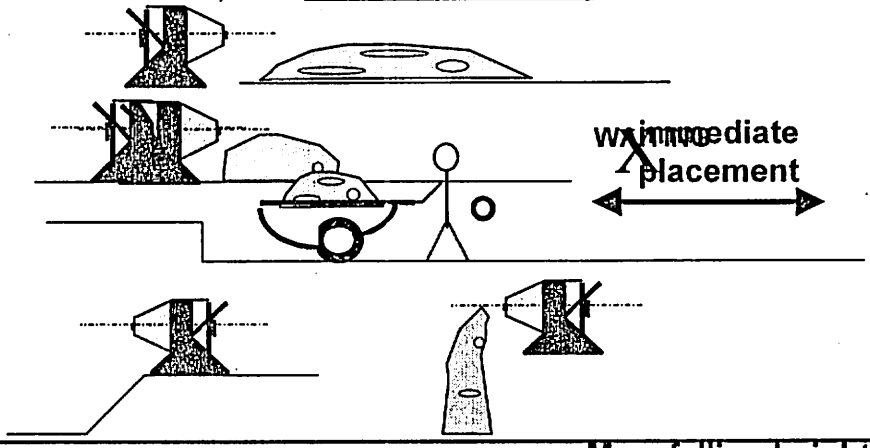
Size of Aggregate (40 ~80 mm)

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

3	**Concrete Placement Work** **Placing**	**Compression Test** 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

Type of Concrete	Compressive Strength (kgf/cm2)			Coefficient of Variation (V)
	Design f'c	Target (fcr)		
		Cube	Cylinder	
A (K-225)	225	270	230	0.18
B (K-175)	175	210	180	0.18
C (K-125)	125	150	130	0.18
D (K-100)	100	120	110	0.18

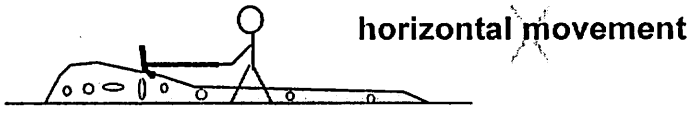
The concrete shall be placed immediately after mixing



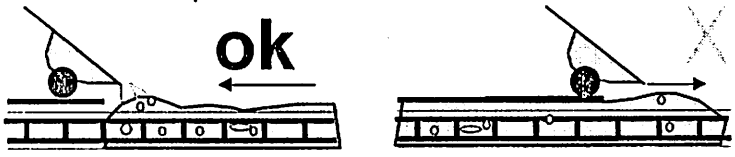
- A use of inclined chute shall be avoided.
- The maximum falling height is 1.5 m

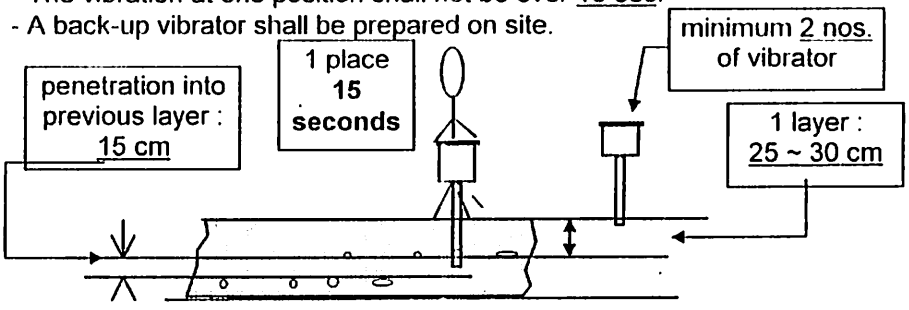
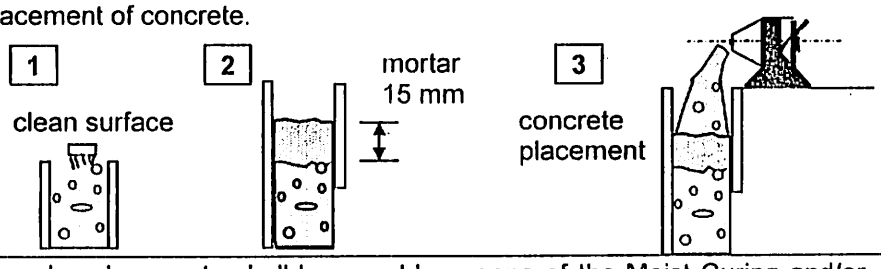
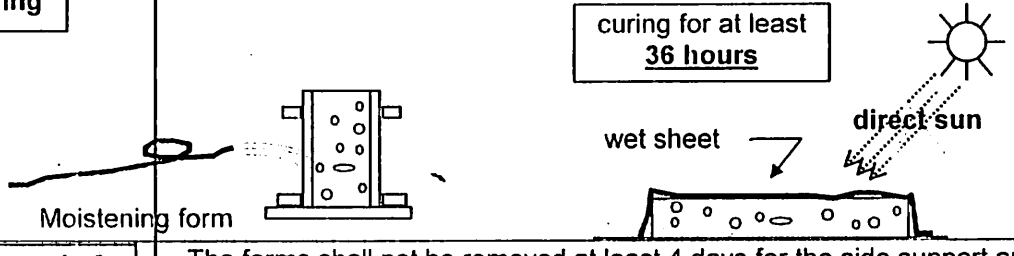
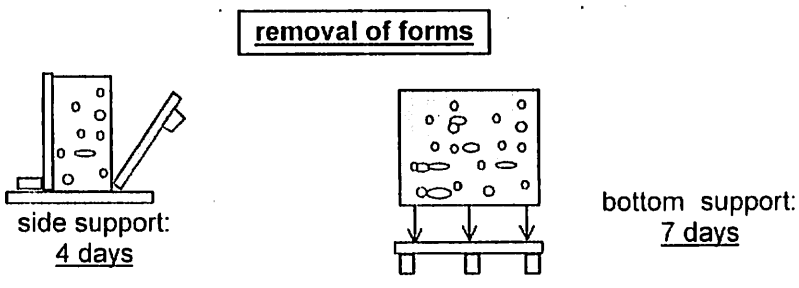
Max. falling height 1.5 m

- The concrete shall not be moved along a horizontal direction.



- The concrete shall be placed backward but not forward.



		- A thickness of one layer for vibrating compaction of concrete is approximately 25 ~ 30 cm. - The vibrator shall penetrate into the previous layer by 15 cm. - The vibration at one position shall not be over 15 sec. - A back-up vibrator shall be prepared on site. 
		- The maximum time interval 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. shall be put on the construction joint with a thickness of about 15 mm and the new concrete shall be immediately placed on it. The surface of the construction joint shall be cleaned before placement of concrete. 
4	**Post Placement Work** **Curing**	- The placed concrete shall be cured by means of the Moist Curing and/or equivalent method for at least 36 hours after placement of concrete. 
	Removal of Forms	- The forms shall not be removed at least 4 days for the side support and 7 days for bottom support after a concrete placement. 

The sample checking forms for the concrete works are attached in the ***APPENDIX-2.***

(3) Minimum Requirement for the Quality Control of Concrete Works

In order to secure the minimum quality of the concrete works, the supervisor should give preferential attention to the following checking points even in for very minor works:

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

5.4 Wet Stone Masonry Works

5.4.1 General

Wet stone masonry work is also one of the most important components of the construction. The quality control for this work, however, is rather difficult compared to earthwork and concrete work. The main reason is due to the difficulty in checking the strength of wet stone masonry. 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 execution of the masonry works is explained with illustrations of the following:

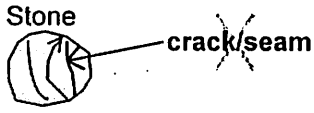
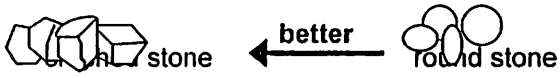
(a) Material;
(b) Placement Manner; and
(c) Construction of Lining and Structural Masonry Works.

In the ***APPENDIX-3*** a sample checking form for the masonry works is attached for the field supervisory use.

5.4.2 Material for Wet Stone Masonry Works

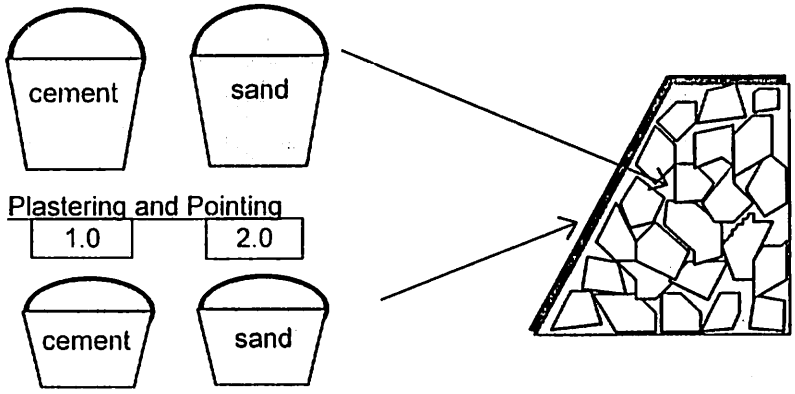
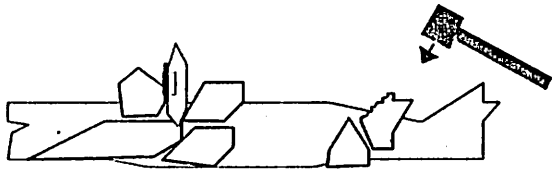
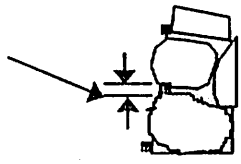
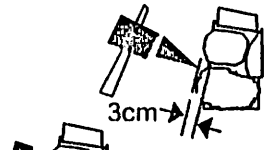
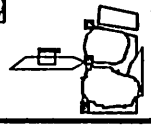
The Wet Stone Masonry is composed of the following 4 kinds of materials:
(a) Water;
(b) Cement;
(c) Sand; and
(d) Stone.

The minimum requirements for the respective materials are as follows:

No.	Material	Minimum Requirement
1	Water	- required the equivalent quality with that of concrete works
2	Cement	- required the equivalent quality with that of concrete works
3	Sand;	- required the equivalent quality with that of concrete works
4	Stone Stone Quality	- free from crack/seam  - crushed stone is preferable  - specific gravity not less than 2.5
	Maximum Stone Size	- maximum stone size is 2/3 (two thirds) of wall thickness and less than 40 centimeters. 

5.4.3 Placement of Wet Stone Masonry

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: **Joint of Masonry** 1.0 4.0  Plastering and Pointing 1.0 2.0
2.	**Moistening**	- The stone shall be moistened before placing. 
3.	**Filling Mortar & Placing Stone**	- The joint mortar shall be sufficiently compacted by the trowel and the stone shall be struck and consolidated by steel hammer. 
4.	**Surface Joint**	- A width of the joint in face stone shall not exceed 3 cm. Max. Surface Joint Width **3 cm**  The surface joint shall be placed in accordance with the following manner:  1 to chip the joint mortar on the surface of masonry to a depth of 3 cm 2 to clean the surface of joint mortar using wire brush and water  3 to fill the mortar with a mix proportion of cement and sand by volume of 1::2

5.4.4 Wet Stone Masonry Construction Works for Lining and Structure

(1) General

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

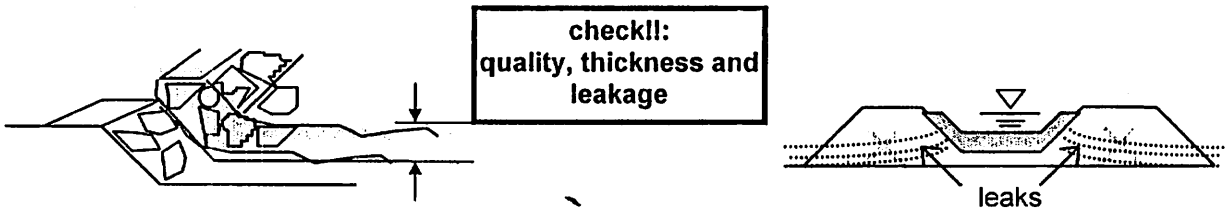
(2) Masonry Lining Works

In the case of the masonry works for canal lining, it is very difficult to conduct the compression test for concrete and to control the quality during the construction works. It is therefore mandatory to carry out the strict post construction check for the masonry lining works.

To secure the good quality of the masonry lining, the following points should be carefully checked after construction.

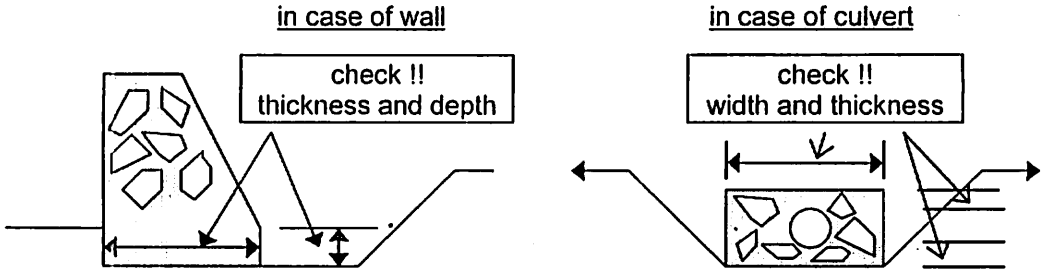
1) quality of joint mortar
2) thickness of lining; and
3) water leakage.

For checking the above points of 1) and 2), 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 the water leak should be checked during the running test. The presence of leaks implies low quality of masonry works. If such lining defects are found out, the lining shall be demolished and reconstructed.



(3) Masonry Structural Works

As already described in the masonry lining works, the quality of the structural masonry works is difficult to control without continuous supervision of the work in the field. Therefore, it is imperative that the project field supervisor shall undertake frequent inspection for the masonry works, particularly the mix proportion of cement and sand, and the structural dimension of the backfilled portion.The condition of every structure shall be checked before the commencement of backfilling through site checking and/or photograph.



5.5 Other Construction Works

5.5.1 General

This chapter describes the quality control methods for canals and their related structures. Main activities are: I) to check the structural dimension and elevation, ii) to check the structural function and iii) to check the general completion condition of canals and structures. In addition, some sample checking forms for canals and the typical irrigation structures are attached in **Appendix-4 and -5** of this manual.

Another main issue of this chapter is the quality control method for the transition portion of canal. There is a tendency of this portion of the canal to become the weakest parts of the structures. Appropriate measures shall be undertaken during contruction to ensure good quality of the Work.

5.5.2 Canal Works

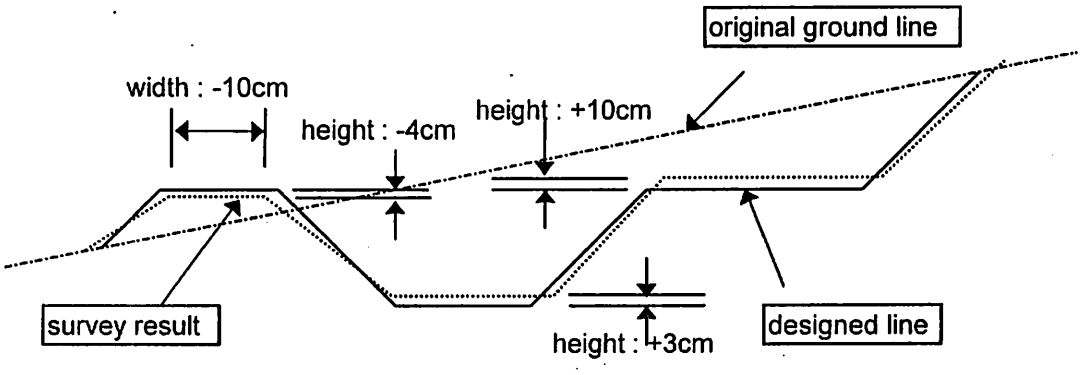
After completion of the canal construction, the constructed canal should be checked through site inspection and cross section survey. During the site inspection the following should be checked:

- compaction condition of embankment
- side slope condition of the canal
- sodding condition of the canal
- finishing work condition of the canal (no remaining disposable soil, no remaining excavation, proper canal slope protection, excavation of side ditch, etc.)
- condition of service road and gravel metalling
- requirements for further additional structure such as cross drain, drain inlet, foot path bridge, etc.

The allowable tolerance of the earthworks are is as follows:

Items	Embankment	Excavation	Remarks
Elevation	+ 10 ~ 20 cm	- 5 cm	a plus tolerance for embankment is due to and depending on the extra embankment height
Dimension	+ 10 + 30 cm	- 5 cm	a plus tolerance for embankment is due to and depending on the extra embankment height

The above works should be checked by the cross section survey at an interval of at least 100 m at the completion of construction works to be assured that the elevations and dimensions are within tolerance. In addition the canal condition should be checked by the site inspection. The sample checking forms for canal works are attached in the ***APPENDIX-4*** of this manual. The following illustration is an example for evaluation of the survey results.



5.5.3 Structural Works

(1) Check of Structural Works

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

i) elevation of the structure
ii) dimension of the structure; and
iii) quality of the structure for securing durability and designed function.

The allowable tolerance of the structural elevation and dimension for the structural works are as follows:

Items	Tolerance	Remarks
Elevation	± 1.0 cm	
Dimension	± 5.0 cm	in the case of the gate and the measuring device: **± 1.0 cm**

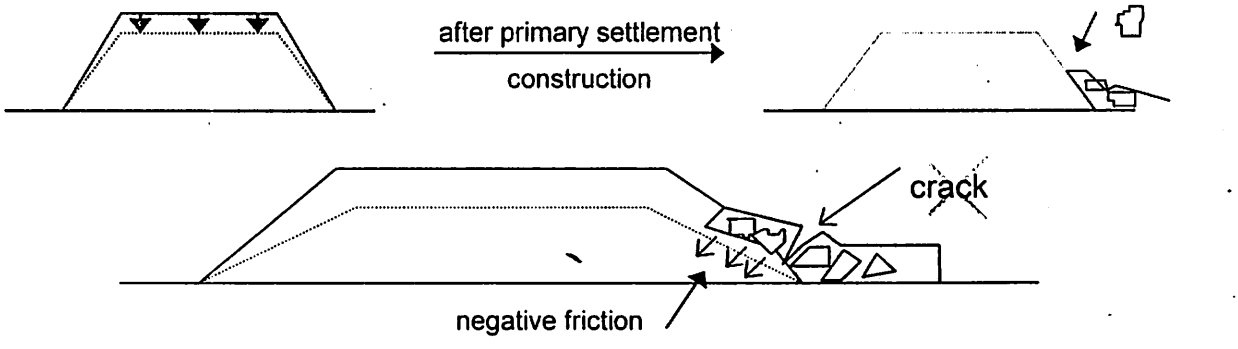
The function and durability of the structure should be checked through the site inspection immediately after the completion of structural works or during the running test. The sample checking forms for the irrigation structures are attached in the ***APPENDIX-5*** of this manual for the following structures:

1. Measuring Device (Broad-Crested Weir)
2. Turnout
3. Check
4. Pipe Culvert (1 pipe)
5. Pipe Culvert (2 pipes)
6. Box Culvert
7. Drop
8. Chute
9. Aqueduct
10. Siphon
11. Bridge
12. Cross Drain

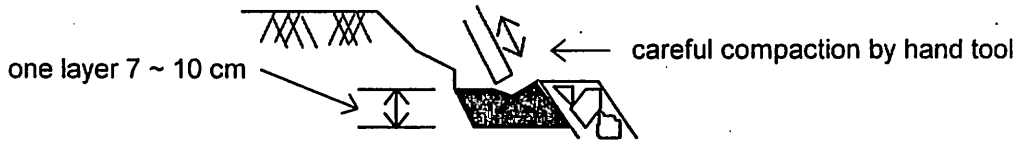
(2) Structural Transition

The construction of the transition portion of the structure, should take care the following:

- construction of the structural transition should be carried out after 1 or 2 month after the completion of embankment works to avoid cracking in the transition wall.

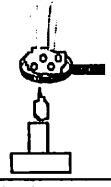
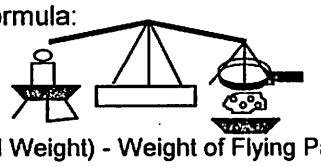
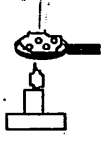


- Backfilling for the transition should be placed and compacted in a thin layer with thickness of 7 ~ 10 cm.
- Compaction of backfilled material should be carefully carried out to avoid a damage to the transition wall, especially compaction adjacent to the transition wall should be carried out by the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



Measuring Soil Moisture in the Field

The measurement of the soil moisture of borrow material and embankment material shall be made with the "Frying Pan Method" owing to its simple and quick testing procedures. An explanation of this method is given below.

Step	Testing Procedures	Explanation
1	Equipment	1. Small Frying Pan  x 1 2. Balance or Weighing Machine (possible to weigh in 0.1g order)  x 1 3. Spirit Lamp or Burner  x 1
2	Weight of Frying Fan	The weight of frying pan shall be checked. Weight of Frying Pan = Wf 
3	Weight of Soil Material with Frying Pan	A weight of sampled earthfill material with the frying pan shall be checked with the Balance/Weighing Machine. A net weight of the material soil is calculated using the following formula: weight of soil = Wws  Wws = (Total Weight) - (Weight of Frying Pan = Wf)
4	Drying Soil Material on the Frying Pan using the Spirit Lamp or Burner	The soil material on the frying pan shall be dried using a Spirit Lamp or Burner until the material becomes completely dry. 
5	Weight of Dried Soil Material with Frying Pan	The weight of the above dried material with the Frying Pan shall be checked with the Balance. The net weight of dried soil material is calculated using the following formula:  Weight of Dried Soil= Wds = (Total Weight) - Weight of Flying Pan (Wf)
6	Reheating Soil Material on the Frying Pan using a Spirit Lamp or Burner	In order to check the above weighing result of dried soil material, the soil material shall be reheated using Spirit Lamp or Burner for a few minutes.  **Reheating**

7	Weigh Reheated Soil Material with Frying Pan <u>again</u>	The reheated soil material soil with the Frying Pan shall be weighed. If the weight of the material is same with the previous weighing result, the dried weight of soil material is considered as **Wds.** If the weight of material still decreases, the drying procedure shall be continued until the weight of material becomes constant.  **= decrease** Dried Soil Weight = **<u>Wds</u>** → return to <u>step 6</u> proceed to Step 8
8	Estimating the Moisture Content of the Soil Material	The moisture content of the soil material shall be estimated using the following formula: (Moisture Content of Soil) = $\frac{(Wws-Wds)}{Wds}$
9	Evaluation of Measuring Results	If a moisture content of the soil material is within the specified range (± **5 %**) of the optimum moisture content), the material can be used for the embankment/earthfill works; otherwise, further wetting or drying treatment for the material is required until the moisture content of the material satisfy the above range.

Sample Calculation for Concrete Mix Design for <u>Type-A Concrete</u>

(1) Conditions

Type of Concrete	Maximum Size of Coarse Aggregate	Fineness Modulus of Fine Aggregate **(FM)**	Water/ Cement Ratio **(W/C)**	Specified Slump	Air Content	Fine Aggregate Content **(s/a)**	Unit Water Weight **(W)**
Specified standard condition	40 mm	2.75	50%	8 cm	1%	35%	150 kg
Targeted value	40 mm	2.95	50%	9 cm	1%	35%	150 kg

Note : Bold face indicates items to be adjusted (refer to (2) Initial Adjustment below).

(2) Initial Adjustment

The initial adjustment shall be made for <u>s/a (fine aggregate content)</u> and <u>W (unit water weight)</u> based on the adjustment factor in <u>Table 5.1 (see page 31)</u> because of variation of FM (fineness modulus) and Slum Height in this case. A process for adjustment is as follows:

Comments	W/C	Slump	FM	adjustment	s/a	adjustment (kg)	Unit Water Weight
specified standard	50%	8 cm	2.75	---	35%	---	150 kg

1st Adjustment	50%	9 cm (+1 cm)	2.75	no adjustment	35%	+1x0.012x 150 = + 1.80 = + 2.0 kg	152 kg
2nd adjustment	50%	9 cm	2.95 (+0.2)	+2 x 0.5 = + 1.0	36%	no adjustment	152 kg

(3) Calculation of Required Material Volume for Trial Mixing (for 1 m^3 concrete)

Material	Weight of Material (kg)	Volume of Material (m^3)
Water	152 kg	152/(1x1000) = 0.152 m^3 ← specific gravity of water
Cement =Water/(W/C)	152 / 0.50 = 304kg	304/(3.15x1000) = 0.097 m^3 ← density of cement
Air	---	1.0% x 1m^3 = 0.001 m^3
Total	152 + 304 = **456 kg**	0.152 + 0.097 + 0.001 = **0.250 m^3**
Total Aggregate		1.0 m^3 - 0.250 =0.750 m^3
Fine Aggregate	s/a (fine aggregate content → 1000 x 0.270 x 2.62 = 707 kg	0.750 x 36% = 0.270 m^3 ← density of fine aggregate
Coarse Aggregate	1000 x 0.480 x 2.64 = 1267 kg	0.750 - 0.270 = 0.480 m^3 ← density of coarse aggregate
Grand Total	456 + 707 + 1267 = 2430 kg	0.250 + 0.270 + 0.480 = 1.000 m^3

(4) Adjustment for Concrete Mixing Volume

The material volume must be adjusted for the concrete volume of trial mixing. If the one batch of the trial mixing is 0.020 m^3, the above required material is adjusted as follows:

Material	Adjustment	Results
Fine Aggregate	707 kg x 0.020 =	14.14 kg
Coarse Aggregate	1267 kg x 0.020 =	25.34 kg
Water	152 kg x 0.020 =	3.04 kg
Cement	304 kg x 0.020 =	6.08 kg
Total		48.60 kg

(4a) Adjustment for Surface Water Content of Aggregate for the Actual Mixing

In case the aggregates contain some water, the water volume to be used for the trial mixing must be decreased for the volume of such surface water. If the surface water content of fine and coarse aggregates is measured at 4% and 0.2% respectively, the adjustment of water volume is calculated as follows:

Material	Adjustment	Results
Fine Aggregate	14.14 kg x 1.04 =	14.71 kg (weight of water : 0.57 kg)
Coarse Aggregate	25.34 kg x 1.002 =	25.39 kg (weight of water ; 0.05 kg)
Water	3.04 kg - 0.57kg - 0.05 kg =	2.42 kg
Cement		6.08 kg

(5) Adjustment based on the Result of the Trial Mixing Results

After the trial mixing, a slump, an air content and a unit weight of concrete must be measured for adjustment of material mix proportion of concrete. If these values are measured at 11 cm, 1.5% and 2350 kg/m^3 respectively, the adjustment of material volume is calculated as follows:

(a) Adjustment for Unit Concrete Weight

Item Volume	Adjustment	Results
Adjusted Concrete Volume = (total weight of material)/(unit weight of concrete)	48.60 kg / 2350 kg/m^3 =	0.0207 m^3
Unit Water Weight	3.04 kg / 0.0207 =	147 kg
Unit Cement Weight	6.08 kg / 0.0207 =	294 kg
Unit Fine Aggregate Weight	14.14 kg / 0.0207 =	683 kg
Unit Coarse Aggregate Weight	25.34 kg / 0.0207 =	1224 kg

(b) Adjustment for Slump and Air Content

Material	Adjustment	Calculation	Adjusted Weight	Volume
Water	1) adjustment for air content of -0.5% (=1.0% - 1.5%) 2) adjustment for slump - 2 cm (= 9cm - 11 cm)	147 kg x 0.003 = + 0.4 kg - slump will be decreased by -1.25 cm due to adjustment for air content, therefore, the required adjustment for slump is; -(2 cm - 1.25 cm) = 0.75 cm 147 kg x 0.012 x (-0.75) = -1.3 kg	147 + 0.4 - 1.3 = 146 kg	0.146 m^3
Cement	Water / (Water-Cement Ratio)	146 kg /0.50 =	292 kg	292 / (3.15 x 1000) = 0.093 m^3
Air Content				0.01 m^3
Total Aggregate	**= 1.0 m^3 -Volume of (Water + Cement + Air)**	1.0 - 0.146 - 0.093 - 0.01 =		0.751 m^3
Fine Aggregate	= Total Aggregate x s/a	0.270 x 2.62 x 1000 =	707 kg	0.751 x s/a (=36%) = 0.270 m^3

Coarse Aggregate	= Total Aggregate x (1 - s/a)	324 kg x 0.020 =		0.707 x (1-s/a) = 0.707 x 0.64 = 0.452 m^3
		0.452 x 2.64 x 1000 =	1193 kg	
Total			**2338 kg**	

The adjustment of material proportion for concrete and the succeeding re-trial mixing shall be done until a satisfactory slump and air content of the concrete is attained.

(6) Field Adjustment

If the material mix proportion of concrete is determined by the above trial mixing, this concrete mix design must be further adjusted in the field based on the actual condition of the aggregate in the field.

In case the specifications requires the use of 694 kg/m3 of fine aggregates and 1246 kg/m3 of coarse aggregates and condition of the aggregates measured are as shown in Table (a), the field adjustment of mix proportion is made by the trial-and-error method which is shown in Table (b) as follows:

Table (a) Field Condition of Aggregates:

(results of sieve analysis and measurement of surface water content)

Size of Aggregate	Fine Aggregate	Coarse Aggregate
0 ~ 5 mm	96 %	5%
5 ~ 40 mm	4 %	95%
Surface Water Content	3.5%	0.9%

Table (b) Sample Adjustment Calculation in the Field

(design mix : fine aggregate = 694 kg., coarse aggregate = 1246 kg., water = 155 kg., cement = 310 kg)

Size of Aggregate	Fine Aggregate	Coarse Aggregate	1st Trial	2nd Trial	3rd Trial
0 ~ 5 mm	96 %	5%	5% x 1193 = 60kg 707kg - 60kg = 647kg 647kg / 96% = 674kg	5% x 1227kg = 61kg 707kg - 61kg = 646kg 646kg / 96% = 673kg	5% x 1227kg = 61kg 707kg - 61kg = 646kg 646kg / 96% = 673kg
5 ~ 40 mm	4%	95%	4% x 674kg = 27kg 1193kg - 27kg = 1166kg 1166kg/95% = 1227kg	4% x 673kg = 27kg 1193kg - 27kg = 1166kg 1166kg/95% = 1227kg	4% x 673kg = 27kg 1193kg - 27kg = 1166kg 1166kg/95% = 1227kg
Total	100%	100%			
1900 kg	707 kg	1193 kg	Design Mix		
1901 kg	674 kg	1227 kg	1st Trial		
1900 kg	673 kg	1227 kg	2nd Trial		
1900 kg	673 kg	1227 kg	3rd Trial		

Surface Water	3.5 %	0.9 %	Sand Gravel	673kg x 1.035 = 697kg 1227kg x 1.009 = 1238kg	
Adjusted Weight of Aggregate for Surface Water	697 kg	1238 kg	(final adjustment results)		
Adjusted Weight of Water for Surface Water	111 kg			673kg x 0.035 = 24 kg 1227kg x0.009 = 11kg 146kg - 24kg - 11kg = 111kg	(surface water of fine aggregate) (surface water of coarse aggregate)

5.5.4 Concrete Canal Lining

Concrete canal lining works is an important component in the construction of irrigation facilities. Since the quality control of the concrete component is already discussed in preceding topic, this section therefore aims to emphasize the right procedures in lining works, as follows:

- check the dimension as well as horizontal and vertical connections of the excavated trench for filter drain.
- make sure that filter drain materials are suitable and are compacted properly.
- the ground surface of the trimmed canal should be moistened before installation of kraft paper.
- check the alignment and elevation of the batterboards.
- sprinkling of water on the kraft paper shall be done prior to start of concrete placement.
- concrete pouring on canal sides should be started at the bottom, at 30 cm height of every layer, and compaction shall be done properly with fabricated steel bars/tamper. Concrete should be provided continuously to avoid cold-joint.
- After concrete has set, cover the surface with wet sheet and keep constantly wet for at least 6 days to protect it from the harmful effects of sunshine, drying winds, rain or running water.
- Reference lines shall be marked on the face of the lining to keep proper alignment of weepholes to be installed.
- and care shall be taken in setting of weephole valves to avoid upside-down positions.

5.5.4.1 Weephole Installation

a. Six(6) inches (150mmØ)PVC blackouts will be used as concrete is poured around the hole.

b. When concrete has sufficiently hardened, PVC blockouts shall be removed and jute sacks shall be inserted inside blockout holes to prevent gravel filters from getting out or rolling out of the blocked-out holes.

c. Prior to installation of weephole assembly, jute sacks previously inserted, shall be removed, then blockout hole shall be inspected for any gravel filter problem. If there is a need to add more gravel, then gravel shall be inserted inside the blockout hole.

d. When gravel filter has been approved by the consultant, then with prepared mortar (1:2 mix), install weephole assembly with its longitudinal axis inclined downwards at 5% towards its outlet end.

e. The outlet part will be well-shaped concrete conforming to the circular shape of the weephole.

5.5.6 Gabion Works

5.5.6.1 General

The procedure for placing of gabion mattresses will vary depending on the slope of the surface where the mattresses are to be laid/installed. Most of the works are on horizontal and slightly inclined surfaces of 2.5% and the other works on limited scale on 1:1.5 and 1:3 slope surfaces.

Works on the latter will also involve laying of filter cloth on the prepared ground surface before installation of the gabion mattresses.

5.5.6.2 Preparatory Works

The work shall include laying out on the site, the lines and grades of the areas or surfaces where gabion mattresses are to be installed.

Rough excavation and trimming shall be undertaken using appropriate equipment. Final trimming shall be performed manually. Excavation and trimming works shall be monitored closely by the surveyors in order to be within the specified lines and grades.

Gabion mattresses are usually laid on undisturbed ground after excavation to the correct lines and grades specified in the drawings. In cases where the soil has been disturbed due to excessive excavation or other operations and is required to be backfilled, then backfilling shall be done in accordance with the pertinent provisions of the Specifications.

5.5.6.3 Assembly of Gabion Cages

Assembly shall be undertaken at the place that is as close as possible to the site where the gabion mattresses are to be installed.

The procedure to be followed shall be in accordance with the manual accompanying the procured gabions. The common practice in this activity, however, is as follows:

1. Unfold each gabion on a hard, flat surface.

   Stretch it out and stamp out any kinks. Make sure that all creases are in the correct positions for forming the box - one at the edge of each panel and each diaphram.

2. Fold the side and end panels into the upright position to form a rectangular box.

   Join the top corners of the box together with the thick selvedge wire sticking out from the corners of each panel. This makes sure that the tops of all four sides of the box are level.

3. Begin wiring up by securing the binding wire at the top corners of the panels to be joined by looping it through and twisting it together. Then lace the wire around the selvedges with single loops and double loops in turn at 100 mm (4 in) intervals. Finally, fasten the wire securely at the bottom corner, and poke the loose end inside the gabion.

   Next lift the diaphrams into vertical positions, and wire them up to the side panels, in exactly the same way.

4. When possible, wire small groups of gabions together off the site, and then carry them to the structure as complete sections for joining to other gabions already in position. This is easier than wiring them on site, especially when working in water.

   Level the ground where the gabion structure is to be built as much as possible before placing the empty gabions in position. Once the gabions are in place, it is difficult to remove unwanted material from underneath.

5. Wire the gabions together, using exactly the same method as for assembling single gabions. Place them front and back to back, so that pairs of facing lids can later be wired down in one go.

6. Place the empty gabion or group of gabions in position. Secure the end from which work is to start by rods driven through the two corners into the ground and tied firmly to a good anchorage. *It is important that the anchorages are at least the height of the gabion to prevent it from collapsing.*

   The remaining empty gabions are wired one to another as work proceeds. Stretch the opposite side or end of the gabion by inserting bars into the bottom corners and levering them forwards. The top and bottom are then kept stretched until the gabion has been filled, by tying them to a fixed point. - eg, a stake driven into the ground and wired to the gabion below.

   In suitable conditions (i.e., construction of a relatively long, straight structure), a Tirfor strainer may be usefully employed instead of stretching each gabion separately. One end of a row of previously-wired together empty gabions is firmly secured to a good anchorage, and the other end attached to the Tirfor by means of rods and a spreader bar. When sufficient tension has been applied over the length (of up to 30 m), the gabions are either wired down to the course below and then filled (if the second or higher course) or filled immediately (if they form the base course).

7. While the gabion is stretched, check that the wiring has been properly carried out and is not pulling apart. If it is, the section must be re-wired.

8. When on the structure, wire the gabions securely along the sides and ends to the adjoining gabions and to the already filled gabions below.

9. Use hard durable stone not larger than 250 mm (10 in) and not smaller than the size of the mesh. The best size range is 125 mm to 200 mm (5 in to 8 in). A small percentage (about 5 to 7%) of smaller material is allowed. In areas where large fill is difficult to obtain, the compartment is lined with large material and the interior filled with smaller.

   Fill the gabions by hand or by machine, making sure that the stone is tightly packed and has a minimum of voids. When possible, leave the last gabion empty, as it is easier to join the next one to it.

10. Fill all the outside compartments of 1 m high gabions only one-third full to begin with. (*500 mm gabions are filled in 2 lifts with bracing at half full. No bracing is necessary with 330 mm gabions.*) Then fix horizontal bracing wires in the gabions directly above the level of the stone in those compartments and 'Spanish' windlass the bracing wires to keep the face even and free from bulging. Next fill to two-thirds, and repeat the bracing. Finally fill the top.

    Level off the fill 25 mm to 50 mm (1in to 2 in.) above the top of the mesh to allow for settlement. Small material is best for this.

    In aprons downstream of weirs and similar places where water falls directly on to the gabions, fit vertical bracing wires between the top and bottom mesh.

11. Stretch the lids tightly over the filling and wire them down. The corners should be temporarily secured first, to ensure that there is enough mesh to cover the whole area. Some filling may have to be removed from the top of the gabion to prevent the lid from being over-stretched.

5.5.6.4 Tools

Pliers - Preferably 10 in long-nose fencing pliers.
Crowbars - for closing down the lids.
Bars - For tensioning; and driven into the ground as fixed points.
Lid Closer - tool for drawing the lid and side panel selvedges together for easy and quick lacing.

5.5.7 Road Surfacing (Gravel Metalling)

5.5.7.1 Preparatory Works

Preparatory works prior of gravel metalling depends on the extent of damage on the existing roadway and obstructions.

An excavator with flat bucket shall be used to strip the existing roadway. Stripped soil and vegetation shall be directly loaded to dump truck for disposal. Tree stumps shall be grubbed by excavator and hollowed bank sections shall be backfilled and properly compacted. Care shall be exercised in stripping to separate the vegetation and unsuitable materials. Avoid contamination of good materials as this could be used for embankment. Cutting of the slope and areas adjacent to the ricefield shall be avoided to maintain its stabilized condition. Stripped roadway shall have 2% slope draining as preparation for rainfall.

5.5.7.2 Subgrade preparation

The O&M road embankment shall be prepared for bonding with the new surfacing materials. Where final grade elevation is same as the existing ground elevation and the roadway has been previously laid with sufficiently thick gravel surfacing, the section shall be trimmed only to its designed camber, with the potholes and projections leveled and compacted to acceptable density.

Where existing gravel metalling is relatively thin, scarifying the existing roadway surface will be conducted for good bond and then compacted as single course.

On road sections where there is no surfacing, the original grounds shall be stripped of grass and vegetation. Unsuitable materials present on the roadway shall be removed and replaced with suitable material from approved source and compacted to acceptable density.

Drainage slope on the roadway shall will be towards the outer side of the canal embankment at 2.0%. All stripped materials shall be disposed of properly to prevent ponding on roadsides.

5.5.7.3 Gravel Metalling

After the subgrade has been satisfactorily prepared, gravel materials shall be delivered on site and spread immediately for continuous access of vehicles on the road section. The gravel materials will likewise be fine-graded to its true level and camber and compacted accordingly. The average thickness of the compacted gravel metalling shall be as specified.

Outer side of the embankment shall be leveled-off for effective drain of surface run-off water.

The inner side of the canal embankment shall likewise be cleared of waste and the side slope above the concrete lining berm shall be cut/trimmed to 1:1.5 as part of bank protection.

APPENDIX - 1

FORM FOR CHECKING EMBANKMENT WORKS BY EQUIPMENT

Material Excavation and Stockpiling Work at Borrow Pit Supervised by:					no : date : place:	
No.		CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	**Stripping of Top Soil**					
	a	removed all obstacles?				
	b	disposed the stripped soil properly?				
	c	depth of stripping (0.20 ~ 0.50 m)				
2	**Material at Borrow Pit**					
	a	different material stocked separately?				
	b	checked usability of material?				
	c	checked moisture content of material?				
	d	appropriate moisture content?				
		(±5% of the optimum moisture content)				
3	**Stockpiling**					
	a	adjusted moisture content?				
	b	no influence of rainfall to stockfile or				
		prepared some protection sheet?				
4	**Adjustment of Moisture Content of Stockpiled Material**					
	(if drier than specified range)					
	a1	spreading stockpile properly (20 cm)?				
	b1	sprayed water for material?				
	c1	mixed material?				
	d1	checked moisture content?				
	e1	appropriate moisture content?				
	(if wetter than specified range)					
	a1	spreading stockpile properly (20 cm)?				
	b1	dryed material (4 - 6 hours)?				
	c1	mixed material?				
	d1	checked moisture content?				
	e1	appropriate moisture content?				

FORM FOR CHECKING EMBANKMENT WORKS BY EQUIPMENT

Material Embankment Work					no : date : place:	
Supervised by:						
No.		CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	**Stripping of Top Soil**					
	a	removed all obstacles?				
	b	disposed the stripped soil properly?				
	c	depth of stripping (0.20-0.50 m)				
	d	foundation with sufficient bearing capacity?				
2-1	**Treatment of Foundation**					
	(if foundation too dry)					
	a1	sprayed water for foundation?				
	b1	disturbed foundation surface?				
	(If foundation too wet)					
	a2	dryed foundation?				
	b2	disturbed foundation surface?				
	(1st layer)					
3-1	**Spreading Embankment Material**					
	a	use of measuring pole?				
	b	spreading thickness 30 cm 3cm?				
	c	spreading width with 10 - 30 cm extra				
		embankment?				
4-1	**Compaction of Embankment Material**					
	a	passage of compactor more than 5 times?				
	b	provided 5% slope of surface?				
(1st or 2nd or 3rd or 5th or __nth layer)						
2-2	**1st layer Treatment**					
	(if last layer too dry)					
	a1	sprayed water for last layer				
	b1	disturbed last layer surface?				
	(if last layer too wet)					
	a2	dryed last layer?				
	b2	disturbed last layer surface?				
3-2	**Spreading Embankment Material**					
	b	spreading thickness 7 - 10 cm?				
	c	spreading width with 10 - 30 cm extra				
		embankment?				
4-2	**Compaction of Embankment Material**					
	a	passage of hand compactor more than 5 times?				
	b	provision of 5% slope for embankment				
		surface?				
5	**Provision of Extra Embankment**					
	a	provision of 10 - 20 cm extra embankment				

FORM FOR CHECKING EMBANKMENT WORKS BY MANUAL LABOR

Material Excavation and Stockpiling Work at Borrow Pit Supervised by:				no : date : place:	
No.	CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	**Stripping of Top Soil**				
	a removed all obstacles?				
	b disposed the stripped soil properly?				
	c depth of stripping (0.20-0.50 m)				
2	**Excavation os Soil Material at Borrow Pit**				
	a different material stocked separately?				
	b checked usability of material?				
	c checked moisture content of material?				
	d appropriate moisture content?				
	(5% of the optimum moisture content)				
3	**Stockpiling**				
	a adjusted moisture content?				
	b surface of stockpile compacted?				
4	**Adjustment of Moisture Content of Stockpiled Material**				
	(if drier than specified range)				
	a1 spreading stockpile properly (20 cm)?				
	b1 sprayed water for material?				
	c1 mixed material?				
	d1 checked moisture content?				
	e1 appropriate moisture content?				
	(if wetter than specified range)				
	a1 spreading stockpile properly (20 cm)?				
	b1 dryed material (4 - 6 hours)?				
	c1 mixed material?				
	d1 checked moisture content?				
	e1 appropriate moisture content?				

FORM FOR CHECKING EMBANKMENT WORKS

Material Embankment Work Supervised by:					no : date : place:	
No.		CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	Stripping of Top Soil					
	a	removed all obstacles?				
	b	disposed the stripped soil properly?				
	c	depth of stripping (0.20-0.50 m)				
	d	foundation with sufficient bearing capacity?				
2-1	Treatment of Foundation					
	(if foundation too dry)					
	a1	sprayed water for foundation?				
	b1	disturbed foundation surface?				
	(If foundation too wet)					
	a2	dryed foundation?				
	b2	disturbed foundation surface?				
	(1st layer)					
3-1	Spreading Embankment Material					
	a	use of measuring pole?				
	b	spreading thickness 30 cm 3cm?				
	c	spreading width with 10 - 30 cm extra				
		embankment?				
4-1	Compaction of Embankment Material					
	a	passage of compactor more than 5 times?				
	b	provided 5% slope of surface?				
(1st or 2nd or 3rd or 5th or __nth layer)						
2-2	1st layer Treatment					
	(if last layer too dry)					
	a1	sprayed water for last layer				
	b1	disturbed last layer surface?				
	(if last layer too wet)					
	a2	dryed last layer?				
	b2	disturbed last layer surface?				
3-2	Spreading Embankment Material					
	b	spreading thickness 30 cm - 3 cm?				
	c	spreading width with 10 - 30 cm extra				
		embankment?				
4-2	Compaction of Embankment Material					
	a	passage of hand compactor more than 5 times?				
	b	provision of 5% slope for embankment				
		surface?				
5	Provision of Extra Embankment					
	a	provision of 10 - 20 cm extra embankment				

APPENDIX - 2

FORM FOR CHECKING CONCRETING WORKS

1. Pre-Placement Work Supervised by:					no : date : place:	
No.		CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	**Water**					
	a	free from impurities ?				
2	**Fine Aggregate**					
	a	washed and stored for at least 72 hours before use?				
	b	stored with some covering sheet and/or under the shelter?				
	c	stored with an appropriate drainage facility?				
	d	stored at separate place with coarse aggregate?				
	e	sieved by 5 mm sieve before use?				
	f	measured surface water content?				
		(surface moisture test twice a day)				
3	**Coarse Aggregate**					
	a	washed and stored for at least 48 hours before use?				
	b	stored with some covering sheet and/or under the shelter?				
	c	stored with an appropriate drainage facility?				
	d	stored at separate place with fine aggregate?				
	e	sieved by 40 or 80 mm sieve before use?				
	f	measured surface water content?				
		(surface moisture test twice a day)				
4	**Cement**					
	a	ordinary Portland cement				
	b	stored less than 3 months?				
	c	stored in the ventilated ware-house?				
	d	ware house with 30 cm elevated floor from the ground?				
	e	stored not contracted with the wall?				
5	**Form Work**					
	a	forms properly braced?				
	b	forms sufficiently tight to prevent loss of mortar?				
	c	acceptable tolerance in elevation?				
	e	the inside of forms clean?				
	f	approved coating materials on forms?				
	g	waterstops properly furnished?				
	h	joint of waterstops fastened together?				
	i	moistened forms before placement of concrete?				
6	**Reinforcement Bars Placing**					
	a	reinforcement bars placed in accordance with drawings?				
	b	lap joint length enough?				
	c	contaminant?				
	e	placed all embedded material properly?				

FORM FOR CHECKING CONCRETING WORKS

II. Concrete Mixing, Placing and Post-Placement Work Supervised by:					no : date : place:	
No.		CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	Preparation Mixing					
	a	adjusted mix proportion according to surface of aggregates?				
2	Concrete Mixing Work					
	a	the inside of mixer clean?				
	b	proper mix proportion of materials?				
	c	proper putting order of material? (water - aggregate - cement - water)				
	d	no of use of 1st batch?				
	e	proper mixing time (around 1.5 minutes)?				
	f	slump within specified range?				
		(twice a day)				
	g	sampling for compression test?				
		member?				
3	Concrete Placing Works					
	a	concrete placement immediately after mixing?				
	b	no use of inclined chute?				
	c	maximum concrete free fall less than 1.5 m?				
	d	no segregation of concrete?				
	f	proper concrete placement direction?				
		(backward direction)				
	g	thickness of one layer for compaction about 25 - 30 cm?				
	h	back-up vibrator on site or at least 2 sets of vibrator on site?				
	j	penetrate vibrator to the previous layer by 15 cm?				
	k	max. vibrating time at one position less than 15 sec.?				
	l	interval time for construction joint less than 2 hours?				
	m	construction joint free from laitance?				
	n	hours interval time for construction joint?				
4	Post Placement Work					
	a	moisten form for curing?				
	b	covered by wet sheet for curing?				
	c	curing at least 36 hours?				
	d	side support?				
	e	bottom support?				
	f	concrete compression test satisfied the specified strength?				

APPENDIX - 3

FORM FOR CHECKING WET STONE MASONRY WORKS

Supervised by:					no : date : place:	
No.		CHECKING ITEMS	EVALUATION OK	EVALUATION NO	INSTRUCTIONS OF SUPERVISOR	REMARKS
1	**Water**					
	a	free from impurities?				
2	**Sand**					
	a	washed before use?				
	b	free from the organic matters and other contamination?				
	c	sieved by 5 mm sieve before use?				
3	**Stone**					
	a	free from crack/seam?				
	b	appropriate max. stone size (40 cm and 2/3 of wall thickness)?				
4	**Placing of Masonry**					
	a	proper cement/sand mix proportion for joint mortar (1:4)?				
	b	moistened stones before use?				
	c	compaction of joint mortar using trowel sufficiently?				
	d	hitting and consolidation of stone by steel hammer?				
	e	width of joints in face stone not exceeding 3 cm?				
	f	sufficient thickness of masonry wall and/or lining?				
5	**Pointing of Surface Joint Mortar**					
	a	chipped the joint mortar to a depth of 3 cm?				
	b	plastering/pointing (1:2)?				
	c	cleaned the surface of joint mortar using wire brush?				
	d	sufficient filling of surface joint mortar?				

APPENDIX - 4

FORM FOR CHECKING CANAL WORKS

Checked by:							no : date : canal:	
			EVALUATION					
			RIGHT SIDE		LEFT SIDE		INSTRUCTIONS OF	
No.		CHECKING ITEMS	OK	NO	OK	NO	SUPERVISOR	REMARKS
1	Canal Embankment and Excavation							
	a	excavation of and check by cross section surveys?						
	b	sufficient compaction for embankment?						
	c	no hole and/or crack in the embankment?						
	d	no side slope sliding?						
	e	surfacing for canal slope?						
	f	no debris and/or obstacles in the canal?						
	g	no remaining excavation?						
	h	sufficient sod facing work and/or slope protection work?						
	i	excavation of side ditch?						
	j	no water leakage from canal?						
	k	no remaining disposal soil around canal?						
	l	no excavation hole or borrow fit hole around canal?						
2	Inspection Road							
	a	flat surface of inspection road?						
	b	sufficient compaction for gravel metaling?						
	c	sufficient width of gravel metaling?						
	d	sufficient thickness of gravel metaling?						
	e	no inclusion of organic matter and vegetables?						
3	Masonry Lining Works (if any)							
	a	acceptable quality of masonry?						
	b	no crack in the lining?						
	c	proper thickness of masonry wall?						
	d	no water leakage?						
	e	execution of and check by cross section survey?						

(PHOTOGRAPH)

		Taken or not	
1	before stripping		
2	after stripping		
3	adjustment work of moisture content		
4	embankment works layer No. _____		
5	embankment works layer No. _____		
6	masonry works		
7	completion condition		

APPENDIX - 5

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: MEASURING DEVICE (BROAD CRESTED WEIR

Dimension											Elevation					
1. Inlet											1. Inlet					
1-1 Width						1-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL1			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
L3			OK	not OK	± 5cm				OK	not OK		EL3			OK	not OK	± 1cm
W1			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W1L			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W1R			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W3			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W4			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Crest											2. Crest					
2-1 Width & Length						2-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L4			OK	not OK	± 5cm	H3			OK	not OK	± 1cm	EL7			OK	not OK	± 1cm
L5			OK	not OK	± 5cm	H4			OK	not OK	± 1cm	EL8			OK	not OK	± 1cm
W7			OK	not OK	± 5cm				OK	not OK		EL9			OK	not OK	± 1cm
W8			OK	not OK	± 5cm				OK	not OK		EL10			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL11			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL12			OK	not OK	± 1cm
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK							
3. Outlet											3. Outlet					
3-1 Width & Length						3-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L6			OK	not OK	± 5cm	H5			OK	not OK	± 1cm	EL13			OK	not OK	± 1cm
L7			OK	not OK	± 5cm	H6			OK	not OK	± 1cm	EL14			OK	not OK	± 1cm
W9			OK	not OK	± 5cm				OK	not OK		1L15			OK	not OK	± 1cm
W10			OK	not OK	± 5cm				OK	not OK		EL16			OK	not OK	± 1cm
W11			OK	not OK	± 5cm				OK	not OK		EL17			OK	not OK	± 1cm
W12			OK	not OK	± 5cm				OK	not OK		EL18			OK	not OK	± 1cm
W12L			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W12R			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W13			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W14			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK													

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: MEASURING DEVICE (BROAD CRESTED WEIR

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1. no crack in the inlet wall?	OK	not OK			
2. no crack in the inlet bottom?					
3. surface plastering or pointing for masonry already?	OK	not OK			
4. quality of masonry enough hard?	OK	not OK			
5. embankment works completed?	OK	not OK			
6. excavation work completed?	OK	not OK			
7. surfacing and sod facing foe each slope already?	OK	not OK			
8. no debris in the inside of inlet?	OK	not OK			
9. furnished all appurtenances already?	OK	not OK			
10. smooth connection with the upstream canal?	OK	not OK			
11. furnished gravel metalling for inspection road?	OK	not OK			
12	OK	not OK			
	OK	not OK			

2. Crest

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1. no crack in the masonry wall?	OK	not OK			
2. no crack in the broad crest/stilling basin?					
3. surface plastering or pointing for masonry already?	OK	not OK			
4. quality of masonry enough hard?	OK	not OK			
5. no piping in the foundation of broad crest weir?	OK	not OK			
6. furnished measuring plate?	OK	not OK			
7. embankment works completed?	OK	not OK			
8. excavation works completed?	OK	not OK			
9. surfacing and sod facing for earth slope completed?	OK	not OK			
10. no debris in the inside of broad crest/stilling basin?	OK	not OK			
11. furnished gravel metaling for inspection road?	OK	not OK			
	OK	not OK			
	OK	not OK			

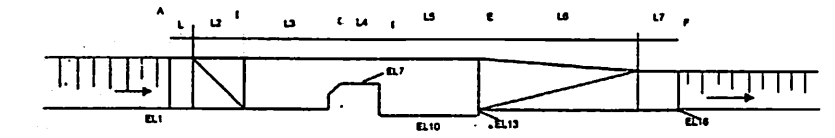
3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1. no crack in the outlet wall?	OK	not OK			
2. no crack in the outlet bottom?	OK	not OK			
3. surface plastering or pointing for masonry already?	OK	not OK			
4. quality of masonry enough hard?	OK	not OK			
5. embankment works completed?	OK	not OK			
6. excavation work completed?	OK	not OK			
7. surfacing and sod facing foe each slope already?	OK	not OK			
8. no debris in the inside of outlet?	OK	not OK			
9. all appurtenances already furnished?	OK	not OK			
10. smooth connection with the downstream canal?	OK	not OK			
11. furnished gravel metaling for inspection road?	OK	not OK			
12. riprap furnished already?	OK	not OK			
13. appropriate size of cobble stone for riprap (20–30 cm)	OK	not OK			

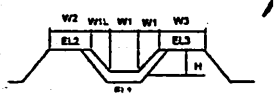
FORM FOR CHECKING STRUCTURAL WORKS

STRUCTURE: MEASURING DEVICE (BROAD CRESTED WEIR)

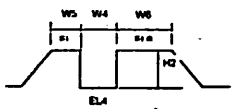
SKETCH OF STRUCTURE



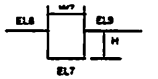
(SECTION A-A)



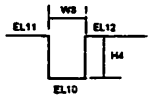
(SECTION B-B)



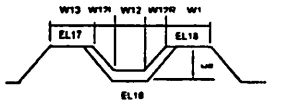
(SECTION C-C)



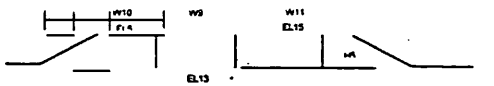
(SECTION D-D)



(SECTION F-F)



(SECTION E-E)



no		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. completion	
4.	
5.	
6.	
7.	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: TURNOUT

Dimension

1. Inlet

1-1 Width

		Standard Deviation
L1	not OK	± 5cm
L2	not OK	± 5cm
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	

1-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Gate Portion

2-1 Width & Length

		Standard Deviation
L3	not OK	± 5cm
L4	not OK	± 5cm
L5	not OK	± 5cm
L6	not OK	± 5cm
L7	not OK	± 5cm
W1	not OK	± 5cm
W2	not OK	± 5cm
D	not OK	± 5cm
	not OK	
	not OK	
	not OK	
	not OK	
	not OK	

2-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H1			OK	not OK	± 1cm
H2			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

3-1 Width & Length

		Standard Deviation
L8	not OK	± 5cm
L9	not OK	± 5cm
L10	not OK	± 5cm
W3	not OK	± 5cm
W3L	not OK	± 5cm
W3R	not OK	± 5cm
W4	not OK	± 5cm
W5	not OK	± 5cm
W6	not OK	± 5cm
W6L	not OK	± 5cm
W6R	not OK	± 5cm
W7	not OK	± 5cm
W8	not OK	± 5cm

3-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H3			OK	not OK	± 1cm
H4			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

Elevation

1. Inlet

	Designed	Actual	Acceptable or not		Standard Deviation
			OK	not OK	± 1cm
			OK	not OK	± 1cm
			OK	not OK	± 1cm
			OK	not OK	± 1cm
			OK	not OK	± 1cm
			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Gate Portion

	Designed	Actual	Acceptable or not		Standard Deviation
EL1			OK	not OK	± 1cm
EL2			OK	not OK	± 1cm
EL3			OK	not OK	± 1cm
EL4			OK	not OK	± 1cm
EL5			OK	not OK	± 1cm
EL6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL7			OK	not OK	± 1cm
EL8			OK	not OK	± 1cm
EL9			OK	not OK	± 1cm
EL10			OK	not OK	± 1cm
EL11			OK	not OK	± 1cm
EL12			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: TURNOUT

Other Check Items

1. Inlet

Check Items	Action to be taken/Comments		
	Demolish	Repair	Others
1. no crack in the inlet wall?			
2. no crack in the inlet bottom?			
3. surface plastering or pointing for masonry already?			
4. quality of masonry enough hard?			
5. embankment works completed?			
6. excavation works completed?			
7. surfacing and sod facing for each slope already?			
8. no debris in the inside of inlet?			
9. all appurtenances already furnished?			
10. furnished block-out for stop log property?			
11. no piping in the foundation?			

2. Gate Portion

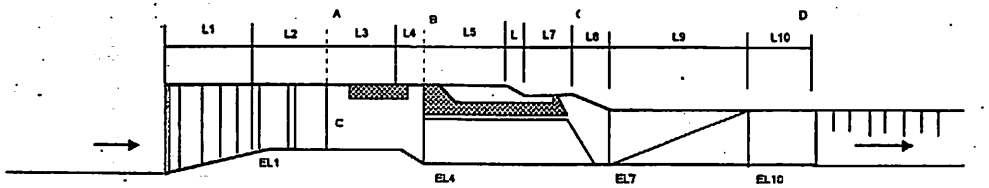
Check Items	Action to be taken/Comments		
	Demolish	Repair	Others
1. no crack in the masonry wall?			
2. no crack in the turnout bottom?			
3. surface plastering or pointing for masonry already?			
4. quality of masonry enough hard?			
5. gate furnished properly?			
6. no leakage of gate?			
7. no heavy friction for gate operation?			
8. furnished operation deck for gate?			
9. no debris in the inside of turnout?			
10. furnished all appurtenances already?			

3.Outlet

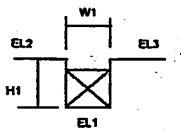
Check Items	Action to be taken/Comments		
	Demolish	Repair	Others
1. no crack in the outlet wall?			
2. no crack in the outlet bottom?			
3. surface plastering or pointing for masonry already?			
4. quality of masonry enough hard?			
5. embankment works completed?			
6. excavation works completed?			
7. surfacing and sod facing for each slope already?			
8. no debris in the inside of outet?			
9. furnished all appurtenances already?			
10. furnished riprap already?			
11. appropriate size of cobble stone for riprap (20-30 cm)?			
12. smooth connection with the downstream canal?			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: TURNOUT

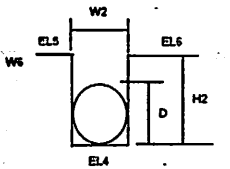
SKETCH OF STRUCTURE



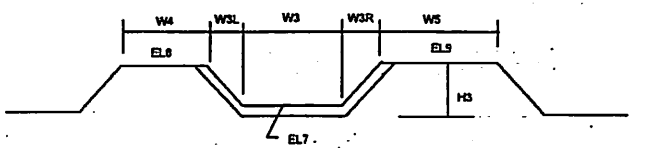
(SECTION A-A)



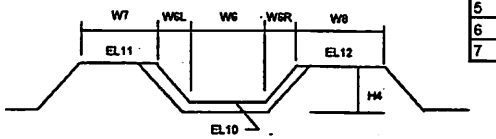
(SECTION B-B)



(SECTION C-C)



(SECTION D-D)



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. gate installation	
4. completion	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CHECK STRUCTURE

Dimension												Elevation					
1. Inlet												1. Inlet					
1-1 Width						1-2 Height											
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL1			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
L3			OK	not OK	± 5cm				OK	not OK		EL3			OK	not OK	± 1cm
W1			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W1L			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W1R			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W3			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W4			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Check Structure												2. Check Structure					
2-1 Width & Length						2-2 Height											
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L4			OK	not OK	± 5cm	H3			OK	not OK	± 1cm	EL7			OK	not OK	± 1cm
L5			OK	not OK	± 5cm	H4			OK	not OK	± 1cm	EL8			OK	not OK	± 1cm
L6			OK	not OK	± 5cm	H5			OK	not OK	± 1cm	EL9			OK	not OK	± 1cm
W7			OK	not OK	± 5cm				OK	not OK		EL10			OK	not OK	± 1cm
W8			OK	not OK	± 5cm				OK	not OK		EL11			OK	not OK	± 1cm
W9			OK	not OK	± 5cm				OK	not OK		EL12			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL13			OK	not OK	
			OK	not OK					OK	not OK		EL14			OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK							
3. Outlet												3. Outlet					
3-1 Width & Length						3-2 Height											
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L7			OK	not OK	± 5cm	H6			OK	not OK	± 1cm	EL15			OK	not OK	± 1cm
L8			OK	not OK	± 5cm	H7			OK	not OK	± 1cm	EL16			OK	not OK	± 1cm
L9			OK	not OK	± 5cm				OK	not OK		EL17			OK	not OK	± 1cm
W10			OK	not OK	± 5cm				OK	not OK		EL18			OK	not OK	± 1cm
W11			OK	not OK	± 5cm				OK	not OK		EL19			OK	not OK	± 1cm
W12			OK	not OK	± 5cm				OK	not OK		EL20			OK	not OK	± 1cm
W13			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W13L			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W13R			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W14			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W15			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK													

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CHECK STRUCTURE

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1. no crack in the inlet wall?	OK	not OK			
2. no crack in the inlet bottom?					
3. surface plastering or pointing for masonry already?	OK	not OK			
4. quality of masonry enough hard?	OK	not OK			
5. embankment works completed?	OK	not OK			
6. excavation works completed?	OK	not OK			
7. surfacing and sod facing for each slope already?	OK	not OK			
8. no debris in the inside of inlet?	OK	not OK			
9. all appurtenances already furnished?	OK	not OK			
10. smooth connection with the upstream canal?	OK	not OK			
11. furnished gravel metaling for inspection road?	OK	not OK			
12. furnished block-out for stop log properly?	OK	not OK			
	OK	not OK			

2. Check Structure

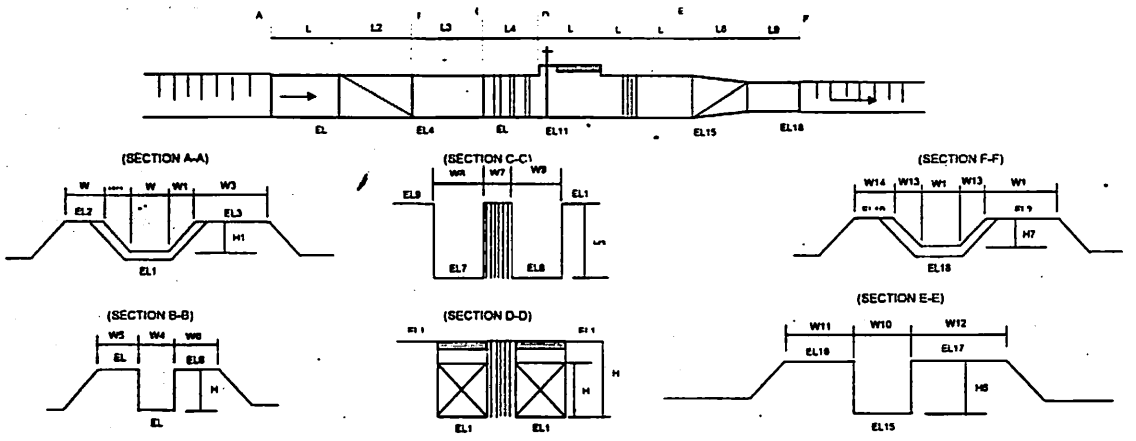
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1. no crack in the masonry wall?	OK	not OK			
2. no crack in the check gate bottom?					
3. surface plastering or pointing for masonry already?	OK	not OK			
4. quality of masonry enough hard?	OK	not OK			
5. gate furnished properly?	OK	not OK			
6. no leakage of gate?	OK	not OK			
7. no heavy friction for gate operation?	OK	not OK			
8. furnished operation deck for gate?	OK	not OK			
9. no debris in the inside of check structure?	OK	not OK			
10. furnished all appurtenances already?	OK	not OK			
11. no piping in the foundation of check structure?	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1. no crack in the outlet wall?	OK	not OK			
2. no crack in the outlet bottom?	OK	not OK			
3. surface plastering or pointing for masonry already?	OK	not OK			
4. quality of masonry enough hard?	OK	not OK			
5. embankment works completed?	OK	not OK			
6. excavation works completed?	OK	not OK			
7. surfacing and sod facing for each slope already?	OK	not OK			
8. no debris in the inside of outet?	OK	not OK			
9. furnished all appurtenances already?	OK	not OK			
10. smooth connection with the downstream canal?	OK	not OK			
11. furnished gravel metaling for inspection road?	OK	not OK			
12. riprap furnished already?	OK	not OK			
13. appropriate size of cobble stone for riprap (20-30 cm)?	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CHECK STRUCTURE

SKETCH OF STRUCTURE



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1 before works	
2 under construction	
3 gate installation	
4 completion	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: PIPE CULVERT

Dimension											Elevation					
1. Inlet											1. Inlet					
1-1 Width						1-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL1			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
W1			OK	not OK	± 5cm				OK	not OK		EL3			OK	not OK	± 1cm
W1L			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W1R			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W3			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W4			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Culvert Pipe											2. Culvert Pipe					
2-1 Width						2-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L3			OK	not OK	± 5cm	H3			OK	not OK	± 1cm	EL4			OK	not OK	± 1cm
W7			OK	not OK	± 5cm	H4			OK	not OK	± 1cm	EL5			OK	not OK	± 1cm
W8			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
D			OK	not OK	± 5cm				OK	not OK		EL7			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL8			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL9			OK	not OK	± 1cm
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
3. Outlet											3. Outlet					
3-1 Width						3-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
W9			OK	not OK	± 5cm	H5			OK	not OK	± 1cm	EL7			OK	not OK	± 1cm
W10			OK	not OK	± 5cm	H6			OK	not OK	± 1cm	EL8			OK	not OK	± 1cm
W11			OK	not OK	± 5cm				OK	not OK		EL9			OK	not OK	± 1cm
W12			OK	not OK	± 5cm				OK	not OK		EL10			OK	not OK	± 1cm
W12L			OK	not OK	± 5cm				OK	not OK		EL11			OK	not OK	± 1cm
W12R			OK	not OK	± 5cm				OK	not OK		EL12			OK	not OK	± 1cm
W13			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W14			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: PIPE CULVERT

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of inlet?	OK	not OK			
8 all appurtenances already furnished?	OK	not OK			
9 smooth connection with the upstream canal?	OK	not OK			
10 smooth connection with culvert pipe?	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Culvert Pipe

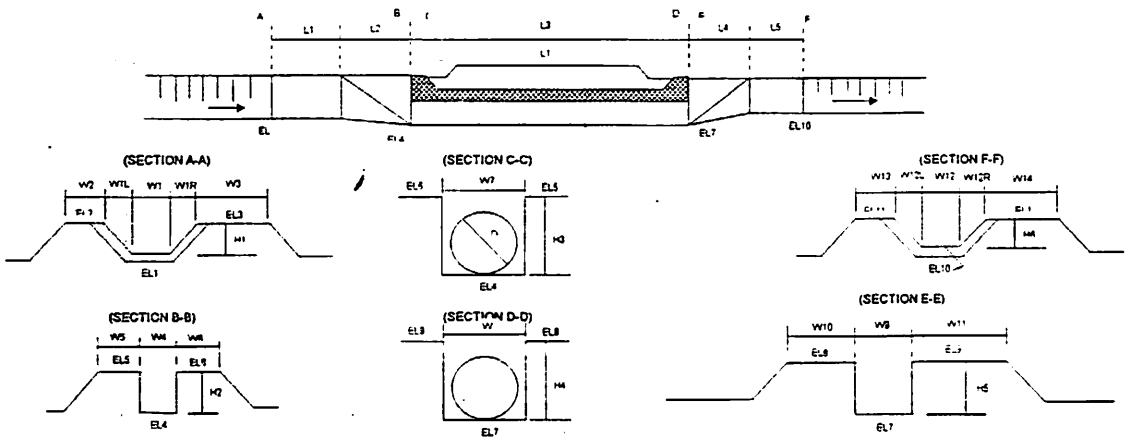
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the retaining wall?	OK	not OK			
2 no crack in the concrete of pipe culvert?	OK	not OK			
3 no debris in the culvert pipe?	OK	not OK			
4 complete earthfilling work for road?	OK	not OK			
5 gravel metaling already?	OK	not OK			
6 handrail furnished already?	OK	not OK			
7 temporary diversion/bridge facility already demolished?	OK	not OK			
8 smooth connection with the existing road?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of outet?	OK	not OK			
8 smooth connection with the downstream canal?	OK	not OK			
9 smooth connection with culvert pipe?	OK	not OK			
10 riprap furnished already?	OK	not OK			
11 appropriate size of cobble stone for riprap (20-30 cm)?	OK	not OK			
	OK	not OK			
	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: PIPE CULVERT (1 PIPE)

SKETCH OF STRUCTURE



no.		
date		
place		
checked by		
Photograph		
Items		taken or not
1. before works		
2. under construction		
3. before backfilling pipe		
4. completion		
5		
6		
7		

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: PIPE CULVERT (2 PIPES)

Dimension

1. Inlet

1-1 Width

	Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm
L2			OK	not OK	± 5cm
W1			OK	not OK	± 5cm
W1L			OK	not OK	± 5cm
W1R			OK	not OK	± 5cm
W2			OK	not OK	± 5cm
W3			OK	not OK	± 5cm
W4			OK	not OK	± 5cm
W5			OK	not OK	± 5cm
W6			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	
			OK	not OK	

1-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H1			OK	not OK	± 1cm
H2			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Culvert Pipe

2-1 Width & Length

	Designed	Actual	Acceptable or not		Standard Deviation
L3			OK	not OK	± 5cm
W7			OK	not OK	± 5cm
W8			OK	not OK	± 5cm
D1			OK	not OK	± 5cm
D2			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H3			OK	not OK	± 1cm
H4			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

3-1 Width & Length

	Designed	Actual	Acceptable or not		Standard Deviation
L6			OK	not OK	± 5cm
L7			OK	not OK	± 5cm
W9			OK	not OK	± 5cm
W10			OK	not OK	± 5cm
W11			OK	not OK	± 5cm
W12			OK	not OK	± 5cm
W12L			OK	not OK	± 5cm
W12R			OK	not OK	± 5cm
W13			OK	not OK	± 5cm
W14			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	
			OK	not OK	

3-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H5			OK	not OK	± 1cm
H6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

Elevation

1. Inlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL1			OK	not OK	± 1cm
EL2			OK	not OK	± 1cm
EL3			OK	not OK	± 1cm
EL4			OK	not OK	± 1cm
EL5			OK	not OK	± 1cm
EL6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Culvert Pipe

	Designed	Actual	Acceptable or not		Standard Deviation
EL4			OK	not OK	± 1cm
EL5			OK	not OK	± 1cm
EL6			OK	not OK	± 1cm
EL7			OK	not OK	± 1cm
EL8			OK	not OK	± 1cm
EL9			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL7			OK	not OK	± 1cm
EL8			OK	not OK	± 1cm
EL9			OK	not OK	± 1cm
EL10			OK	not OK	± 1cm
EL11			OK	not OK	± 1cm
EL12			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: PIPE CULVERT (2 PIPES)

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of inlet?	OK	not OK			
8 all appurtenances already furnished?	OK	not OK			
9 smooth connection with the upstream canal?	OK	not OK			
10 smooth connection with culvert pipe?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Culvert Pipe

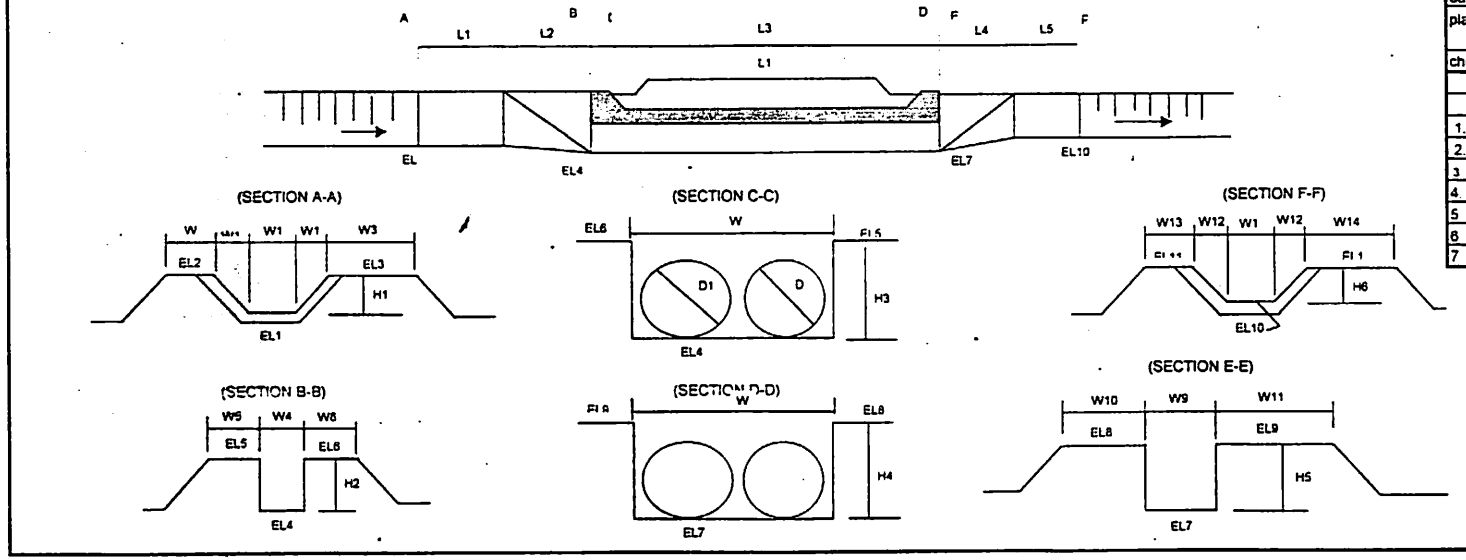
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the retaining wall?	OK	not OK			
2 no crack in the concrete of pipe culvert?					
3 no debris in the culvert pipe?	OK	not OK			
4 complete earthfilling work for road?	OK	not OK			
5 gravel metaling already?	OK	not OK			
6 handrail furnished already?	OK	not OK			
7 temporary diversion/bridge facility already demolished?	OK	not OK			
8 smooth connection with the existing road?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of outet?	OK	not OK			
8 smooth connection with the downstream canal?	OK	not OK			
9 smooth connection with culvert pipe?	OK	not OK			
10 riprap furnished already?	OK	not OK			
11 appropriate size of cobble stone for riprap (20-30 cm)?	OK	not OK			
	OK	not OK			
	OK	not OK			

FORM FOR CHECKING STRUCTUPAL WORKS
STRUCTURE: PIPE CULVERT (2 PIPES)

SKETCH OF STRUCTURE



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. before backfilling pipe	
4. completion	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: BOX CULVERT

Dimension											Elevation					
1. Inlet											1. Inlet					
1-1 Width						1-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL1			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
W1			OK	not OK	± 5cm				OK	not OK		EL3			OK	not OK	± 1cm
W1L			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W1R			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W3			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W4			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Culvert Box											2. Culvert Box					
2-1 Width						2-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L3			OK	not OK	± 5cm	H3			OK	not OK	± 1cm	EL4			OK	not OK	± 1cm
W7			OK	not OK	± 5cm	H4			OK	not OK	± 1cm	EL5			OK	not OK	± 1cm
W8			OK	not OK	± 5cm	H5			OK	not OK		EL6			OK	not OK	± 1cm
			OK	not OK		H6			OK	not OK		EL7			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL8			OK	not OK	± 1cm
			OK	not OK					OK	not OK		EL9			OK	not OK	± 1cm
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
3. Outlet											3. Outlet					
3-1 Width & Length						3-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L4			OK	not OK	± 5cm	H7			OK	not OK	± 1cm	EL7			OK	not OK	± 1cm
L5			OK	not OK	± 5cm	H8			OK	not OK	± 1cm	EL8			OK	not OK	± 1cm
W9			OK	not OK	± 5cm				OK	not OK		EL9			OK	not OK	± 1cm
W10			OK	not OK	± 5cm				OK	not OK		EL10			OK	not OK	± 1cm
W11			OK	not OK	± 5cm				OK	not OK		EL11			OK	not OK	± 1cm
W12			OK	not OK	± 5cm				OK	not OK		EL12			OK	not OK	± 1cm
W12L			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W12R			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W13			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W14			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK													

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: BOX CULVERT

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of inlet?	OK	not OK			
8 all appurtenances already furnished?	OK	not OK			
9 smooth connection with the upstream canal?	OK	not OK			
10 smooth connection with culvert box?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Culvert Box

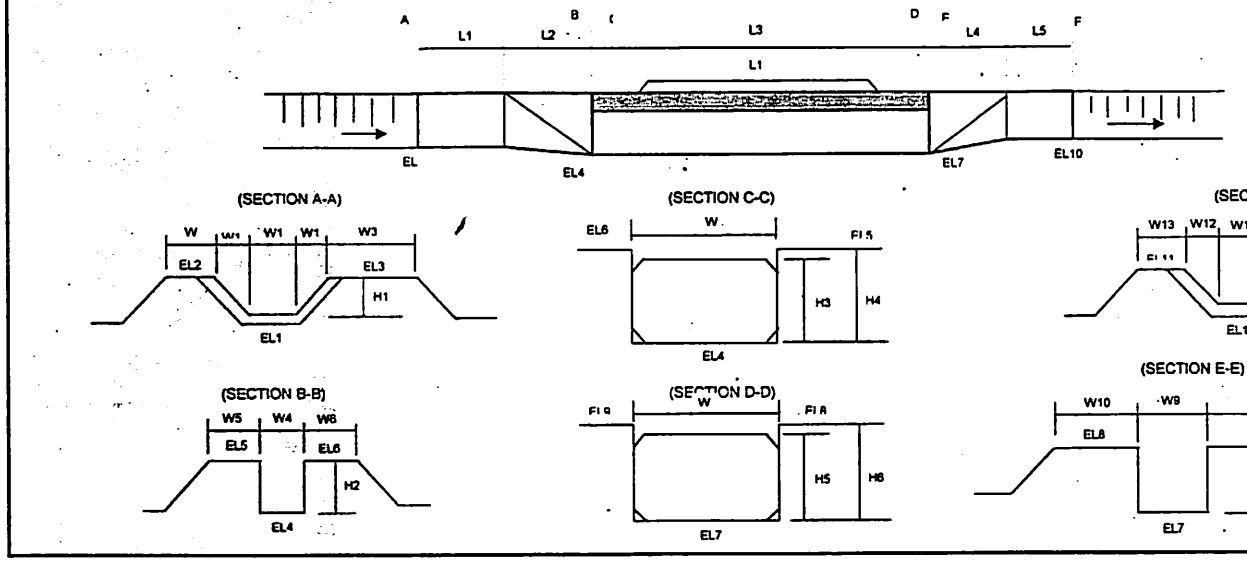
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 smooth concrete surface?	OK	not OK			
2 no crack in the culvert concrete?					
3 no debris in the culvert box?	OK	not OK			
4 complete earthfilling work for road?	OK	not OK			
5 gravel metaling or asphalt surfacing already?	OK	not OK			
6 handrail furnished already?	OK	not OK			
7 temporary diversion/bridge facility already demolished?	OK	not OK			
8 smooth connection with the existing road?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of outet?	OK	not OK			
8 smooth connection with the downstream canal?	OK	not OK			
9 smooth connection with culvert pipe?	OK	not OK			
10 riprap furnished already?	OK	not OK			
11 appropriate size of cobble stone for riprap (20-30 cm)?	OK	not OK			
	OK	not OK			
	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: BOX CULVERT

SKETCH OF STRUCTURE



no		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. concrete placement	
4. before backfilling culvert	
5. completion	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: DROP

Dimension

1. Inlet

1-1 Width

	Acceptable or not		Standard Deviation
L1	OK	not OK	± 5cm
L2	OK	not OK	± 5cm
W1	OK	not OK	± 5cm
W1L	OK	not OK	± 5cm
W1R	OK	not OK	± 5cm
W2	OK	not OK	± 5cm
W3	OK	not OK	± 5cm
W4	OK	not OK	± 5cm
W5	OK	not OK	± 5cm
W6	OK	not OK	± 5cm
	OK	not OK	
	OK	not OK	
	OK	not OK	

1-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H1			OK	not OK	± 1cm
H2			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Drop

2-1 Width & Length

	Acceptable or not		Standard Deviation
L3	OK	not OK	± 5cm
L4	OK	not OK	± 5cm
L5	OK	not OK	± 5cm
W7	OK	not OK	± 5cm
W8	OK	not OK	± 5cm
	OK	not OK	
	OK	not OK	
	OK	not OK	
	OK	not OK	
	OK	not OK	
	OK	not OK	
	OK	not OK	
	OK	not OK	

2-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H3			OK	not OK	± 1cm
H4			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

3-1 Width & Length

	Acceptable or not		Standard Deviation
L6	OK	not OK	± 5cm
L7	OK	not OK	± 5cm
W9	OK	not OK	± 5cm
W10	OK	not OK	± 5cm
W11	OK	not OK	± 5cm
W12	OK	not OK	± 5cm
W12L	OK	not OK	± 5cm
W12R	OK	not OK	± 5cm
W13	OK	not OK	± 5cm
W14	OK	not OK	± 5cm
	OK	not OK	
	OK	not OK	
	OK	not OK	

3-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H5			OK	not OK	± 1cm
H6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

Elevation

1. Inlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL1			OK	not OK	± 1cm
EL2			OK	not OK	± 1cm
EL3			OK	not OK	± 1cm
EL4			OK	not OK	± 1cm
EL5			OK	not OK	± 1cm
EL6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Drop

	Designed	Actual	Acceptable or not		Standard Deviation
EL7			OK	not OK	± 1cm
EL8			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL9			OK	not OK	± 1cm
EL10			OK	not OK	± 1cm
EL11			OK	not OK	± 1cm
EL12			OK	not OK	± 1cm
EL13			OK	not OK	± 1cm
EL14			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: DROP

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 excavation works completed?	OK	not OK			
7 surfacing and sod facing for each slope already?	OK	not OK			
8 no debris in the inside of inlet?	OK	not OK			
9 furnished all appurtenances already?	OK	not OK			
10 smooth connection with the upstream canal?	OK	not OK			
11 furnished gravel metaling for inspection road?	OK	not OK			
12	OK	not OK			
	OK	not OK			

2. Drop

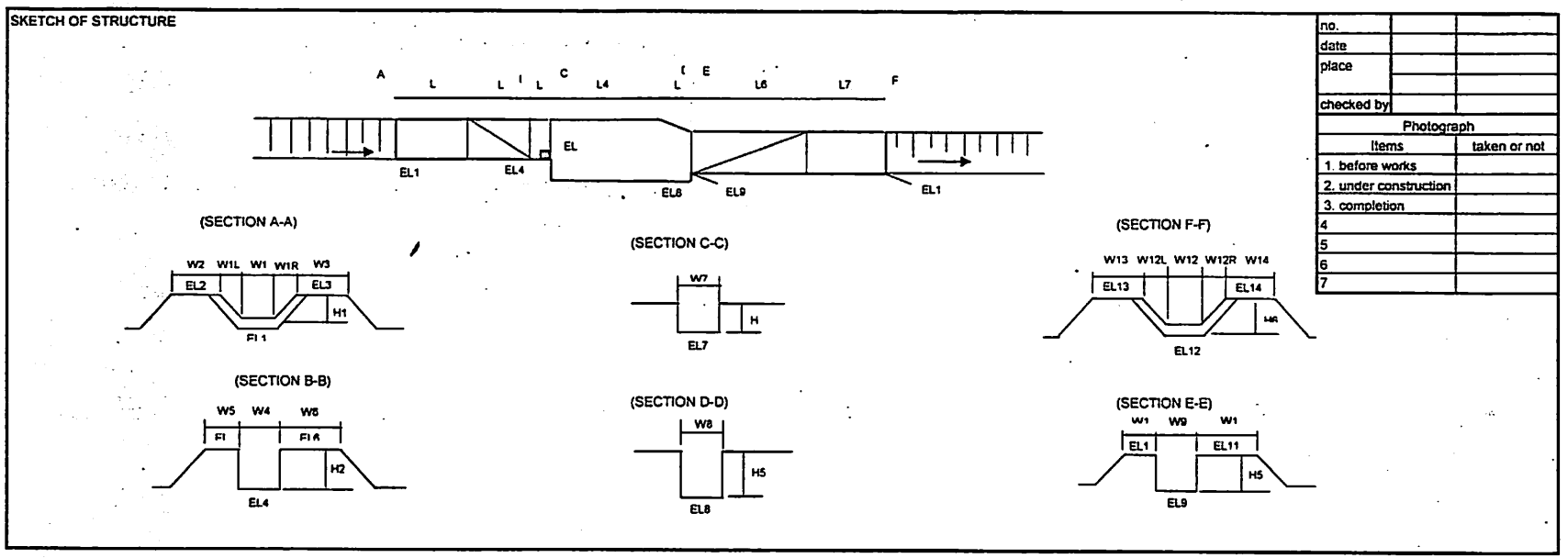
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the masonry wall?	OK	not OK			
2 no crack in the broad crest/stilling basin?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 no piping in the foundation of broad crest weir?	OK	not OK			
6 furnished measuring plate?	OK	not OK			
7 embankment works completed?	OK	not OK			
8 excavation works completed?	OK	not OK			
9 surfacing and sod facing for earth slope completed?	OK	not OK			
10 no debris in the inside of broad crest/stilling basin?	OK	not OK			
11 furnished gravel metaling for inspection road?	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 excavation works completed?	OK	not OK			
7 surfacing and sod facing for each slope already?	OK	not OK			
8 no debris in the inside of outlet?	OK	not OK			
9 all appurtenances already furnished?	OK	not OK			
10 smooth connection with the downstream canal?	OK	not OK			
11 furnished gravel metaling for inspection road?	OK	not OK			
12 riprap furnished already?	OK	not OK			
13 appropriate size of cobble stone for riprap (20~30 cm)	OK	not OK			

FORM FORCHECKING STRUCTURAL WORKS
STRUCTURE: DROP

SKETCH OF STRUCTURE



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. completion	
4	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CHUTE

Dimension											Elevation					
1. Inlet											1. Inlet					
1-1 Width						1-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL1			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
W1			OK	not OK	± 5cm				OK	not OK		EL3			OK	not OK	± 1cm
W1L			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W1R			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W3			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W4			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Chute											2. Chute					
2-1 Width						2-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L3			OK	not OK	± 5cm	H3			OK	not OK	± 1cm	EL7			OK	not OK	± 1cm
L4			OK	not OK	± 5cm	H4			OK	not OK	± 1cm	EL8			OK	not OK	± 1cm
L5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
L6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W7			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W8			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK							
3. Outlet											3. Outlet					
3-1 Width & Length						3-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L7			OK	not OK	± 5cm	H5			OK	not OK	± 1cm	EL9			OK	not OK	± 1cm
L8			OK	not OK	± 5cm	H6			OK	not OK	± 1cm	EL10			OK	not OK	± 1cm
W9			OK	not OK	± 5cm				OK	not OK		EL11			OK	not OK	± 1cm
W10			OK	not OK	± 5cm				OK	not OK		EL12			OK	not OK	± 1cm
W11			OK	not OK	± 5cm				OK	not OK		EL13			OK	not OK	± 1cm
W12			OK	not OK	± 5cm				OK	not OK		EL14			OK	not OK	± 1cm
W12L			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W12R			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W13			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W14			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK													

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CHUTE

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 excavation works completed?	OK	not OK			
7 surfacing and sod facing for each slope already?	OK	not OK			
8 no debris in the inside of inlet?	OK	not OK			
9 furnished all appurtenances already?	OK	not OK			
10 smooth connection with the upstream canal?	OK	not OK			
11 furnished gravel metaling for inspection road?	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Chute

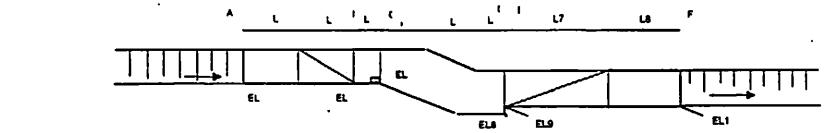
Check items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the masonry wall?	OK	not OK			
2 no crack in the broad crest/stilling basin?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 no piping in the foundation of drop?	OK	not OK			
6 furnished measuring plate?	OK	not OK			
7 embankment works completed?	OK	not OK			
8 excavation works completed?	OK	not OK			
9 surfacing and sod facing for earth slope completed?	OK	not OK			
10 no debris in the inside of broad crest/stilling basin?	OK	not OK			
11 furnished gravel metaling for inspection road?	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

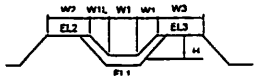
Check items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 excavation works completed?	OK	not OK			
7 surfacing and sod facing for each slope already?	OK	not OK			
8 no debris in the inside of outlet?	OK	not OK			
9 all appurtenances already furnished?	OK	not OK			
10 smooth connection with the downstream canal?	OK	not OK			
11 furnished gravel metaling for inspection road?	OK	not OK			
12 riprap furnished already?	OK	not OK			
13 appropriate size of cobble stone for riprap (20~30 cm)	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CHUTE

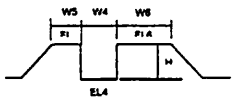
SKETCH OF STRUCTURE



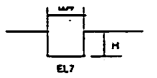
(SECTION A-A)



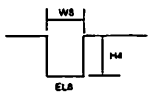
(SECTION B-B)



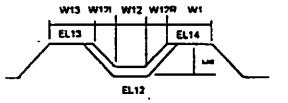
(SECTION C-C)



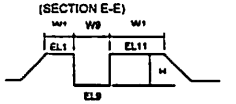
(SECTION D-D)



(SECTION F-F)



(SECTION E-E)



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1 before works	
2 under construction	
3 completion	
4	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: AQUEDUCT

Dimension

1. Inlet

1-1 Width

	Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm
L2			OK	not OK	± 5cm
W1			OK	not OK	± 5cm
W1L			OK	not OK	± 5cm
W1R			OK	not OK	± 5cm
W2			OK	not OK	± 5cm
W3			OK	not OK	± 5cm
W4			OK	not OK	± 5cm
W5			OK	not OK	± 5cm
W6			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	
			OK	not OK	

1-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H1			OK	not OK	± 1cm
H2			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Flume

2-1 Width

	Designed	Actual	Acceptable or not		Standard Deviation
L3			OK	not OK	± 5cm
L4			OK	not OK	± 5cm
L5			OK	not OK	± 5cm
L6			OK	not OK	± 5cm
W7			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H3			OK	not OK	± 1cm
			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

3-1 Width & Length

	Designed	Actual	Acceptable or not		Standard Deviation
L7			OK	not OK	± 5cm
L8			OK	not OK	± 5cm
W8			OK	not OK	± 5cm
W9			OK	not OK	± 5cm
W10			OK	not OK	± 5cm
W11			OK	not OK	± 5cm
W11L			OK	not OK	± 5cm
W11R			OK	not OK	± 5cm
W12			OK	not OK	± 5cm
W13			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	
			OK	not OK	

3-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
H4			OK	not OK	± 1cm
H5			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

Elevation

1. Inlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL1			OK	not OK	± 1cm
EL2			OK	not OK	± 1cm
EL3			OK	not OK	± 1cm
EL4			OK	not OK	± 1cm
EL5			OK	not OK	± 1cm
EL6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Flume

	Designed	Actual	Acceptable or not		Standard Deviation
EL7			OK	not OK	± 1cm
EL8			OK	not OK	± 1cm
EL9			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL10			OK	not OK	± 1cm
EL11			OK	not OK	± 1cm
EL12			OK	not OK	± 1cm
EL13			OK	not OK	± 1cm
EL14			OK	not OK	± 1cm
EL15			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: AQUEDUCT

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of inlet?	OK	not OK			
8 all appurtenances already furnished?	OK	not OK			
9 smooth connection with canal?	OK	not OK			
10 smooth connection with aqueduct flume?	OK	not OK			
11 furnished bearing material already?	OK	not OK			
12 appropriate size of block out for stoplog?	OK	not OK			
	OK	not OK			

2. Flume

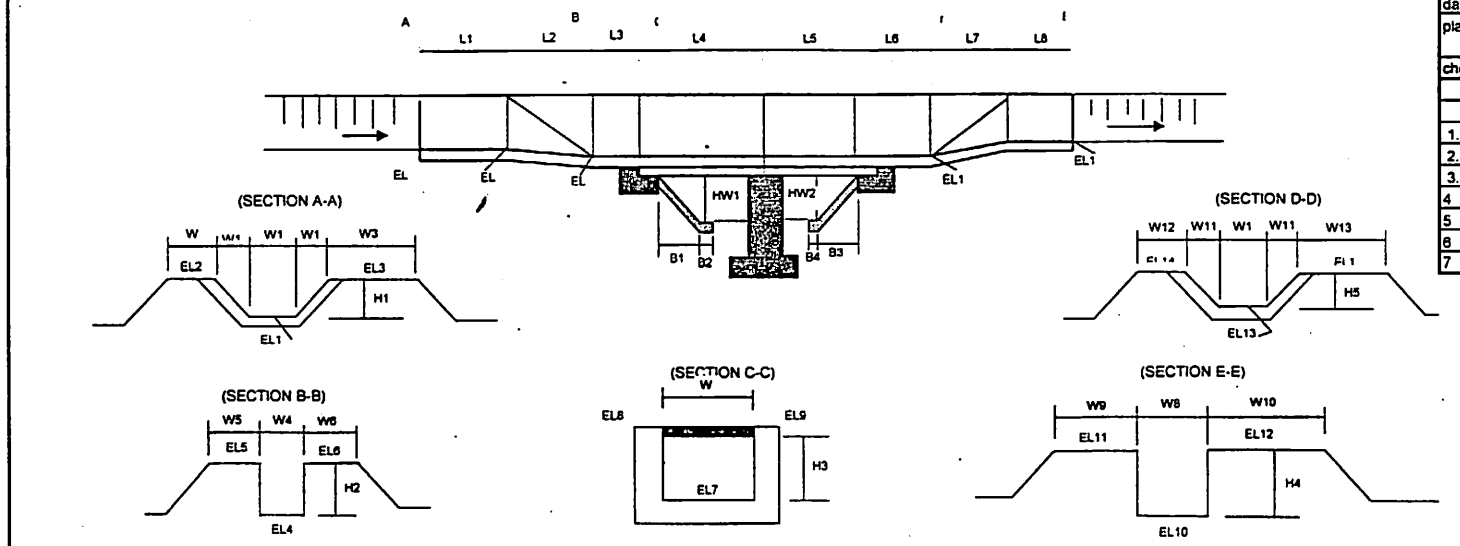
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 smooth concrete surface?	OK	not OK			
2 no crack in the flume concrete?					
3 no debris in the aqueduct flume?	OK	not OK			
4 gabion protection for river section already furnished?	OK	not OK			
5 no leakage from joint of flume?	OK	not OK			
6 no crack in the abutment of flume?	OK	not OK			
7 no crack in the pier of flume?	OK	not OK			
8 no crack in the retaining wall for abutment?	OK	not OK			
9 re-shaping of river already?	OK	not OK			
10 handrail furnished (if any) already?	OK	not OK			
11 complete demolishment of temporary facility?	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of outet?	OK	not OK			
8 smooth connection with canal?	OK	not OK			
9 smooth connection with flume?	OK	not OK			
10 riprap furnished already?	OK	not OK			
11 appropriate size of cobble stone for riprap (20-30 cm)?	OK	not OK			
12 riprap furnished already?	OK	not OK			
13 appropriate size of cobble stone for riprap (20~30 cm)	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: AQUEDUCT

SKETCH OF STRUCTURE



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. completion	
4	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: SIPHON

Dimension

1. Inlet

1-1 Width

	Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm
L2			OK	not OK	± 5cm
L3			OK	not OK	± 5cm
W1			OK	not OK	± 5cm
W1L			OK	not OK	± 5cm
W1R			OK	not OK	± 5cm
W2			OK	not OK	± 5cm
W3			OK	not OK	± 5cm
W4			OK	not OK	± 5cm
W5			OK	not OK	± 5cm
W6			OK	not OK	± 5cm
W7			OK	not OK	± 5cm
W8			OK	not OK	± 5cm

1-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
B1			OK	not OK	± 5cm
B2			OK	not OK	± 5cm
B3			OK	not OK	± 5cm
			OK	not OK	± 5cm
			OK	not OK	± 5cm
			OK	not OK	± 5cm
HW1			OK	not OK	± 1cm
HW2			OK	not OK	± 1cm
H1			OK	not OK	± 1cm
H2			OK	not OK	± 1cm
H3			OK	not OK	± 1cm
			OK	not OK	

2. Barrel

2-1 Width & Length

	Designed	Actual	Acceptable or not		Standard Deviation
L4			OK	not OK	± 5cm
L5			OK	not OK	± 5cm
L6			OK	not OK	± 5cm
L7			OK	not OK	± 5cm
L8			OK	not OK	± 5cm
L9			OK	not OK	± 5cm
W9			OK	not OK	± 5cm
W10			OK	not OK	± 5cm
W11			OK	not OK	± 5cm
W12			OK	not OK	± 5cm
B4			OK	not OK	± 5cm
B5			OK	not OK	± 5cm
			OK	not OK	

2-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
HW3			OK	not OK	± 1cm
HW4			OK	not OK	± 1cm
H4			OK	not OK	± 1cm
H5			OK	not OK	± 1cm
H6			OK	not OK	± 1cm
H7			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

3-1 Width & Length

	Designed	Actual	Acceptable or not		Standard Deviation
L10			OK	not OK	± 5cm
W13			OK	not OK	± 5cm
W14			OK	not OK	± 5cm
W15			OK	not OK	± 5cm
W16			OK	not OK	± 5cm
W17			OK	not OK	± 5cm
W18			OK	not OK	± 5cm
W18L			OK	not OK	± 5cm
W18R			OK	not OK	± 5cm
W19			OK	not OK	± 5cm
W20			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	

3-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
B6			OK	not OK	± 5cm
B7			OK	not OK	± 5cm
B8			OK	not OK	± 5cm
			OK	not OK	
			OK	not OK	

3-2 Height

	Designed	Actual	Acceptable or not		Standard Deviation
HW5			OK	not OK	± 1cm
HW6			OK	not OK	± 1cm
HW7			OK	not OK	± 1cm
H8			OK	not OK	± 1cm
H9			OK	not OK	± 1cm
H10			OK	not OK	± 1cm

Elevation

1. Inlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL1			OK	not OK	± 1cm
EL2			OK	not OK	± 1cm
EL3			OK	not OK	± 1cm
EL4			OK	not OK	± 1cm
EL5			OK	not OK	± 1cm
EL6			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

2. Barrel

	Designed	Actual	Acceptable or not		Standard Deviation
EL7			OK	not OK	± 1cm
EL8			OK	not OK	± 1cm
EL15			OK	not OK	± 1cm
EL16			OK	not OK	± 1cm
EL17			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

3. Outlet

	Designed	Actual	Acceptable or not		Standard Deviation
EL9			OK	not OK	± 1cm
EL10			OK	not OK	± 1cm
EL11			OK	not OK	± 1cm
EL12			OK	not OK	± 1cm
EL13			OK	not OK	± 1cm
EL14			OK	not OK	± 1cm
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	
			OK	not OK	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: SIPHON

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of inlet?	OK	not OK			
8 smooth connection with the upstream canal?	OK	not OK			
9 smooth connection with barrel?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Barrel

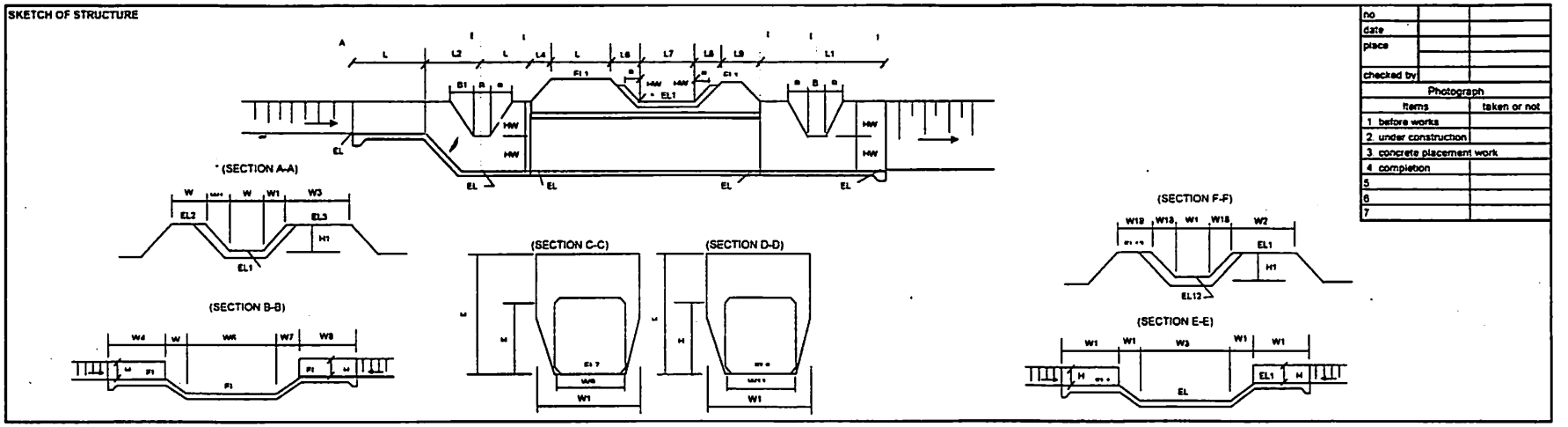
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 smooth concrete surface?	OK	not OK			
2 no crack in the barrel concrete?					
3 no debris in the barrel?	OK	not OK			
4 complete canal embankment for barrel?	OK	not OK			
5 no settlement of canal embankment?	OK	not OK			
6 furnished wet stone masonry for irrigation canal?	OK	not OK			
7 no crack in the wet stone masonry for irrigation canal?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the outet?	OK	not OK			
8 smooth connection with downstream canal?	OK	not OK			
9 smooth connection with barrel?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE SIPHON

SKETCH OF STRUCTURE



no		
date		
place		
checked by		

Photograph	
Items	taken or not
1 before works	
2 under construction	
3 concrete placement work	
4 completion	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: BRIDGE

Dimension											Elevation					
1. Inlet											1. Inlet					
1-1 Width						1-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
W1			OK	not OK	± 5cm				OK	not OK		EL1			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Bridge Structure											2. Bridge Structure					
2-1 Width						2-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL3			OK	not OK	± 1cm
W3			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W4			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W5			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W7			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W8			OK	not OK	± 5cm				OK	not OK					OK	not OK	
B1			OK	not OK	± 5cm				OK	not OK					OK	not OK	
B2			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK							
3. Outlet											3. Outlet					
3-1 Width & Length						3-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
W9			OK	not OK	±1cm				OK	not OK		EL7			OK	not OK	± 1cm
W10			OK	not OK	±1cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK													

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: BRIDGE

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Bridge Structure

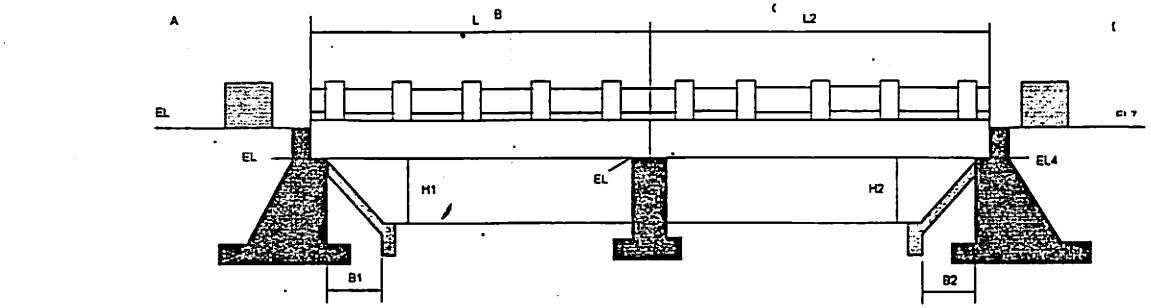
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

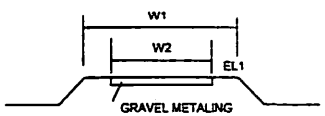
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

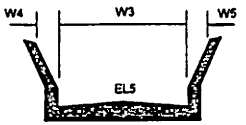
FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: BRIDGE

SKETCH OF STRUCTURE

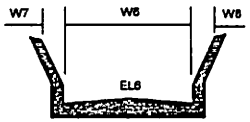


(SECTION A-A)



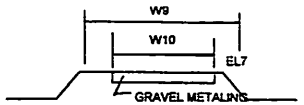


(SECTION B-B)



(SECTION C-C)

(SECTION D-D)



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. concrete placement work	
4. completion	
5	
6	
7	

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CROSS DRAINS

Dimension											Elevation					
1. Inlet											1. Inlet					
1-1 Width						1-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L1			OK	not OK	± 5cm	H1			OK	not OK	± 1cm	EL1			OK	not OK	± 1cm
L2			OK	not OK	± 5cm	H2			OK	not OK	± 1cm	EL2			OK	not OK	± 1cm
W1			OK	not OK	± 5cm				OK	not OK		EL3			OK	not OK	± 1cm
W1L			OK	not OK	± 5cm				OK	not OK		EL4			OK	not OK	± 1cm
W1R			OK	not OK	± 5cm				OK	not OK		EL5			OK	not OK	± 1cm
W2			OK	not OK	± 5cm				OK	not OK		EL6			OK	not OK	± 1cm
W3			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W4			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W5			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W6			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
2. Barell											2. Barell					
2-1 Width & Length						2-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L3			OK	not OK	± 5cm	H3			OK	not OK	± 1cm	EL7			OK	not OK	± 1cm
W7			OK	not OK	± 5cm	H4			OK	not OK	± 1cm	EL8			OK	not OK	± 1cm
W8			OK	not OK	± 5cm				OK	not OK		EL15			OK	not OK	± 5cm
			OK	not OK					OK	not OK		EL16			OK	not OK	± 5cm
			OK	not OK					OK	not OK		EL17			OK	not OK	± 5cm
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
3. Outlet											3. Outlet					
3-1 Width & Length						3-2 Height										
	Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation		Designed	Actual	Acceptable or not		Standard Deviation
L4			OK	not OK	± 5cm	H5			OK	not OK	± 1cm	EL9			OK	not OK	± 1cm
L5			OK	not OK	± 5cm	H6			OK	not OK	± 1cm	EL10			OK	not OK	± 1cm
W9			OK	not OK	± 5cm				OK	not OK		EL11			OK	not OK	± 1cm
W10			OK	not OK	± 5cm				OK	not OK		EL12			OK	not OK	± 1cm
W11			OK	not OK	± 5cm				OK	not OK		EL13			OK	not OK	± 1cm
W12			OK	not OK	± 5cm				OK	not OK		EL14			OK	not OK	± 1cm
W12L			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W12R			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W13			OK	not OK	± 5cm				OK	not OK					OK	not OK	
W14			OK	not OK	± 5cm				OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK					OK	not OK					OK	not OK	
			OK	not OK													

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CROSS DRAINS

Other Check Items

1. Inlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the inlet wall?	OK	not OK			
2 no crack in the inlet bottom?					
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 trash rack furnished already?	OK	not OK			
6 appropriate block out for stop log installation?	OK	not OK			
7 embankment works completed?	OK	not OK			
8 surfacing/sod facing for embankment slope already?	OK	not OK			
9 no debris in the inside of inlet?	OK	not OK			
10 all appurtenances (steel step, hand rail, etc.) already furnished?	OK	not OK			
11 smooth connection with upstream canal?	OK	not OK			
	OK	not OK			
	OK	not OK			

2. Barrel

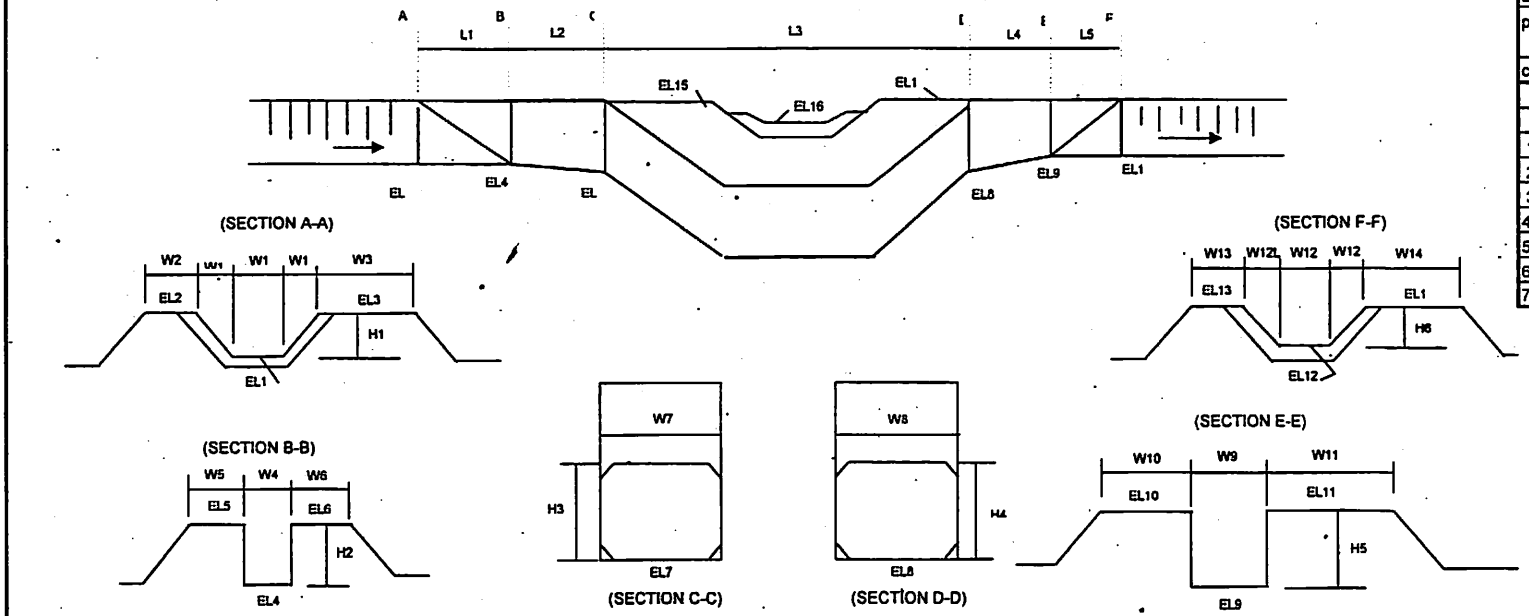
Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 smooth concrete surface?	OK	not OK			
2 no crack in the barrel concrete?					
3 no debris in the barrel?	OK	not OK			
4 no large head loss comaring to designed one?	OK	not OK			
5 no water leakage?	OK	not OK			
6 complete backfilling for barrel?	OK	not OK			
7 furnished gabion protection for crossing river already?	OK	not OK			
8 re-shaping of crossing river already?	OK	not OK			
9 demolished temporary diversion facility already?	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			
	OK	not OK			

3.Outlet

Check Items	Acceptable or not		Action to be taken/Comments		
			Demolish	Repair	Others
1 no crack in the outlet wall?	OK	not OK			
2 no crack in the outlet bottom?	OK	not OK			
3 surface plastering or pointing for masonry already?	OK	not OK			
4 quality of masonry enough hard?	OK	not OK			
5 embankment works completed?	OK	not OK			
6 surfacing/sod facing for embankment slope already?	OK	not OK			
7 no debris in the inside of outet?	OK	not OK			
8 all appurtenances (steel step, hand rail, etc.) already furnished?	OK	not OK			
9 smooth connection with the downstream canal?	OK	not OK			
10 smooth connection with barrel?	OK	not OK			
11 riprap furnished already?	OK	not OK			
12 appropriate size of cobble stone for riprap (20-30 cm)?	OK	not OK			
	OK	not OK			

FORM FOR CHECKING STRUCTURAL WORKS
STRUCTURE: CROSS DRAINS

SKETCH OF STRUCTURE



no.		
date		
place		
checked by		

Photograph	
Items	taken or not
1. before works	
2. under construction	
3. completion	
4	
5	
6	
7	