Industrial Infrastructure Development Division Department of Industry Ministry of Economic Affairs



Royal Government of Bhutan Ministry of Finance

Tender Document

For

"Major Maintenance of Street Light and Accessories at Bjemina Industrial Estate"



Preface

This Standard Bidding Document for the Procurement of small works up to Nu. 4 million has been prepared by the Public Procurement Policy Division (PPPD) Ministry of Finance to be used for the Procurement of small works through National Competitive Bidding (NCB) in projects that are financed in whole or in part by the Royal Government of Bhutan (RGoB). It should be used in conjunction with the Procurement Rules and Regulations.

Those wishing to submit comments or questions on this Bidding Document or to obtain additional information on procurement under RGoB-financed projects may contact:

Public Procurement Policy Division (PPPD) Ministry of Finance Royal Government of Bhutan pppd@mof.gov.bt



INVITATION FOR BID

(IFB)



ROYAL GOVERNMENT OF BHUTAN INVITATIONS FOR BIDS (IFB)

NATIONAL COMPETITIVE BIDDING

MoEA/IIDD(Bjemina-W02/2016-2017/ Date:01-05-2017

1. The Industrial Infrastructure Development Division, Department of Industry, Ministry of Economic Affairs, Thimphu invites bids from eligible W3 (small) contractors registered with the Construction Development Board for the work "Major Maintenance of Street Light and Accessories at Bjemina Industrial Estate".

2. Bidding documents may be downloaded from the web site <u>www.moea.gov.bt.</u>

3. Bids must be accompanied by a bid security of 2% of the quoted amount, in favor of Dy. Chief Account Officer MoEA, Thimphu. Bid security will have to be in any one of the forms as specified in the bidding document and shall have to be valid for 30 days beyond the validity of the bid.

4. Bids must be delivered to Industrial Infrastructure Development Division, Department of Industry, Ministry of Economic Affairs, Changzamthog, Thimphu. on or before 12PM on 17th. May 2017 and will be opened on the same day at 2:30PM, in the Department Of Industry(DoI) conference hall in the presence of the bidders who wished to attend.

5. For any information or queries regarding the above work, please contact at (02) 323536/02-371097.

Chief Engineer Industrial Infrastructure Development Division, Department of Industry, MoEA.



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Section 1: Instructions to Bidder (ITB)

A. General

- 1. Scope of Tender
- 1.1 The Employer, as **indicated in the BDS** issues this Bidding Document for the procurement of Works as specified in Section 6 (Employer's requirement): The name, identification and identification of this bidding are **provided in the BDS**.
- 1.2 The successful Bidder will be required to complete the Works within the Time for Completion stated in the Special Conditions of Contract (SCC).
- 1.3 Throughout this Bidding Documents;
 - (a) The term "in writing means communicated in written form with proof of receipt;
 - (b) If the context so requires, singular means plural and vice versa; and
 - (C) "day" means calendar day.
- 2. Corrupt 2.1 Fraudulent Collusive or Coercive 2.2 Practices

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The Royal Government of Bhutan requires that Employers and the Bidders shall observe the highest standard of ethics during the implementation of procurement proceedings and the execution of Contracts under public funds.

- In pursuance of this requirement, the Employer shall
- (a) exclude the bidder from participation in the procurement proceeding concerned or reject a proposal for award; and
- (b) declare a bidder ineligible, either indefinitely or for a stated period of time, from participation in procurement proceedings under public funds;
- if it, at any time, determines that the bidder has engaged in corrupt, fraudulent, collusive or coercive practices in competing for, or in executing, a Contract under the public funds.
- 2.4 The Government defines, for the purposes of this provision, the terms set forth below as follows :

a) "*corrupt practice*"¹ is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;

*b) "fraudulent practice*⁷² is any intentional act or omission including misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefits or to avoid an obligation;

c) "*collusive practice*"³ is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the

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¹ 'Another party' refers to a public official acting in relation to the procurement process or contract execution.

actions of another party;

d) "coercive practice"^{*t*} is impairing *or* harming or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party.

- 2.5 The bidder shall be aware of the provisions on fraud and corruption stated in GCC Clause 3 and GCC Sub-Clause 34.2(d).
- 2.6 The RGoB requires that the Employer's personnel have an equal obligation not to solicit, ask for and/or use coercive methods to obtain personal benefits in connection with the said proceedings.
- 3. Eligible 3.1 Bidders of the categories **specified in the BDS** are eligible to participate in this bidding process.
 - 3.2 The Employer shall invite Bids using the Open Tendering Method (National Competitive Bidding) or limited tender as applicable.
 - 3.3 The bidder shall meet the qualification requirement stated in the BDS
- 4. Site Visit 4.1 The Bidders, at their own responsibility and risk, is encouraged to visit and examine the Site and obtain all information that may be necessary for preparing the bid and entering into a Contract for performance of the Works. The costs of visiting the Site shall be at the bidder's own expense.

B. Content of Bidding Document

 Contents of Bidding
 Documents
 The sections comprising the Bidding Document are listed below and should be read in conjunction with any Amendment issued in accordance with ITB Clause 7:

PART 1 Bidding Procedures

•

- Section 1: Instructions to Bidders (ITB)
- Section 2: Bidding Data Sheet (BDS)
- Section 3: Evaluation and Qualification Criteria
 - Section 4: Bidding forms
- Section 5: General Conditions of Contract (GCC)
- Section 6: Special Conditions of Contract (SCC)
- Section 7: Contract Forms
- Section 8: Bill of Quantities & Specifications
- Section 9: Drawings
- 5.2 The Employer is not responsible for the completeness of the Bidding Document and their Addenda, if they were not obtained directly from the source stated by the Employer in the Invitation for Bids.
- 5.3 The Bidder is expected to examine all instructions, forms terms, and specifications in the Bidding Documents. Failure to furnish all information or documentation required by the Bidding Documents may result in the rejection of the bid.

6. Clarification 6.1 of Bidding Documents

- 1 A prospective Bidder requiring any clarification of the Bidding Document shall contact the Employer in writing at the Employer's address **indicated in the BDS**.
- 7. Amendment of Bidding Documents
 7.1 At any time prior to the deadline for submission of Bid, the Employer may amend the Bidding Document by issuing addenda and extend the deadline for the submission of bids at its discretion. Any amendment issued shall become an integral part of the Bidding Document and shall be communicated in writing to all those who have purchased the Bidding Document.

⁴ A 'party' refers to a participant in the procurement in the procurement process or contract execution.

C. Preparation of Bids

- One Bid per Bidder
 A Bidder shall submit only one (1) Bid. A Bidder who submits or participates in more than one (1) Bid shall cause all the proposals with the Bidder's participation to be disgualified.
- 9. Bid Preparation Costs
 9.1 The Bidder shall bear all costs associated with the preparation and submission of its Bids, and the Employer shall in no case be responsible or liable for those costs, regardless of the conduct or outcome of the Bidding process.
- 10. Language of 10.1 All documents relating to the Bid shall be in the language specified in the BDS.
 - 11.1 The original and copy(ies) of Bid submitted by the Bidder shall comprise the following:
 - (a) The Bid form (in the format indicated in Section IV Forms of Bid, Qualification Information, Letter of Acceptance, and Contract);
 - (b) License and certificate

11. Documents

comprising the Bid

- (c) Bid Security in accordance with Clause 19;
- (d) Priced Bill of Quantities;
- (e) and any other materials required to be completed and submitted by Bidders, as specified in the BDS.
- 11.2 The Instruction to Bidders, Bidding Data Sheet, General Conditions of Contract, Special Conditions of Contract, Specifications and drawings are for the information of the bidders and is not required to be submitted by the bidder,
- 12 Letter of Bid and Schedule 12.1 The letter of Bid, Schedules, and all documents listed under Clause 11, shall be prepared using the relevant forms in Section 4 (Bidding Forms), if so provided in BDS. The forms must be completed without any alterations to the text, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.
- 13. Alternative Bid 13.1 Alternative Bid shall not be considered in small works.
- 14. Bid Price and 14.1 The prices and discounts quoted by the Bidder in the Letter of Bid and in the Schedules shall confirm to the requirements specified below;
 - 14.2 The bidder shall submit a bid for the whole of the works described in ITB 1.1 by filling in prices for all items of the Works, as identified in Section 4, Bidding Forms. In case of admeasurements contracts, the Bidder shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items against which no rate or price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed covered by the rates for other items and prices in the Bill of Quantities.
 - 14.3 The Bid price shall take into account the cost of materials, transportation, labour, taxes, levies, overheads and profit and any other cost. The Bid price shall be fixed for the duration of performance of the Contract and shall not be subject to any adjustment on any account. The Bid price shall be applicable for the whole works described in the Drawings, Specifications and Schedule of Works.

- 15 Currencies of 15.1 All prices shall be quoted in Bhutanese Ngultrum (BTN) and shall be paid Bid and in BTN.
 Payment
- 16 Documents 16.1 The bidder shall furnish a work plan in simple bar chart and other information if provided in BDS, to demonstrate the adequacy of the Bidders' proposal to meet the work requirements and the completion time.
- 17 Documents establishing the Qualification of the Bidder
- 18 Bid Validity 18.1 Bids shall remain valid for the period **specified in the BDS**. Any Bids which does not meet the validity requirement as per the BDS shall be rejected by the Employer as non-responsive.
- 19 Bid Security 19.1 The Bidder shall at their option furnish, as part of the Bid, a Bid Security as **specified in the BDS** issued by any reputed Financial Institutions in Bhutan and shall be valid thirty (30) days beyond the Bid validity period.
 - a) Unconditional Bank Guarantee;
 - b) A demand Draft; or
 - c) Cash Warrant
 - 19.2 In exceptional circumstances, prior to the expiration of the Bid validity period, the Employer may solicit the Bidder's consent to an extension of the Bid validity period. The request and responses shall be made in writing. The validity of Bid Security shall be suitably extended promptly.
 - 19.3 The Bid Security may be forfeited:
 - (a) if the Bidder withdraws the Bid after Bid opening during the period of Bid validity. Further the bidder may be excluded from future participation for a period of two years.
 - (b) if the Bidder does not accept the correction of the Bid price, pursuant to clause 31; or
 - (c) in the case of a successful Bidder, if the Bidder fails within the specified time limit to sign the Agreement; or furnish the required Performance Security.
- 20 Format and Signing of Bid
 20.1 The Bidder shall prepare one (1) original of the documents comprising the Bid as described in ITB Clause 11 and clearly mark it "ORIGINAL." In addition, the Bidder shall prepare the number of copies of the Bid, as specified in the BDS and clearly mark each of them "COPY." In the event of any discrepancy between the original and the copies, the original shall prevail.
 - 20.2 The original and each copy of the Bid shall be typed or written in indelible ink and shall be signed by the person duly authorized to sign on behalf of the Bidder.
 - 20.3 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialled by the person(s) signing the Bid.



		D. S	Submission and Opening of Bids
2	1 Sealing and Marking of Bids	21.1	The Bidder shall enclose the original in one (1) envelope and all the copies of the bid in another envelope, duly marking the envelopes as "ORIGINAL" and "COPY." These two (2) envelopes shall then be enclosed in one (1) single outer envelope.
		21.2	The inner envelopes shall:
			(a) Be signed across the seals by the person authorised to sign the Bid on behalf of the Bidder;
			(b) Be marked "ORIGINAL" and " COPY" and
			(c) Bear the name and address of the Bidder.
		21.3	The outer envelope shall;
			(a) Be sealed with adhesive or other sealant to prevent reopening;
		21.4	be addressed to the Employer at the address specified in the BDS; bear a statement "DO NOT OPEN BEFORE" the time and date for Bid opening as specified in the BDS.
		21.5	If all or any envelopes are not sealed and marked as required by ITB Sub- Clause 21, the Employer shall not reject the bids but assume no responsibility for the misplacement or premature opening of the Bid.
2	2 Bid Submission	22.1	Bids must be received by the Employer at the address and no later than the date and time specified in the BDS.
	Deadline	22.2	Bids may be hand delivered, posted by registered mail or sent by courier.
		22.2	The Employer may, at its discretion, extend the deadline for the submission of Bids by amending the Bidding Document in accordance with ITB Clause 7, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the new deadline as extended.
2	3 Late Bids	23.1	Late bids shall not be considered and shall be returned unopened
2	4 Modification, Substitution or Withdrawal of Bids	24.1	A Bidder may modify, substitute or withdraw their Bids after it has been submitted by sending a written notice before the deadline for submission of Bids.
2	5 Bid Opening	25.1	The Employer shall open the Bids in the presence of the bidders who is attending the bid opening, including modifications or substitutions made pursuant to ITB Clause 24. Bidders or their representatives shall be allowed to attend and witness the bid opening and shall sign a register evidencing their attendance.
		25.2	The name of the Bidder, Bid modifications, substitutions or withdrawals, total amount of each Bid, number of corrections, discounts, and the presence or absence of requisite Bid Security, and such other details as the Employer, at its discretion, may consider appropriate, shall be read out aloud and recorded.
		25.3	The Employer shall prepare minutes of the Bid opening. The minutes shall include, as a minimum, the name of the Bidders and whether there has been a withdrawal, substitution or modification; the Bid Price including any discounts and the presence or absence of a Bid Security if one was

required.

25.4 Bids not opened and read out at the Bid opening shall not be considered, irrespective of the circumstances, and shall be returned unopened to the Bidder.

E. Tender Opening and Evaluation

26 Confidentiality 26.1 After the opening of Bids, information relating to the examination, clarification, and evaluation of Bids and recommendations for award shall not be disclosed to Bidders or other persons not officially concerned with the evaluation process until after the award of the Contract is announced.

- 27 Clarification 27.1 The Employer may ask Bidders for clarification of their Bids in order to facilitate the examination and evaluation of Bids. The request for clarification and the response shall be in writing, and any changes in the prices or substance of the Bid shall not be sought, offered or permitted, except to confirm the correction of arithmetical errors discovered by the Employer in the evaluation of the Bids, in accordance with ITB Clause 31.
- 28 Bidder: 28.1 Following the opening of Bids and until the Contract is signed no Bidder shall make any unsolicited communication to the Employer or try in any way to influence the Employer's examination and evaluation of Bids which may result in the rejection of bids. If any Bidder wishes to contact the Employer on any matter related to the Bidding process, it should do so in writing
- 29 Determination 29.1 Prior to detailed evaluation of bids, the employer shall determine whether each bid (a) meets the eligibility criteria defined in ITB clause 3; (b) has been properly signed; (c) is accompanied by the bid security; and (d) is substantially responsive to the requirements of the bidding documents.
 - 29.2 A substantially responsive Bid is one that conforms in all respects to the requirements of the Bidding Document without material deviation, reservation or omission. A material deviation, reservation or omission is one that:
 - (a) affects in any substantial way the scope, quality, or performance of the Works specified in the Contract; or
 - (b) limits in any substantial way, or is inconsistent with the Bid Document, the Employer's rights or the Bidder's obligations under the Contract; or
 - (c) if rectified would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.
 - 29.3 If a Bid is not substantially responsive to the Bidding Document it shall be rejected by the Employer and shall not subsequently be made responsive by the Bidder by correction of the material deviation, reservation or omission.

29.4 There shall be no requirement as to the minimum number of responsive Bids.

- 30 Non Conformities, Errors and Omissions 30.1 The Employer may regard a Bid as responsive even if it contains minor deviations that do not materially alter or depart from the characteristics, terms, conditions and other requirement set forth in the Bidding Document or if it contains errors or oversights that are capable of being corrected without affecting the substance of the Bid.
- 31Evaluation
and
Comparison of
Tenders31.1The Employer shall evaluate and compare only those Bids determined to
be substantially responsive to the requirements of the Bidding Document.
Substantially responsive Bids are those which fulfil the requirements of
ITB Clauses 11 and 12.
 - 31.2 The evaluation will take into account corrected Bid Price and discounts (if any).
 - 31.3 The Employer will check substantially responsive Bids for any arithmetical errors. Where there is a discrepancy between the amounts in figures and words, the amount in words will govern. If a Bidder refuses to accept the correction, its Bids shall be rejected. The Employer shall correct arithmetical errors on the following basis:
 - (a) if there is a discrepancy between the unit price and the line item total, the unit price shall prevail and the total price shall be corrected, unless in the opinion of the Employer there is an obvious misplacement of the decimal point in the unit price, in which case the total price, as quoted, shall govern and the unit price shall be corrected; and
- 32. Employer's 32.1 The Employer reserves the right to accept any Bid, to annul the Bid proceedings, or to reject any or all Bids, at any time prior to Contract award, without thereby incurring any liability to Bidders, or any obligation to inform Bidders of the grounds for the Employer's actions.

F. Contract Award

- 33. Award Criteria 33.1 The Employer shall award the Contract to the Bidders whose offer is substantially responsive to the Bidding Document and that has been determined to be the lowest evaluated Bid, provided that the Bidder is determined to be qualified to perform the Contract satisfactorily
- 34. Letter of Intent 34.1 The Employer shall notify the concerned Bidder whose bid has been selected in accordance with ITB 33.1 in writing (in the format in Section 4-hereafter called the "Letter of Intent to Award) that the Employer has intention to accept its bid and the information regarding the name, address and amount of selected bidder shall be given to all other bidders who submitted the bid. Such notification should be communicated in writing, including by cable, facsimile, telex or electronic mail to all the bidders on the same day of dispatch. The Employer shall ensure that the same information is uploaded on their website on the same day of dispatch.
 - 34.2 If no bidder submits an application pursuant to ITB 35 within a period of ten (10) days of the notice provided under ITB 34.1, Prior to the expiration of the period of Bid validity, the Employer shall notify the successful Bidder, in writing that its Bid has been accepted. Until a formal contract is prepared and executed, the Notification of Award shall constitute a binding Contract.
 - 34.3 Within fifteen (15) working days of the receipt of the Notification of Award from the Employer, the successful Bidder shall furnish the Performance

Security, in the amount specified in the BDS.

- 34.4 The proceeds of the performance security shall be payable to the Employer unconditionally upon first written demand as compensation for any loss resulting from the Contractor's failure to complete its obligations under the Contract
- 34.5 Within fifteen (15) working days of receipt of the notification of award, the successful Bidder shall sign, date and return it to the Employer.
- 35.Complaints
- 35.1 The Bidder shall submit the complaint in writing within ten (10) days from the date of letter of intent to award the contract pursuant to ITB 34.1 to the Employer.
- 35.2 The Bidder may appeal to the Independent Review Body only if the Employer has not delivered the decision within the specified time, or the complainant is not satisfied with the decision of the Employer in accordance with rules and procedures of Independent Review Body.



mentioned	s for completing the Bidding Data Sheet are provided, as needed, in the notes in italics I for the relevant ITB Clauses				
ITB Clause	Amendment of, and Supplements to, Clauses in the Instructions to Bidders				
V. 11	A. General				
ITB 1.1	The Employer is Chief Engineer, Industrial Infrastructure Development Division, Department of Industry, Ministry of Economic Affairs, Changzamthog, Thimphu.				
	The Name and Identification of the Contract is/are "Major Maintenance of Street Light at Bjemina Industrial Estate"				
	The Works are replacement of Existing fluorescent fitting of streetlight, replacement of main cable, painting of existing poles, and installation of individual energy meter to office and other occupants and all main controllers has be replaced with new one. Etc				
ITB 3.2	Option A: Limited Bidding method:				
	All Bidders regardless of whether enlisted or not enlisted with the Dzongkhag may submit Bids provided they otherwise qualify.				
ITB 3.3	The evaluation shall be based on the lowest price of the responsive bidder and the work will awarded to the lowest responsive bidder. [Generally the selection is based on the lowest price. If there is a specific project need basic minimum technical qualification requirement should specified here]				
	B. Bidding Documents				
ITB 7.1	For clarification of Tenders purposes only, the Employer's address is:				
	Attention: Daba, Estate Manager				
	Address: Bjemina Industrial Estate				
	Telephone: 02-371097/1707963				
	Facsimile number: 02-323536				
	Electronic mail address				
	C. Preparation of Bids				
ITB 15.1	The Bid validity period shall be 60 days after the submission of the bid.				
ITB 15.2	A Bid Security in the amount of Nu. 2 % of the quoted amount, in favour of Dy. Chief Account Officer, MoEA, Thimphu.				
	a) Unconditional Bank guarantee				
	b) Cash warrant; or				

ITB 19.1	In addition to the original, (Complete set of Bidding document), identical copy shall be submitted.					
	D. Submission and Opening of Bids					
ITB 17.2	The inner and outer envelopes shall bear the following additional identification marks:					
	"DO NOT OPEN BEFORE" 2:30 PM, ON 17TH. MAY 2017 and should mark "ORGINAL" and "COPY" for the inner envelope.					
ITB 17.2	For Bid submission purposes only, the Employer's address is:					
	Attention: Chief Engineer					
	Address: Industrial Infrastructure Development Division, Department of Industry, Ministry of Economic Affairs, Changzamthog, Thimphu.					
	The deadline for the submission of Tenders is:					
	On or before12 Noon, on 17 th . May 2017					
ITB 21.1	The Bid opening shall take place on the same day as the closing day of the bid submission at: conference hall, Department of Industry, Ministry of Economic Affairs, Thimphu.					
	Date: on 17th. May 2017; Time:14:30 hours(2:30PM)					
	F. Award of Contract					
ITB 34.2	The amount of Performance Security shall be Ten (10) percent of the Contract Price.					



Section 3 – Evaluation and Qualification Criteria

This section contains all the criteria that the Employer shall use to evaluate bids and qualify Bidders if the bidding was not preceded by a prequalification exercise and post qualifications are applied. Procuring Agency may apply basic minimum technical qualification requirement (manpower and equipments) only if there is a project specific need.

1. Evaluation

1.1 Evaluation shall be done to determine the responsiveness and the award shall be made to the lowest evaluated bidder.

Section 4: Forms of Bid & Qualification Information

Table of Standard Forms

Standard Form: Form of Bid

Standard Form: Letter of Intent

Standard Form: Letter of Acceptance

Standard Form: Bid security Bank Guarantee



Standard Form: Form of bid

Notes on Form of Bid:

The Bidder shall fill in and submit this bid form with the Bid. If Bidders do not fill in the Contract Price and does not sign this Bid form, the bids will be rejected.

[date]
<u>To</u>
Address
-
We offer to execute the contract for construction of """ in accordance
with the Conditions of Contract accompanying this Bid for the Contract Price of [amount in]
figures] ()
[amount in words] [name of currency].
The contract shall be paid in Ngultrums (Nu.)
This Bid and your written acceptance of it shall constitute a binding Contract between us. We understand that you are not bound to accept the lowest or any Bid you receive.
We hereby confirm that this Bid complies with the Bid validity and Bid Security required by the bidding documents and specified in the Bidding Data.
Authorized Signature:
(Affix Legal Stamp)
Name and Title of Signatory:
Name of Bidder:
Address:

Standard Form: Qualification Information

Notes on Form of Qualification Information: The following information is to be filled in by bidders which will be used for purposes of evaluation

1. Individual bidders

1.1 Constitution of legal status of Bidder

[attach copy]

Place of registration:

Principal place of business:

Power of attorney of signatory of Bid [attach]

1.2 Qualifications and experience of key personnel proposed for administration and execution of the Contract. Refer BDS. The supporting documents such detailed CVs signed in original supported by certificates for qualification and experience.

Position	Name	Qualification & year of experience (general)	Year of experience in proposed position	Remarks
Supervisor				



Standard Form: Letter of Intent

(Letterhead paper of the Employer)

Notes on standard form of letter of Intent This issuance of Letter of Intent(always before letter of acceptance) is the information of the selection of the bid of the successful bidder by the Employer and for providing information to other unsuccessful bidders who participated in the bid as regards the outcome of the procurement process
The Employer shall allow 10 days as described in ITB 34.2 between this letter of intent and letter of acceptance to allow aggrieved bidders to challenge your decision if they feel they have treated unfairly.
(Insert date)
To:[Name and address of the Contractor]
This is to notify you that, it is our intention to award the contract for your Bid dated [<i>Insert date</i>] for execution of the[<i>Insert name of the contract and identification number,</i> as given in the BDS/SCCI for the Contract Price of
words and name of currency] as corrected and modified[<i>if any corrections</i>] in accordance with the Instructions to Bidders.
Authorized Signature:
Name and Title of Signatory:

Name of Agency:-

CC: [Insert name and address of all other bidders who submitted the bid]



Standard Form: Letter of Acceptance

[letterhead paper of the Employer]

Notes on Standard Form of Letter of Acceptance

The Letter of Acceptance will be the basis for formation of the Contract as described in Clauses 31 and 32 of the Instructions to Bidders. This Standard Form of Letter of Acceptance should be filled in and sent to the successful Bidder only after evaluation of bids has been completed.

_____[date]

To:

[name of the Contractor]

[address of the Contractor]

This is to notify the for the execution	at your Bid da of the contr	ted act for the constr	ruction of	£ "	
	" for the	e Contract Price		[amoun	t in
numbers]				[amount	in
words]		[name of current	ncy], as co	prrected and mod	ified
in accordance with	the Instructions	to Bidders is hereb	y accepted	l by our Agency.	The
start date of the pro-	oject is	The completion	on date for	r whole of the w	orks
shall be	·				

You are hereby instructed to proceed with the execution of the said Works in accordance with the Contract documents.

Authorized Signature:

DIVISION+

Name and Title of Signatory:

Name of Agency:

Attachment: Agreement

Bank Guarantee for Bid Security

[this is the format for the Bid Security to be issued by a financial institutions in Bhutan in accordance with ITB Clause 19]

Invitation for Bid No:

Date:

Bid Package No:

To:

[Name and address of Employer]

TENDER GUARANTEE No:

We have been informed that [name of Bidder] (hereinafter called "the Bidder") intends to submit to you its Bid dated [date of bid] (hereinafter called "the Tender") for the execution of the Works of [description of works] under the above Invitation for Bids (hereinafter called "the IFB").

Furthermore, we understand that, according to your conditions Bids must be supported by a Bid Guarantee.

At the request of the Bidder, we [name of bank] hereby irrevocably undertake to pay you, without cavil or argument, any sum or sums not exceeding in total an amount of Nu [insert amount in figures and words] upon receipt by us of your first written demand accompanied by a written statement that the Bidder is in breach of its obligation(s) under the Bid conditions, because the Bidder:

- (a) has withdrawn its Bids during the period of Bid validity specified by the Bidder in the Form of Bid; or
- (b) does not accept the correction of errors in accordance with the Instructions to Bidders ITB; or
- (c) having been notified of the acceptance of the Bid by the Employer during the period of Bid validity, (i) fails or refuses to furnish the performance security in accordance with the ITT, or (ii) fails or refuses to execute the Contract Form,

This guarantee will expire

- (a) if the Bidder is the successful Bidder, upon our receipt of a copy of the Performance Security and a copy of the Contract signed by the Bidder as issued by you; or
- (b) if the Bidder is not the successful Bidder, thirty days after the expiration of the Bidder's Tender validity period, being [date of expiration of the Tender].

Consequently, we must receive at the above-mentioned office any demand for payment under this guarantee on or before that date.

LISNON!

Signature

Signature

Section 5. General Conditions of Contract

1.1

1. Definitions



- The following words and expressions shall have the meaning hereby assigned to them. Boldface type is used to identify the defined terms:
- (a) Completion Certificate means the Certificate issued by the Employer as evidence that the Contractor has executed the Works in all respects as per drawing. specifications, and Conditions of Contract.
- (b) The Completion Date is the date of completion of the Works as certified by the Engineer, in accordance with GCC Clause 18.
- (c) **Contract** means the Agreement entered into between the Employer and the Contractor to execute, complete and maintain the Works.
- (d) Contractor means the person or corporate body whose Tender to carry out the Works has been accepted by the Employer and is named as such in the SCC.
- (e) Contract Price is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract. The Contractor's Bid is the completed Bid Document including the priced offer submitted by the Contractor to the Employer.
- (f) Days mean calendar days.
- (g) A Defect is any part of the Works not completed in accordance with the Contract.
- (h) The Employer is the party named in the SCC who employs the Contractor to carry out the Works.
- The Engineer is the person named in the SCC, who is (i) responsible for supervising the execution of the works and administering the Contract.
- The Intended Completion Date is the date specified in (i) the SCC on which the Contractor shall complete the Works and may be revised if extension of time or an acceleration order is issued by the Engineer.
- (k) The **Site** is the area defined as such in the SCC.
- The Works are what the Contract requires the Contractor (I) to construct, install, and hand over to the Employer, as defined in the SCC.
- 2.1 In interpreting the GCC, singular also means plural, male also means female or neuter, and the other way around. Headings in the GCC shall not be deemed part thereof or be taken into consideration in the interpretation or construance of the Contract. Words have their normal meaning under the language of the Contract unless specifically defined.
- 2. Interpretation & Documents forming the Contract

- 2.2 The following documents forming the Contract shall be interpreted in the following order of priority:
 - (a) the signed Contract Agreement.
 - (b) the letter of Notification of Award.
 - (c) the completed Bid form as submitted by the Bidder.
 - (d) the Special Conditions of Contract.
 - (e) the General Conditions of Contract.
 - (f) Specifications
 - (g) the Drawings.
 - (h) any other document listed in the PCC as forming part of the Contract.
- 3. Corrupt, Fraudulent, Collusive or Coercive Practices

3.1 The Government requires that Employers, as well as Contractors shall observe the highest standard of ethics during the implementation of procurement proceedings and the execution of Contracts under public funds.

- 3.2 In pursuance of this requirement, the Employer shall
 - (a) exclude the Contractor from participation in the procurement proceedings concerned or reject a proposal for award; and
 - (b) declare a Contractor ineligible, either indefinitely or for a stated period of time, from participation in procurement proceedings under public fund;
- 3.3 The Government defines, for the purposes of this provision, the terms set forth below as follows:
 - (a) corrupt practice"⁵ is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value⁶ to influence improperly the actions of another party;
 - (b) "fraudulent practice"⁷ is any intentional act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;

DIVISION: NUCLEAR OF THE OWNER

⁵ "another party" refers to a public official acting in relation to the procurement process or contract execution. In this context, "public official" includes staff and employees of any organizations (including any institutions providing finance for the Works) taking or reviewing procurement decisions.

⁶ "anything of value" includes, but is not limited to, any gift, loan, fee, commission, valuable security or other asset or interest in an asset; any office, employment or contract; any payment, discharge or liquidation of any loan, obligation or other liability whatsoever, whether in whole or in part; any other services, favour or advantage, including protection from any penalty or disability incurred or apprehended or from any action or proceeding of a disciplinary or penal nature, whether or not already instituted and including the exercise or the forbearance from the exercise of any right or any official power or duty.

⁷ a "party" refers to a public official; the terms "benefit" and "obligation" relate to the procurement process or contract execution; and the "act or omission" is intended to influence the procurement process or contract execution.

			(c) "collusive practice" ⁸ is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party; and
			(d) "coercive practice" ⁹ is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party.
		3.4	The Government requires that the Client's personnel have an equal obligation not to solicit, ask for and/or use coercive methods to obtain personal benefits in connection with the said proceedings.
4.	Governing Language and Law	4.1	The Contract as well as all correspondence and documents relating to the Contract exchanged by the Contractor and the Employer, shall be written in English unless otherwise stated in the SCC. The Contract shall be governed by and interpreted in accordance with the laws of the Kingdom of Bhutan.
5.	Engineer's Decision	5.1	Except where otherwise specifically stated in the SCC, the Engineer will decide Contractual matters between the Employer and the Contractor in the role as representative of the Employer.
6.	Delegation	6.1	The Engineer may delegate any of his duties and responsibilities to his representative, after notifying the Contractor, and may cancel any delegation, without retroactivity, after notifying the Contractor.
7.	Communications and Notices	7.1	Communications between Parties pursuant to the Contract shall be in writing to the address specified in the SCC. A notice shall be effective when delivered or on the notice's effective date, whichever is later.
8.	Sub- Contracting	8.1	The Contractor shall not be permitted to subcontract any part of the Works in whole or in part.
9.	Contractor's Personnel	9.1	The Contractor shall employ the key personnel named in the Schedule of Key Personnel, as referred to in the SCC, to carry out the functions stated in the Schedule, or other personnel approved by the Engineer.
10.	Welfare of Labourers & Child Labour	10.1	The Contractor shall provide proper accommodation to his labourers and arrange proper water supply, conservancy and sanitation arrangements at the site in accordance with relevant regulations, rules and orders of the government.
		10.2	The Contractor shall comply with the applicable minimum age, labour laws and requirements of (including applicable treaties which have been ratified by) the Government of Bhutan regarding hazardous forms of child labour.

 [&]quot;parties" refers to participants in the procurement process (including public officials) and an "improper purpose" includes attempting to establish bid prices at artificial, non competitive levels.
 a "party" refers to a participant in the procurement process or contract execution.

11.	Safety, Security and Protection of the Environment	11.1	The compl therein	Contractor shall throughout the execution and etion of the Works and the remedying of any defects n:
			(a)	have full regard for the safety of all persons entitled to be upon the Site and keep the Site and the Works in an orderly state;
			(b)	provide and maintain at the Contractors own cost all lights, guards, fencing, warning signs and watching for the protection of the Works or for the safety on-site; and
			(c)	take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of the Contractors methods of operation.
12.	Access to the Site	12.1	The autho place carrie	Contractor shall allow the Engineer and any person orised by the Engineer access to the Site and to any e where work in connection with the Contract is being ed out or is intended to be carried out.
13.	Documents, Information.	13.1	The sche may	Contractor shall furnish to the Engineer all information, dules, calculations and supporting documentation that be requested of it.
14.	Property	14.1	If the contr to re Worł	e contract is terminated by the Employer because of the ractors default, then, the contractor shall not be allowed move any materials on the Site, Plant, and Temporary s until the matter is amicably resolved.
15.	Insurance	15.1	Th SC	e Contractor shall provide insurance as stated in the
		15.2	The insu bef	e Contractor shall deliver policies and certificates of urance to the Engineer, for the Engineer's approval, ore the Start Date.
		15.3	lf th ceri insu recu pay pay deb	the Contractor does not provide any of the policies and tificates required, the Employer may effect the urance which the Contractor should have provided and over the premiums the Employer has paid from ments otherwise due to the Contractor or, if no ment is due, the payment of the premiums shall be a ot due.
16.	Possession of the Site	16.1	Th of the	e Employer shall give possession of the Site, or parts the Site, to the Contractor on the date(s) specified in e SCC.
17.	Commencement of Works	17.1	Th on SC ma	e Contractor may commence execution of the Works the Start Date, or other such date as specified in the C, and shall carry out the Works in an expeditious anner.
		17.2	lf t ab dis Pe	the Contractor fails to commence the works within the ove stated period, the Employer may, at his sole cretion, terminate the Contract and forfeit the rformance Security, if any.

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18.	Completion of Works	18.1	The Contractor shall complete the Works within the number of days stated in the SCC from the date of commencing the Works on the Site.
19.	Programme of Works	19.1	Within the time stated in the SCC, the Contractor shall submit to the Engineer for approval a work program. The Contractor shall submit to the Engineer for approval an updated Programme at intervals no longer than the period stated in the SCC.
20.	Early Warning	20.1	The Contractor shall warn the Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work result in increase to the Contract Price or delay in the execution of the Works.
21.	Compensation	21.1	The following shall be Compensation Events:
	Events		 (a) the Employer does not give access to the Site or part of the Site by the Site Possession Date stated in the SCC; and
			(b) if the payment is delayed pursuant to Clause 25.1.
		21.2	If a Compensation Event would prevent the work being completed before the Intended Completion Date, the Intended Completion Date shall be extended, as appropriate, by the Engineer.
22.	Non-Scheduled Items of Works	22.1	The Contractor shall be paid for non-scheduled items of works only when the Engineer approves such works and at the rates and in the manner stated in the SCC.
23.	Schedule of Works	23.1	The Schedule of Works will contain rates for all items for the construction including temporary works, installation, testing, and commissioning work to be done by the Contractor.
		23.2	The Contractor shall be paid for the quantity of the work done at the rate in the Contract Agreement for each item.
		23.3	The Contractor shall be entirely responsible for all taxes, duties, license fees, and other such levies imposed outside and inside Bhutan.
24.	Payment Certificates	24.1	The Contractor shall submit to the Engineer monthly statements of the estimated value of the work executed less the cumulative amount certified previously. The Engineer shall check the Contractor's monthly statement and certify the amount to be paid to the Contractor.
		24.2	The value of work executed shall be determined by the Engineer.
		24.3	The value of work executed shall comprise the value of the quantities of the items in the Schedule of Works completed.
		24.4	The value of work executed shall include the valuation of Variations, Certified Dayworks and Compensation Events.
		24.5	The Engineer may exclude any item certified in previous certificates or reduce the proportion of any item previously

certified in any certificate in the light of later information.

25. Payments and 25.1 The Employer shall pay the Contractor the amounts certified by the Engineer within thirty (30) days of the date Currency of each certificate. 25.2 The Employer shall make Advance Payment (mobilization and secured advance) to the Contractor of the amounts and by the dates stated in the SCC against provision by the Contractor of an unconditional Bank Guarantee, (Form 4). The Contractor is to use the advance payment only to pay 25.3 for Equipment, Plant, Materials, and mobilisation expenses required specifically for the execution of the Contract. The Contractor shall demonstrate that the advance payment has been used in this way by submitting copies of invoices or other documents to the Employer. 25.4 The advance payment shall be repaid by deducting proportionate amounts from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis. No account shall be taken of the advance payment or its repayment in assessing valuations of work done, variations, claims or any amount payable due to failure to complete the works. 26. Retention 26.1 The Employer shall retain from each payment due to the Contractor the proportion stated in the SCC until the completion of the whole of the Works. 26.2 On completion of the whole of the Works, half the total amount retained shall be repaid to the Contractor, the remaining half when the Defects Liability Period has passed and the Engineer has certified that all Defects notified by the Engineer to the Contractor before the end of this period have been corrected. 27. Liquidated 27.1 The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the SCC for each Damages day that the Completion Date is later than the Intended Completion date for the works or for any part thereof. 28. Performance 28.1 Upon Notification of Award, a Performance Security shall Security be provided to the Employer in the amount and form stated in the Contract Forms (Form 3). The Performance Security shall be valid until a date thirty (30) days from the date of issue of the Certificate of Completion. The rates and prices in the bill of quantities are fixed for 29. Price Adjustment 150,29.1 the duration of the Contract and not subject to price adjustment during the performance of the Contract. 30. Completion 30.1

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The Contractor shall request the Engineer to issue a Certificate of Completion of the Works, and the Engineer will do so upon deciding that the work is substantially completed.

- 31. Correction of Defects
 31.1 The Engineer shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion, and is defined in the SCC. The Defects Liability Period shall be extended for as long as the Defects remain to be corrected.
 31.2 If the Contractor has not corrected a Defect within the time specified in the Engineer's notice, the Engineer will assess the cost of having the Defect corrected, and the Contractor will pay this amount.
 32. Taking Over 32.1 The Employer shall take over the Site and the Works
- 32. Taking Over 32.1 The Employer shall take over the Site and the Works within seven (7) days of the Engineer issuing a Certificate of Completion.
- 33. Final Account 33.1 The Contractor shall supply the Engineer a detailed account of the total amount that the Contractor considers payable under the Contract. The Engineer shall certify any final payment that is due to the Contractor within twenty-one (21) days of receiving the Contractor's account if it is correct and complete.
 - 33.2 The Employer shall effect payment of the final account within thirty (30) days from the date of certification by the Engineer.
- 34. Termination

34.1 The Employer or the Contractor by giving thirty (30) days written notice of default to the other party, may terminate the Contract in whole or in part if the other party causes a fundamental breach of Contract.

- 34.2 Fundamental breaches of the Contract shall include, but shall not be limited to, the following:
 - the Contractor stops work for more than thirty (30) days when no stoppage of work is shown on the current Programme and the stoppage has not been authorised by the Engineer;
 - (b) the Engineer gives notice that failure to correct a particular defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer;
 - (c) the Contractor has delayed the completion of the Works by the number of days for which the maximum amount of Liquidated Damages can be paid;
 - (d) the Contractor, in the judgment of the Employer, has engaged in corrupt or fraudulent practices, as defined in GCC Clause 3, in competing for or in executing the Contract; and
 - (e) a payment certified by the Engineer is not paid to the Contractor by the Employer within sixty (60) days of the date of the Engineer's certificate.

- 34.3 The Employer and the Contractor may at any time terminate the Contract by giving notice to the other party if either of the parties becomes bankrupt or otherwise insolvent. In such event, termination will be without compensation to any party provided that such termination will not prejudice or affect any right of action or remedy that has accrued or will accrue to the other party.
- 34.4 Notwithstanding the above, the Employer may terminate the Contract for convenience.
- 34.5 If the Contract is terminated, the Contractor is to stop work immediately, make the Site safe and secure and hand over the Site to the Employer as soon as reasonably possible.
- 35. Payment upon 35.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer shall Termination issue a certificate for the value of the work done and Plant and Materials ordered less advance payments received up to the date of the issue of the certificate and less the percentage to apply to the value of the work not completed, as indicated in the SCC.. Additional Liquidated Damages shall not apply. If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable to the Employer.
 - 35.2 If the Contract is terminated for the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Contractor shall be entitled to payments for completed works and the materials that have been brought to the site for the purpose of the works, but not used as certified by the Engineer after adjusting any payments received by the Contractor.
- 36. Release from 36.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Performance Employer or the Contractor, the Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible. after receiving this certificate. The Contractor shall be paid for all works carried out before stoppage of work and any work carried out afterwards to which a commitment was made.
 - For the purposes of this Contract, "Force Majeure" means 37.1 an exceptional event or circumstance:
 - which is beyond a Party's control, (a)
 - (b) which such Party could not reasonably have provided against before entering into the Contract,
 - (c) which, having arisen, such Party could not reasonably have avoided or overcome, and
 - (d) which is not substantially attributable to the other Party.

37.2 Force Majeure may include, but is not limited to, exceptional events or circumstances of the kind listed below, so long as conditions (a) to (d) above are satisfied:

37. Force Majeure



- (a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies,
- (b) rebellion, terrorism, sabotage by persons other than the Contractor's Personnel, revolution, insurrection, military or usurped power, or civil war,
- (c) riot, commotion, disorder, strike or lockout by persons other than the Contractor's Personnel,
- (d) munitions of war, explosive materials, ionizing radiation or contamination by radio-activity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity, and
- (e) natural catastrophes such as earthquake, hurricane, typhoon or volcanic activity.
- 37.3 However, force majeure shall not include the following;
 - i. rainfall
 - ii. snowfall
 - iii. strikes in other countries
 - iv. non-availability of labourer and materials such as timbers, boulders, sand, and other materials
 - v. difficulty and risky terrain and remoteness of site.
- 38.1 The Employer and the Contractor shall use their best efforts to settle amicably all disputes arising out of or in connection with this Contract or its interpretation.
 - 38.2 Any dispute between the parties to the Contract that may not be settled amicably will be referred to Arbitration at the initiative of either of the parties.
 - 38.3 The Arbitration shall be conducted in accordance with the Arbitration Rules of the Kingdom of Bhutan in force.
- 38. Settlement of Disputes

Section 6. Special Conditions of Contract

Instructions for completing the Special Conditions of Contract are provided, as needed, in the notes in italics mentioned for the relevant GCC Clauses.3

Clause Ref	Amendments of, and Supplements to, Clauses in the General Conditions of Contract		
GCC 1.1(d)	The Contractor is		
GCC 1.1(i)	The Employer is Chief Engineer, Industrial Infrastructure Development Division, Department of Industry, Ministry of Economic Affairs, Thimphu.		
GCC 1.1(j)	The Engineer is Daba, Estate Manager, Bjemina Industrial Estate, IIDD, Dol, MoEA.		
GCC 1.1(k)	The Intended Completion Date for the whole of the Works shall be 1.5(one and half) Months .		
GCC 1.1(I)	The Site is located at <i>Bjemina Industrial Estate,Thimphu.</i>		
GCC 1.1(m)	The Works are replacement of Existing fluorescent fitting of streetlight, replacement of main cable, painting of existing poles, and installation of individual energy meter to office and other occupants and all main controllers has be replaced with new one. Etc		
GCC 2.2(i)	The additional documents forming part of this Contract are:		
	i. Bill of Quantity.		
	ii. Specification.		
GCC 4.1	The Language governing the Contract shall be English.		
GCC 5.1	The Engineer shall obtain specific approval of the Employer before taking any of the following actions:		
GCC 7.1	The addresses for Communications shall be:		
	For the Employer:		
	Chief Engineer, Industrial Infrastructure Development Division, Department of Industry, Ministry of Economic Affairs, Changzamthog, Thimphu.		
	For the Contractor:		
GCC 9.1	The Key Personnel of the Contractor are:Site		
	Engineer/Site supervisor.		
GCC 15.1	For insurance purposes the type of cover required shall be: The contractor shall be responsible for the insurance as per norm of the RICBL and BIL.		
GCC 16.1	Possession of the site shall be within Seven (7) days from the date of signing of the Contract.		
GCC 17.1	Commencement of work shall be within Fifteen (15) days from the date of handing over possession of the Site.		



GCC 18.1	Completion of works shall be within one and half (1.5) months from the date of commencing the works at site.
GCC 19.1 & 19.2	The Contractor shall submit the first work plan Immediately after signing the Contract, and shall update the work plan every Two weeks during the period of the Contract.
GCC 22.1	" The rates for non-scheduled item of works shall be determined by the engineer"
GCC 25.2	An advance payment of 10% of the Contract Price will be made to the Contractor within (15) days of Contract signing date.
GCC 26.1	The Retention shall be (Ten) 10% of the Contract Price.
GCC 27.1	The liquidated damages for the whole of the Works are 0.10 <i>percentage of the final contract price per day</i> . The maximum amount of liquidated damages for the whole of the Works is 10(Ten)percent of the initial Contract Price.
GCC 31.1	The Defects Liability Period shall be 6 (six) months.
GCC 35.1	The percentage to apply to the value of the work not completed, representing the Employer's additional cost for completing the Works, is 20% of the Final Contract Price .



Section 7 – Contract Forms

This section contains forms which, once completed, will form part of the Contract. The forms for Performance Security and Advance Payment Security, when required, shall only be completed by the successful Bidder after Contract award.

Contract Forms Form	Title
Form -1	Notification of Award
Form -2	Contract Agreement
Form -3	Bank Guarantee for Performance Security
Form -4	Bank Guarantee for Advance Payment



Form-1

Notification of Award

Contract No:

Date:

То:

[name and address of Contractor]

This is to notify you that your Bid dated *[insert date]* for the execution of the Works for *[name of project / Contract]* for the Contract Price of Nu *[amount in figures and in words]*, as corrected and modified in accordance with the Instructions to bidder is hereby accepted by *[name of the Employer]*.

You are requested to proceed with the execution of the Works on the basis that this Notification of Award shall constitute the formation of a Contract, which shall become binding upon you furnishing a Performance Security within fourteen (14) days, in accordance with ITB Clause 32, and the signing the Contract Agreement within twenty-one (21) days, in accordance with ITB Clause 33.

We attach the Contract Agreement and Special Conditions of Contract for your perusal and signature.

Signed

Duly authorised to sign for and on behalf of [name of Procuring Entity]

Date:



Form-2

Contract Agreement

THIS AGREEMENT, made the [*day*] of [*month*] [*year*] between [*name and address of Employer*] (hereinafter called "the Employer") of the one part and [*name and address of Contractor*] (hereinafter called "the Contractor") of the other part.

WHEREAS, the Employer invited Tenders for certain Works, viz, [*brief description of the Works*] and has accepted a Tender by the Contractor for the execution of those works in the sum of Ngultrum [*insert amount in figures and words*], hereinafter called "the Contract Price.

NOW THIS AGREEMENT WITNESSETH as follows:

- 1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the General Conditions of Contract hereinafter referred to.
- 2. The documents forming the Contract shall be interpreted in the following order of priority:
 - (a) The signed Contract Agreement;
 - (b) The letter of Acceptance;
 - (c) The completed Bid form as submitted by the Bidder;
 - (d) The Special Conditions of Contract;
 - (e) The General Conditions of Contract;
 - (f) Specifications
 - (g) The Drawings; and
 - (h) Any other document listed in the SCC as forming part of the Contract..
- 3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and to remedy any defects therein in conformity in all respects with the provisions of the Contract.
- 4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the Parties thereto have caused this Agreement to be executed in accordance with the laws of Bhutan on the day month and year first before written.

For the Employer

For the Contractor

Signature

Print Name

Title

In the presence of (Name)

Address


Form-3

Bank Guarantee for Performance Security

[this is the format for the Performance Security to be issued by any financial institute in Bhutan in accordance with **ITB** Clause 35]

Contract No:

Date:

To:

[Name and address of Employer]

PERFORMANCE GUARANTEE No:

We have been informed that *[name of Contractor]* (hereinafter called "the Contractor") has undertaken, pursuant to Contract No *[reference number of Contract]* dated *[date of Contract]* (hereinafter called "the Contract"), the execution of works *[description of works]* under the Contract.

Furthermore, we understand that, according to your conditions, Contracts must be supported by a performance guarantee.

At the request of the Contractor, we [name of bank] hereby irrevocably undertake to pay you, without cavil or argument, any sum or sums not exceeding in total an amount of Nu [insert amount in figures and in words] upon receipt by us of your first written demand accompanied by a written statement that the Contractor is in breach of its obligation(s) under the Contract conditions, without you needing to prove or show grounds or reasons for your demand of the sum specified therein.

This guarantee is valid until [date of validity of guarantee], consequently, we must receive at the above-mentioned office any demand for payment under this guarantee on or before that date.

Signature

Signature



Form-4

Bank Guarantee for mobilisation advance

[this is the format for the Advance Payment Guarantee to be issued by a financial institutions in Bhutan in their letter pad in accordance with SCC Clause 25.2]

Contract No:

Date:

To:

[Name and address of Employer]

ADVANCE PAYMENT GUARANTEE No:

We have been informed that *[name of Contractor]* (hereinafter called "the Contractor") has undertaken, pursuant to Contract No *[reference number of Contract]* dated *[date of Contract]* (hereinafter called "the Contract"), the execution of works *[description of works]* under the Contract.

Furthermore, we understand that, according to your conditions, Advance Payments must be supported by a bank guarantee.

At the request of the Contractor, we [name of bank] hereby irrevocably undertake to pay you, without cavil or argument, any sum or sums not exceeding in total an amount of Nu. [insert amount in figures and in words] upon receipt by us of your first written demand accompanied by a written statement that the Contractor is in breach of its obligation(s) under the Contract conditions, without you needing to prove or show grounds or reasons for your demand of the sum specified therein.

We further agree that no change, addition or other modification of the terms of the Contract to be performed, or of any of the Contract documents which may be made between the Employer and the Contractor, shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

This guarantee is valid until [date of validity of guarantee], consequently, we must receive at the above-mentioned office any demand for payment under this guarantee on or before that date.

Signature

Signature



Name of work: Major Renovation of the existing street light at Bjemina Industrial Estate

				Rate in Figure, (in	Rate in	Amount (in
Sl.No	Discription of the work	unit	Quantity	Nu.)	Words(Nu.)	Nu.)
1	OUTDOOR LUMINIARIES (Supply)					
	Supplying of prewired street lighting fluoresent lamp luminiaries housing of CRCA sheet steel rail,end (with lamp holders, copper wound ballast, starter, starter holder, terminal block etc. but without lamp, HPF suitable for					•3
1.1	street or outdoor lighting					
	each	each	65			
2	LAMPS & LAMP SHADE					
	Lamps					
2.1	Supplying of fluorescent lamps 250 volts A C					
2.1	TLF lamp 36/40 watt	each	65			
3	CONTROL CEAP & BUSBAD (Supply)	cacii	05			
	Pucher & Pucher Chember					
3.1	Supplying of pre-fabricated MS busbar chamber with copper busbar complete with all accessories etc. as required					
	4 strips, 300mm bar, 100A	each	1			
3.2	Moulded Case Circuit Breaker (MCCB)					
	Supplying of panel moulded case circuit breaker (MCCB) with electronic release, breaking capacity 16KA, 3 pole 415 volt A.C complete with all accessories etc. as required					
3.3	100A	each	2			
3.4	Miniature Circuit Breaker (MCB)					
3.4.1	Supply of miniature circuit breaker (MCB) SPN, 230 volt A.C complete with all accessories suitable to fix on a din-bar etc. as required					
	63A	each	4			
3.4.2	Supply of miniature circuit breaker (MCB) single pole, 230 volt A.C complete with all accessories suitable to fix on a dinbar etc. as required					
	6A	each	65			
3.5	Timer Switch					
3.5.1	Supply of electronic timer switch double pole, 50Hz, sensitivity 30mA, 230 volt A.C complete with all accessories suitable to to fix on a din-bar etc. as required					
	7days/24hrs	each	1			
	- dusnowi + We					39

3	ERECTION/INSTALLATION				
3.1	Busbars Installation				
3.1.1	Installation, testing and commissioning of prefabricated bus bar chamber with copper bus bar complete with all accessories including connections etc. as required				
	A string 200/450 mm langth 100 A	a a a h	1		(1
3.2	4 strips, 300/450mm length, 100A Miniature Circuit Breaker (MCB)	each	1		
3.2.1	Installation, testing and commissioning of TPN/four pole miniature circuit breaker (DIN type) complete with all accessories to accommodate on/in prefabricated MS surface /MS cubical control panel board including drilling holes, connections etc as required				
	20A, 415V	each	1		
3.2.2	Installation, testing and commissioning of SPN/DP miniature circuit breaker DIN type complete with all accessories to accommodate on/in prefabricated MS surface /MS cubical control panel board including drilling holes, connections etc as required				
	6/10/16/20A	each	1		
	Installation, testing and commissioning of SPN/DP miniature circuit breaker/ isolator DIN type complete with all accessories to accommodate on/in prefabricated MS surface /MS cubical control panel board including drilling holes, connections etc as required				
	50/63A	each	4		
	Moulded Case Circuit Breaker (MCCB)				
	Installation, testing and commissioning of four pole moulded case circuit breaker (DIN type) breaking capacity 16/25/36K/earth leakage module complete with all accessories to accommodate on/in prefabricated MS surface /MS cubical control panel board including drilling holes, connections etc as required				
	100A, 415V	each	1		
3.3	NISION*				



, 	Installation. testing and commissioning of DP		, I			
ļ	timer switch assembly in a case complete with		1			
ļ	all accessories to accommodate on/in		1			
I	prefabricaetd MS surface/MS cubical control		1			
, I	panel board recessed including drilling holes,		1			
3.3.1	connections etc as required		·'	<u> </u>	ļ	
	Adjustment range either 24/24hrs or		í 1			
<u>-</u>	//days/24hrs	eacm		 	 	
4	Metal Panel Board		<u>'</u>		<u> </u>	(
ļļ	Switch Fuse Units	↓	·'		<u> </u>	I
	Installation, testing and commissioning of		1			
. I	TPN/four pole steel encloser/panel mounting		1			
I	front drive switch ruse unit complete with an		1			
I	prefabricated MS surface /MS cubical control		1			
. I	panel board including drilling holes,		1			
ا <u> ا</u>	connections etc as required		ı'			I
I	125A 415V	each	1 1	<u> </u>	 	1
	Providing & fixing of prefabricated panel	+	, ,	1	+	+
	board with minimum 50x50x6mm angle iron		1			
	frame work with horizontal and vertical		1			
	intermidiate members of flat iron 40x6mm		1			
	and 24 SWG sheet cover for mountingof		1			
	switch gears incoming/ outgoing bus bars		1			
	including drilling holes, insulator, painting,		1			
4.1	denting, grouting etc. as required	++	·'		<u> </u>	
	Floor mounted cubical control panel board of welded construction		1 1			
++	Providing and fixing medium volt danger	+	 	<u> </u>	+	+ 1
	notice plate made of mild steel and painted		1			
	with vitreous enamelled white paint on both		1			
	sides, and with inscription in signal red colour		1			
	on front side as required on prefabricated MS		1			
	surface/ MS cubical control panel board on		1			
	surface including drilling noies etc. as		1			
	, lequited ,	++	·'		+	
!	200x150x2mm	each	3			
5	EARTHING		· '			
5.1	Earthing & Loop Earthing		'			
I	Providing and fixing of earthing including all	I	ı '			
	accessories, machinery enclosure, C.I cover		1			
	plate having locking arrangement, watering		1			
	pipe with excavation and refilling work		1			
	including charcoal or coke and salt complete		1			
5.1.1	as required as per standard earning drawing	+	·'		<u> </u>	!
	With copper earth plate 600x600x3mm	each	1 <u>1</u>			
ı	Providing and laying earth connection from		·,			
	earth electrodes in 15mm dia G.I pipe from		1			
	earth electrodes as required as per guidence of		1			
5.2	standard earthing drawing	↓ !	·'	_	<u> </u>	
	With 4,06mm dia (8SWG) copper wire	m	20			
6	POWER CABLE (Supply)	[I	'		Γ	
1543	(S) (S) (S) (S)	_				



	Supplying of 2- Core 1.1KV grade PVC insulated and sheathed Copper conductor armoured power <u>cables</u>				
	16 sq.mm	m	75	 	T
	Supplying of 3- Core 1.1KV grade PVC insulated and sheathed Copper conductor armoured power cables				
	25 sq.mm	m	45	 	
6.1	Power Cables (1.1kV) 2- Core Copper- Armoured, PVC insulated & sheathed			 	
	6 sq.mm	m	170	 	
7	cable end termination at the terminal block with copper thimble/lugs including supply of flat type copper thimble suitable for 10/25 sqmm cable size installation, testing and commissioning complete as required but without compression gland,(Note: for more than two way distribution, double terminals including thimbles/lugs to be provided	each	36		
8	POWER CABLE LAYING	T I		_	
8.1	Laying of one number PVC insulated and sheathed power cable copper/aluminium,armoured/un-armoured 1.1KV single core to four core direct in the ground including excavation, sand cushing, protective covering and refilling the trenches etc. as required.(Note: refer the detail drawing)				
	Above 6sq.mm to 25sq.mm	m	215		
9	Rou <u>te Marker</u>			 	
9.1	Providing and making route marker of size 600x600mm at bottom and 500x500mm at top with a thickness of 100mm including inscreption as required				
	With cement concrete 1:2:4, 20mm stone	each	61		
10.3	Supplying of junction box fabricated with 14SWG MS sheet, removal cover plate with gasket for dust and vermine proof, 2 earthing terminals with nut, bolts and spring washer, 2 entry holes 16mm dia at bottom, 32mm dia for cable entry at back , including 4 way terminal block & HRC fuse unit with fuse of 6A with locking arrangement and finish coat painting complete with all accessories as required as per standard drawing	Cach	01		
	MS junction box out door duty	each	40		
11	Providing & applying 2(Two) coats of aluminium paints on existing streetlight pole and new arm bracket including red oxide priming.	each	60		
	Providing & laying H.D.P.E pipes, pressure class 10kg sq m including H D P E fittings				
	for laying cables from the base of the pole up		• •		

15	PVC insulated Single Core Copper conductor (1.1KV) 2.5 sq.mm	m	1071		
16.1	Earth Work				
16.1.1	Hand excavation and refilling in layers < 200mm, of trenches for pipes & sockets, cables, including dressing of sides/ ramming of bottom, depth upto 1.5m, disposal of surplus material within lead of 50m: Ordinary Soil				4
	Pipes, cables etc. 80mm to 300mm dia	m	80		
	Total Amount in Nu.				



Drawing attached as Annexure I



-4



DETAIL DRAWING

PROJECT : MAJOR RENOVATION OF STREET LIGHT AT BJEMINA INDUSTRIAL ESTATE, THIMPHU.

FUNDING AGANCY:RGOB

TYPE OF WORK : LIMITED BIDDING

CLIENT : ESTATE MANAGER, BJEMINA INDUSTRIAL ESTATE, IIDD, DoI, MoEA, THIMPHU.











TECHNICAL SPECIFICATIONS (Annexure I)

ABBREVIATIONS

The following abbreviations are used in the Technical Specifications.

AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ACV	Aggregate Crushing Value
AIV	Aggregate Impact Value
ALD	Average Least Dimension
ASTM	American Society of Testing and Materials
BOQ	Bill of Quantities
BS	British Standards
BSR	Bhutan Schedule of Rates
CBR	California Bearing Ratio
c/c	center to center
Cu.m	Cubic metre
CR	Crushing Ratio
DCP	Dynamic Cone Penetrometer
DoFS	Department of Forestry Services
DoR	Department of Roads
DGM	Department of Geology and Mines
Dia	diameter
ECOP	Environment Code of Practice for Highways and Roads
EMP	Environmental Management Plan
FI	Flakiness Index
GCC	General Conditions of Contract
HMAC	Hot mix asphalt concrete
IRC	Indian Road Congress (i.e. Recommended Code of Practice by IRC)
IS	Indian Standards
ISO	International Organization for Standardization
LAA	Los Angeles Abrasion Value
LS	Linear Shrinkage
MC	Moisture Content
MDD	Maximum Dry Density
min	minute
NEC	National Environment Commission
No	Number (units), as in 6 no.
No	Number (order) as in No 6
OMC	Optimum Moisture Content
OPC	Ordinary Portland Cement
PCC	Particular Conditions of Contract
PI	Plasticity Index
PL	Plastic Limit
PM	Plasticity Modulus (PI x % passing 0.425 mm sieve)
QA	Quality Assurance
PS	Provisional Sum
QC	Quality Control
RGoB	Royal Government of Bhutan
RROW	Road Right of Way
SE	Sand Equivalent
sec	second
SG	Specific Gravity
SI	International Standard Units of Measurements
SSS	Sodium Sulphate Soundness test, loss on 5 cycles
STV	Standard Tar Viscosity
Sq.m	Square metre
UC	Uniformity Coefficient
UCS	Unconfined Compressive Strength
VIM	Voids in Mix
w/c	Water cement ratio
Wt	Weight
%	Percent

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101 GENERAL

The Technical Specifications and Bill of Quantities shall be read in conjunction with all other Contract Documents. All the documents and drawings are to be regarded as mutually explanatory. In the event of any discrepancy or assumed discrepancy being found between them, the Contractor shall immediately inform the Engineer of the matter in writing and the Engineer will issue his instructions in the matter in accordance with the Conditions of Contract including the Environmental Codes of Practice for Highways and Roads and other relevant references/codes.

The terminology "Engineer" in these Technical Specifications shall be read or understood as the Supervising Engineer/Consultant appointed by the Client according to the General and Particular Conditions of the Contract (i.e. GCC and PCC).

The Sections, Clauses and/or Sub-clauses mentioned in these Specifications deem to apply those of these Specifications only, if otherwise not specified. The Specifications or Technical Specifications shall denote the same meaning of the specifications.

102 PROGRAM OF WORKS

As soon as possible after the letter of acceptance and before signing of the Contract Agreement, the Contractor shall submit in triplicate the Program and particulars required under Clause 8 of the General Conditions of Contract. The Contractor shall provide all information needed for fulfilment of the Program and required in accordance with the Conditions of Contract including the sequence in which the Contractor intends to work including implementation of quality assurance plan. In the Program and particulars the Contractor shall provide details of how the Contractor proposes to carry out the Works including:

- (1) The Program for the construction and completion of the works shall be established using CPM/PERT techniques or equivalent. The Program shall be detailed enough to give, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of materials, procurement/rental/leasing of equipment, progress milestones, fabrication of special products/equipments if any and their installation and testing, and for all activities of the Engineer that are likely to affect the progress of work. It shall be prepared so as to permit revisions, inclusion of additional detail and regular updates as the work progress. The Program shall also include the Contractor's general requirements for any road closures pursuant to Clause 105 of the Technical Specifications to be agreed in principle with the Engineer. Such agreement shall not relieve the Contractor of his responsibility to obtain specific approval for each closure or series of closures. In all respects the Contractor shall pay particular attention to seasonal weather pattern including rainfall and snow conditions (if any), and the construction sequencing while preparing the Program.
- (2) A detailed Statement of Construction Management Procedures the Contractor proposes to adopt.

Once approved by the Engineer the Program and Statement of Construction Management Procedures shall be incorporated into the Contract Agreement and shall be strictly adhered to unless any alterations are found to be necessary during the construction of the Works and are confirmed in writing by the Engineer. If the Contractor requests a change in the sequence and such change is approved by the Engineer, the Contractor shall have no claim as per the Conditions of Contract for delay arising from such revisions to the Program.

The Contractor shall update all activities in accordance with the Conditions of Contract on the basis of the decision taken at the periodic site review meetings or as directed by the Engineer.

The Contractor shall furnish, at least 14 days in advance, his site work program of commencement of item of work, the method of working he intends to adopt for various items of work such as site clearance, construction for embankment, sub-base, base, surfacing, culverts, retaining walls, and such other items for which the Engineer demands the submission of the method of working. The Contractor shall provide information regarding the details of the method of working and equipment he proposes to employ and satisfy the Engineer about the adequacy and safety of the same. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will, however, rest on the Contractor, irrespective of any approval given by the Engineer.

103 INSURANCE

The Contractor shall provide and maintain the insurance cover in accordance with Clause 18 of the General Conditions of Contract from an approved insurance company from the start date to the end of the Defects Liability Period.

Measurement and Payment

Payment for insurance cover shall be made at actual cost for insurance assessed by the insurance company and it shall be the full and the final compensation to the Contractor.

104 SUBMITALS

1 General Requirements

The Contractor shall maintain an approved system of recording and tracking submissions indicating dates, status (i.e. approved, not approved, approved subject to conditions), quantities, and other details as required.

Copies of all approved submissions will be retained securely and properly filed on site, available for reference by the Engineer at any time.

2 Contractor's Monthly Progress Report

The Contractor shall report monthly progress report to the Engineer submitted in triplicate and showing actual work done superimposed upon copies of the program. He shall furnish an explanation of any deviation from the Program stating his proposals for improving progress should this be lacking in any respect and he shall furnish the Engineer with his amended critical path analysis in triplicate. The Contractor shall comply with the reporting requirements on implementation of Environmental Management Plan in the monthly report following the guidelines provided by the Engineer.

The contractor shall submit monthly Laboratory/Field test report including cumulative number of test done in the prescribed format. If required, the Engineer shall ask the contractor to submit quarterly Fund Projection Statement.

3 Samples

The Engineer may at his discretion request or take samples of any material or product intended for use in the Works. Where samples are requested in the Specifications they shall be submitted in the number requested or as directed by the Engineer.

Samples shall be of the type and size specified and fully representative of the materials proposed to be used. Samples shall be indelibly and clearly marked with the date of submission, material reference and any other data required to determine the source and kind of sample. One or more samples of each kind submitted will either be returned marked "ACCEPTED" and signed by a representative of the Engineer or the Contractor will be requested to provide new samples and be notified of deficiencies present in the submitted samples.

One or more "accepted" samples will be retained by the Engineer for comparison with materials and workmanship supplied and will form the standard of acceptance. One or more "accepted" samples shall be retained at the Contractor's site office and be available for reference on request.

The Engineer may reject any materials and goods which in his opinion are inferior to the samples thereof previously approved and the Contractor shall promptly remove such materials and goods from the Site.

4 Copies of Orders

The Contractor shall provide the Engineer with one copy of all orders for the supply of materials and goods required in connection with the Works as the Engineer may require.

5 Site Trials

Site trials of pavement and other similar works as specified shall be prepared by the Contractor for review and acceptance of the Engineer. They shall be in a location agreed with the Engineer, and if so specified may be incorporated into the work in a clearly identified position upon approval of the Engineer. The Contractor shall carry out such changes or carry out field trials as required to obtain the Engineer's approval. Approved field trials shall form the standard of acceptance of subsequent materials and workmanship.

6 Construction Drawings

- a) The Contractor shall prepare and submit construction drawings for details of construction work, temporary or permanent works, if required under the contract.
- b) The construction drawings shall show at a suitable scale all the particulars of the work including dimension, materials, finishes, lines, levels, tolerances and other details to show compliance with the specification, the suitability of item for its compliance.
- c) The Engineer and his representatives will review the drawings only for their general compliance with the intent of the drawings and specifications. Responsibility for accuracy of dimensions, technical design, performance and suitability for intended purpose of the items shall remain with the Contractor.
- d) Four (4) copies of each construction drawing shall be submitted in sufficient time to allow for review, possible revisions and resubmission for approval prior to ordering materials, coordinating all affected and contingent work without delay to the schedule of construction.
- e) Two copies of all construction drawings will be retained by the Engineer. The remaining copies will be returned to the Contractor signed by a representative of the Engineer and marked "REVIEWED" with either:
 - a request for resubmission and notes as to deficiencies;
 - a note indicating the drawing has been reviewed but is subject to conditions noted or listed, and does not require resubmission; or
 - a note indicating the drawing has been reviewed and is considered to meet the intent of the design and does not require resubmission.
- f) The drawings shall be submitted at least two weeks before the commencement of construction of work for which these drawings are intended.
- g) Construction should not commence until the drawings have been reviewed and are returned under the Conditions of Contract except where instructed by the Engineer.
- h) The materials or products should not be ordered until drawings have been reviewed and are returned under Conditions of Contract except when instructed by the Engineer.

7 As Built Drawings

At least one month prior to the end of the Defects Liability Period, the Contractor shall submit As Built Drawings based on Mylar print. It is advisable that the Contractor prepares the as-built drawings as the work is completed at the site to facilitate checking and verification. The following requirements will apply:

- (a) The drawings shall be prepared in latest version of AUTOCAD.
- (b) The drawings shall include all available information on existing conditions as well as new construction.
- (c) Site drawings shall include all the items as in the original drawings.
- (d) The drawings shall include the road plan and profiles at the locations of geometry improvement; updated road inventory plan showing details of major improvement, rehabilitation etc including

schematic road strip with details of pavement strengthening measures (overlay, reconstruction, rehabilitation, resurfacing) including pre-treatment works and side drains, shoulders improvement; road cross-sections at 25 meters intervals with finished levels, walls, drains, shoulders and other structures; details of slope stabilization, drainage, road retention works, road safety measures, etc.

- (e) Drawings shall be at a scale suitable for easy reference and as required to clearly depict all required information as directed by the Engineer.
- (f) The Contractor shall conduct such on-site checks as required to ensure the accuracy of the as-built drawings.
- (g) One original and four copies of drawings shall be submitted in bound sets sub-divided by discipline. Copyright of all materials submitted will remain with the Employer without further compensation or charge.

Measurement and Payment

No separate measurement and payment shall be made for above items under Clause 104 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included with other related items of the work in the Bill of Quantities.

105 ACCOMMODATION OF TRAFFIC

(1) Scope

This Clause covers the construction and maintenance of the necessary detours and diversions, barricades and signs, and everything necessary for the safe and easy passage of all public traffic during the construction period and also the removal of diversions as they become redundant including restoration of the area into its original condition. The Contractor shall take necessary safety procedures regarding traffic diversion or temporary road closures that are needed in execution of the works in accordance with the Specific Provisions of the Particular Conditions of Contract (PCC). The Contractor shall take precaution regarding safety at road works. The Contractor shall strictly adhere to the prevailing safety standards, guidelines or as instructed by the Engineer.

(2) General Requirements

The Contractor shall at all time carry out works on the road in a manner creating least interference to the flow of traffic. For all works involving improvements of the existing road, the Contractor shall provide and maintain a passage for traffic either along a part of the existing carriageway under improvement, or along a temporary diversion constructed close to the road. The Contractor shall take prior approval of the Engineer regarding traffic arrangements during construction.

The Contractor may be allowed to stop traffic temporarily. The period of such closure shall be as agreed by the Engineer. For this the Contractor shall submit the time and period of the closure to the Engineer at least 14 days in advance, to enable the Engineer to issue the relevant notices.

106 MAINTENANCE OF SERVICES

If any government, publicly and privately owned service for drinking water, electricity, drainage, irrigation channels, sewers, telecommunication cables/lines and other services and structures, passing through the site is affected by the works, the Contractor shall provide a satisfactory alternative service in full working order to the satisfaction of the owner of the services and of the Engineer before terminating the existing service.

Drawings and scheduling the affected services like water pipes, sewers, cables, etc. owned by various authorities including government and public undertakings and local authorities shall be verified by the Contractor for the accuracy of the information prior to the commencement of any work.

The Contractor must also allow for any effect of these services and alternations upon the works and for arranging regular meetings with the various bodies at the commencement of the contract and throughout the period of the works in order to maintain the required co-ordination.

No clearance or alterations to the utility shall be carried out unless ordered by the Engineer.

Any services affected by the works shall be restored immediately by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the works.

The Contractor may be required to carry out the permanent removal or shifting or diversion of certain services/utilities on specific orders from the Engineer for which payment shall be made to him. Such works shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.

Measurement and Payment

No separate measurement and payment shall be made for the work of temporarily supporting; maintaining and protecting the government, publicly and privately owned services. All costs in connection with the work specified herein shall be considered to be included with other related items of the work in the Bill of Quantities.

The measurement and payment shall be made for the work carried out under Sub-Clause 106(6) of the Technical Specifications. Payment shall be made at the actual cost plus ten percent extra to this as the Contractor's overhead and profit in accordance with Clause 36, Special Provisions of the Particular Conditions of Contract.

107 SURVEY AND SETTING OUT

During the period of Commencement of works the Contractor shall resurvey the Base Lines, Traverse Points, Bench Marks and confirm the co-ordinates and levels of the stations. He shall immediately notify the Engineer of any discrepancies and shall agree with the Engineer any amended values to be used during the contract, including replacements for any stations missing from the original stations.

The Contractor shall check, replace and supplement as necessary the station points, location of batter pegs(only if required) and agree any revised or additional station details with the Engineer.

All stations and reference points shall be clearly marked and protected to the satisfaction of the Engineer.

Where a survey station point is likely to be disturbed during construction operations, the Contractor shall establish suitable reference stations at locations where they will not be disturbed during construction. No old station shall be covered, disturbed or destroyed until accurate reference stations have been established and details of such stations have been approved by the Engineer.

The Contractor shall establish working Bench Marks tied with reference stations soon after taking possession of the site. The coordinates and the elevations of the reference stations shall be obtained from the Engineer. The working Bench Marks shall be at the rate of four per kilometer and also near all major/medium structure sites. Regular checking of these Bench Marks shall be made and adjustments, if any, got agreed with the Engineer and recorded.

The Contractor shall be responsible for the accurate establishment of the center lines based on the Drawing and data supplied. The center lines shall be accurately referenced in a manner satisfactory to the Engineer. The reference points shall be established at every 25 m interval or as instructed by the Engineer, with marker pegs or/and chainage boards set in the right of way. A schedule of reference dimensions shall be prepared and supplied by the Contractor to the Engineer.

The existing profile and cross-sections shall be taken jointly by the Engineer and the Contractor. These shall form the basis for the measurements and payments. If in the opinion of the Engineer, design modifications of

the center lines and/or grade are advisable, the Engineer shall issue detailed instructions to the Contractor and the Contractor shall perform modifications in the field, as required, and modify the levels on the crosssections accordingly.

Accurate control of lines and levels shall be provided by the Contractor at all stages of the construction. In respect of road, control shall be at least 10 m interval or such interval as may be directed by the Engineer. The lines and levels of formation, side slope, drainage works, etc. shall be carefully set out and frequently checked. Care shall be taken to ensure that correct gradients and cross-sections are obtained everywhere. Wherever necessary, but particularly on completion of subgrade, subbase and base, the Contractor shall re-establish center line pegs at sufficiently close intervals to determine the edges of base and surfacing accurately.

The Contractor shall provide the Engineer with all necessary assistance for checking the setting out, agreement of levels and any other survey or measurement which the Engineer needs to carry out in connection with the contract during the entire period of contract. Such assistance shall include:

- (a) provision of manpower like assistants, prism men, labours to work under the direction of the Engineer as required.
- (b) provision of all necessary logistical support like hand tools, pegs and materials.
- (c) provision of survey equipment (total station, distomat) as required by the Engineer for survey works.

Measurement and Payment

No separate measurement and/or payment shall be made for the work required under Clause 107 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included in the related items of the work specified in the Bill of Quantities.

108 ACCESS TO ABUTTING PROPERTIES

For the duration of the works the Contractor shall at all times provide convenient access to paths, steps, bridges or driveways for all entrances to property abutting the site and maintain them clean, tidy, and free from mud or objectionable matter.

Measurement and Payment

No separate measurement and/or payment shall be made for the work required under Clause 108 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included in the related items of the work specified in the Bill of Quantities.

109 NOTICE BOARD

The Contractor shall erect and maintain notice boards (2m×1.2m) at each end of the site giving details of the contract in the format and wording as directed by the Engineer. These boards shall be erected within 14 days after the Contractor has been given the Possession of Site.

The Contractor shall not erect any advertisement sign board on or along the work without the written approval of the Employer.

All sign boards shall be removed by the Contractor by the end of the Defects Liability Period.

Measurement and Payment

No separate measurement and/or payment shall be made for the work required under Clause 109 of the Technical Specifications. All costs in connection with the work specified herein shall be considered included in the related items of the work specified in the Bill of Quantities.

111 ENVIRONMENT PROTECTION WORKS

The environment has been defined to mean surrounding area including human and natural resources to be affected by execution and after completion of works.

The Contractor shall take all precautions for safeguarding the environment during the execution of the contract. He shall abide by all prevailing laws, rules and regulations governing environmental protection. In particular, the Contractor shall fully comply with the Environmental Codes of Practice for Highways and Roads. The Contractor shall follow the requirements specified in the Environmental Management Plan for the environmental protection and management of the works under the contract. The Contractor shall be responsible for implementation of Environmental Management Plan (EMP) and compliance. As part of this, the Contractor shall follow the guidelines and submit the required information on monthly basis for monitoring of the EMP implementation by the Engineer. The Contractor at all time shall ensure that requirements of EMP are fulfilled.

The Contractor shall prohibit his/her employees from unauthorized handling/use of explosives, poaching wildlife, fishing and cutting trees. Where possible the workers must be provided with kerosene for cooking. Where it is not possible to get kerosene firewood must be provided by purchasing it through the local firewood contractor. Where there is no local firewood contractor, proper forestry permits must be obtained for collection of firewood. The Contractor shall be responsible for the action of his/her employees.

Environmental protection works, among others, shall also include the following:

(1) Provision and Maintenance of Camps, Offices, Stores, Equipment Yards and Workshops

Various works defined under this item are related to provision and maintenance of camps for workmen and employees, Contractor's site offices, stores, equipment yards and workshops. These camps must be adequate, rain-proof, spacious, airy and hygienic with proper lighting and materials storage facilities. The area shall be kept neat and clean.

Space allocated for storage of materials such as cement, gabion wire, reinforcing wire etc. shall in general be damp-free, rain-proof and away from petroleum products storage.

Permission may be granted by the Engineer to erect temporary suitable camps within the right of way free of charge, if such establishments do not cause obstructions to traffic, nuisance to works execution and adverse effect to the environment. Camps must be located in stable areas where there are no possibilities of landslides or erosion. To prevent disturbance to nearby communities the labor camps must be located at least 500 m away from the nearest settlement.

Prior approval in writing must be obtained from the Engineer for proper establishment and maintenance of such camps. Failure to compliance with the Engineer's instruction in respect of overall standard will lead to reduction or withholding of any payment to the Contractor.

The Contractor shall ensure that proper drinking water, waste disposal and toilet facilities are provided to the camps. This arrangement shall be enforced to avoid proliferation and generation of various water borne diseases. The Contractor shall inform the Engineer regarding sources, installation and supply of potable water within a week after the supply is commenced.

Provision of toilets for labour and employees shall be made to avoid public nuisance as well as pollution of water courses and air. Toilets shall not be located near streams or rivers. The Contractor shall construct suitable septic tanks and/or soak pits. Sufficient water must be provided and maintained in the toilets. Proper methods of sanitation and hygiene should be employed during the whole project duration. The contractor shall provide waste disposal facilities such as dustbins and waste disposal pits.

A first aid kit along with proper medical supplies must be made available in the camps for treating injuries or common health problems. Services shall also include on-the-way service and other arrangements required for taking them to the nearest hospital in case of emergency. If imported laborers are required for construction, proper medical tests of the laborers shall be carried out to prevent the spread of diseases such as STD and HIV/AIDS amongst the communities near the construction sites. Arrangement should be made for the services of at least one part-time experienced health worker/health assistant with a minimum of once

a week full time site visit. The Contractor shall also supply and provide adequate medicines and facilities required for standard first aid. The Contractor shall inform the Engineer regarding the medical facility within a week after its establishment and operation.

All workers shall be provided with adequate safety gears such as gumboots, gloves, face masks, ear plugs, helmets, safety jackets and safety belts to prevent injuries and health hazards.

During shifting of the camp all trash and unwanted material must be burnt or disposed off properly. Pit latrines must be adequately covered. Areas without any vegetation must be re-vegetated by carrying out appropriate bioengineering works.

(2) Site Clearance and Removal of Top Soil

Loss of trees and vegetative cover is a permanent impact that cannot be avoided. However, the Contractor shall take all measures to minimize removal of vegetation and remove only what is necessary. During clearing activities the Contractor shall make efforts not to disturb or destroy the vegetation outside the construction corridor. Proper clearing and grubbing procedures shall be followed in accordance with the Technical Specifications. The contractor shall store top soil of the cleared area and reused for carrying out bioengineering activities, as appropriate.

(3) Borrow/Quarry Sites

The contractor shall use approved borrow/quarry sites in the construction works. The Contractor shall abide by the rules and regulations of the governing bodies while operating, using river sand and rock quarries for the construction materials. All new rock quarry sites must be located in stable areas that are away from rivers, streams, settlements, drinking water intakes, cultivable lands and drainage systems.

The Contractor shall obtain the prior approval of the concerned authorities and permission of the Engineer before opening any borrow pits or quarries. Such borrow pits and quarries may be prohibited or restricted in dimensions and depth by the Engineer where they might:

- (i) affect the stability or safety of the works or adjacent property;
- (ii) Interfere with natural or artificial drainage or irrigation;
- (iii) be environmentally unsuitable.

The Contractor shall not purchase or receive any borrow materials from private individuals unless the source of such materials has been approved by the Engineer.

After completion of quarry operations the contractor shall restore the site properly. Where necessary the quarry site shall be restored immediately after completion of construction works. Restoration will include spreading of top soil and carrying out bioengineering works as per the instruction of the Engineer.

The Engineer shall have the power to disallow the method of construction and/or the use of any borrow/quarry area, if in his opinion, the stability and safety of the works or any adjacent structure is endangered, or there is undue interference with the natural or artificial drainage, or the method or use of the area will promote undue erosion.

All areas susceptible to erosion shall be protected as soon as possible either by temporary or permanent drainage works. All necessary measures shall be taken to prevent concentration of surface water and to avoid erosion and scouring of slopes and other areas. Any newly formed channels shall be backfilled.

The cutting of trees shall be avoided or if necessary shall be carried out only after obtaining approval of the Department of Forests & Park Services. Temporary ditches and/or settling basins shall be dug to prevent erosion. The undesirable ponding of water shall be prevented through temporary drains discharging to natural drainage channels.

Earthwork operations shall be strictly limited to the areas to be occupied by the permanent works and approved borrow areas and quarries unless otherwise permitted by the Engineer. Due provision shall be made for temporary drainage. Erosion and/or instability and/or sediment deposition arising from earthwork operations not in accordance with the Technical Specifications shall be made good immediately by the Contractor.

At least 14 days before the Contractor intends to commence opening up any approved borrow pit or quarry, the Contractor shall submit to the Engineer the intended method of working and restoration. These shall include but not be limited to:

- (i) the location, design and method of construction of any access track;
- (ii) the volume and nature of materials to be removed;
- (iii) the sequence and method of excavation of materials;
- (iv) measures for controlling runoff and sediment from the site during operations;
- (v) proposals for site restoration including approximate finished levels, drainage, erosion and sediment control, slope stabilization and re-vegetation, including reinstatement of any access track.

Operation of borrow pit or borrow area shall not be permitted until the method of working for that particular pit or area has been approved by the Engineer in writing. Restoration shall be to the satisfaction of the Engineer.

(4) Disposal of Spoil and Construction Waste

Materials in excess of the requirements for permanent works and unsuitable materials shall be disposed off in locations and in the manner as agreed with the Engineer. The locations of disposal sites shall be such as not to promote instability, destruction of properties and public service systems. Exposed areas of such disposal sites shall be suitably dressed and be planted with suitable vegetation. The top soil of the tipping sites must be stored and reused for restoring the tipping site and carrying out bioengineering works. Provisions shall be made to facilitate proper drainage around the site.

(5) Crushing Plants

Crushing plants shall be located away from communities and water sources. Suitable dust control device shall be fitted to the crusher to control emission of dust from the plant. The plants shall be operated only during the day time to minimize disturbance to nearby communities and wildlife. Water shall be sprinkled on the crushing plant and surrounding areas to minimize dust. At the same time appropriate drainage measures shall be constructed to drain out excess water from the site in order to keep the area dry.

(6) Hot Mix Plants and Batching Plants

Hot-mix plants and batching plants shall be located away from the population centers. The Contractor shall take every precaution to reduce levels of noise, vibration, dust and emission from the plants. No bituminous material shall be discharged into drains. Nearby trees, vegetation and property shall be protected during spraying of bitumen.

(7) Use of Bitumen including Heating and Storage of Bitumen

Heating of the bitumen will be necessary for use in pavement works. The bitumen will be heated using firewood or kerosene. Where it is necessary to heat the bitumen using firewood, the Contractor shall obtain firewood through local firewood contractor. In locations where there is no local firewood contractor the Contractor shall obtain forestry permits from the local territorial Forestry authorities for collecting firewood from the nearby forests. During application of bitumen improper storage of the bitumen barrels and bleeding of the bitumen shall be avoided to prevent scarring and loss of aesthetic of the landscape.

(8) Hazardous Materials

The Contractor shall not store hazardous materials near water surfaces. The Contractor shall provide protective clothing or appliances when it is necessary to use some hazardous substances. High concentration of airborne dust resulting in deposition and damage to crops and water resources shall be avoided. The Contractor shall take every precaution to control excessive noise resulting in disruption to wildlife and human population. Only controlled blasting methods shall be applied in construction works as per the Technical Specifications.

(9) Operation of Vehicles, Machinery and Equipment

The contractor shall regularly maintain all vehicles, machinery and equipment in order to minimize exhaust pollution. Oil and lubricants must be stored properly to prevent any spills and leakage and pollution of the surrounding soil as well as water bodies.

(10) Reinstatement of Environment

The Contractor shall arrange and execute works as well as related activities in such a way that environmental conditions are reinstated. The Contractor shall be required to carry out filling, removal and disposal works along with plantation of grass and trees as directed by the Engineer at his own costs at identified locations to reinstate environment.

Written instruction/approval shall be given by/sought from the Engineer regarding reinstatement of environment both during and after completion of works and up to the end of Defects Liability Period.

Measurement and Payment

No separate measurement and payment shall be made for the works described in this Clause. All costs in connection with the work specified herein shall be considered included in the related items of the work specified in the Bill of Quantities.

112 **PHOTOGRAPHS**

The Contractor shall undertake, maintain and provide photographic records of the existing condition and work progress. A complete photographic record of existing site conditions shall be undertaken by the Contractor before commencing any work on site. The record shall include existing pavement, drainage, structures and site areas affected by the work in sufficient detail to clearly portray all existing conditions of structures, finished surfaces. No work shall be undertaken prior to receiving approval at any work site. The Contractor shall supply photographs, of such portions of the works in progress and completed, as may be directed by the Engineer. The negatives and prints shall not be retouched. The negative of each photograph shall be the property of the Employer and shall be delivered to the Engineer with prints. No prints from these negatives shall be supplied to anyone without the written permission of the Engineer.

The submission of photographs shall be as follows:

- progress photographs (each of them shall have 6 color prints without mounting in 150x100 mm size (a) and the negative supplied within first week of each month)
- (b) record photographs (each of them shall have 4 color prints in 150x100 mm without mounting and the negative supplied within first week of each month)

The Contractor shall supply four prints of each of the photograph which shall be taken at locations and times determined by the Engineer.

Both categories of photographs shall be properly referenced to the approval of the Engineer and on the back of each print shall be recorded the date of the photograph and the direction in which the camera was facing, and identifying description of the subject, and the reference.

Photographs taken for the record purposes as instructed by the Engineer shall have on the reverse of one print the signature of the Contractor and the Engineer's Representative for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.

Measurement and Payment

No separate measurement and payment shall be made for the works described in this Clause. All costs in connection with the work specified herein shall be considered included in the related items of the work specified in the Bill of Quantities.

113 AUDIO-VISUAL DOCUMENTATION

The work consists of taking video film of important activities of the work as directed by the Engineer during the execution of the contract and editing them to a video film of playing time 60 minutes as directed by the Engineer. It shall contain narration of activities in English and Dzongkha by a competent narrator. The edition of the video film and the script shall be approved by the Engineer. The video cassettes shall be of acceptable quality and the film shall be capable of producing colour pictures.

Measurement and Payment

No separate measurement and payment shall be made for the works described in this Clause. All costs in connection with the work specified herein shall be considered included in the related items of the work specified in the Bill of Quantities.

114 CONSTRUCTION EQUIPMENT

In addition to the conditions of the contract, the following conditions regarding use of equipment in the Works shall be complied by the Contractor:

- a) The Contractor shall be required to give a trial run of the equipment for establishing their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Engineer before commencement of the work;
- b) All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Engineer;
- c) All the plant/equipment to be deployed on the works shall be approved by the Engineer for ensuring their fitness efficiency before commencement of work;
- d) Any equipment not meeting the approval of the Engineer shall be removed from the site;
- e) No equipment will be removed from site without permission of the Engineer; and
- f) The Contractor shall promptly make available the equipment at site for quality control of works as directed by the Engineer.

No extra payment shall be made to the Contractor for fulfilling the above conditions regarding the use of equipment in the Works.

115 SITE INFORMATION

The information about the scope of work and site conditions in the Bidding Documents is given in good faith for guidance only but the Contractor shall satisfy himself regarding all aspects of site conditions.

The location of the works and the general site particulars are as generally shown on the Site plan/index plan enclosed with the Bidding Documents.

Whereas the Right-of-Way to the bridge sites/road works shall be provided to the Contractor by the Employer, the Contractor shall have to make his own arrangement for the land required by him for site offices, labour camps, stores, etc.

It is assumed that the Contractor has fully inspected the site, location of quarries; borrow areas etc., before quoting his rates for the work to assess the availability of construction materials in required quantity and quality.

116 NOTES ABOUT MEASUREMENT AND PAYMENT

(1) GENERAL RULES FOR THE MEASUREMENT OF WORKS FOR PAYMENT

1.1 General

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections read in conjunction with the General Conditions of Contract.

All measurements and computations, unless otherwise indicated, shall be carried out nearest to the following limits.

i	length and breadth	: 10 mm
ii	height, depth or thickness of earthwork, sub-grade, bases, surfacing and structural	: 5 mm
	members	
iii	areas	: 0.01 sq.m
iv	cubic contents	: 0.01cu.m

In recording dimensions of work, the sequence of length, width and height or depth or thickness shall be followed.

1.2 Measurement of Lead for Materials

Where lead is specified in the Contract for construction materials, the same shall be measured as described hereunder:

Lead shall be measured over the shortest practicable route and not the one actually taken and the decision of the Engineer in this regard shall be taken as final. Lead up to 50 m shall be deemed to be included into the respective items of works, hence shall not be paid separately. Measurements shall be carried out for different leads of beyond 50m to 500 m, beyond 500m to 1000 m, beyond 1000 m. The transported materials shall be measured in cu.m on the transporting truck just before unloading at the disposal site and the lead distance shall be measured from the point of loading to the point of disposal/unloading.

1.3 Measurement of Pavement Thickness for Payment on Volume Basis

The finished thickness of sub-base and base shall be measured on volume basis while the wearing course shall be measured in area which shall be computed in the following manner:

Levels shall be taken before and after construction, at grid of points 10 m centre to centre longitudinally in straight reaches but 5 m at curves. The levels shall be taken at positions transversely, as specified by the Engineer.

Suitable references for the transverse grid lines should be left in the form of embedded monument on either ends or by other means so that it is possible to locate the grid points for level measurements after each successive course is laid.

For pavement courses laid only over widening portions, at least one line of levels shall be taken on each strip of widening, or more depending on the width or widening as decided by the Engineer.

Notwithstanding the above, the measurements may be taken at closer intervals also, if so desired by the Engineer, the need for which may arise particularly in the case of estimation of the volume of the material for profile corrective course (levelling course). The average thickness of the pavement course in any area shall be the arithmetic mean of the difference of levels before and after construction at all the grid points falling in the area, provided that the thickness of finished work shall be limited to those shown on the Drawings or approved by the Engineer in writing.

As supplement to level measurements, the Engineer shall have the option to take cores/make holes to check the depth of pavement construction. The holes made and the portions cut for taking cores shall be made good by the Contractor by laying fresh mix/material including compacting as required at no extra cost immediately after the measurements are recorded.

1.4 Checking of Pavement Thickness for Payment on Area Basis

Where payment for any bituminous course is to be made on area basis, the Engineer may have its thickness checked with the help of a suitable penetration gauge at regular intervals or other means as he may decide.

(2) SCOPE OF RATES FOR DIFFERENT ITEMS OF WORK

- 2.1 For item rate contracts, the contract unit rates for different items of works shall be paid in full for completing the work to the requirements of the Specifications including full compensation for all the operations detailed in the relevant sections for these specifications under "Rates". In the absence of any directions to the contrary, the rates are to be considered as the full inclusive rate for finished works covering all labour, materials, wastage, transportation, temporary work, plant, equipment, overhead charges and profit as well as the general liabilities, obligations, insurance and risks arising out of General Conditions of Contract.
- **2.2** The item rates quoted by the contractor shall, unless otherwise specified, also include compliance with the following:
 - (i) General works such as survey and setting out, clearance of site before setting out and clearance of works after completion;
 - (ii) A detailed Program for the construction and completion of the works (using CPM/PERT techniques or equivalent) giving, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipment and their installation and testing, and for all activities of the Employer that are likely to affect the progress of work, etc., including updating of all such activities on the basis of the decisions taken at the periodic site review meetings or as directed by the Engineer as per Clause 102 of the Technical Specifications.
 - (iii) Samples of various materials proposed to be used on the Work for conducting tests thereon as required as per the provisions of the Contract;
 - (iv) Design of mixes as per the relevant Clauses of the Specifications giving proportions of ingredients, sources of aggregates and binder along with accompanying trial mixes as per the relevant clauses of the Technical Specifications to be submitted to the Engineer for his approval before use on the Works.
 - (v) Detailed design calculation and drawings for all Temporary Works (such as formwork, staging, centring; specialised constructional handling and launching equipment and the like);
 - (vi) Detailed drawings for templates, support and end anchorage, bar bending and cutting schedules for reinforcement, material lists for fabrication of structural steel, etc.
 - (vii) Mill test reports for all mild and high tensile steel and cast steel as per the relevant provisions of the Specifications;
 - (viii) Testing of various finished items and materials including bitumen, cement, concrete, bearings as required under these Specifications and furnishing test reports/certificates;
 - (ix) Inspection Reports in respect of form work, staging, reinforcement, and other items of work as per the relevant Specifications;
 - Any other data which may be required as per these Specifications or the conditions of Contract or any other annexes/schedules forming part of the contract;
 - (xi) Any other items of works which is not specifically provided in the Bill of Quantities but which is necessary for complying with the provisions of the Contract;
 - (xii) All temporary works as per (v) above;
 - (xiii) Cost of in-built provisions for Quality Assurance;
 - (xiv) Cost of safeguarding/protection of the environment;
 - (xv) Cost of monthly progress reports, construction and as-built drawings and other submittals;
 - (xvi) Cost of accommodation of traffic;
 - (xvii) Cost of all taxes, duties and royalties;
 - (xviii) Cost of site commissioning
 - (xix) Cost of all operations like storing, erection, moving into final position, etc. necessary to complete and protect the work till handing over to the Employer; and
 - (xx) All incidental costs
- 2.3 Portions of road works beyond the limits of the contract and/or any other work might be constructed by the Employer through other contractors. Accordingly, other contractors employed by the Employer may be working in the vicinity of the Works being executed by the Contractor. The Contractor shall liaise with such contractors and carry out activities for the completion of work accordingly and no claim or compensation due to any reason whatsoever will be entertained on this

account. The Employer will be indemnified by the Contractor for any claims from other agencies on this account.

117 EQUIVALENCY OF STANDARDS

Wherever reference is made in these Specifications to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work to be performed or tested, the provisions of latest current edition or revision of relevant standards and codes in effect shall apply. Other authoritative standards which ensure a substantially equal or higher performance than the specified standards and codes shall be accepted subject to the Engineer's prior review and approval. Differences between the standards specified and the proposed alternative standards shall be fully described by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event that the Engineer determines that such proposed deviations do not ensure substantial performance, the Contractor shall comply with the standards and codes specified in the contract documents.

118 UNITS OF MEASUREMENT

Units of Measurement

The Symbols for units of measurement are used in these Specifications as they are given below.

hr	hour
μ	micron = m x 10 $^{-6}$
mm	millimetre
m	metre
km	kilometre
sq. mm or mm ²	square millimetre
sq. cm or cm ²	Square centimetre
sq.m or m ²	square metre
sq. km or km²	square kilometre
ha	hectare
cu. m. or m ³	cubic metre
lit or l	litre
rad	radian
°C	degrees Celsius
kg	kilogram
g	gram = kg x 10 ⁻³
mg	milligram = kg x 10 ⁻⁶
mg/l	milligram per litre
t	tonne = kg x 10 3
kg/ m ³	kilogram per cubic metre
t/ m ³	tonne per cubic metre
Ν	newton
N/m²	newton per square metre
Max	Maximum
Min	Minimum

SECTION 200 - MATERIALS AND TESTING OF MATERIALS

- 201 SCOPE
- 202 QUALITY OF MATERIALS
- 203 SOURCES OF MATERIALS
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- 209 SIEVES
- 210 SOILS AND GRAVELS
- 211 STONE, AGGREGATE, SAND AND FILLERS
- 212 CEMENT
- 213 CONCRETE
- 214 BITUMINOUS BINDERS
- 215 BITUMINOUS/ASPHALT CONCRETE MIXTURES

- 216 REINFORCING STEEL
- 217 BRICKS
- 218 MORTAR
- 219 REINFORCED CONCRETE PIPES
- 220 HIGH DENSITY POLYTHENE PIPES
- 221 GEOTEXTILES
- 222 TIMBER FOR STRUCTURAL WORKS
- 223 PAINT FOR ROAD MARKING
- 224 MANHOLE COVERS AND FRAMES
- 225 PRECAST CONCRETE CHANNELS
- 226 CAST IRON DRAINAGE GRATINGS
- 227 GABION
- 228 MEASUREMENT AND PAYMENT

SECTION 200 – CONSTRUCTION MATERIALS AND TESTING

201 SCOPE

This section covers the general requirements relating to materials, the specific requirements for basic materials, the tests and methods of testing which are required for the selection and quality control of materials.

202 QUALITY OF MATERIALS

The materials supplied and used in the works shall comply with the requirements of the Technical Specifications. They shall be new, except as provided elsewhere in the contract or permitted by the Engineer in writing. The materials shall be manufactured, handled and used skilfully to ensure completed works to comply with the contract.

203 SOURCES OF MATERIALS

The use of any one type of material from more than one source is prohibited, except by written permission of the Engineer. Such permission, if granted, shall set forth the conditions under which the change may be made. The sources or kinds of material shall not be changed without written permission of the Engineer. If the product of any source proves unacceptable, the Contractor shall make necessary arrangements for the supply of acceptable material. Any claims for compensation associated with such arrangements or changes shall not be considered, unless the source of the unacceptable material is designated in the contract as a source of material.

In the case of borrow pits, gravel, sand, binder, soil deposits and rock quarries, the "source of material designated in the contract" shall be construed to mean:

- (1) any restricted area (within the pit or quarry) which is designated as the source of material; or
- (2) the entire area of the pit or quarry, if no such restricted area is designated.

Movements of equipment within the "source" as above defined shall not be considered as a "change of source."

Selection and exploitation of material sources as well as use of the materials shall follow the DOR, "Environmental Codes of Practice, Highways and Roads" and "Blasting Manual" and comply with other pertinent environmental specifications including those detailed in Section 100 and other Sections. Prior approval of the material sources shall be required from concerned authorities as per the prevailing rules and regulations of Royal Government of Bhutan.

204 INSPECTION AND ACCEPTANCE OF MATERIALS

Final inspection and acceptance of materials shall be made only at the site of the work. The Engineer reserves the right to sample, inspect, and test the materials throughout the duration of the Works and to reject any materials which are found to be unsatisfactory. The Contractor/Engineers representative shall strictly follow the system of joint sampling and testing for material/ works.

A preliminary inspection of materials may be made at the source for the convenience and accommodation of the Contractor, but the presence of a representative of the Engineer shall not relieve the Contractor of the responsibility of furnishing materials complying with the Specifications.

The representative of the Engineer shall have free entry at all times to those parts of any plant which concern production of the materials ordered. The contractor shall strictly follow System of Request for Inspection (RFI).

205 MATERIALS AND MANUFACTURED ARTICLES

(1) Order for Materials and Manufactured Articles
The Contractor shall, before placing any order for materials and manufactured articles for incorporation in the Works, submit to the Engineer the names of the firms from whom he proposes to obtain such materials and manufactured articles, giving for each firm a description of the materials and manufactured articles to be supplied, their origin, the manufacturer's specification, quality, weight, strength and other relevant details. The Contractor shall submit the samples of such materials and manufactured articles when requested by the Engineer and when appropriate, manufacturer's certificates of recent test carried out on similar materials and manufactured articles shall also be submitted.

(2) Storage

All materials and manufactured articles shall be stored on site in a manner acceptable to the Engineer. The Contractor shall carefully protect all work, materials and manufactured articles from the weather and vermin.

(3) Test Certificates

When instructed by the Engineer, the Contractor shall submit to him all Test Certificates from the suppliers/manufacturers of the materials and/or manufactured articles to be used for the contract. Such certificates shall certify that the materials and/or manufactured articles concerned have been tested in accordance with the requirements of these Specifications. All test results shall be enclosed along with such certificates. The Contractor shall provide adequate means of identifying the materials and/or manufactured articles delivered on the site with the corresponding certificates.

206 DEFECTIVE MATERIALS

All materials not conforming to the requirements of the contract shall be rejected whether in place or not. They shall be removed immediately from the site unless otherwise permitted by the Engineer. Even after rectification of the defects no rejected material shall be used in the work unless approved by the Engineer in writing. Upon failure of the Contractor to comply promptly with any order of the Engineer given under this Clause, the Engineer shall have authority to cause the removal and replacement of rejected material and to deduct the cost thereof from any monies due to the Contractor. The Engineer/Engineers representative shall strictly follow the system of Non-conformance Report (NCR) in case of Non-conformance of materials/works.

207 TRADE NAMES AND ALTERNATIVES

For convenience in designation in the contract, certain articles or materials to be incorporated in the work may be designated under a trade name or the name of a manufacturer and his catalogue information. The use of an alternative article or material which is of equal or better quality and of the required characteristics for the purpose intended shall be permitted, subject to the following requirements:

- (1) The proof as to the quality and suitability of alternatives shall be submitted by the Contractor. The Contractor shall also furnish all information necessary as required by the Engineer. The Engineer shall be the sole judge as to the quality and suitability of alternative articles or materials and his decision shall be the final and binding upon the Contractor.
- (2) Whenever the specifications permit the substitution of a similar or equivalent material or article, no tests or action relating to the approval of such substitute material shall be made until the request for substitution is made in writing by the Contractor accompanied by complete data as to the equality of the material or article proposed. Such request shall be made well in advance to permit approval without delaying the work.

208 FOREIGN MATERIALS

Materials which are manufactured, produced or fabricated outside Bhutan shall be delivered at a point in Bhutan as specified in the contract where they shall be retained for a sufficient time to permit inspection, sampling, and testing. The Contractor shall not be entitled to an extension of time for acts or events occurring outside Bhutan and it shall be the Contractor's responsibility to deliver materials obtained from outside Bhutan to the point of delivery in Bhutan. The Contractor shall supply the facilities and make necessary arrangement at his own cost. All testing by the Contractor shall be subject to witnessing by the Engineer.

The Contractor shall furnish to the Engineer a "Certificate of Compliance" with the specifications from the manufacturer, producer or fabricator of foreign material where required.

209 SIEVE SIZES

IS sieves shall be used for all tests. Based on IS-460 the standard sieves series shall be as follows:

125; 90; 75; 63; 50; 45; 40; 37.5; 31.5; 25; 22.4; 20; 19; 16; 12.5; 11.2; 10; 9.5; 8; 6.3; 5.6; 4.75; 4.00; 2.8; 2.36; 2; 1.7; 1.4; 1.18; 1; 0.85; 0.71; 0.6; 0.5; 0.425; 0.400; 0.300; 0.250; 0.212; 0.180; 0.150; 0.125; 0.090; 0.075 mm.

In addition, sieves of other test standards shall be used as required in the Technical Specifications as directed by the Engineer.

210 SOILS AND GRAVELS

(1) Sampling and Samples

Sampling of soils and gravels shall be carried out as specified or as directed by the Engineer.

Samples shall be prepared for testing as indicated in IS 2720 part I, except that:

- (a) mass (in g) of a sample required for sieve analysis is about 400D, D being the maximum particle size (mm).
- (b) sample containing particles larger than 19 mm size shall be prepared for compaction and CBR tests as described hereunder, provided the proportion in weight of such particles is less than 30%:

An adequate quantity of representative material shall be sieved over the 50 mm and 19 mm sieve. The material passing the 50 mm sieve and retained on the 19 mm sieve shall be weighed and replaced with an equal mass of material passing the 19 mm sieve and retained on the 4.75 mm sieve. The material for replacement shall be taken from the remaining portion of the main sample.

When preparing gravel samples, the aggregations of particles shall be broken with a wooden or rubber hammer or pestle. Care shall be taken that no individual particles are crushed in the operation.

(2) Standard Methods of Testing

Tests on soils and gravels shall be performed in accordance with the standard methods given in Table 2.1. The type of tests shall be as directed by the Engineer.

Table	2.1. TESIS FIU	Leudies Applicable to Samples of Solis and Gravels	
Tests	Test procedure		
Determination of:			
Moisture Content	IS 2720	Part 2 (Oven-drying method)	
Liquid Limit	IS 2720	Part 5 (Cone Penetrometer or by Casagrande Apparatus)	
Plastic Limit	IS 2720	Part 5	
Plasticity Index	IS 2720	Part 5	
Linear Shrinkage	IS 2720	Part 20	
Specific Gravity of Particles	IS 2720	Part 3	
Particle Size Distribution	IS 2720	Part 4	
Organic Matter Content	IS 2720	Part 22	
Total Sulphate Content	IS 2720	Part 27	
Density-Moisture Content relationship (2.5 kg rammer)	IS 2720	Part 7	
Density-Moisture Content relationship (4.5 kg rammer)	IS 2720	Part 8	
California Bearing Ratio	IS 2720	Part 16	
Sand Equivalent	IS 2720	Part 37 (Mechanical Shaker or Manual Shaker method)	
Field Dry Density	IS 2720	Part 28/Part 29	

Table 2.1: Tests Procedures Applicable to Samples of Soils and Gravels

It is further specified that:

- (a) Wherever in the text of these Specifications the term "x % of the MDD (IS 2720 Part 27 or IS 2720 Part 28) is used it shall mean that a standard of compaction shall be achieved such that the dry density of the compacted material is x% of the maximum dry density determined from the respective tests mentioned in Table 2.1. Samples for the compaction tests shall be taken before compaction of the layers begin unless in the opinion of the Engineer the compaction effort proposed or applied by the Contractor is such that the material characteristics have changed in which case the samples for the tests shall be taken after all compaction is complete.
- (b) Compaction tests: when the material is susceptible to crushing during compaction, a separate and new sample shall be used in the determination of each point on the moisture/density curve.
- (c) The dry density of material placed in the works shall be determined by the Sand Replacement Method unless the Engineer directs to other method. In the case of nuclear method, tests shall be done at least at the same frequency required when using the Sand Replacement Method, but at each nuclear densometer test location the average of three readings taken at positions rotated by 90° shall be used. A check/comparison test using the Sand Replacement Method shall be carried out at 10 test interval.

Initial calibration of the nuclear density testing equipment shall be done by carrying out at least fifty tests in parallel with the Sand Replacement Method for each different material encountered. The check tests shall be used to update the initial calibration of the nuclear density testing equipment.

211 STONE, AGGREGATE, SAND AND FILLERS

(1) Sampling and Preparation of Samples

Sampling shall be carried out as per ASTM–D75 and the samples shall be prepared in accordance with IS 2386 or according to sampling procedures specified for the Standard Methods of testing given in Table 2.2.

(2) Standard Methods of Testing

Tests on stone aggregate, sand and filler shall be performed in accordance with the standard procedures given in the Table 2.2. The type of tests shall be as directed by the Engineer.

Tests		Test Procedure		
Determination of:				
a)	Particle Size Distribution (Gradation)	IS 2386	Part 1	
b)	Clay, Silt, Dust in Aggregates	IS 2386	Part 2	
c)	Flakiness Index	IS 2386	Part 1	
d)	Specific Gravity	IS 2386	Part 3	
e)	Moisture Content	IS 2386	Part 3	
f)	Bulk Density, Voids & Bulking	IS 2386	Part 3	
g)	Soluble Chloride Content	BS 812	Part 117	
h)	Mica Content	Manual mineralogical of	counting	
i)	Water Absorption	1S 2386	Part 3	
j)	Crushing Ratio	Manual counting & weighing		
k)	Los Angeles Abrasion	IS 2386	Part 4	
I)	AIV - ACV	IS 2386	Part 4	
m)	Polished Stone Value	IS 2386	Part 4	
n)	Sodium Sulphate Soundness	IS 2386	Part 5	
o)	Alkali Aggregate Reactivity Test	IS 2386	Part 7	
p)	Bitumen Stripping Test	IS 6241		
q)	Deleterious Substances	IS 2386	Part 2	
r)	Sand Equivalent	IS 2720	Part 37	
s)	Crushing Strength of stone	IS 2386	Part 4	

Table 2.2: Tests Procedures Applicable to Stone, Aggregate and Fillers

212 CEMENT

Ordinary Portland Cement (OPC) shall be sampled according to IS 3535 and tested according to IS 4031. The requirements on their physical characteristics shall be as given in Table 2.3.

S.N.	Physical characteristics	OPC	Test Procedure
i)	Fineness, m ² /kg: (by Blaine's Air Permeability method)	225	IS-4031 Part 2
ii)	Setting Time :		
	(a) Minimum Initial Setting Time (minutes)	45	IS 4031 Part 5
	(b) Maximum Final Setting Time (minutes)	600	
iii)	Soundness by Lechatelier method, mm, maximum	10	IS 4031 Part 3
iv)	Compressive Strength :		
	Minimum Average Compressive Strength of three mortar cube(N/mm ²)		
	(a) 3 days	16	
	(b) 7 days	22	IS 4031 Part 6
	(c) 28 days	33	

Table 2.3: Requirements on the Physical Characteristics of Cement

213 CONCRETE

Sampling and testing on concrete shall be carried out in accordance with the standard methods given in the Table 2.4. The type of tests shall be as specified by the Engineer.

	Tests	Test Procedures
Dete	ermination of :	
(i)	Compressive strength of concrete cubes	BS 1881–116
(ii)	Water absorption	BS 1881–122
(iii)	Mixing and sampling fresh concrete in laboratory	BS 1881–125
(iv)	Normal curing of test specimens (20° C method)	BS 1881–111
(v)	Making test cubes from fresh concrete	BS 1881–108

Table 2.4: Test Procedures Applicable to Concrete

The test specimens shall be cured at a temperature of $27^{\circ}C \pm 2^{\circ}C$. Water to be used in concrete shall be tested as specified in BS 3148.

214 BITUMINOUS BINDERS

(1) Sampling and Samples

Sampling of straight-run and cut-back bitumen shall be carried out in accordance with ASTM D 140.

Sampling of bitumen emulsion shall be carried out in accordance with BS 434, Part 1, except that where a delivery is made in drums or barrels, the number of samples shall be as indicated in AASHTO sampling method, T40 para.11.1.

(2) Standard Methods of Testing

(a) Straight-run Bitumen

Test on straight-run bitumen shall be carried out in accordance with the standard methods given in Table 2.5. The type of tests shall be as instructed by the Engineer.

	Tests Test Procedure				
Dete	rmination of :				
i)	Penetration	ASTM D 5			
ii)	Softening point (Ring and Ball)	ASTM D 36			
iii)	Flash and fire points (Cleveland open cup)	ASTM D 92			
iv)	Loss on heating	ASTM D 6/D1754			
V)	Ductility	ASTM D 113			
vi)	Water Content	ASTM D1461/D95			
vii)	Solubility in Trichloroethylene	ASTM D 2042			
viii)	Specific gravity	ASTM D70			
ix)	Penetration of residue from loss on heating	ASTM D5			

Table 2.5: Tests Procedure Applicable to Straight run Bitumen

(b) Cut Back Bitumen

Test on cut-back bitumen shall be carried out in accordance with the standard methods given in Table 2.6. The type of tests shall be as directed by the Engineer.

	Tests Test Procedure				
Dete	ermination of :				
i)	Kinematic viscosity	ASTM D 2170			
ii)	(a) Flash point (Tag open cup) (RC-MC)	ASTM D 3143			
	(b) Flash point (Cleveland open cup) (SC)	ASTM D 92			
iii)	Penetration	ASTM D 5			
iv)	Specific gravity by hydrometer method	ASTM D 3142			
V)	Asphalt residue of 100 pen (SC)	ASTM D 243			
vi)	Water content	ASTM D 95			
vii)	Distillation	ASTM D 402			
viii)	Penetration of residue from distillation	ASTM D 5			
ix)	Ductility of residue from distillation	ASTM D 113			
x)	Solubility of residue from distillation	ASTM D 2042			

(c) Bitumen Emulsion

Test on bitumen emulsion shall be carried out in accordance with the standard methods given in Table 2.7. The type of tests shall be as directed by the Engineer.

	Test		Test Pro	cedures	8
De	termination of :				
(i)	Residue on 0.710 mm sieve	BS 43	34 Part I	, Appen	dix C ₁
(ii)	Residue on 0.150 mm sieve	"	"	"	C ₂
(iii)	Stability to mixing with coarse aggregate	"	"	"	D ₁
(iv)	Stability to mixing with cement	"	"	"	D ₂
(v)	Binder content	"	"	"	Е

Table 2.7: Tests Procedure Applicable to Bitumen Emulsion

(vi)	Engler viscosity	"	"	"	F1
(vii)	Redwood II viscosity	"	"	"	F ₂
(viii)	Storage stability (short period)	"	"	"	H ₁
(ix)	Storage stability (long period)	"	"	"	H_2
(x)	Particle charge	"	"	"	J

(3) Requirements

(a) General

Before any bituminous binder is delivered to the site, the Contractor shall provide the Engineer with a certificate from the manufacturer that the material to be supplied complies in all respects with the relevant specifications.

Any bituminous binder delivered in leaking or deteriorated containers shall be rejected.

(b) Straight-run Bitumen

Straight run bitumen shall comply with all the requirements give in Table 2.8.

	U		
S.N.	Specifications	Penetration Grade	
		80/100	
i)	Penetration, at 25°C (100g-5s), in 0.1 mm	80-100	
ii)	Softening point (Ring and Ball), °C	41-51	
iii)	Flash point (Cleveland open cup), °C (min)	225	
iv)	Ductility at 25°C, cm (min)	100	
V)	Loss on heating (5 h at 163°C) % (max)	0.5	
vi)	Penetration of residue from loss on heating at 25°C		
	(100 -5s) % of initial pen (min)	80	
vii)	Specific Gravity at 25°C	1.00-1.05	
viii)	Water, % by weight (max)	0.2	
ix)	Solubility in trichloroethylene, % by weight (min)	99.5	

Table 2.8: Specification for Straight run Bitumen

The number of tests and criteria for conformity shall be as per IS 73.

(c) Cut Back Bitumen

Slow curing, medium-curing and rapid curing cut-backs bitumen shall comply with all the requirements of ASTM Standard Specification D2026, D2027 and D2028 respectively and the number of tests and criteria for conformity shall be as per IS 217.

(d) Bitumen Emulsion

Bitumen emulsions shall comply with all the requirements of BS 434, Part 1.

215 BITUMINOUS/ASPHALT CONCRETE MIXTURES

(1) Sampling and Samples

Sampling of bituminous mixtures shall be carried out in accordance with ASTM Method D 979.

(2) Standard Methods of Testing

Tests on bituminous mixtures shall be carried out in accordance with the standard methods given in Table 2.9.

Tests	Test Procedure		
Determination of :			
i) Moisture and volatile distillates	ASTM D 1461		
ii) Quantitative extraction of bitumen	ASTM D 2172		

Table 2.9: Tests Procedure Applicable to Bituminous Mixtures

iii)	Specific gravity of compacted mixture	ASTM D 1188 & D 2726
iv)	Recovery of bitumen from solution	ASTM D 1856
V)	Coating and stripping	ASTM D 1664, IS 6241
vi)	Degree of particle coating	ASTM D 2489
vii)	Maximum specific gravity	ASTM D 2041
viii)	Degree of pavement compaction	AASHTO T230
ix)	Marshall stability	ASTM D1559

216 REINFORCING STEEL

All reinforcement for use in the Works shall be tested for compliance as specified in Section 1600 in a Laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. In addition to the testing requirements described above, the Contractor shall carry out additional testing as instructed by the Engineer.

217 BRICKS

Bricks shall conform to the requirements of IS 1077.

218 MORTAR

Mortar shall comply with IS 2250–1981.

219 REINFORCED CONCRETE PIPES

Reinforced concrete pipes shall comply with the requirements of IS 458:1988.

220 HIGH DENSITY POLYTHENE PIPES

High density polythene pipes shall be as approved by the Engineer.

221 GEOTEXTILES

Geotextiles used for sub-surface drains shall be continuous fibre non –woven, needle punched; UV stratified such as "polyfelt TS 30 or equivalent".

Geotextiles used for reinforcing walls shall be non-woven, needle punched; UV stratified such as "polyfelt TS 70 or equivalent".

Unless otherwise shown on the Drawing or directed by the Engineer, the geotextiles shall meet the specifications in Table 2.10.

rabie 2116 Requirement of geotoxinoe				
Property	Test standard	Unit	10KN	24KN
			geotextile	geotextile
Tensile strength(Av)	ISO 10319	KN/m	9.5 min	24
CBR puncture strength	ISO 12236	Ν	1200	3000
Vertical water flow (100mm head)	ISO 11058	l/m2/s	217	117
Rod Puncture resistance	ASTM D 4833	Ν	255	650
Apparent opening size (O95)	ASTM D 4751	mm	0.26	0.18
Permittivity	ASTM D 4491	l/s	3.0	1.70
Nominal mass	ISO 9864	g/m2	125	325
Thickness 2Kpa	ISO 9863	mm	1.2	2.9
Weight of roll		kg	135/60	140

Table 2.10 Requirement of geotextiles

- (a) Geotextiles shall have a grab strength more than 475/420 N for 10 KN and 1500/1400 for 24 KN and grab elongation corresponding to this limit in accordance with ASTM D4632.
- (b) apparent opening size should be as shown on the Drawing or as mentioned under table 2.1.

- (c) allow vertical water to flow through it at right angles to its principal plane, at a rate of not less than 217 litres/sq.m./sec for 10KN geotextiles and 117 litres/sq.m./sec for 24 KN geotextiles under a constant head of 100 mm, determined in accordance with BS: 6906 (Part 3) or ASTM D4491, or ISO 11058, unless otherwise shown on the Drawing. The flow rate determined in the test shall be corrected to that applicable to a temperature of 15°C using data on variation in viscosity of water with temperature.
- (d) minimum dynamic drop cone puncture should be of 30 mm diameter when determined in accordance with ISO 13433.

Geotextiles used for drilled sub-surface drains shall also be as specified above and as per Section 1700.

222. TIMBER FOR STRUCTURAL WORKS

Timber used for structural works shall comply with IS: 883.

223. PAINT FOR ROAD MARKING

The paint for road marking shall be manufactured for road markings and suitable for use in the climatic conditions of Bhutan. Paint colors shall be as shown on the Drawings. The paints shall be to the approval of the Engineer.

224 MANHOLE COVERS AND FRAMES

Manhole covers and frames shall be of cast iron and shall comply with IS: 1726-1991. For manholes constructed in carriageway and shoulders, heavy duty circular covers and frames shall be used. In footpaths, medium duty circular covers shall be used. In other locations light duty covers and frames shall be used.

225 PRECAST CONCRETE CHANNELS

Precast concrete channels, kerbs, edging, quadrants and gutters shall comply with the requirements of IS: 5758 - 1984.

226 CAST IRON DRAINAGE GRATINGS

Cast iron gratings shall comply with the requirements of IS: 5961 – 1970.

227 GABION

All wire used in the fabrication of gabions and wiring operations during construction shall comply with the requirements of IS 280. The wires shall be galvanised with heavy coating of zinc. The coating of zinc shall comply with IS 4826 (Heavy Coated Wire).

228 MEASUREMENT AND PAYMENT

Unless otherwise specified in the contract, no separate measurement and payment shall be made for sampling, samples and testing of materials, site trials and construction control/process control testing. It shall be deemed to have included in the rates of the relevant items for complying with the requirements of this Section.

SECTION 300 - QUALITY CONTROL

- 301 SCOPE
- 302 RESPONSIBILITY OF CONTRACTOR FOR QUALITY OF WORKS
- 303 QUALITY CONTROL SYSTEM
- 304 QUALITY ASSURANCE PLAN
- 305 TESTING PROCEDURES AND SETS OF TESTS
- **306** LABORATORY TRIALS TO CONFIRM COMPLIANCE WITH SPECIFICATIONS
- 307 SITE TRIALS OR TRIAL SECTIONS
- 308 CONTROL TESTING DURING CONSTRUCTION
- **309** ACCEPTANCE TESTS FOR COMPLETED WORKS OR PARTS OF THE WORKS
- 310 RECAPITULATIVE SCHEDULE OF TESTS
- 311 LABORATORY

SECTION 300 - QUALITY CONTROL

301 SCOPE

This Section covers the Quality Control System and procedures, Quality Assurance Plan, program of tests, trials, and general procedures for acceptance as well as laboratory arrangements and related facilities which are required for the selection and control of the quality of materials and workmanship.

302 CONTRACTOR'S RESPONSIBILITY FOR QUALITY OF WORKS

All materials incorporated and all workmanship performed shall be strictly in conformity with the requirements of the Technical Specifications and the Contractor shall be fully responsible for the quality of the works.

The Contractor shall provide, use and maintain on the Site, throughout the period of execution of the contract, a laboratory with adequate laboratory equipment operated by competent staff for carrying out tests required for the selection and quality control of the materials and for the quality control of workmanship in accordance with these Specifications. The list of laboratory equipment to be procured and laboratory facilities to be provided shall require approval from the Engineer. The Contractor shall assume that tests shall be required on all materials to be used in the works and on all finished works or part of works.

303 QUALITY CONTROL SYSTEM

The Quality Control System comprises the methods, procedures and organisation for the Quality Control of the works. The Contractor shall implement the Quality Control System in the following sequences:

(1) Sequence

- (a) Compliance testing for materials including laboratory trials,
- (b) Compliance testing for methods and equipment prior to the commencement of the work, including site trials or trial sections,
- (c) Control testing during construction,
- (d) Acceptance testing on completed works or parts of the works.

The Contractor shall carry out all necessary tests and shall report to the Engineer the results of such tests before submitting materials and/or finished works or part of works to the Engineer for approval in accordance with this Specification. In certain circumstances, tests may be carried out at the place of manufacture as per the Conditions of Contract.

For satisfying himself about the quality of the works, quality control tests shall be conducted by the Engineer himself or by any other agencies deemed fit by the Engineer. Additional tests may also be conducted where in the opinion of the Engineer such tests are needed.

Before commencement of the work, the Contractor shall demonstrate a trial run of all construction equipment for establishing their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Engineer.

(2) The supply, testing and monitoring shall be in compliance with a Quality Assurance Plan, Clause 304 and other provisions in the contract.

304 QUALITY ASSURANCE PLAN

The Contractor shall submit to the Engineer for his approval, the Quality Assurance Plan (QAP) which shall be based on the detailed Program of the Works as per Clause 102 of the Technical Specifications.

The Quality Assurance Plan shall include the following:

- (1) The Quality Control Schedule comprising of:
 - (a) The recapitulative test schedule and testing program detailing the list of tests for compliance, laboratory trials, site trials and trial sections, construction control tests and their frequencies, tests for acceptance of the completed works with their dates.
 - (b) Recapitulative list of "critical" acceptance testing procedures, for equipment or parts of the works which corresponds to the tasks on the Critical Path according to the construction Program.
 - (c) Estimate of the number of tests to be carried out, list and number of appropriate equipment to conduct them, list of tests to be conducted outside the site laboratory, if any, identification of the outside laboratory where proposed to carry out the test.
 - (d) List of staff assigned to the laboratory, their position and responsibilities in the quality control procedures, their qualification and experience, general description and detailed organisation of the laboratory activities.
- (2) The list of sources of materials and/or of manufactured articles, their main characteristics, their identification mode as provided by the supplier when required; the programme of supply and procurement of material and/or manufactured articles in accordance with the Programme pursuant to Clause 102.
- (3) The list of tests and quality control procedures to be implemented by the Sub-contractors, if any, pointing out the "critical" acceptance testing procedures relating to the Sub-contracted works, which correspond to the tasks on the Critical Path included in the Sub-contracted works.

The Contractor shall implement the Quality Control in compliance with the approved QAP.

The Engineer's approval of the QAP shall not relieve the Contractor from his responsibility of the quality of the Works as per the Conditions of Contract and these Specifications nor shall the Engineer's approval of the QAP exempt the Contractor of any procedure to inform the Engineer in writing or request for the Engineer's approval or re-approval as specified in the Conditions of Contract and/or in these Specifications

The Contractor shall monitor and update the QAP on the basis of the decisions taken at the periodic review meetings or as directed by the Engineer and in accordance with the program of the works as per Clause 102 and the Conditions of Contract.

305 TESTING PROCEDURES AND SET OF TESTS

For ensuring the quality of the work, the materials and the workmanship shall be subjected to testing in accordance with procedures, sets of tests and frequencies as specified in Section 200 and respective Sections of these Specifications. The specified testing frequencies are not restrictive. The Engineer shall direct for the tests to be carried out as frequently as deemed necessary that the materials and workmanship comply with the Specifications.

Sets of tests to be carried out on the materials and the workmanship as specified in these Specifications are recapitulated in Clause 310. Where no specific testing procedure is mentioned in the Specifications, the tests shall be carried out as per the prevalent accepted engineering practice or directions of the Engineer.

306 LABORATORY TRIALS TO CONFIRM COMPLIANCE WITH SPECIFICATIONS

(1) Filling and Pavement Materials

Laboratory trials shall be carried out by the Contractor on filling and pavement materials proposed to be used in the works in their natural state. The laboratory trials shall establish a relationship between their specified requirements of the end product and properties which can be determined in the field for construction control purposes. Laboratory mixes and site trials for bituminous mixes shall be carried out in accordance with the requirements of Section 200.

The mixed materials, the composition of which meets the specified requirements and is accepted by the Engineer, shall then be used in the site trials carried out in accordance with Clause 307 to ensure that all specified requirements of the completed pavement courses can be achieved.

The Contractor shall submit the proposals for the site trails to the Engineer at least two weeks before he intends to use the mixed materials in the site trials in accordance with Clause 307.

(2) Concrete

Laboratory trials for concrete mixes as specified in Section 1600 shall be carried out by the Contractor to demonstrate that the composition of the mixes proposed for the concrete meets the requirements of the Technical Specifications.

The compositions of concrete mixes which meet the specified requirements and are accepted by the Engineer shall be then used in the site trials carried out in accordance with Clause 307.

307 SITE TRIALS OR TRIAL SECTIONS

(1) Earthworks and Pavement Materials

Site trails for laying and compaction shall be carried out by the Contractor on all earthworks and pavement materials proposed for the works, using the same constructional plant and methods proposed by the Contractor for use in the works. The trials shall demonstrate the suitability of the method and equipment for laying and compaction of the material to the specified density and confirm that other specific requirements of the completed earthwork or pavement work can be achieved.

Each trial area shall be at least 100 metres long and to the full construction width and shall be laid to the specified depth for the material. It may form a part of the works provided it complies with the required Specifications. Any areas, which do not comply with the Specifications, shall be removed and new trial shall be made.

The Contractor shall allow in his Program for conducting such site trials and for carrying out the appropriate tests on them in accordance with the Quality Assurance Plan. The trials on each pavement layer shall be undertaken at least 21 days ahead of the commencement of the related work.

The Contractor shall compact each section of the trial over the range of compaction effort the Contractor is proposing. The data in respect of the following shall be recorded for each level of compaction effort at each site trial:

- (a) The composition and grading of the material before the site trial.
- (b) The composition and grading of the material including the lime or bitumen content.
- (c) The moisture content at the time of compaction and the optimum moisture content for the specified compaction.
- (d) The type, size, tyre pressures, frequency of vibration and the number of passes made by the compaction equipment.
- (e) The maximum dry density or target density as appropriate measured on a sample before and at intervals through the site trials.
- (f) The density achieved.
- (g) The compacted thickness of the layer.
- (h) Any other relevant information as directed by the Engineer.

At least, eight sets of tests shall be made by the Contractor on each 100 metres length of trial section for each level of compaction effort. If all eight sets of results over the range of compaction effort proposed by the Contractor meet the specified requirements for the material, the site trial shall be deemed successful. The above data recorded in the trial shall become the agreed basis on which the particular material shall be provided and processed to achieve the specified requirements. If required, the QAP shall be updated or modified on the basis of these data.

If, during the execution of the works, the construction control tests indicate that the requirements for a material are not being consistently achieved, then work on that layer shall be stopped until the cause is investigated by the Contractor. Such investigation may include further laboratory and site trials on the

materials to determine a revised set of data as stated above which when agreed, shall be the basis on which all subsequent material shall be provided and processed to achieve the specified requirements.

(2) Concrete

Site trials for concrete mixes as specified in Section 1600 shall be carried out by the Contractor to demonstrate the suitability of his mixing equipment. During the site trials, compliance with the Specifications for weighing equipment, storage of ingredients, means of transport for concrete, placing, compaction and curing shall be checked by the Engineer.

During the site trial a full scale sequence including placing and compaction of concrete shall be carried out on a part of the works which will represent particular difficulties due to the presence of reinforcement, obstructions or others.

The Contractor shall allow in his Program for conducting the site trials and for carrying out the appropriate tests, including the time required to obtain compressive strength test results at 28 days. The Contractor shall inform in writing to the Engineer at least two weeks before the date he proposes to use the concrete mixes in the site trials with all relevant data including the trial program, the results of the laboratory trial tests for the proposed concrete mixes and compliance tests results of all constituents i.e. cement, aggregates, water and admixtures, if any.

(3) Production of Materials and Crushing Plant

Full scale site trials corresponding to one day production shall be carried out by the Contractor on all type of materials to be processed using the crushing plant, related devices and methods to demonstrate the suitability of the equipment to provide materials of the characteristics and performances specified in these Specifications.

At each stage of the processing, materials shall be sampled, and the following characteristics shall be determined in the laboratory and recorded:

- (a) the grading of the material
- (b) characteristics of the fine fraction: Sand Equivalent (SE); Mica Content; and if SE<40, Plasticity Index.
- (c) characteristics of the coarse fraction : LAA, AIV, ACV, FI, stripping test, Crushing Ratio.

At least three sets of tests shall be conducted by the Contractor at each stage of the production. If all the three sets of results over the full sequence of production proposed by the Contractor meet the specified requirements for the materials, the site trial shall be deemed successful.

308 CONTROL TESTING DURING CONSTRUCTION

(1) Earthworks and Pavement Materials, Backfill to Drainage and Other Structures

All earthworks, pavement layers, and backfill to drainage and other structures shall be subject to control testing (process control) including, if required, testing by the Engineer in accordance with the Conditions of Contract and Clause 303. The Contractor shall allow in his programme or sequence of operations for any disturbance or delays occasioned by such control and testing.

(2) Other Works and Equipment

Testing and quality control procedures for other works and equipments are detailed in the relevant Sections of the Technical Specifications.

309 ACCEPTANCE TESTS FOR COMPLETED WORKS OR PARTS OF THE WORKS

(1) Earthworks and Pavement Materials, Backfill to Drainage and Other Structures

The Contractor shall request, in writing using standard Request for Inspection sheet (RFI) for the Engineer's approval for each layer of each section of earthwork, pavement construction and backfill to drainage and other structures. Such requests shall be made only when the Contractor is fully satisfied that the section of the works concerned is in the condition required by the relevant Specifications. Such request shall be accompanied by the tests results required by the Sub-clause 303 (1) (a), (b), (c) and the relevant Sections of the Technical Specifications.

The Engineer shall thereupon, without undue delay, inspect the Section for any visible defects including, heaving material (visible during compaction or on proof rolling) segregation, and for the uniformity of the mixing and compaction. If the visual aspects are satisfactory the Engineer shall test the Section of the works submitted and inform the Contractor in writing of the results of the tests specifying acceptance or rejection of the Section or the layer concerned. The Engineer/Engineers representative, for this purpose, shall use the standard Non –Conformance Report form (NCR).

Work on a layer shall in no circumstances commence until the preceding layer has been approved and accepted by the Engineer in writing. The Contractor shall be fully responsible for protecting and maintaining the condition of the work which has been submitted for approval.

Should any layer be left unprotected for more than 24 hours subsequent to approval, the Contractor shall request for re-approval of the layer and the layer shall again be subject to proof rolling, construction control testing, and tolerance checks in accordance with these Specifications.

Notwithstanding the Engineer's approval of a layer, the Contractor shall be responsible for making good any subsequent damage due to traffic, ingress of water or any other reason and should any damage occur the layer shall again be subject to proof rolling, construction control testing and tolerance checks in accordance with these Specifications.

(2) Other Works and Equipment

Acceptance tests for other works and equipment are detailed in the relevant Sections of the Technical Specifications.

310 RECAPITULATIVE SCHEDULE OF TESTS

The tests to be carried out and their frequency for the quality control of the works are detailed in the relevant Sections of the Technical Specifications. The frequency of tests to be conducted shall be as per Table 3.1 or as directed by the Engineer.

The following Table 3.1 recapitulates the testing schedule for the main types of works.

PART OR COMPONENT OF	Section/	_	
THE WORKS	Clause No	TESTS	FREQUENCY
PRODUCTION OF MATERIALS	400		
NATURAL AND CRUSHED MATERIALS		Site Trails:Other tests on materials	 Before starting production According to the relevant component of the works
EARTHWORKS	600		
FILL MATERIAL		 Material Identification, MDD, 	 For each new source and in
COMPACTION		OMC, CBR	every 1500 m ³ or part of it
		• MC	 For each new source and in
			every per 250 m ³ or part of it
		Field Density	 One set per 500m² of each layer with a minimum 3 test per Section
SUBGRADES			
MATERIALS	700	 Material Identification, MC MDD, OMC, CBR 	 For each new material and not less than once per 3000 m² of
	703		each layer
COMPACTION	& 704	Field Density	 Once per 250 m² of each layer or part of it

Table 3.1: Testing Schedule

MECHANICAL STABILISATION			
IN-SITU MATERIAL	705	 Material Identification, MC MDD, OMC, CBR 	 One test for each new material and one test per 3000 m² of each layer or part of it.
STABILISER		Grading, se (for sand)	 One test for each new source and one test per 500 m³ of additive material or part of it.
MIXED MATERIAL		 MDD,OMC,CBR,MC 	 One test for each new material and one test per 400 m² of each layer or part of it.
COMPACTION		Field Density	 Once per 250 m² of each layer or part of it.
SUBBASE	900		
MATERIALS		• Material Identification, MC, Gradation, Plasticity Index,	 Once per 200 m³ or part of it and change in source with a minimum of 2 tests per section
		MDD, OMC	 Once per 1000 m³ or part of it and change of source, with a minimum of 2 tests per section
COMPACTION		Field Density and moisture content	 Once per 500 m² of each layer with a minimum of 2 tests per section.
WET MIX CRUSHED STONE BASE COURSE	1001		
MATERIALS		 Material Identification, Gradation, Plasticity Index, FI 	 Once per 200 m³ or part of it and change in source with a minimum of 2 tests per section
		LAA,AIV, Crushing Ratio,	 Once per 200 m³ or part of it and every change of source
		• SSS, CBR	 Once per 500 m³ or part of it and every change of source
		MDD, OMC	 Once per 1000 m³ or part of it & every change of source, with a minimum of 2 tests per
COMPACTION		Field Density and moisture content	 Once per 500 m² of each layer with a minimum of 2 tests per section.
GRAVEL WEARING COURSE	1003		
MATERIALS		 Material Identification, Gradation, Plasticity Index, CBR, LAA, AIV 	• Once per 300 m ³ or part of it and for each new source
		• MDD,OMC	Once per 400 m ³ or part of it and for each change in
		Field Density and moisture content	Once per 200 m ² of each layer with a minimum of 3 tests per Section.
BITUMINOUS SURFACE AND PAVEMENT COURSES	1200		
PRIME COAT - TACK COAT	1202		
MATERIALS		Quality of Binder	 Certificates from suppliers. One set of tests for each 50,000 litres of supply or part of it

CONSTRUCTION		 Binder temperature for application 	At regular close intervals
		Rate of spread of binder	 2 tests per run
SURFACE DRESSING	1203		
MATERIALS		 Material Identification, Gradation, FI 	 Once per 50 m³ or part of it and change in source
		• LAA, AIV, CR	 Once per 250 m³ or part of it and change in source
		• SSS	Once per 500 m ³ or part of it and change in source
		Striping Value	One set of 3 specimens for each source of supply. Then, when warranted, by change in
		Quality of Binders	 Certificates from suppliers. One set of tests for each 50,000 litres or part of it of
CONSTRUCTION		 Rate of application of Chippings Binder temperature for application 	supply.Two per dayAt close intervals
		Rate of application of Binder	Two per run
ASPHALT CONCRETE	1205		
MATERIALS		 Material Identification, Gradation, 	Once per 100 m ³ and change in source
		LAA, ACV, SSS, SE	Once per 500 m ³ and change in source
		Flakiness Index	Once per 100 m ³ "
		Quality of Filler	Per 50 tonnes "
		Quality of Binders	Certificates from suppliers.
		Penetration test	One set of tests for each 50,000 litres of supply or part of it
		Mixture	Daily
CONSTRUCTION		Grading and Bitumen Content	 Each 100t of mix or part of it
		Marshall stability, flow & voidsControl of Temperature	 Each 100t of mix or part of it As required
STONE MASONRY WORK			
MATERIALS	1302	Quality of cement and sand	As required
MORTAR	1212	- Control tooto	$-$ Even $10m^3$ of measure of rest
MORIAR	1313	Control tests Compressive strength of mortar	of it
BRICK MASONRY WORK			
MATERIALS	1402	Quality of BricksQuality of cement and sand	As required
MORTAR	1412	Control tests Compressive strength of mortar	 Every 10 m³ of brick work or part of it.
GABIONS			
MATERIALS	1501	Gabion wires : Tensile Strength, Mass, Uniformity and adhesion of Zinc	Sub-clause 1501
		Water absorption of stones	• Every 50 m ³ or part of it
CONCRETE	1600		

MATERIALS		 Cement : Acceptance Tests: Control Tests : Chemical composition Physical properties Aggregates: Acceptance Tests : Control Tests : Grading Silt & clay content Organic Impurities Choride content, sulphate content, Alkali reactivity Water, Admixtures 	 Conservative samples for each supply and not less than every 200 t or part of it. Testing in case of non compliance of the mixes or storage on site for longer than 1 month Sub-clause 1603 (5) Each delivery and every 100 t or part of it for fine aggregate and 250 t or part of it for coarse aggregate As frequently as required. Sub-clause 1603 (7) and (8)
		Concrete Lab. Trials Site Trials Control tests Compressive strength Reinforcement	 Sub-clause 1504 (3) Sub-clause 1504 (4) Early work: every 6 m³ of each class. When compliance is established: every 20 m³ or part of it. Clause 1614
CROSS DRAINAGE WORKS	1700		
MATERIALS FOR RE-FILLING THE TRENCHES		Identification : Gradation, Plasticity Index, CBR , In-Situ Density (95% MDD)	As specified or required by the Engineer

311 LABORATORY

(1) Scope

This Clause covers the establishment of laboratory as required for testing of materials as part of quality control of the construction works executed under the contract for the project. The following laboratory provision will be required to cover the quality control of construction materials/works in the project for road works.

(a) Establishment of Field Laboratory

The Contractor shall establish a field laboratory manned by a qualified laboratory technician of the contractor. The space should be adequate to provide testing facilities for construction works. A laboratory space of minimum 35 sqm is required. As required the space shall be partitioned to provide rooms/space for testing, sample preparation, sample storage, office and toilet and to accommodate the Lab. Technician and other support staff. The necessary furnitures and consumables shall be also provided for the laboratory.

The Contractor shall give following consideration to the preparation of space for laboratory. The floor of the laboratory shall be smooth concrete of sufficient quality to withstand the expected use. All rooms shall be painted, provided with sufficient ceiling lights and power outlets. Ceiling fans shall be provided as required. Piped water suitable for drinking use shall be supplied to the laboratory building, together with tank storage sufficient to provide supply for 24 hours. Sufficient power for lighting and other electrical appliances and apparatus shall be provided. The Contractor shall built in this cost in the rates for this item.

(b) Laboratory Equipment

All equipment necessary for testing of materials and workmanship shall be deemed to form part of the permanent works unless otherwise provided in the contract. It shall be delivered to the site in accordance with the schedule of requirements of such equipment described in the contract. However the non-inclusion of

any item of such equipment in the schedule of requirements shall not relieve the Contractor of the responsibility to supply it if it is required for the proper control of the quality of the materials and/or workmanship, notably when identified in the list of appropriate equipment to be supplied in accordance with Clause 304 (1) (c). The Schedule of Laboratory Equipments is provided in the Table below.

SN	Item Description	No. of Items
1.	Grain Size Analysis (coarse sieves)	
	a) 450 mm dia G.I. Sieves for coarse aggregates	
	150mm	2 no.
	100 mm	2 no.
	75.0 mm	2 no
	63.0 mm	2 no.
	50.0 mm	2 no.
	40.0 mm	2 no.
	40.0 mm	2 110. 2 no
	37.5 IIIII 28.0 mm	2 110. 2 no
	26.0 (1)(1)	2 110.
	25.0 mm	2 no.
	20.0 mm	2 no.
	19.0 mm	2 no.
	16.0 mm	2 no.
	14.0 mm	2 no.
	13.2 mm	2 no.
	12.5 mm	2 no.
	10.0 mm	2 no.
	9.5 mm	2 no.
	6.30 mm	2 no.
	5.00 mm	2 no.
	4.75 mm	2 no.
	b) G.I. Pan (450 mm dia)	As required
	c) G.I. Cover (450 mm dia)	
	d) Wire Sieve Brushes	
2	Grain Size Analysis (fine aggregate)	
-		
	a) 200 mm dia Span Brass Wire Sieve for fine aggregate	
	4 75 mm	2 no
	2.26 mm	2 no.
	2.00 mm	2 110. 2 no
	2.00 mm	2 110. 2 no
	1.1011111	2 HO.
	1.00 mm	2 no.
	0.60 mm	2 no.
	0.425 mm	4 no.
	0.300 mm	2 no.
	0.212 mm	2 no.
	0.150 mm	4 no.
	0.075 mm	6 no.
	b) Brass Pan (200 mm dia)	2 no.
	c) Brass Cover (200 mm dia)	2 no.
	d) Wire Sieve Brushes	6 no.
	e) Sieve Shaker motorised, 220 V, 50 Hz, single phase supply	1 set
3.	Specific Gravity and Bulk Density	
	Duchamatar professed with appillant apprices 50 ml	2 no
	Pychometer preferred with capillary opening 50 ml	∠ 110. 2 ma
	Pychometer preferred with capillary opening 250 mi	∠ 110. 0 m s
	Pycnometer preterred with capillary opening 1000 ml	2 no.
	vvire Basket (4 mm mesn size)	1 no.
	Bucket for Immersing Aggregate	2 no.
	Bulk Density Measures (20 ltr., 10 ltr)	2 set
	Tamping Rod (16 mm dia.)	1 no.

Schedule	ofIa	aboratory	, Equi	nments
Schedule	ᄓᄂᇲ	abbraibry	Eyui	pineins

SN	Item Description	No. of Items
4.	Liquid Limit Device with Counter Number	
		1 no.
	Grooving tool and Gauge	1 no.
	Removing Counter Kit	1 no.
	Spatula (Elexible with round tip. 80 mm long and 20 mm wide blade)	2 no.
	Sample Container (steel) with cover	20 no
	Wash bottle	2 no.
	Glass plate (Absorbent type) [300 mm x 450 mm]	2 no.
	Diass plate (Absolute it type) [500 min x 450 min]	2 110.
	Plastic Linit Rou Compactor Dereolain Dich. 120 mm die	2110.
		2 110.
5.	Proctor Compaction Apparatus	
	- Compaction moulds 150 mm dia	2 no
	- 45 kg Rammer	2 no. 3 no
	- Compaction moulds 100 mm dia	4 no
		4110.
	- 2.5 kg. Rammer	2 no.
	- Gauging Trowel	2 no.
	- Straight edge (steel)	2 no.
	- Vernier Calliper, 0-200 mm x 0.05 mm (equivalent to Mitutovo)	1 no.
	- Sample travs (600 mm x 600 mm x 75 mm)	3 no.
	- sample trave (450 mm x 270 mm x 45 mm)	3 no
	- sample trays (270 mm x 210 mm x 4500 mm)	3no
	sample tray (220 mm x 175 mm x 45 mm)	300
	- Sample avtruder (Hydraulic)	100
	- Rubber Gloves as required	IIIO
6	California Bearing Ratio (CBR) Apparatus	
0.	Camorina Boaring Hallo (OBH) Apparatao	
	- CBR Moulds	3 no.
	- Spacer Disc	3 no
	Swell Plate	3 no
	Tripod Attachment	3 no.
	Dial Indicator	3 no.
	- Dia mulcalor Surebargo Woight	12 no
	- Suichaige Weight	12 110. 2 no
	- Filler Paper, Doxes	3 110.
	- Filler Screen Mechanical Loading Broop	3 NO.
7	- Mechanical Loading Fless Field Density Test (Sand Cone Method)	1 110.
<i>'</i> .		
	- Sand Pouring Cylinder 150 mm dia.	2 set
	- Sand Pouring Cylinder 200 mm dia.	2 set
	- Calibrating Container 150 mm dia	1 no.
	- Calibrating Container 200 mm dia	1 no.
	- Metal Travs (400 mm x 400 mm x 50 mm) with central hole	2 no.
	- Density Spoon (medium)	2 no
	- Metal dibber tools	2 no.
		2 no.
	Brush (different sizes)	2 110. 6 no
	Chical	2 no
		2 110. 2 no
		2 11U.
	- Howels	∠ 110. 2 no
	- I Ky Kubber Mallets	∠ no.
	- Covered Containers (moisture sampling)	ю по.
L	- Standard Density Sand 850 /600	500 Kg
8.	Concrete Test and Slump Cone Apparatus	
	- Cube Moulds (150 mm)	12 no
	- Slump cone apparatus	2 no.
	Tamping rod (16 mm dia)	2 no.
	- Steel ruler (calibrated)	2 no.
9	Compression Testing Machine	2 110.
0.		
	- Compression Testing machine set (electric and hand driven), 100 t	1 set

SN	Item Description	No. of Items
10.	Flakiness Index	
	- Flakiness Sieves 10 mm - 5.0 mm	2 no
	- Flakiness Sieves 14 mm - 10 mm	2 no
	- Flakiness Sieves 20 mm - 14 mm	2 no
	- Flakiness Sieves 28 mm - 20 mm	2 no
	- Flakiness Sieves 37.5 mm - 28 mm	1 no
	- Flakiness Sieves 50 mm - 37.5 mm	1 no
11.	Bitumen Penetration	
	- Standard Penetrometer	1 set
	- Standard needles	4 no
	 Transfer Dish + Transparent glass dishes 	8 no
	- Standard Trays for Binder heating	2 no
	- Digital Thermometer with probe, 0° to 300° C	2 no
	-	
12.	Softening Point Test	
	- Complete test set with ring and ball arrangements including water	1 set
	bath	
	- Glass plate (300 mm x 5 mm)	2 no
	- Thermometer, -2" to 400" C	2 no
	- Thermometer, 30° to 200° C	2 no
13.	Specific Gravity and Water Absorption Test	
	- Gas Jar (75 mm dia x 300 mm high with glass cover)	1 set
	- Tamping Rod	1 no
4.4		
14.	Buik Density of Aggregates	
	Bulk density measure 10 dm ³	1 no
	- Duik density measure, 10 um Bulk density measure, 7 dm^3	1 110
	- Duik density measure, 7 din	1 110
	- Tamping Dal Tamping Pod	2 no
	- Tamping Rod Straight edge	2 110 1 no
	- Balance 10 kg canacity	1 no
		1110
15	Compaction of Bituminous Mixtures and Marshall Test	
10.		
	- Compaction mould	2 no
	- Compaction mould body	2 no
	- Compaction pedestal	1 no
	- Compaction hammer (4.5 kg)	1 no
	- Sample extruder	1 set
	- Marshal Tester (Motorized Load frame 50 kN)	2 no
	- Breaking head stability mould	4 no
	- Dial Gauge (various capacity)	1 no
	- Water Bath with Thermostat	1 no
16.	Binder Determination (Centrifuge Extractor Method)	
	- Hand operated extractor, 1500 g capacity	1 set
	- Filter discs (100 per pack)	As required
	- Bowl	2 no
4=		
17.	Balances: (as specified)	
		1 no
	a) Duoyancy Datance, TO ky capacity, 0.1 g accuracy for specific aravity determination	
	(1) yravity usis initiation b) Triple Ream Balance 2610 a 0.1 accuracy (equivalent to $OUAUS)$	1 no
	c) Heavy Duty Solution Balance, 20 kg, 1 a accuracy (equivalent to	1 no
	OHAUS)	
1		1

SN Item Description	No. of Items
18. <u>Glassware: (as specified)</u>	
SN Item Description 18. Glassware: (as specified) a) Flat bottom flasks 500 ml b) Volumetric Flask, 500 ml c) Graduated glass beakers (100 ml - 1000 ml) d) Measuring cylinder (100 ml - 1000 ml) e) Glass rod dia 10 mm x 400 mm long f) Reagent bottles (500 ml - 1000 ml) g) Spare corks for bottles 19. Miscellaneous Equipment: (as specified) - Laboratory oven(250°), 220 V, 50 Hz, Single Phase, Thermostatically controlled, 330 dmsu ³ - Air circulated laboratory oven, 220 V, 50 Hz, single phase, 250 dm ³ - Hydrometer set (consisting of 1 hydrometer and 6 hydrometer jars, 1000 ml) - Speedy moisture tester - Pocket type thermometer, 0-250°C	6 no. 6 no. 6 no 12 no 6 no 6 no 12 no 12 no 12 no 12 no 12 no 12 no 12 no 2
 Pocket type themometer, 0-25°C Metal thermometer, 0-25°C Armoured Thermometer, 0-25°C x 2°C Dial Thermometer, 0-250°C x 2°C Stopwatch Sample splitter, 25 mm, 19 mm, 12 mm size or as specified Moisture can, 90 mm diameter 50 mm, deep Mixing pan 400 mm x 100 mm x 765 mm, Mixing pan 220 mm x 100 mm x 75 mm, Mixing pan 450 mm x 450 mm x 75 mm Tin sample boxes Laboratory tongs Wire gauges Electric hot plates, 220/50 1000 watts 10-20 litre buckets, stainless steel or equivalent Aluminium pot 3 litre capacity Kitchen knives, stainless steel 10 litre jerry cans Yield bucket Spades Hammer 1KG,5KG Chisel 300mm long Steel calibrated ruler Others as required 	2 no 2 no 4 no 3 no 6 no 6 no 12 no 12 no 12 no 12 no 12 no 3 no 1 no 3 no 2 no 2 no 3 no 3 no 3 no 2 no

(2) Ownership

Unless otherwise stated in the contract the ownership of all laboratory equipment including testing equipment and furniture of the laboratory shall remain as the property of Department.

(3) Attendance

The Contractor shall keep the laboratory in a well maintained, clean and habitable condition. The Contractor shall keep all laboratory equipment in good working condition throughout the period of the contract at his own expense. Testing apparatus shall be maintained in serviceable condition and all measuring and control equipment will be checked and calibrated from time to time, as required by the Engineer, and immediately adjusted or replaced if it is found that correction is not possible. Any equipment, which become unserviceable during use shall be repaired or replaced by the Contractor at no extra cost to the Employer.

The Contractor shall provide all tools, accessories, services for utility, communication, consumable items for testing and operating, and all the assistance as may be required by the Engineer and his staff for measuring and checking the works.

(4) Testing

Without relieving the Contractor of any of his responsibility for the testing of materials the Engineer may as and when he desires carry out any of the tests specified above using the facilities. The Engineer may order the Contractor to carry out additional laboratory tests in independent laboratory, as deemed necessary.

For all testing which cannot be carried out in the Laboratory at the Site, the Contractor shall be responsible for arranging for such testing to be carried out at an independent laboratory to be approved by the Engineer. The Contractor shall be responsible for all attendance on staff from these approved testing laboratories, including if necessary the provision of transport for personnel, equipment and test specimens. No testing by external laboratories shall be carried out without the written instruction of the Engineer.

(5) Measurement and Payment

- (a) Establish a field laboratory at the designated location and payment shall be made from Lump Sum amount to cover the overhead cost, profit and other incidentals for establishments, completion and approval of laboratory set up as specified in contract.
- (b) Provide and maintain furniture as required and payment shall be made from the Lump Sum amount in BoQ on the basis of equal monthly installments of the contract period since completion of installation and operation of the laboratory.
- (c) Provide and maintain all necessary services and consumables as required for the project.

The payments to respective items as above shall be the full and the final compensation to the Contractor as per Clause 116.

SECTION 400 - QUARRIES, BORROW PITS, STOCKPILE AND SPOIL AREAS

- 401 GENERAL
- 402 DEFINITIONS
- 403 IDENTIFY MATERIAL SOURCES
- 404 SAFETY AND PUBLIC HEALTH REQUIREMENTS
- 405 ACCESS ROADS AND TRAFFIC CONTROL
- 406 SITE CLEARANCE AND REMOVAL OF TOPSOIL AND OVERBURDEN
- 407 SELECTION, MIXING AND STOCKPILING OF MATERIALS
- 408 PRE-SELECTION OF MATERIALS
- 409 PROCESSING
- 410 MATERIAL UTILISATION
- 411 MEASUREMENT AND PAYMENT

SECTION 400 - QUARRIES, BORROW PITS, STOCKPILE AND SPOIL AREAS

401 GENERAL

Unless otherwise stated in the contract, it is the responsibility of the Contractor to select the sources of rock/stone for pavement materials (such as subbase, base course, asphalt concrete/bituminous base/binder and wearing courses, chippings for surface dressing and other wearing courses); stones for masonry works, aggregates for mortar and concrete; natural/suitable materials, such as fill material, for the construction of embankments; gravel for road subbase and shoulder. Such sources shall be designated as rock quarries, river quarries/alluvial deposits, quarries and borrow pits and are defined in Clause 402. Certain rock quarries, quarries, authorities prior to the commencement of the contract and the Engineer shall instruct the Contractor as to which of these shall be utilized for the extraction as natural or suitable materials to be used in the works.

Provisions are included in subsequent clauses of this section of the Technical Specifications for additional rock quarries, quarries, alluvial deposits, borrow pits to be identified and located by the Contractor during the contract. The Contractor during execution of the contract can explore further suitable material sources and get approval on their extraction from concerned authorities, and materials from such sites could be permitted by the Engineer depending upon their suitability to meet the requirements of the Technical Specifications.

Stockpile and spoil areas shall be located by the Contractor subject to the approval of the Engineer.

402 DEFINITIONS

(1) Rock Quarry

A rock quarry is an open surface working in massive rock from which stone is removed by drilling, blasting for use in the works.

(2) Quarry

A quarry is an open surface working from which stone or aggregates for subbase, base and surfacing are extracted for use in the works.

(3) Alluvial Deposit

An alluvial deposit is a site where gravel and aggregates of alluvial origin are extracted for use in the works.

(4) Borrow Pit

A borrow pit is a site from which loose material, other than stone, is removed for use in the works.

(5) Stockpile Area

A stockpile area is an area where material such as topsoil, fill material, gravel or aggregate is stockpiled prior to use in the works.

(6) Spoil Area

A spoil area is a site upon which surplus or unsuitable materials arising out of the works are dumped within or beyond the road reserve as indicated on the Drawing or directed by the Engineer.

403 LOCATING MATERIAL SOURCES

(1) The Contractor shall be responsible for locating all material sources and for obtaining approval, the acquisition or renting of all land required for rock quarries, quarries, alluvial deposits, borrow pits, spoil and stockpile areas and for access thereto in accordance with the Conditions of Contract.

The location and size of rock quarries, quarries, alluvial deposit, borrow pits, spoil and stockpile areas proposed by the Contractor shall be subject to the approval of the Engineer.

The Engineer shall withhold his approval, if in his opinion the rock quarry, quarry, alluvial deposit, borrow pit, spoil and stockpile area, or access into them under the following circumstances:

- (a) it is not approved from the concerned authorities;
- (b) it will have a detrimental effect on the environment;
- (c) it would be very difficult to acquire;
- (d) it is in or near an urban centre;
- (e) it will require an access road which is excessively long;
- (f) it has excessively thick layers of overburden;
- (g) it covers too large an area; and
- (h) it would constitute a danger to the public
- (2) The Contractor shall submit for the Engineer's approval full information regarding the proposed location of the material source not later than 30 days after issuance of the order to commence the works of all rock quarries, quarries, alluvial deposits, borrow pits, spoil and stockpile areas that the Contractor will require for the whole of the works.

The Contractor's written notice shall include the following for each rock quarry, quarry, alluvial deposit, borrow pit, spoil and stockpile areas:

- (a) A plan at 1:500 scale giving details of:
 - (i) type of land (government, community, private), details and plot/land boundaries
 - (ii) government land including required details and permission from concerned government authorities
 - (ii) private land including land owners' names and addresses, and other details, as required.
 - (iii) Dzongkahg, Geog, village, Land Record registration (i.e.Tharm number) for each plot;
 - (iv) local details such as buildings, fences, types and areas of cultivation and services, all agreed with the concerning land owners; and
 - (v) areas to be used for working areas, stockpile areas, safety blasting zones etc.
- (b) Cadastral maps covering the areas to be acquired, as available.
- (c) Details of the proposed access road route.
- (d) Technical information relevant to rock quarries, quarries, alluvial deposits, borrow pits, including:
 - (i) Summary of material investigation, indicating the alluvial deposits, the thickness of layers, thickness of overburden, lenticular beds, depth and configuration of the bedrock, etc., and in addition for rock quarries, the discontinuities thickness and nature of the infilling, the Weathering Index,
 - (ii) Laboratory results including petrographic identification, and for alluvial deposit material, grading, tests on the fine fraction (PI, Mica content, Organic matters), tests on the coarse fraction (LAA, AIV, ACV, FI, Bitumen Adhesive test), CBR test, or for quarry material, LAA, AIV, ACV, Bitumen Adhesive test, Specific Gravity, Water Absorption, as appropriate
 - (iii) Conclusions on qualities and quantities.
- (3) Where the Contractor uses an approved rock quarry, quarry, alluvial deposit, or a borrow pit identified or instructed by the Engineer he shall obtain the Engineer's approval of the areas required for the rock quarry, quarry, alluvial deposit, or borrow pit and of the siting of the access roads into the rock quarry, quarry, alluvial deposit, or borrow pit. The Engineer may require the Contractor to modify his requirements for any of the reasons outlined in Sub-clause 403(1) (b), (c), (d), (e), or (g).

Where rock quarries, quarries, alluvial deposits, or borrow pits, available for inspection at the time of the bidding, are instructed by the Engineer the Contractor shall satisfy himself as to the quality and

quantity of materials available before providing the information required in this Clause. Should such investigations reveal that there is insufficient suitable material for the use for which such material sources were intended, the Contractor shall immediately inform the Engineer in writing and the Engineer shall either direct that such sources are extended or that new sources shall be used.

(4) When a rock quarry, quarry, alluvial deposit, borrow pit spoil or stockpile area has insufficient suitable material or area for the use for which it was intended the Contractor shall propose in writing that either any existing rock quarry, quarry, alluvial deposit, borrow pit, spoil or stockpile area be extended or that a new rock quarry, quarry, alluvial deposit, borrow pit spoil or stockpile area shall be used. The approval and acquisition of such new or extended rock quarries, quarries, alluvial deposits, borrow pits, spoil or stockpile areas shall be in accordance with all the above provisions of this Clause for the acquisition of the original rock quarries, quarries, alluvial deposits, borrow pits, spoil or stockpile areas.

404 SAFETY AND PUBLIC HEALTH REQUIREMENTS

The Contractor shall comply with the relevant laws, rules and regulations in force including those of the Local Authority regarding public health and safety in respect of the operation of rock quarries, quarries, alluvial deposits, borrow pits, spoil or stockpile areas, and in the absence of, or in addition to such Regulations, shall comply with the following conditions:

- (1) All areas of work, if they are not naturally under water, shall be drained and kept drained. Where a quarry or borrow pit has been excavated such that it will not drain naturally, it shall be kept pumped dry while being used.
- (2) The Contractor shall confine his operations solely to the areas provided and shall demarcate the boundary of the area and erect temporary or permanent fencing as instructed by the Engineer.
- (3) Where the height of any face exceeds 1 metre, the Contractor shall provide, erect and maintain at his own expense stock proof fencing and gates to prevent unauthorised access to the top of the working face.
- (4) On completion of the work all faces shall be neatly trimmed to a slope flatter than 1:4. Where this is impracticable or where the working face is to be left exposed, the edge shall be permanently fenced, as instructed by the Engineer.
- (5) On completion of work, temporary fences and all temporary structures shall be demolished and removed. All latrine pits shall be filled in and drained. The site shall be top soiled and left neat and tidy.

405 ACCESS ROADS AND TRAFFIC CONTROL

The Contractor shall comply with the provisions of Clause 106 and with the Conditions of Contract with regard to the construction and maintenance of access roads to rock quarries, quarries, alluvial deposits, borrow pits spoil and stockpile areas and with regard to traffic operations thereon.

406 SITE CLEARANCE AND REMOVAL OF TOPSOIL AND OVERBURDEN

Unless otherwise specified in the contract or instructed by the Engineer, the Contractor shall clear the sites of all rock quarries, quarries, alluvial deposits, borrow pits, spoil and stockpile areas in accordance with Section 500 but measurement and payment shall be made in accordance with this Section.

All existing fences, trees, hedges and other features shall not be removed or otherwise dealt unless instructed by the Engineer. They shall be protected in accordance with Section 500.

Unless otherwise directed by the Engineer, the Contractor shall remove topsoil and/or overburden from rock quarries, quarries, alluvial deposits, borrow pits and spoil and stockpile areas. The Engineer shall direct whether topsoil shall be stripped and stockpiled separately or shall be excavated and spoiled together with the overburden. If suitable, the Engineer may direct for the use of overburden in the works.

On completion of the work in any rock quarry, quarry, alluvial deposit, borrow pit, spoil or stockpile area the overburden and/or topsoil which has not been used in the works shall be pushed back, spread and landscaped over the area of the rock quarry, quarry, alluvial deposit, borrow pit, spoil or stockpile area. Where topsoil has been stockpiled separately, it shall be pushed back and spread over the rock quarry, quarry, alluvial deposit, borrow pit, spoil or stockpile area for topsoil or stockpile area after landscaping unless the Engineer has instructed that it shall be used for topsoiling in accordance with Section 1900.

407 SELECTION, MIXING AND STOCKPILING OF MATERIALS

Before a quarry, alluvial deposit or borrow pit is opened, the Engineer shall instruct the Contractor as to the type of material to be excavated and the areas and depth to be worked. The Engineer may require specific operations of equipment according to the characteristics of the raw material and the characteristics of the final product to be obtained in accordance with Clauses 408 and 409 or other relevant Sections of those Specifications.

The Contractor may be required to mix the selected materials by bulldozing into stockpiles and/or face loading by shovel. The stockpiles shall be formed at least six weeks before intended use of the materials which are to be treated and at least three weeks before intended use for materials which are not to be treated.

The Contractor shall ensure that oversize material, clay humus or unsuitable material encountered in the working operations is separated from the materials proposed for use in the works and such inferior material shall be removed to spoil.

A separate stockpile shall be used for each type and grading of material.

When removing material from stockpiles, none of the underlying material shall be mixed with it, and generally at least the bottom 100 mm layer shall be left behind.

Should any stockpile prove surplus to requirements, the Contractor shall spread the material over the area of the quarry or borrow pit unless otherwise directed by the Engineer.

408 PRE-SELECTION OF MATERIALS

When necessary to meet requirements of the Specifications for materials extracted from quarries or alluvial deposits the Contractor shall carry out a preliminary size selection or screening of the raw materials as instructed by the Engineer.

409 PROCESSING

The Contractor shall use adequate processing equipment and methods to achieve the characteristics and performances of the aggregates to be produced.

The processing methods may include successive steps such as primary crushing, screening for elimination of fine and soft materials, secondary crushing and recycling, washing.

The Contractor shall carry out site trials in accordance with Clause 307 using the Constructional Plant and methods proposed for selecting and processing the materials to demonstrate their suitability to achieve the materials requirements specified in the Technical Specifications.

(1) Crushing

The crushing process shall include all crushing stages, such as primary crushing, secondary crushing or grinding (after primary screening) tertiary grinding (after secondary screening), as necessary to meet the requirement of the final product specified in the Technical Specifications. The feeding hoppers shall be

equipped with appropriate devices, such as drawer or vibrating metallic desk, to allow for a regular and full charge supply of the materials to the crushers.

(2) Screening

The Contractor shall eliminate polluted or soft materials after the primary crushing by screening the crushed materials through a 50 mm mesh screen.

The Engineer may instruct the Contractor to modify the above mentioned size for the elimination of soft materials according to the results of the laboratory trials.

In case of materials sensitive to crushing, the Engineer may instruct the Contractor to carry out a secondary screening after the secondary crushing.

(3) Recycling and Sand Production

According to the type and quality of materials to be produced, and notably the sand materials, the Contractor shall include in the crushing process the recycling of the coarse fraction resulting from the primary crushing through the secondary crusher or through the secondary or tertiary grinder.

(4) Washing

Where the washing of aggregates is required to meet the cleanliness requirements, and notably for the chippings for surface dressing, the Contractor shall incorporate to the processing plant an appropriate washing station including adequate equipment such as vibratory washing machine, a washing screw, washing tube etc. and of adequate capacity.

Sands with too high mica content shall be washed using appropriate equipment such as screw classifiers, paddle wheel etc.

(5) Testing

Each type of final products shall be tested in accordance with the tests and frequencies of testing as specified in the relevant Sections of these Specifications.

(6) Records

The Contractor shall maintain records in respect of the following data throughout the production period:

- (a) daily production
- (b) testing results, in accordance with the test schedules specified in the relevant Sections of these Specifications.
- (c) Incident occurred during the production, if any.

410 MATERIAL UTILISATION

All materials from rock quarries, quarries, alluvial deposits, borrow pits as instructed by the Engineer shall only be used for permanent works shown on the Drawing or instructed by the Engineer and any other use shall be subject to the Engineer's approval.

411 MEASUREMENT AND PAYMENT

No separate measurement and payment shall be made in respect of all items in this Section, unless otherwise specified in the contract. The Contractor shall be deemed to have allowed the cost of complying all requirements of this Section elsewhere in his rates including all site clearance, overburden and topsoil removal, access roads to rock quarries, quarries, alluvial deposits, borrow pits, spoil or stockpile areas and reinstatement including landscaping and spreading topsoil.

SECTION 500 - CLEARING, GRUBBING AND REMOVALS

501 CLEARING AND GRUBBING

(1) Scope

This Section covers the clearing and grubbing necessary for the construction of the works covered by the contract. Conservation of the top soil and flora is also covered under this Section.

(2) Description of Work

(a) Clearing

Clearing shall consist of the cutting, removing and disposal of all trees, bushes, shrubs, grass, weeds, other vegetation, anthills, rubbish, fences, top soil of thickness approximately 200 mm and all other objectionable material, resulting from the clearing and grubbing. It shall also include the removal and disposal of structures that obtrude, encroach upon or otherwise obstruct the work.

The moving of a certain amount of soil or gravel material may be inherent to or unavoidable during the process of clearing and no extra payment shall be made for this. Clearing shall include the removal of all rocks and boulders of up to 0.15 m^3 in size exposed or lying on the surface.

(b) Grubbing

All trees measuring less than 300 mm girth (measured at 1 m from the ground)within the road formation, including the stumps and roots shall be removed to a depth of not less than 150 mm below the sub-grade level or a minimum of 600 mm below the original ground level whichever is lower.

Except in borrow areas the cavities resulting from the grubbing shall be backfilled with approved material and compacted to a density not less than the density of the surrounding ground.

(c) Conservation of Top Soil

Where suitable topsoil exists within the limits of the area to be cleared and grubbed, the Contractor shall, if ordered by the Engineer, remove the topsoil together with any grass and other suitable vegetation. If not used immediately, the topsoil shall be transported and deposited in stockpiles for later use.

(d) Conservation of Flora

Where provided for in the contract, certain designated flora encountered in the road reserve and borrow areas shall be carefully protected by the Contractor. In his contract price, the Contractor shall include for the careful removal and planting of the flora in a protected and fenced-off area and, on completion of the road, for the replanting of the flora in suitable positions in the road reserve in accordance with the Engineer's instructions.

(3) Execution of Work

(a) Areas to be Cleared and Grubbed

Stumps, embedded logs, roots and all other vegetable growth and accumulated rubbish of whatsoever nature and all other objectionable material shall be completely removed to a depth as specified in Subclause 501 (2) (a) and (b).

Normally the portions of the road reserve that fall within the limits of the road prism, as well as certain borrow areas shall be cleared and/or grubbed. Where the road reserve is to remain unfenced, the full width of the

road reserve shall be cleared and/or grubbed except for such trees designated by the Engineer to be left standing and uninjured.

The Contractor shall mark the boundaries of the area for clearing and grubbing and seek the approval of the Engineer before commencement of the work. The Engineer shall designate in detail the exact areas to be cleared and grubbed and the time at which it shall be done.

(b) Cutting, Felling of Trees

The Contractor shall take the necessary precautions to prevent damage to structures and other private or public property.

The Contractor shall carry out felling and cutting of trees with girth not less than 300 mm and above (measured at 1 m from the ground) manually or using equipments. Such individual trees shall be approved and marked at the site by the Engineer.

Due process must be followed and approval/permit for cutting trees must be obtained from the Department of Forests & Park Services who may require that trees be numbered, measured and marked in the presence of officials from the Department of Forests & Park Services. The copies of permits for tree felling and record of numbering, marking and felling of trees must be maintained by the Contractor. Cutting of such trees shall then be carried out by the Contractor and the timber stored at designated locations within the road Right of Way.

Felling and cutting of trees on the site and piling them off the site shall conform to the requirements of the Department of Forests & Park Services.

Wood, branches, twigs of trees and other useful material shall be property of the Government. The serviceable materials shall be stacked at sites in the manner as directed by the Engineer. All unserviceable materials shall be disposed off as per the instructions of the Engineer.

All timber except such timber as can be used and all brush, stumps, roots, rotten wood and other refuse from the clearing and grubbing operations shall be completely removed from the road Right of Way. The roots of trees shall be dug at least up to 600mm from the ground level or 150mm below sub-grade level whichever is lower. All holes or hollows formed by digging up roots shall be carefully filled up with earth and properly compacted.

If felling of trees is carried out by bulldozer/excavator, power chain or any other suitable equipment shall be used to minimize any damages including environment.

(i) Blasting for Removal of Trees

The blasting operation, if any, for felling of trees shall be carried out strictly as per the guidelines given in DoR, Blasting Manual. All blasting operations shall only be done under careful supervision of trained/certified personnel and the contractor shall take all precautions as per Explosives Rules in force.

The contractor shall be responsible for any damage arising out of accident to the workmen, public or property due to storage, transportation and use of explosive during blasting operation.

For felling of trees, the holes shall be drilled inclined downward with a 30 mm auger. The location of holes shall be in parallel section of the trunk just above the butt. For trees up to 450 mm in girth one drill hole will be generally sufficient. For larger trees a series of equally spaced radial holes drilled within about 25 to 50 mm center to center shall be used.

The placing and quantity of explosives required shall vary with each tree and is governed by the age, type and girth. As general rule 1.2kg to 1.52 kg of explosives per square meter of cross section will be sufficient.

For removal of stumps or standing trees, placing of drill holes and quantity of explosives required shall vary with each tree and is governed by the size, type of stumps or tree, and the root system. Sandy or loose soil will require heavier charges than clay soil. The charge shall be placed centrally under the butt. But if there is

only one taproot the explosives shall be placed under the fork formed by two of the largest surface roots. In stumps 900mm in girth or over, the charge shall be split and placed at two or more places around the tree.

(c) Dealing with Anthills

Where anthills are encountered within the limits of the road prism, they shall be excavated to a depth of not less than 750 mm below the finished road level and the material carted to spoil. Cavities resulting from the clearance of anthill material shall be backfilled with approved material and compacted to a density not less than that of the surrounding ground.

Where directed by the Engineer, the area covered by anthills shall be treated, after excavation and before backfilling of cavities, with an approved ant control chemical. Payment for such treatment shall be made in the manner specified in the contract.

(d) Disposal of Material

Material obtained from clearing and grubbing shall be disposed off in borrow pits or other suitable places and be covered up with soil or gravel as directed by the Engineer. The burning of combustible material shall not, normally, be permitted and may only be done with the prior written approval of the Engineer.

Where fences have to be taken down, fencing wire shall be neatly wound into reels and all such wire, together with all fence posts and other serviceable material from structures, etc., shall be stacked at sites indicated by the Engineer.

Rock dumping shall be carried out at the places identified by the Engineer. The dump site shall be made good by placing soil layer and planting vegetation. Alternatively, the dump sites may be shotcreted if in the opinion of Engineer such operation is warranted by the site condition. The Engineer shall implement this operation using the provision of days work.

(e) Re-clearing of Vegetation

When portions of the road reserve, borrow or other areas have been cleared in accordance with the Technical Specifications, but in the course of time, vegetation grows again during construction, the Engineer may, if he considers it necessary, order that the area be re-cleared.

Before the bottom layer of the embankment is made, the Contractor shall grub up and remove any vegetation that may in the meantime have grown on the surfaces previously cleared and grubbed.

Such re-clearing of areas previously cleared include the removal and disposal of grass, shrubs and other vegetation in the same manner as for the first clearing operation. No separate payment shall be made for re-clearing of vegetation.

(4) Measurement

Clearing and grubbing executed as per this Specification shall be measured in square meter.

Cutting trees including removal of stumps and their roots and backfilling to required compaction shall be measured in number according to the sizes given below:

- (a) 300 mm to 600 mm
- (b) Above 600 mm to 900 mm
- (c) Above 900 mm

For this purpose girth shall be measured at a height 1 meter above ground. No separate measurement shall be made for blasting for removal of trees.

(5) Payment

Clearing and grubbing and cutting trees shall be paid at their respective contract unit rates which shall be the full and the final compensation to the Contractor as per Clause 116. The contract unit rate for cutting of trees shall also include handling, salvaging, piling and disposing off the cleared materials for all leads and lifts. The cost for cutting of trees less than 600 mm girth including removal of stumps and roots and backfilling of holes with compaction shall be built in the relevant items of the Specification and shall not be paid for under the item – cutting and felling of trees.

502 DISMANTLING CULVERTS, OTHER STRUCTURES AND PAVEMENTS

(1) Scope

This work shall consist of removing as hereinafter set forth existing culverts, pavements, buildings and other structure like guard-rails, kerbs, manholes, catch basins, inlets, walls, drains etc., which are in place but interfere with the new construction or are not suitable to remain in place, and salvaging and disposing off the resulting materials and back filling the resulting trenches and pits.

(2) General

- (a) Only those structures designated by the Engineer, or shown on the Drawings, shall be demolished or removed.
- (b) Dismantling and removal operations shall be carried out in such a way that the adjacent pavement, structures are left intact and in place. All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to start of new work.
- (c) Existing culverts, buildings and other structures which are within the road and which are designated for removal, shall be removed up to the limits and extent specified on the Drawing or as indicated by the Engineer.
- (d) Materials that are to be salvaged shall be carefully removed and stockpiled near the site at a location designated by the Engineer. Materials which are to be salvaged or used in the reconstructed work and have been damaged or destroyed as a result of the Contractor's operations, shall be repaired or replaced by the Contractor at his expense. Materials that are not to be salvaged and stockpiled shall become the property of the Employer. In general, abutments shall be removed to at least 300 mm below ground level measured at the face unless a different depth is designated or specified. Existing reinforcement that is to be incorporated in new work shall be protected from damage and shall be thoroughly cleaned of all adhering material before being embedded in new concrete.
- (e) When pipe culverts, wooden culverts, gabion walls or other structures with a salvaged value are removed, care shall be exercised in their safe removal. The material involved shall be kept intact without damage. The Contractor shall be responsible for the satisfactory removal of such structures in a usable condition.
- (f) Salvaged reinforced concrete pipes, steel pipes, other structures shall be stored at places as directed by the Engineer or as shown in the Drawing. Structures or portions thereof which are specified in the contract for re-erection shall be stored in separate piles.
- (g) Timber from old structures which is designated by the Engineer as materials to be salvaged shall have all nails and bolts removed there from and shall be stored in neat piles in locations suitable for loading.
- (h) All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.
- (i) All salvaged or un-salvaged materials shall be the property of the Employer.

(j) All materials obtained from dismantling operations which, in the opinion of the Engineer, cannot be used or auctioned shall be disposed off.

(3) Dismantling Culverts and Bridges

The structures shall be dismantled carefully and the materials shall be so removed as not to cause any damage to the serviceable materials to be salvaged. The part of the structure to be retained and other structures nearby shall be safeguarded against any damages.

Where existing culverts are to be otherwise incorporated in the new work, only such parts of the existing structure shall be removed as are necessary and directed by the Engineer to provide a proper connection to the new work. The connection edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained.

(4) Dismantling Other Structures

In removing kerbs, gutters, walls and structures like catchpits, outlets, etc., where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with face perpendicular to the surface of existing structure. Sufficient removal shall be made to provide connections with the new work as directed by the Engineer.

(5) Back-filling

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density as directed by the Engineer.

(6) Measurement

Prior to commencement of dismantling, the work of dismantling structures shall be measured in the units given below:

	Type of Work	Unit
(i)	Dismantling brick/stone masonry/	
	concrete (plain and reinforced)	cu.m.
(ii)	Dismantling gabion	cu.m.
(iii)	Dismantling timber structures	cu.m.
(iv)	Dismantling pipes, guard rails,	
	kerbs and gutters	lin. m.
(v)	Dismantling Utility services	lump sum
(vi)	Dismantling pipe culverts	no.
(vii)	Dismantling pitching and rip raps	sq. m.

Associated works like disposal, stockpiling, marking and numbering, etc. shall not be measured separately.

(7) Payment

The various dismantling works shall be paid at their respective contract unit rates which shall be the full and the final compensation to the Contractor as per Clause 116 and for the cost of all operations involved for completion of this item.

SECTION 600 - EARTHWORKS

- 601 SCOPE
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CUTTINGS

- 607 EXCAVATION FOR FOUNDATION, DITCHES, PAVEMENT, SLOPES, LANDSLIDE
- 608 REFILLING OF FOUNDATION PITS AND TRENCHES, REMOVAL OF SUPPORTS AND FILLINGS TO STRUCTURES
- 609 FORMING OF EMBANKMENT AND OTHERS AREAS OF FILL
- 610 COMPACTION OF EMBANKMENTS AND OTHER AREAS OF FILL/BACKFILL
- 611 COMPACTION TRIALS
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- 616 FILLING EXISTING WATERCOURSES
- 617 PROCESS CONTROL
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- 619 PAYMENT

SECTION 600 – EARTHWORKS

601 SCOPE

This Section covers the works related to the roadway excavation (with or without blasting), roadway filling, excavation for foundation (with or without blasting), backfilling, excavation for drains, channels, intercepting drains etc. The works shall consist of excavation (with or without blasting), transport and disposing of all unsuitable and excess materials and excavating, hauling, placing and compacting suitable materials, from areas of excavation or borrow, all as required to construct the graded areas, embankments, roads, drainage, building construction sites and parking, or other fill area. The work shall be done in accordance with these specifications and in conformity with the lines, levels, grades, dimensions and typical cross-sections shown on the Drawings and as directed by the Engineer.

Suitable materials taken from excavation shall be used in the formation of embankment, subgrade, or for backfilling, or construction of structures all as indicated on the Drawings or as directed by the Engineer. When the volume of suitable excavated material exceeds that required to construct the works to the grades indicated, the excess shall be hauled, disposed with proper soil management at safe tipping sites as directed. When the volume of excavation is not sufficient for constructing the works to the grades indicated, the deficiency shall be supplied from the borrow areas.

602 DEFINITIONS AND GENERAL REQUIREMENTS

(1) Earthwork includes two types of operations i.e. (i) earth excavation and disposal of the excavated materials (ii) earth excavation and use of excavated materials. The use of excavated materials may be in the form of filling embankment, backfilling, filling other areas as required.

Earth excavation and disposal implies excavation of all types of materials including part of the structures below ground level within and outside of the limit of the road right of way except otherwise specified, shaping the exposed surface of excavation as specified or directed by the Engineer, removal, hauling and disposal of the excavated material at the locations and in the manner as specified or directed by the Engineer.

Excavation and filling implies excavation of materials and shaping the exposed surface of excavation as stated above, removal, hauling and use of the excavated material at the location and in the manner as specified or directed by the Engineer.

Excavation and disposal shall include:

- (i) Excavation and disposal of any type of material indicated on the Drawing.
- (ii) Excavation and removal or partial removal of existing pavement.
- (iii) Excavation and disposal of landslides, breakages and caving-ins.
- (iv) Excavation and disposal for stream channel, trenches and drains etc.
- (v) Excavation required in cuts or under embankments below the lowest normal limit of excavation as indicated on the Drawing or below ground line.
- (vi) Excavation and disposal of unsuitable materials.
- (vii) Removal or partial removal of existing embankments and disposal of the materials as shown on the Drawing or as directed by the Engineer.
- (viii) Excavation for foundation and disposal of materials.

Excavation and filling shall include:

- (i) Filling for embankment
- (ii) Backfilling in trenches, foundation pits etc.
- (iv) Any type of other filling or backfilling whereby the ground level is raised or a hole is filled up.
- (2) The following definitions of earthwork materials shall apply to this and other Clauses of these specifications, if otherwise not specified.
 - (i) "Topsoil" shall mean the top layer of soil that can support vegetation. It shall include turf acceptable for turfing.
 - (ii) "Suitable Material" shall comprise all that is acceptable in accordance with the Contract for use in the Works and which is capable of being compacted in the manner specified in Clauses 609 and 610 to form a stable fill having side slopes as indicated in the Drawing. The material used in fill (except for rock fill) shall not contain rock fragments with dimensions of more than 75 mm.
 - (iii) "Unsuitable Material" shall mean other than suitable material and shall include:
 - (a) Material from swamps, marshes or bogs;
 - (b) Peat, logs, stumps, perishable material, organic clays;
 - (c) Material susceptible to spontaneous combustion;
 - (d) Material in a frozen condition; materials classified as such, if otherwise suitable, shall be classified as suitable when unfrozen.
 - (e) Clay of liquid limit exceeding 70 and/or plasticity index exceeding 45;
 - (f) Any such materials unless otherwise permitted in the contract
 - (iv) "Rock Fill" shall consist of hard material of suitable size for deposition and compaction as given in Clause 609 and also may comprise rock as defined in Clause 603 and broken stones.
 - (v) "Cohesive Soil" is defined as fine grained soil, which is plastic within a moderate to wide range of water content. Dry specimens are very hard, and no powder can be detached by rubbing the surface of dried pots with the fingers. Cohesive soils are formed due to chemical weathering of rocks. Example: clay, plastic silt, etc.
 - (vi) "Cohesionless Soil" is defined as fine or coarse grained aggregates of rounded sub-angular or angular fragments of more or less unaltered rocks or minerals, which are formed due to physical disintegration of rocks and which is non-plastic in nature. Example: sand, gravel etc.
 - (vii) "Well Graded Granular Material" consisting of gravel and/or sand shall conform to Clause 609.
 - (viii) "Uniformly Graded Material" includes sands and gravels with a uniformity coefficient of 10 or less.
- (3) Prior to the commencement of any excavation, the Contractor shall satisfy himself as to the circumstances at the site and of all and the various materials, obstructions, strata, water streams including the possibility of floods, etc., and of all other items and things liable to affect or be encountered in the excavation necessary for the proper construction of the works. The rates priced in the Bill of Quantities shall provide for these circumstances.
- (4) The Contractor shall ensure that earthwork operation do not cause interference to the public. If excavations are carried out within 5 m of buildings, the Contractor shall execute the work in a way that will minimize damage and disturbances. In general, vertically sided excavation will be required in such places and all necessary timbering or other support shall be provided. Under-excavation of excavation sides will not be permitted.
- (5) No excavated suitable material other than surplus to requirements of the contract shall be removed from the site except on the direction of the Engineer. Should the Contractor be permitted to remove

suitable material from Site to suit his operational procedure, then he shall make good at this own expense any consequent deficit of filling arising therefrom.

- (6) Material in surplus to the total requirements of works, and all unsuitable materials shall, unless the Engineer permits otherwise, be run to spoil dumps.
- (7) Where the excavation reveals a combination of suitable and unsuitable materials the Contractor shall carry out the excavation in such a manner that the suitable materials are excavated separately for use in the works without contamination by the unsuitable materials.
- (8) The Contractor shall make his own arrangements for the stockpiling of top-soil and/or suitable material.
- (9) At all times the Contractor shall ensure that earthworks are not damaged by weather or traffic. In the event of such damage occurred, the Engineer may withdraw approval from the affected works until the Contractor has carried out repairs to restore the works to their original condition.

The cost of all such repairs and any additional testing shall be borne by the Contractor without extra cost to the Employer.

- (10) Prior to commencement of any earthwork, the work shall be set out where required as specified in Clause 107 following the clearing and grubbing as per Section 500 and a survey of the existing ground shall be conducted jointly by the Contractor and the Engineer. The survey records shall serve as initial measurements for the determination of the final quantities of earthwork performed under the contract.
- (11) Work on embankments and/or cuttings in areas required for the construction of bridges and other structures shall not be carried out until the Engineer agrees that construction of such structures is sufficiently advanced that there is no interference or damage to them.
- (12) The Contractor shall get approval of the Engineer in respect of method of earthwork, type of equipment to be used, disposal and other details before commencement of the earthwork.

603 CLASSIFICATION OF EXCAVATED MATERIALS

The excavated materials shall be classified under the following two categories. The decision of the Engineer in respect of the classification of excavated materials shall be the final and binding upon the Contractor.

(1) Soil

It shall mean any type of soil other than rock. Generally this included any material which yields to the application of pick, shovel, scarifiers or other digging implements. This shall comprise any of the following:

- (a) Vegetable or organic soil, turf, sand, loam clay, mud, peat, black cotton soil, stiff heavy clay, shale, moorum, mud concrete and any mixture of these soil.
- (b) Gravel, shingle and boulders having maximum dimensions up to 300mm in one direction.
- (c) Soling of roads, paths, etc. and hard core, macadam surfaces of any description (water bound, grouted, bituminous surface etc.)
- (d) Any masonry work in cement mortar below ground level.
- (e) Generally any material which requires the close application of picks, shovels, or other digging implements.

(2) Rock

It shall mean rock comprising any type of rock, un-reinforced/ plain cement concrete, reinforced cement concrete which can be quarried or split or broken or excavated with crowbars or wedges, or require the use of mechanical equipment or blasting.

The PETTIFER point load index graph as per BS: 5930 shall be used to classify the material type (soil or rock) in case of any misunderstanding and or disputes between the contractor and the Engineer in the classification of soil.

The classification requires testing of the rock lumps of 5 representative samples in the laboratory using point load test apparatus to obtain point load Index (I_c 50). The discontinuity spacing index (I_i) shall be noted jointly by the contractor and the Engineer. Using these two parameters the 'soil' or 'rock' type shall be classified. All easy to hard digging shall be classified as soil and easy ripping to material requiring blasting shall be classified as 'rock'.



Figure 6.1: PETTIFER point load Index graph

604 EXPLOSIVES AND BLASTING

(1) General

The procurement, transportation, storage, use, account and disposal of balance and defective explosive materials shall be strictly in accordance with DoR "Blasting Manual" and Explosive Rules in force, which is available at DoR Head Office and the by-laws issued by the Ministry of Home Affairs, RGoB and ordinances applicable to the work site. Should there be any discrepancy found between procedures described hereunder and the prevalent laws and ordinance, the later shall supersede.

Blasting shall be carried out in a controlled manner that completes the excavation to the lines indicated on the Drawing or as directed by the Engineer, with the least disturbance to adjacent material. It shall be done only with the written permission of the Engineer.

The Contractor shall adopt such method that is consistent with the safety and job requirements. Prior to starting any phase of the operation, the Contractor shall provide information describing pertinent blasting procedures, dimensions and notes.

(2) Materials, Tools and Equipment

All the materials, tools and equipment used for blasting operations shall be of approved type. The Engineer may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be water-resistant and shall remain unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a length being cut in order to permit sufficient time to the firer to reach to a safe place before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators, fuses, etc., shall be fresh and not damaged due to dampness, moisture or any other cause. They shall be inspected before use. The damaged articles, if any, shall be discarded totally and safely removed from the site immediately.

(3) Personnel

The blasting operation shall remain in the charge of competent and experienced blaster with legal license and thorough knowledge of handling explosives and blasting operations. The Contractor shall employ blasters experienced in controlled blasting and these blasters must be in possession of a current blasting certificate or should recently have participated in training for Controlled Blasting organized by Department of Roads.

(4) Blasting Operations

Explosives shall be used in the quantities and manner recommended by the manufacturers. The written permission of the Engineer shall be obtained for each location or series of locations where the Contractor wishes to use more than 5 kg of explosives in one series of blast. Such permission shall not in any way relieve the Contractor of his liabilities under the Conditions of Contract.

The blasting shall be carried out during fixed hours of the day as ordered in writing by the Engineer. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the blaster only.

The Engineer must be notified at least 24 hours in advance of any blasting operation. When blasting is to be carried out, the Contractor shall determine the danger zone likely to be created, and shall ensure that all personnel, vehicles and livestock are clear of the zone before and during the blast. In settlement areas, the Contractor shall take steps to avoid damage to property from flying rock by using blasting mats or other suitable blanketing materials.

The Contractor shall notify each public utility organization/company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from damage/injury.

Danger red flags shall be displayed prominently in all directions during the blasting operations. The flags shall be planted 200 m from the blasting site in all directions. People, except those who actually light the fuse, shall be prohibited from entering this area, and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing. A warning siren should be sounded for the purpose.

The charge holes shall be drilled to required depths and at suitable places. Blasting shall be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

Not more than 10 charges shall be prepared and fired at a time. The man in charge shall blow a siren in a recognized manner for cautioning the people. The charges shall be lighted by the blasters only. The blaster shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the work site.

After blasting operations, the Contractor shall compact the loose residual material removed below sub-grade and replace the material removed below sub-grade with suitable material.

When forming final cut faces, pre-split blasting techniques as recommended in the Blasting Manual of DOR shall be carried out to ensure that blasting damage to the cut face is minimized. Details of the pre-splitting technique to be used shall be notified to and approved by the Engineer at least 24 hours in advance of the blasting operation.

(5) Account

A careful and day to day account of the explosive shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer at all times. Records must be kept by the Contractor of all drilling and blasting operations showing hole diameters and depths, drilling pattern, explosive charge and type per hole, detonator delay times and total charge per blast. These records must be submitted to the Engineer on completion of charging.

605 EXCAVATION IN CUTTING

- (1) Clearing and grubbing shall be performed as specified in Section 500.
- (2) Excavation shall be carried out true to the line and levels and where blasting is to be resorted to, the same shall be carried out in accordance with Clause 604.
- (3) While executing excavations, the Contractor shall take adequate precautions against soil erosion and water pollution.
- (4) All suitable excavated materials shall be used in construction of the roadway to the extent as required.
- (5) Hauling of material from cuttings or borrow pits to embankments or other areas of fill shall proceed only when sufficient plant or labour is operating at the place of deposition to ensure that adequate spreading and compaction of material can take place.
- (6) Over-excavation shall not be permitted. Any excess depth excavated below the formation levels as specified shall be made good by the Contractor at his own expense by backfilling with suitable material of similar characteristics to those of moved materials with compaction as specified in Clauses 609 and 610.
- (7) The slopes of cutting shall be cleared of all rock fragments which move when pricked by a crowbar, unless otherwise directed by the Engineer. Where the Engineer considers that the slope, immediately after dressing, shall not be permanently stable, he shall direct the Contractor as to the stabilization measures required. The Contractor shall carry out these measures soon after Engineer's instruction.

When completed, the excavation slopes shall be true to the lines and levels as shown on the Drawing or directed by the Engineer. When completed, no point on slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock, no point shall vary more than 300 mm from the designated slope.

- (8) If slips, slides, over breaks or subsidence occur in cutting, they shall be removed. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction.
- (9) If water is encountered in excavations due to seepage, springs, or other causes, it shall be removed by suitable diversions or bailing out and the excavation shall be kept dry. The drained water shall be discharged into suitable outlets as not to damage the works, crops or any other property. If any such damage is caused due to any negligence of the Contractor, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

606 EXCAVATION BELOW EMBANKMENTS AND BELOW FORMATION LEVEL IN CUTTINGS

- (1) Where any unsuitable material below the natural ground level under proposed embankments or below formation level in cuttings is required to be excavated, it shall be removed to such depth and over such areas as shown on the Drawing or as directed by the Engineer. The excavated materials shall be disposed off as indicated on the Drawing or directed by the Engineer. The resultant excavation shall be backfilled with suitable material or capping layer and shall be leveled and compacted to the density as specified for forming of the embankments. Nevertheless, if such backfill has to be carried out in standing water, the Contractor shall use only approved non-plastic well-graded granular material having maximum size of not greater than 75mm. Such materials may be deposited in water without use of compaction equipment.
- (2) Where shown on the Drawing, approved, graded stones having size from 380 mm to 150 mm and containing not more than 10 percent, below 150 mm in size shall be placed directly on the natural occurring unsuitable material. This type of rock fill material shall be deposited in accordance with the requirements of Clause 609 and compacted as per Clause 610.
- (3) If after the removal of material as specified in Sub-clause 606 (1), the Contractor allows the materials so exposed to reach a condition where compaction of back filling is impracticable, he shall make good at his own expense either by additional excavation and filling in the manner specified in this Clause, or by waiting until the condition of the exposed material is fit to receive the approved backfill.

607 EXCAVATION FOR FOUNDATION, DITCHES, PAVEMENT, SLOPES

1. Excavation for Foundation

(1) Scope

Excavation shall consist of the removal of material for the construction of foundations for drainage structures, retaining walls, head walls, cut off walls, culvert, bridges and other similar structures to the lines and dimensions shown on the Drawing or as instructed by the Engineer in accordance with the requirements of these Specifications. The work shall include construction of protection and subsequent removal of all necessary sheeting, shoring, bracing, diversion of water/flow, draining and pumping, the removal of all logs, stumps, grubs and other deleterious matters and obstructions necessary for placing the foundations; trimming bottoms of excavations; and clearing up the site and the disposal of all surplus material. No portion of the work shall be covered unless inspected by the Engineer. The Contractor shall give a minimum of 24 hours notice in writing to the Engineer for each item of work to be covered or buried.

(2) Excavation

Excavation shall be taken to the length and width of the lowest step of the footing and the sides shall be left to plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench does not permit vertical sides, the Contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the Drawing or as directed by the Engineer.

Where blasting is to be resorted to, the same shall be carried out in accordance with Clause 604.

(3) Dewatering, Diversion of Flow and Protection

Normally, open foundations shall be laid dry. Where water is encountered in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, cofferdams and other necessary works to keep the foundation pit or trenches dry, when so required and to protect the green concrete/masonry against damage by erosion, failure of cut slopes or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor, but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the works.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump and is separated from the concrete work by a watertight wall or other similar means.

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the area of excavation.

The Contractor shall take all precautions in diverting flow and in discharging the drained water as not to cause damage to the works, crops or any other property. If any such damage is caused due to any negligence of the Contractor, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

(4) Preparation of Foundation Base

The bottom of the foundation pit shall be leveled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed, if surface is not wet. In the event the Contractor carries out excavation deeper than that shown on the Drawing or as otherwise ordered by the Engineer, the Contractor shall make up the extra depth with concrete or masonry at the cost of the Contractor. Ordinary filling shall not be allowed for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed of all soft and loose materials, cleaned and cut to firm surface either leveled or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of rock excavation, annular space around footing shall be filled with concrete of grade M10 up to top level of rock or as instructed by the Engineer.

After the excavation is completed, the Contractor shall inform the Engineer to that effect and no footing, bedding materials or structures shall be placed until the Engineer has approved the depth and the suitability of foundation material. The Contractor shall give a minimum of 24 hours notice in writing to the Engineer for each item of work to be covered or buried.

If, at any point, in any foundation excavation, material unsuitable for foundations is encountered, the Contractor shall, if so instructed by the Engineer, shall remove all such materials and refill with suitable materials thoroughly compacted by tamping or rolling in layers of not more than 150 mm thick each.

(5) Slips and Blows

If there are any slips or blows in the excavation, these shall be removed by the Contractor at his own cost.

(6) Public Safety

Where required, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights/reflectors at night to avoid accident as per Sub-clause 105 (5).

The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures.

(7) Removal of Shoring and Protection

All shoring, sheeting, bracing used in the foundation and protection shall be removed by the Contractor after the completion of the substructure unit. The removal shall be carried out in such a manner as not to disturb or damage the finished work.

2. Excavation for Ditch, Clearing of Existing Drains and Channels

Ditch excavation shall consist of excavation for drains, channels, or any other type as designated on Drawings or as directed by the Engineer. The work shall be performed in the proper sequence with other

construction. The location of all ditches shall be established on the ground before starting construction of adjacent works. Suitable excavated material shall be placed in fills or stockpiles while unsuitable or surplus material shall be placed in spoil areas or as directed by the Engineer. Intercepting ditches shall be constructed prior to the starting of adjacent excavation operations. The excavation operations shall be carried out as required to secure a finish true to line, elevation and cross section, as designated.

Ditches constructed in the works shall be maintained to the required cross-section and shall be kept free from debris or obstructions until completion of the contract. As necessary, sufficient openings shall be provided through spoil banks to permit drainage from adjacent lands. No extra payment shall be made for ditches constructed in the works.

Existing drains and channels where shown on the Drawings or as directed by the Engineer, shall be cleared by removing vegetation growths and debris deposits. The sides shall be trimmed throughout and the bottoms uniformly graded and the ditches kept clean and trimmed and maintained for the period of the Works. Unsuitable material removed from existing drains, channels shall be disposed off in spoil areas designated by the Engineer.

3. Excavation (Scarification) for Pavement

During the subgrade preparation, if unsuitable materials are encountered, it shall be excavated and disposed off in designated location and the site shall be replaced with selected/suitable materials as capping layer, the density and moisture content of which is the same as the other part of the subgrade.

Where shown on the Drawings or as directed by the Engineer the existing pavement surfacing or pavement layers in carriageway and shoulders shall be scarified, transported and stockpiled at designated area for reuse or disposed to spoil. The surface after scarification shall be prepared to meet the requirements of Section 900 of the Technical Specifications. It will be broken, if needed, mixed to achieve required grading of base, subbase including adding extra base, subbase materials as required, watered and laid to required profiles and compacted in its final position as directed by the Engineer.

4. Excavation for Slopes and Removal of Landslides

Where shown on the Drawings or as directed by the Engineer the excavation shall be carried out for slopes in widening of road or curves, removal of unstable slopes/landslide, trimming of slopes, etc. The earthwork for removal of landslides shall be other than those encountered in routine maintenance of road as specified in Clause 109 of the Specifications. Suitable excavated material shall be placed in fills or stockpiles while unsuitable or surplus material shall be placed in spoil areas or as directed by the Engineer.

608 REFILLING OF FOUNDATION PITS AND TRENCHES, REMOVAL OF SUPPORTS AND FILLING TO STRUCTURES

Refilling of foundation pits and trenches shall consist of pervious backfill and/or common backfill as shown on the Drawing or as directed by the Engineer.

(1) Materials

(a) Pervious Backfill

Unless otherwise specified in the contract, it shall consist of gravel, crushed gravel, crushed rock, natural sands, manufactured sands or combinations thereof. It shall conform to the grading limits set out in Table. 6.1.

		g Einnie er i er nede Baerann			
Sieve Size (mm)	Percentage Passing by Weight				
	Class 1, Fine Grade	Class 2, Medium Grade	Class 3, Coarse Grade		
40	-	-	95-100		
20	-	90-100	50-100		
10	100	40-100	15-55		
4.75	90-100	25-40	0-25		
2.36	80-100	18-33	0-5		

Table 6.1: Grading Limits of Pervious Backfill

1.18	50-95	-	-
0.60	30-75	5-15	-
0.300	10-30	0-7	-
0.150	1-10	-	-
0.075	0-3	0-3	0-3



Where D_{15} and D_{50} (filter) are used to designate the size of sieve passing 15 percent and 50 percent respectively size of filter material (i.e. the size of the sieve that allows 15 percent and 50 percent respectively by weight of the filter material to pass through it).

(b) Common Backfill

Common backfill materials other than pervious backfill shall be suitable material as defined in Sub-clause 602 (2).

(2) Method of Filling

Backfilling material shall not be permitted under water unless specifically described in the contract or approved by the Engineer. It shall be placed and compacted in layers in compliance with the requirements of Clause 610. Any support structures for the excavation shall be withdrawn as the filling proceeds unless described in the contract or ordered by the Engineer to be left in. The backfill shall be placed in by such methods which shall avoid loading the structure in any manner which may affect its stability or overload its underlying foundation material or substructure. The backfill in front of abutments and wing walls shall be placed first to avoid the possibility of forward movement. Precautions shall be taken to prevent any wedge action against upright surfaces, and the slopes bounding the excavation shall be stepped as directed by the Engineer before backfill is placed. The backfill material around box culverts, piers and curtain walls shall be placed simultaneously on both sides of the structure.

609 FORMING OF EMBANKMENT AND OTHER AREAS OF FILL

- (1) The work shall consist of the construction of embankment, filling on other areas and backfill not specified elsewhere by providing materials as specified or approved by the Engineer, placing, compacting and shaping to lines, levels, grades and cross sections as shown on the Drawing or as directed by the Engineer. The maximum size of the coarse material in the mixture shall not exceed 75mm for general earth fill.
- (2) The limits of embankment shall be built sufficiently wider than the design dimension to facilitate in achieving required compaction nearby outer faces of the embankment. The surplus material shall be trimmed to the specified side slopes and width of the embankment.

- (3) Where necessary, the original ground shall be scarified, mixed with water, leveled and then compacted so as to achieve the density mentioned in Clause 610. Where the height of embankment, as measured from formation level to the original ground level, is less than 200 mm, the embankment foundation shall be compacted in accordance with the requirements of Clause 610 such that the required compaction is achieved within the upper 300 mm below formation level. Where necessary, embankment foundations shall be excavated/furrowed and brought under optimum moisture content and re-compacted in layers of 150 mm each in order to achieve the required level of compaction.
- (4) Embankments shall be built up evenly over the entire width and shall be maintained at all times with a sufficient camber to enable surface water to drain rapidly from them. Damage to compacted layers by constructional or other traffic shall be made good by the Contractor.
- (5) The natural moisture content and the optimum moisture content of the material to be placed in the embankment shall be checked before start of placing material. If these parameters are found to be out of the specified limits, the same shall be made good. Where water is required to be added in such construction, it shall be sprinkled uniformly and thoroughly mixed in soil by blading or harrowing until uniform moisture content as specified is obtained.

Moisture content, checked in accordance with IS 2720 (Part 2), at the time of compaction shall be between 90% and 105% of the Optimum Moisture Content as determined in accordance with IS 2720 (Part 8).

If the material delivered for fill/backfill is too wet, it shall be dried by aeration and exposure to sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced by the above procedure, compaction work shall be suspended.

If the material deposited as fill subsequently reaches a condition such that it cannot be compacted in accordance with the requirements of the specifications the Contractor shall

- (i) Make good by removing the material off the embankment and placing suitable material; or
- (ii) Make good by tipping it elsewhere until it is in a suitable physical condition for re-use; or
- (iii) Make good the material by mechanical or chemical means to improve its properties acceptable to the Engineer.
- (6) Where fill is required to be constructed across water logged or soft clayey ground that displays excessive movement under normal constructional equipment, it may be necessary to construct a capping layer in accordance with Clause 806.
- (7) Rock used in rockfill embankments shall be deposited in horizontal layers not exceeding 450 mm each extending up to the full width of the embankment.

Material shall be spread, leveled and compacted in accordance with Clause 610. Each layer shall consist of reasonably graded rock and all surface voids shall be filled with broken fragments before the next layer is placed. The top surface and side slopes of embankments so formed shall be thoroughly blinded with approved well graded material to seal the surface.

- (8) Isolated boulders each within the range of 0.05 cubic meters in size may be incorporated in embankments, not of rock fill, at the discretion of the Engineer provided that the specified compaction requirements are met and it shall not be placed less than 1 m below formation level of carriageways or shoulders.
- (9) While filling embankments up to or over culverts or pipe drains, and where required in the contract, up to bridges, the Contractor shall bring the embankments up equally on both sides. In rock fill embankments the rock shall be carefully packed for such distance from the structure as described in the contract.

Where provision of filter membrane is specified behind structures, the same shall be laid in layers simultaneously with the laying of fill material.

(10) If the Contractor wishes to continue to use the surface of embankments including shallow filling for constructional traffic before trimming to formation level, he shall bring up and maintain the area

between the extremities of the carriageways including (if any) central reserve and hard shoulders to a level not less than 150 mm above formation level whereupon constructional traffic shall be allowed to use the surface and shall be made good by the Contractor at his own expense. When it is necessary to complete the formation level and this has been done, the movement and use of construction equipment thereon shall be in accordance with Clause 803.

610 COMPACTION OF EMBANKMENTS AND OTHER AREAS OF FILL/BACKFILL

- (1) The Contractor shall obtain the Engineer's approval of all fill layers before covering with subsequent layers.
- (2) All fill shall be compacted to the depth and degree of compaction as specified in Table 6.2 or as shown on the Drawing. This requirement applies whether the specified zone is in fill or in existing ground, except for any part which may fall within rock or rockfill. Formation level in this context shall mean top of subgrade.

Table 6.2: Depth and Degree of Compaction					
Location	Depth below Formation	Minimum Compaction (%			
	Level (mm)	MDD Heavy Compaction)			
Roadway Embankment	0-300	95			
Roadway Cut	0-300	95			
Backfill for soil reinforced walls with	0-300	95			
gabion facia					
All other roadway fill and backfill not	-	93			
separately specified					

Table 6.2: Dopth and Degree of Compaction

(3)	Compaction	shall	be	undertaken	to	the	requirements	of	Table	6.3	by	approved	compaction
	equipment.												

		Cohesi	ve Soil	Well Graded gra	anular and	Uniformly Graded materials		
Type of Compaction Equipment	Category	Maximum depth of Compaction Layer (mm)	Minimum No. of Passes	Maximum depth of Compaction Layer (mm)	Minimum No. of Passes	Maximum depth of Compaction Layer (mm)	Minimum No. of Passes	
Smooth Wheeled Roller	Load per mm. width or roll							
	2.14 - 2.67 kg. 2.68 - 5.35 kg. More than 5.35 kg.	130 130 130	8 6 4	130 130 150	10 8 8	Unsuitable Unsuitable Unsuitable		
Grid Roller	Load per mm. width of roll							
	2.65 - 5.35 kg. 5.36 - 8.00 kg. More than 8.00 kg.	150 150 150	10 8 4	Unsuitable 130 150	12 12	150 Unsuitable Unsuitable	10	
Pneumatic Tyre Roller	Wheel Load 1000 – 1500 kg. 1500 – 2000 kg. 2000 – 2500 kg. 2500 – 4000 kg. 4000 – 6000 kg. 6000 – 8000 kg. 8000 – 12000 kg. More than 12000 kg.	130 150 180 230 305 355 405 455	6 5 4 4 4 4 4 4	Unsuitable Unsuitable 130 130 130 150 150 180	12 10 10 8 8 6	Unsuitable Unsuitable Unsuitable Unsuitable Unsuitable Unsuitable Unsuitable		
Vibratory Roller	Static Load per mm. width of Vibratory roll	Unsuitable		75	16	150	16	
	0.21 0.11 Ng.	Chicaltable		.0	.0		.0	

Table 6.3: Compaction Requirements

		Cohesi	ve Soil	Well Graded gra Dry cohesiv	anular and e soils	Uniformly Graded materials		
Type of Compaction Equipment	Category	Maximum depth of Compaction Layer (mm)	Minimum No. of Passes	Maximum depth of Compaction Layer (mm)	Minimum No. of Passes	Maximum depth of Compaction Layer (mm)	Minimum No. of Passes	
	0.45 - 0.71 kg. 0.72 - 1.25 kg. 0.26 - 1.78 kg. 1.79 - 2.32 kg. 2.33 - 2.86 kg. 2.87 - 3.56 kg. 3.57 - 4.28 kg. 4.28 - 5.00 kg.	Unsuitable 100 130 150 180 200 230 225	12 8 4 4 4 4 4	75 130 150 150 180 200 230 225	12 12 8 4 4 4 4 4	150 150 200 230 255 280 305 305	12 6 10 12 10 8 8 6	
Vibrating Plate Compactor	<u>Static Pressure under</u> <u>base plate</u> 0.088 - 0.105 kg/sq.cm 0.106 - 0.123 kg/sq.cm 0.124 - 0.141 kg/sq.cm 0.142 - 0.176 kg/sq.cm 0.177 - 0.211 kg/sq.cm More than 0.211 kg/sq.cm	Unsuitable Unsuitable Unsuitable 100 150 200	6 6 6	Unsuitable 75 75 130 150 200	10 6 5 5	75 100 150 150 200 255	6 6 4 4 4	
Vibro-tamper	<u>Weight</u> 50 - 63 kg. 64 - 75 kg. Mote than 75 kg.	100 130 200	3 3 3	100 130 150	3 3 3	150 200 230	3 3 3	
Power Rammer	<u>Weight</u> 100 kg 500 kg. More than 500 kg.	150 280	4 8	150 280	6 12	Unsuitable Unsuitable		

- (4) Each layer of rock used to fill in embankments shall be spread and leveled in accordance with Subclause 609(7) and systematically compacted.
- (5) Layers of material other than rockfill shall not exceed 150 mm compacted depth unless and until the Contractor can demonstrate to the satisfaction of the Engineer that he can successfully compact layers of a greater thickness.
- (6) Each layer shall be constructed in lengths suitable to the compaction and working methods used. Materials of each layer shall be thoroughly mixed with water as necessary to facilitate its compaction to the specified density.
- (7) In cut areas, the subgrade shall be processed as necessary and compacted to the depth and compaction requirements as given in Table 6.1 and Table 6.2. In the event that the Contractor is unable to achieve the minimum compaction requirements below formation level he shall excavate and recompact in layers as necessary.
- (8) Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory rollers, power rammers or plate compactor. Care shall be taken to ensure that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to it.

611 COMPACTION TRIALS

(1) Before commencing filling embankment and from time to time as may be considered necessary by the Engineer, the Contractor shall carry out compaction trials in the presence of the Engineer on each of the main types of soil and rockfill to be used and compacted in the Works. The Contractor shall carry out all necessary laboratory and field testing as required by the Engineer and shall submit the results of all tests to the Engineer. The trial procedure shall include the compaction of trial areas selected by the Engineer. The surface of each area shall first be well compacted to the satisfaction of the Engineer. Each type of material being used shall be compacted in equal layers at uniform but differing moisture contents to a predetermined number of passes using the Contractor's proposed compaction equipment.

- (2) Following completion of the compaction trials, the Contractor shall submit to the Engineer, for his approval, his proposals for the compaction of each type of material to be encountered in the Works and its specified degree of compaction. The Contractor's proposals shall include reference to the types of equipment, the operating weights and tyre pressure, the methods of adjusting the moisture content, the number of passes and the loose depth of each layer.
- (3) If, in the opinion of the Engineer, the results of the compaction trials indicate that the Contractor's proposed plant and methods shall achieve the densities as specified, the Engineer shall approve the same. Otherwise the Contractor shall submit, in writing, proposals for modifying the plant and/or methods and shall, if the Engineer so requires, compact further trial areas in accordance with these modified proposals until the Engineer approves of Contractor's proposals.
- (4) When compaction of earthworks is in progress, the Contractor shall adhere to the compaction procedures approved by the Engineer.
- (5) Notwithstanding the Engineer's approval of any of the Contractor's plant or methods, the Contractor shall at all times be solely responsible for executing the earthworks in accordance with the Specifications and the Drawing.

612 BENCHING

- (1) Where embankments are to be constructed on hill slopes or slopes with more than or equal to 1 vertical to 4 horizontal slopes, benches with vertical and horizontal faces shall be cut into the existing slope (including rock) and the embankment shall be built up in successive layers. Where the cross slope is less than 1 vertical to 4 horizontal slope (other than rock) shall be loosened by scarifying to a depth of not less than 100 mm measured perpendicular to the slope, to ensure a good bond between the embankment and the embankment foundation. Material which has been loosened shall be covered with the first layer and compacted to the specified density simultaneously with the first layer of embankment material placed.
- (2) Where existing embankments are to be widened or included in a new embankment and slopes are not more than 1 vertical to 4 horizontal, the slope of the existing embankment shall be scarified to a depth of not less than 100 mm to ensure bond. Where the slope is less than 1 vertical to 4 horizontal, continuous horizontal benches, each at least 300 mm wide, shall be cut in existing slopes and the widened embankment shall be built up in successive layers of thickness of 150 mm to the level of old road.

Where the width of the widened portions is insufficient to permit the use of heavy rollers, compaction to the specified density shall be carried out with the help of small vibratory roller/plate compactor/rammer or other approved methods.

613 FINISHING OF SLOPES

The slopes of cuttings shall be trimmed to neat line and to a standard that is attainable with proper care and workmanship in the type of material concerned. All loose rocks, stones and nests of loose material shall be removed especially in solid rock cuts which must be completely free of such material. The final surface batters must not be absolutely smooth, but shall have a slightly rough surface that would be suitable for subsequent grassing or for the natural vegetation to be established on the surface.

Fill slopes shall be finished to neat lines with all loose rocks and non compacted material removed. The degree of finish required shall depend on the nature of the material used for the fill slopes but shall be as smooth as in consistent with the material involved and good workmanship. No boulders in excess of 150 mm in size will be permitted and isolated large boulder in otherwise smaller size material shall not be allowed to project out of the surface. In the case of rock fill soft material shall be worked into the interstices between the rock on the surface of the slope.

Except in solid rock the tops and bottoms of all slopes, including the slopes of drainage ditches, shall be rounded as indicated on the Drawings or as directed by the Engineer. Slopes at the junctions of cuts and fills shall be adjusted and warped to flow into one another, or into the natural ground surfaces, without any noticeable break.

Cut and fill slopes shall be finished to a uniform appearance without any noticeable break readily discernible from the road. The degree of finish required for all fill slopes and for cut slopes flatter than 1 in 4 shall be that obtainable by motor grader.

The slopes of cuts and fills which are designated for grassing shall, after finishing, be prepared for grass planting and /or top soil for grass planting.

All trimming of side slopes of cuttings shall be completed before any work on the subbase is commenced inside such cuttings.

614 EARTHWORKS TO BE KEPT FREE OF WATER

By providing temporary water course, ditches, drains, pumping or other means the Contractor shall arrange for the rapid dispersal of water from the areas of earthworks. Where practicable the water shall be discharged into the permanent outlet for the drainage system. Adequate means for trapping silt shall be provided on temporary systems while discharging into permanent drainage systems.

615 WATERCOURSES

Excavations carried out in the diversion, enlargement, deepening or straightening of watercourses shall include the operations of any necessary trimming of slopes, grading of beds, disposal of excavated materials and pumping, tampering works and materials necessary for dealing with the flow of water.

616 FILLING EXISTING WATERCOURSES

Where watercourses have to be diverted from the sites of embankments or other works, the original channels shall be cleared of all vegetative growths and soft deposits and filled in with suitable materials deposited and compacted as specified in Clauses 609 and 610.

617 PROCESS CONTROL

- (1) Throughout the works the Contractor shall perform tests to determine the suitability and compaction characteristics of soils to be used in roadway. The compaction test shall be conducted in accordance with IS 2720 Part 8 in every 1500 cum of fill material and every change in material type. The moisture content test shall be conducted in accordance with IS 2720 Part 2 in every 250 cum of material.
- (2) In addition to the foregoing tests, the Contractor shall carry out field density tests on the compacted fill materials in accordance with IS 2720 Part 28/29. At least one set of density determination consisting of three tests per 500 sqm (or any lesser area) shall be carried out in each layer, including original ground surface on which embankment is to be constructed. If the result of any test shows that the minimum specified density has not been achieved, further compaction shall be executed to the area concerned and the layer re-tested. Unless the test results are satisfactory, the addition of another layer shall not be allowed.
- (3) The Contractor shall carry out tests for determination of moisture content at frequent intervals on all materials during the course of compaction as per Sub-clause 609(5) to ensure that the requirements of Clause 610 are met with.

618 MEASUREMENT

(1) The quantities of the various classes of earthwork to be measured for payment under the contract shall be limited to the lines, grades, slopes and dimensions shown on the Drawing or as determined by the Engineer. (2) All roadway excavation including road formation, foundations, side drains, landslides, filling and backfilling compacted in place shall be measured in cubic metres by the average end area method as computed from the original and final cross-sections of the completed work. The distance between two end areas shall be the distance measured along central line of the road. Where due to changed conditions, or the nature of a particular operation, or for any other reason, it is impossible or impractical to measure the quantities by means of average end areas, the Engineer shall compute the quantities by a volumetric method, if in his opinion, it is the best suited method to obtain an accurate determination.

No separate measurement for payment shall be made for excavation made on borrows, quarries, temporary works or in places outside the scope of permanent works specified in the contract.

No measurement shall be made for any excavation other than the limited excavation described above. Excavation over increased width or length, cutting of slopes, shoring, shuttering and planking shall be deemed as convenience for the Contractor in executing the work and shall not be measured and paid for. Backfill to be measured shall be limited to this void only with due consideration of the nature of the structure.

Foundation excavation in rock shall be deemed to be covered by the rate for rock excavation.

No separate measurement shall be made for any quantities of finishing of slopes and preparatory work for formation of embankment and other areas of fill.

Measurement for scarifying, processing, laying, profiling and compaction of existing pavement, and preparation for laying of pavement layers will be made in number of square meters of accepted work. The quantity shall be determined by volume of material in its original position prior to excavation. Quantities shall be computed to the neat lines shown on the Drawings, or to such limits as may be staked out and approved for scarification by the Engineer. No separate measurement shall be made for any extra subbase material required including reworking, placing, and compaction to final position.

- (3) Use of explosive materials, leveling, watering and compaction of original ground, construction of coffer dams, pumping out water and other ancillary and incidental works necessary to complete the item as per this Specification shall not be measured for payment. They are deemed to have been included in the measurement of the concerned item.
- (4) If the excavated materials are disposed beyond 10m length and more than 1.5m height from the place of excavation and if filling materials are brought from beyond 50m and/or 1.5m below the place of filling, additional leads and lift shall be measured separately for payment. However initial lead of 50m and lift of 1.5m shall not be measured separately. They are deemed included in the measurement of the item itself. However, the measurement of foundation excavation shall be inclusive of all leads and lifts (i.e. no separate leads and lifts shall be measured in foundation excavation).

The measurement of leads and lifts shall be based on mass diagram of the haulage wherever applicable. All leads and lifts shall be measured as per the contract. If the material obtained from roadway excavation is used fully or partially in roadway filling, the quantities for roadway excavation and roadway filling shall be computed as below.

The quantities of roadway excavation and filling of the distances under reference shall be calculated separately adopting the method described as above in this Section. The computed quantity of roadway filing shall be measured in roadway filling while difference between quantities of roadway excavation and filling shall be measured in roadway excavation. The same excavated material shall not be measured both in roadway excavation and roadway filling.

619 PAYMENT

(1) Various classes of earthworks i.e. roadway excavation, roadway filling, backfilling, additional leads and lifts, and others measured as described above shall be paid at contract unit rate of the respective item.

The contract unit rates shall be the full and the final compensation to the Contractor as per Clause 116 and for the cost of:

- (i) Arrangement of land as a source of supply of materials as much as needed.
- (ii) Process Control tests.
- (iii) Execution of all relevant operations described above in this Section and necessary to complete the item as per this specification.
- (2) Foundation excavation for structures, measured as described above, shall be paid for at the contract unit rate for all classes of excavation. The contract unit rate for foundation excavation shall be the full and the final compensation to the Contractor as per Clause 116 of the Technical Specifications. No payment shall be made for the disposal of the excavated materials irrespective of all leads and lifts, preparation of foundation base, cofferdams, cribs, sheeting, shoring and bracing, foundation sealing, dewatering including pumping, removal of logs and stumps, cleaning and grubbing, diversion of flow/channel, if required and all incidentals works necessary to complete the item in accordance with this Specification.
- (3) Payment for scarifying, processing, laying, profiling and compacting existing pavement, and preparation of surface for laying of pavement layers shall be made at the contract unit rate, which shall be the full and the final compensation to the Contractor as per Clause 116. No separate payment shall be made to the Contractor for any extra base, subbase material required to be added to scarified subbase material to prepare it to comply the requirements of the specifications; reworking; placing and compacting for the final position.
- (4) Payment for excavation/transport of landslide clearance (other than those in routine maintenance as per Clause 109) shall be made at contract unit rate. The contract unit rate shall be the full and the final compensation to the Contractor as per Clause 116 of the Specifications.

620 ROCKFILL EMBANKMENTS

a) Scope

Rockfill embankments are to be constructed as shown on the drawings. In general, such construction will involve filling of deep gullies with suitable coarse rock material excavated from roadside cuttings. Because of the typical depth and inaccessibility of such gullies, compaction will only be possible once the rockfill level approaches the road formation level.

b) Rockfill Material Requirements

The source of the most suitable and economical rockfill shall be jointly agreed between the contractor and the Engineer. In general this will be covered under Earthworks – Rock, including necessary lead to the rockfill site.

- i) Rockfill material shall have very low plastic soil content. Fines should be mostly from rock rather than soil.
- ii) Should have <15% minus 4.75mm (based on visual assessment/field grading)
- iii) Oversize (>0.65m nominal) should all be broken (rock breaker) and distributed evenly
- iv) Should be reasonably well graded after spreading layer. If very coarse/broken oversize, mix in smaller material to reduce voids
- v) Should give uniform appearance after spreading of layer
- vi) Should have no large rock protruding through surface of any layer.

For dumping of materials, the above references to compaction and layers are not applicable.

c) Typical Construction Process

The typical construction process is as listed below. This will differ depending upon the characteristics of individual sites. The actual methodology to be adopted shall be as agreed between the Engineer and the contractor.

- i) Clear the site of vegetation (grubbing is not required)
- ii) Construct toe wall of either masonry, boulders or gabions as dictated by site conditions and requirements. The details of the location and type of such walls are to be approved by the Engineer.
- iii) Protect the toe wall against damage by falling/rolling boulders during rockfill placement. Where necessary, this shall comprise manually placed dry stone protection against the wall of at least 1m in thickness.
- iv) Dumping of coarse rockfill (without compaction). Initial dumping should consist of the coarsest material available to provide a toe region highly resistant to any scouring.
- v) Once the rockfill reaches a level that is accessible to construction plant (as jointly agreed by the Engineer and the contractor), commence track rolling by a minimum "D6" sized dozer or minimum 20 tonne excavator. Any necessary ramps of cutting required for such access shall be paid separately.
- vi) Compaction by track rolling shall comprise 700mm layers with 5 passes across the full layer extent. The maximum size of rock to be used shall be such that no single rock shall protrude through the surface of the compacted layer.
- vii) As the rockfill level advances, benching (in soil) of the gully sides shall be undertaken as shown on the drawings.
- viii) Verification/assessment of compaction achieved shall be based on the US Army Corps of Engineers standard procedure. In summary, this consists of measuring the average settlement of a trial layer through each of 8 passes of track rolling. This is measured by means of 5 or more steel settlement plates and level survey before and after each consecutive pass. In general, the settlement after 5 passes should be greater than 80% of the settlement at 8 passes (or near refusal). The plotted relationship between passes and settlement for representative materials can then be used to verify compaction. The frequency of such testing shall be as directed by the Engineer.
- ix) Batter treatment shall be as shown on the drawings. Dumped rock should be carefully placed to as uniform slope as possible, and be approximately at the natural angle of repose. Some manual packing or batter treatment may be directed by the engineer for the dumped rock sections. This shall be paid separately provided dumping has not been haphazard. For compacted rockfill, the batter shall comprise interlocked larger size rip-rap (nominally greater than 500mm) on the face. As directed by the Engineer, this may be constructed in the form of a rock cascade.
- x) The top of the rockfill shall have a 10 kN/m tensile strength non woven geotextile and above the geotextile, a minimum thickness of soil cushion (filling) beneath the pavement. In many locations, the section immediately above the rockfill is to include a precast inverted "U" box culvert (with cast in-situ base slab) or hume pipe. Appropriate levels for the rockfill and cushion/culvert backfill where applicable will be provided by the Engineer.
- xi) With predominantly dumped rockfill material in the lower part of the rockfill, post construction settlement/consolidation is expected to be significant. For this reason, construction of any precast culverts and/or roadbase and bituminous surfacing shall be deferred until at least 3 months from the time of completion of the rockfill. During this period rainwater can be allowed to discharge through or over the rockfill (discharges are comparatively low for all rockfill). The Engineer may direct that settlement readings are taken at regular intervals (bi-monthly or monthly).

d) Payment

Payment for rockfill construction shall comprise:

i) Track rolling as described in Clause c) on a cubic meter basis

ii) Separation, necessary stockpiling and placement (by excavator) of coarse rip-rap boulders (greater than nominal 500mm size) on the batters – on a cubic meter basis.

All rockfill materials shall come from roadside excavation and shall not be paid separately. Clearing, construction of walls if required, benching and necessary (approved) excavation; necessary labour (for correction of batter profile); and provision of soil and cushion filling and selected backfill for culverts shall be paid under relevant items under the contract.

SECTION 700 – PROCESS CONTROL TESTING & TOLERANCES

- 701 HORIZONTAL ALIGNMENTS, SURFACE LEVELS AND SURFACE REGULARITY OF PAVEMENT COURSES
- 702 ADVERSE WEATHER WORKING
- 703 USE OF SURFACES BY CONSTRUCTIONAL TRAFFIC
- 704 CARE OF WORKS
- 705 MEASUREMENT AND PAYMENT

SECTION 700 - PROCESS CONTROL TESTING & TOLERANCES

701 HORIZONTAL ALIGNMENTS, SURFACE LEVELS AND SURFACE REGULARITY OF PAVEMENT COURSES

(1) Construction Control Testing/Process Control Testing

Unless otherwise directed, values given in these Specifications are minimum values for the properties of materials and the workmanship. They shall be considered satisfactory, if all results of the tests, taken at the frequencies specified, are at least equal to the values given in the relevant Section of the Technical Specifications.

(2) Tolerances

(a) Horizontal Alignments

Horizontal alignments shall be determined from the centreline of the pavement surface as shown or calculated from the Drawing. The centreline of the pavement surface as constructed, and all other parallel alignments, shall be correct within a tolerance of \pm 13 mm therefrom.

(b) Thickness of Pavement Layers

The average thickness of any pavement layer measured at five consecutive points at every 20m in any Section shall not be less than the thickness specified nor more than 120% of the thickness specified or ordered by the Engineer. The thickness of the pavement layer measured at any point shall have tolerance of + 25 % and - 2 % of the thickness specified.

(c) Surface Levels of Pavement Layers and Formation

The level measured at any point on the surface of a pavement layer to the formation level shall not deviate from the corresponding level calculated from the Drawing by more than the tolerances shown in Table 7.1.

For checking compliance with Table 7.1 measurements of surface levels shall be taken at points to be selected by the Engineer at 12.5m centres longitudinally and at 2m centres transversely. At junctions, the grid point spacing shall be determined by the Engineer.

(d) Surface Regularity

The surface regularity of pavement layers and the formation shall be tested at points decided by the Engineer with a rigid, steel straight-edge of 3 m length placed parallel to or at right angles to the centreline of the road. The maximum allowable deviation of the surface below the straight-edge shall not deviate from that shown on the Drawing by more than the tolerances shown in Table 7.1.

In addition the longitudinal slope or transverse cross fall shall not deviate from that shown on the Drawing by more than the tolerances shown on Table 7.1. If tolerances given in Table 7.1 for level and straight edge are not in agreement, the tolerances given for straight edge shall prevail.

	Level	Straight edge	Slope or Crossfall %		
Layer	mm	mm			
Bituminous Wearing Course	± 10	6*	± 0.25		
Bituminous Binder Course	± 10	6	± 0.25		
Base	± 10	6	± 0.25		
Subbase	± 15	10	± 0.50		
Gravel Wearing Course	± 15	15	± 0.50		
Formation (subgrade)	+0	20	± 0.50		
	-25				

Table 7.1: Tolerances for Level and Surface Regularity

* In case of asphalt concrete surface it shall be 4mm.

(e) Shoulders

Shoulders shall be constructed to the same requirements of thickness, level and surface regularity as for the adjacent pavement layers.

(f) Cuttings and Embankment Slopes

In the final trimmed slope of cuttings or embankment a tolerance of +0.25 shall be permitted, i.e. if a slope of 1 in 2 is specified, the acceptable slope shall be not steeper than 1 in 2 or slacker than 1 in 2.25.

(g) Width of Cuttings and Embankments

The tolerance permitted in the width of the bottom of cuttings shall be 200 mm between the centreline of the road and the toe of the cutting slope.

The width of embankments measured horizontally and perpendicular to the centreline of the road at the top of the embankment shall not be less than shown on the Drawing or more than that shown on the Drawing plus 50 mm.

(h) Depth of Side Drains

The difference between road level measured at the centre line of the road and that of the bottom of the side drain measured perpendicular to the centre line of the road shall not deviate from the specified in the drawing by \pm 25 mm.

(3) Rectification of Earthworks and Pavement Layers Exceeding Tolerances

Where any tolerances in Sub-clause 701 (2) are exceeded, the Contractor shall assess the full extent of the area which is out of tolerances and shall make good the surface of the pavement course, earthworks or formation in the manner described below.

(a) Earthworks

Where a cut slope is steeper, and an embankment slope is slacker than the specified slope, then the slope shall be trimmed to the specified slope. When the cut slope is slacker, the natural ground slope above top of the cutting and the adjacent cut slopes in both sides of the slacker slope shall be so trimmed that the entire cut slopes match together and they are stable. Where an embankment slope is steeper than the specified slope, then the slope shall be benched and fill material shall be placed and compacted. Subsequently the slope shall be trimmed all in accordance with the requirements of Section 600.

Where the width of a cutting is less than, and the width of an embankment is more than the specified width, then the cutting or embankment shall be trimmed to the specified width. Where the width of the cutting is more than the specified width but cut slope is slacker than the specified slope, the slope shall be trimmed as described in the preceding paragraph. If the cut slope is steeper, it shall be trimmed to specified slope. The adjacent slopes shall be also trimmed to make them in harmony. Where the width, of an embankment is less than the specified width, the embankment shall be benched and filled with suitable material and compacted. The slopes shall be trimmed all in accordance with the requirements of Section 600.

Where the depth of a side drain is less than that specified, the side drain shall be excavated to the specified depth and grade. Where the depth of a side drain is more than the specified depth, the side drain shall be backfilled with suitable material, compacted to a dry density of at least 95% of MDD (Heavy compaction) up to the specified depth or the extra excavated depth shall be made good by the same material of lining of the drain as directed by the Engineer.

(b) Subgrades

Where the levels and or widths are out of tolerance, the full depth of the layer shall be reworked to the Specification. The area to be treated shall be as determined by the Engineer necessary to comply with the Specification.

Where the results of the construction control tests are less than specified the full depth of the layer in the area representing the test shall be reworked to the Specifications. However, if needed, more tests shall be conducted to ascertain the extent of the area required to be reworked.

(c) Base and Subbase

Where these consist of unbound (i.e. natural or graded stone) material the full depth of the material shall be replaced by the material complying with the Specifications. The area treated shall be at least 30m long and 3m wide or such area determined by the Engineer necessary to comply with the Specification.

For bituminous bases the material of the full depth of the layer shall be replaced with fresh approved material laid and compacted to specification. Any area so treated shall be at least 5m long and the full width of the paving laid in one operation.

(d) Wearing Course

The method of rectification shall be adopted depending upon the nature of the failure. Rectification shall be effected either by removing base and replacing with approved material and laying wearing course or relaying wearing course alone. The Engineer shall instruct appropriate method of rectification. The area rectified shall be the full width of the paving laid in one operation and at least 15m long.

(4) Measurement and Payment

The Contractor shall be deemed to have allowed in his general rates and prices for the cost of complying with the requirements of Clause 701.

Notwithstanding the provisions of Sub-clauses 701 (2) and 701 (3) measurement and payment for earthworks and pavement works shall be made on the basis of the net-cross-Section and/or area basis whichever is applicable ordered by the Engineer or as shown on the Drawing. No additional payment shall be made for any variation. If the executed work is within the limit of tolerance, but is less than as specified on drawing or ordered by the Engineer, the payment shall be made for actual quantity executed, if the executed work is more, the payment shall be made for as shown on the drawing or ordered by the Engineer.

702 ADVERSE WEATHER WORKING

- (1) No material in frozen condition shall be incorporated in the works, but it shall remain on site for use, if suitable when unfrozen.
- (2) Laying of materials containing bitumen, or mixture thereof, shall cease under the following adverse conditions:
 - (a) during foggy and rainy weather;
 - (b) when rain is imminent.
- (3) While the air temperature is rising, work may be performed at the temperatures of:
 - (a) 6 degree Celsius with a wind velocity of 25 km/hr
 - (b) 10 degree Celsius with a wind velocity of 55 km/hr
- (4) When the air temperature is falling, works must be stopped as soon as the temperature reaches 6 degree Celsius, regardless of wind velocity. It shall not be resumed until the temperature is definitely rising.
- (5) When strong wind is blowing and this is likely to interfere with the proper execution of the work, no surfacing, especially spraying of binder shall be done.
- (6) Concrete shall not be placed during falling temperatures when the ambient temperature falls below 7 degree Celsius or during rising temperatures when the ambient temperature is below 3 degree Celsius. The temperature of the placed concrete shall not be allowed to fall below 5 degree Celsius until the concrete has thoroughly hardened. When necessary, concrete ingredients shall be heated before mixing but cement shall not be heated.

When the ambient air temperature exceeds 40 degree Celsius during the concreting operation, the Contractor shall take measures to control the temperature of the ingredients. Such measures shall include spraying the aggregates stockpile with water to promote cooling down by evaporation and, where feasible, shading of stockpiles and the area where concreting is carried out, reducing time between mixing and placing, and restricting concreting as far as possible to early mornings and late evenings. Curing shall commence after placing of the concrete in order to prevent excessive loss of moisture.

703 USE OF SURFACES BY CONSTRUCTION TRAFFIC

- (1) The loads and intensity of construction traffic used on pavements under construction shall be regulated so that no damage is caused to sub-grade and pavement layers already constructed.
- (2) The wheels and track of plant moving over various pavement courses shall be kept free of deleterious materials.
- (3) Bituminous base course shall be kept clean and uncontaminated as long as it remains uncovered by a wearing course and surface treatment. Should the base course or tack/prime coat becomes contaminated, the Contractor shall make good by cleaning it to the satisfaction of the Engineer, including removal of the contaminated layer and replacing it as per the requirements of these Specifications which shall be done by the Contractor at his own risk and cost.

704 CARE OF WORKS

The general obligations for "Care of the Works" shall inter-alia include the following:

(1) Materials shall not be spread on a layer that is wet and may damage it during compaction of subsequent layer or when opened to traffic.

When material is spread out on the road, it shall, be given a good cross-fall and a light compaction on the surface with a steel-tyre roller, in order to facilitate run-off during rainy weather.

- (2) All completed works in a layer shall be protected and maintained until the subsequent layer is placed. Maintenance shall include immediate repairs to any damage or defects, which may occur and shall be repeated as often as is necessary to keep the layer continuously intact and in a good condition.
- (3) Before priming any completed layer or placing a subsequent layer thereon, any damage to the existing layer shall be repaired so that after repair or reconstruction if necessary, it shall conform in all respects to the requirements specified for that layer. All repair work other than repairs of minor surface damages shall be inspected and tested before covering up.

The previously constructed layer shall also be thoroughly cleaned of all foreign material before construction of a succeeding layer. In the case of bituminous work, the existing layer shall be thoroughly broomed and all dung, clay, mud and other deleterious and loose material shall be removed. Where necessary, the surface shall be sprayed with water before, during and after brooming to remove all foreign material.

Roads shall not be made dirty as a result of construction of works, transportation of equipments, plants, labour and/or materials. In the case the roads are rendered dirty, they shall be cleaned immediately.

705 MEASUREMENT AND PAYMENT

No measurement and payment shall be made for the works required under this Section. All costs in connection with the requirements specified herein shall be deemed included in the rates and prices of the related items of works in the Bill of Quantities.

SECTION 1100 - GRAVEL WEARING COURSE AND SHOULDER

1102 HARD SHOULDERS

1101 GRAVEL WEARING COURSE

(1) General

(a) Definitions

The term "gravel" used throughout in this Clause means any material used as a wearing course, and shall include crushed rock and natural or crushed gravel.

A "gravel wearing course" means a top surfacing course constructed from one or a combination of the materials stated above and may be a course placed on the formation of a new road where final pavement surface is not included in the Contract, or placed on the formation of a service, diversion or access road.

(b) Sources of Material

Material for gravel wearing course may be obtained from any of the sources described hereunder.-

- (i) Borrow pits, alluvial deposits, etc.
- (ii) Spoil areas
- (iii) Excavation in cuttings, widened if necessary.

The source for material may be river bed or pit gravels, rock quarry, alluvial deposits, crusher-run, or other naturally occurring granular materials meeting the requirements of the Technical Specifications.

The Contractor shall comply with all the requirements of Section 400 in respect of borrow pits, alluvial deposits, etc. and spoil areas.

(2) Material Requirements

Particle Size Distribution

The grading of the gravel after placing and compaction shall be a smooth curve within and approximately parallel to the grading envelope given in the Table 10.4.

		0
Sieve size	Percentage	passing by weight
(((((()))))))))))))))))))))))))))))))))	Class 1	Class 2
37.5	-	100
25.0	100	85-100
20.0	95-100	85-100
14.0	80-100	65-100
10.0	65-100	55-100
4.75	45-85	35-92
2.00	30-68	23-77
1.00	25-56	18-62
0.425	18-44	14-50
0.075	12-32	10-40

Table 10.4: Particle Size Distribution of Wearing Course Material

In addition, following specification for materials for unpaved roads are recommended as per Table 10.5.

16	
Maximum size	37.5 mm
Oversize index (I _o)	< 5 percent
Shrinkage product (Sp)	100 to 240 (preferably 240)
Grading coefficient (G _c)	16 to 34
CBR	> 30% soaked 4 days at 97% of the Modified AASHTO compaction and OMC
where I	n and the tail and an 07 F man along
wnere, I _o =	percent retained on 37 5 mm sieve.

Table 10.5: Special recommendation for unpaved road

 S_p = Linear shrinkage x percent passing 0.425mm sieve.

550 D 500 SLIPPERY 90 450 PRODUCT 400 350 GOOD (BUT MAY BE DUSTY) 300 A С 250 +-**`E**-+ ERODIBLE MATERIALS RAVELS 200 GOOD 赤 150 100 В 50 **RAVELS AND CORRUGATES** 18 20 22 24 26 28 30 32 34 36 12 14 16 10 38 /0 12 AA 46 n 2 A 6 8 GRADING COEFFICIENT (G,)

The relationships between shrinkage product and grading coefficient are shown schematically in Figure 10.1.

Figure 10.1: Relationship between Shrinkage Product, Grading Coefficient and Performance of Unpaved Wearing Course Gravels

By plotting the shrinkage and grading properties of potential unpaved wearing course gravel on the figure, an indication of the suitability and any potential problems can be obtained. However, personal judgment should be used. In flat, dry areas, materials falling into zones A and D may be acceptable if the site-specific potential to erode or become slippery is not excessive.

The following conclusions can be drawn about each zone as defined in the figure:

- Zone A: Materials in this zone generally perform satisfactorily but are finely graded and particularly prone to erosion by water. They should be avoided if possible, especially on steep grades and sections with steep cross-falls and super-elevations. Most roads constructed from these materials perform satisfactorily but may require periodic labour-intensive maintenance over short lengths and have high gravel losses due to water erosion.
- Zone B: These materials generally lack cohesion and are highly susceptible to the formation of loose material (raveling) and corrugations. Regular maintenance is necessary if these materials are used and the roughness is to be restricted to reasonable levels.
- Zone C Materials in this zone generally comprise fine, gap-graded gravels lacking adequate cohesion, resulting in raveling and the production of loose material.
- Zone D Materials with a shrinkage product in excess of 365 tend to be slippery when wet.
- Zone E Materials in this zone perform well in general, provided the oversize material is restricted to the recommended limits.

Plasticity Index

The Plasticity Index of fines passing 0.425 mm sieve shall be in the range of 12 to 18 percent.

California Bearing Ratio

The material shall have a minimum CBR of 30% after 4 days soaking at 95% MDD (heavy compaction).

(4) Sequence of Works

Unless otherwise instructed by the Engineer, the Contractor shall commence laying wearing course starting as close as possible to the source and shall work away from it so that the maximum amount of compaction is given to the wearing course by the Contractor's vehicles. The Contractor shall route/regulate his vehicles to give even wear and compaction over the whole width of the wearing course.

(5) Preparation of Formation

For new road construction, the formation shall be prepared in accordance with Section 800.

For existing roads the minimum requirements for preparation of the formation are as follows:

The formation shall be cleaned of all foreign matter and loose materials. Any potholes, ruts, corrugations, depressions and other defects which have appeared due to improper drainage, traffic or any other cause shall be corrected. If considered necessary by the Engineer, the Contractor shall scarify, spray water and mix, grade and recompact the subgrade to line and level all at his own expense. The Engineer may require the formation to be proof rolled by a loaded truck, scraper or other approved means prior to dumping of the wearing course material. The cost of all such proof rolling shall be at the Contractor's expense.

(6) Setting Out

The gravel wearing course shall be set out to the tolerances given in Section 700.

(7) Laying and Compacting

The gravel wearing course material shall be deposited in such quantity and spread in a uniform layer across the full width required, so that the final compacted thickness is nowhere less than shown in the Drawing or instructed by the Engineer. Every reasonable effort shall be made to prevent segregation during the loading, hauling, dumping, spreading, mixing, trimming and compacting operations.

The compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm and where a greater compacted thickness is required, the material shall be laid and processed in two or more equal layers.

The oversize material shall be broken down in the pavement to the grading specified in Sub-clause 1003.2 (3). Any oversize material which cannot be broken down to the required size shall be removed and disposed off by the Contractor.

The material shall be scarified and the moisture content adjusted by either uniformly mixing with water or drying out the material such that the moisture content during compaction is between 95% and 102% of the Optimum Moisture Content determined as per IS 2720 Part 8. It shall be graded and trimmed to final line and level. Light compaction may be applied before the final trim is carried out but once 25% of the compaction effort has been applied no further trimming or correction of surface irregularities shall be allowed.

The final trim shall be in cut and the Contractor shall ensure that material from the trim is neither deposited in low areas nor spread across the section but graded clear of the works.

Following the final trim the material shall be compacted to a dry density of at least 98% MDD (Heavy compaction). During the grading, trimming and compaction of the material the Contractor shall ensure that the surface and/or the material does not dry out by applying fog sprays of water or other approved means sufficient to maintain the surface and/or material within the specified limits of moisture content.

Vibratory rollers shall not be allowed for the final compaction.

(8) Proof Rolling

The Contractor shall proof roll the completed layers in accordance with Section 1000.

(9) Tolerances

The gravel wearing course shall be constructed to the tolerances specified in Section 700.

(10) Testing

(a) Process control

The minimum testing frequency for process control shall be as given in Table 10.6. However, the frequency of tests to be conducted will be as directed by the Engineer.

Table 10.6. Winnihum Testing Frequency							
Tests	One test in every	Min no. of test per section.					
Materials :							
Gradation	300m ³ or part of it and change in source	Clause 300					
Plasticity index	" " "	-					
CBR	и и и	-					
LAA	и и и	-					
AIV	и и и	-					
Maximum Dry Density and	400m ³ "	-					
Optimum moisture content							
Field Density & moisture content	200m ² of each layer	3					
Construction Tolerance:							
Surface Levels	10m						
Thickness	25m						
Width	200m						
Smoothness	40m ²						

Table 10.6	Minimum	Testing	Frequency	1
1000 10.0	. IVIII III III III III III III III III	resung	ricqueriey	Ι.

(b) Routine Inspection and Testing

Routine inspection and testing will be carried out by the Engineer to test the quality of materials and workmanship for compliance with the requirements of this Section.

Any materials or workmanship that do not comply with the specified requirements shall be replaced with materials and/or workmanship complying with the specified requirements or be repaired so that after being repaired it complies with the specified requirements.

(11) Maintenance

The wearing surface shall be maintained by the Contractor in its finished condition and shall be watered, graded, dragged, reshaped, or re-compacted as necessary, until the Certificate of Completion is issued, or until the Engineer instructs that the road shall be opened to public traffic, whichever is the sooner.

(12) Measurement

Gravel wearing course shall be measured in cubic metre by taking cross Sections at intervals of 10 metres or as directed by the Engineer in the original position before the work starts and after its completion and computing the volumes in cubic metres by average end area method.

(13) Payment

Gravel wearing course shall be paid at their respective contract unit rate all the operations, materials, labor and machineries involved and any incidental costs. In addition to the stipulation in Clause 116, the contract unit rate shall be also the full and the final compensation for cost of making arrangement for traffic control and other costs required to complete the work complying with the requirement of Sections 300 and 400.

1102 SHOULDERS

(1) Definition

The term "shoulder" means the part of the road falling between the edge of the pavement and the side ditch or embankment slopes above the formation level.

(2) Material for Construction of Shoulders

Material for construction of shoulders shall be as shown on the Drawing or instructed by the Engineer. It may consist of and include:

- (a) Gravel wearing course or subbase material in accordance with Clauses 1101 and 900.
- (b) Wet mix crushed stone material in accordance with Clause 1003.
- (c) Surface of the shoulder may be sealed with bituminous course in accordance with Clause 1204.

(3) Construction of Shoulders

Shoulders shall be constructed concurrently with construction of the adjacent pavement layers and with the same materials, except in case the base course is a bituminous mix, the "upper shoulder" shall be constructed subsequent to the base course. Shoulders shall not be constructed ahead of adjacent pavement layers and the Contractor shall ensure that the method of construction is such that at no time water gets prevented from draining off the pavement layers. The method of laying and compacting shoulder material and the compaction requirements shall be in accordance with the relevant Clauses of Section 900 and Section 1000 of the Technical Specifications.

(4) Setting out and Tolerances

Shoulders shall be set out and constructed to the tolerances given in Section 700.

(5) Surface Treatment of Shoulders

Surface treatment of shoulders shall be as shown on the Drawing or instructed by the Engineer. Materials for bituminous surface treatment shall be in accordance with Section 1203 and the method of construction shall be in accordance with the relevant Clauses of Section 1200.

Where topsoil and grassing is shown on the Drawing or instructed by the Engineer, 50 mm of humus or topsoil shall be spread on the completed shoulder and lightly rolled. Grass seeds shall be planted in accordance with the relevant Clauses of Section 1900 and kept watered until growth is established. Top soiling and grassing shall be in accordance with relevant Clauses of Section 1900.

(6) Measurement and Payment

Where shoulders are constructed with the same material as the adjacent pavement layers and no separate items are included in the Bill of Quantities for shoulder construction, the measurement and payment shall be in accordance with the relevant Clauses of Sections 900 and Section 1000.

Hard shoulder constructed different from that of adjacent pavement layers shall be measured in cubic metre by taking cross Sections at intervals of 10 metres or as directed by the Engineer in the original position before the work starts and after its completion and computing the volumes in cubic metres by average end area method.

SECTION 1300 – STONE MASONRY WORK

- 1301 SCOPE
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SECTION 1300 – STONE MASONRY WORK

1301 SCOPE

This Section covers furnishing of materials and construction of different types of stone masonry works in accordance with the Drawing and this Specification or as directed by the Engineer. These works will be required for retaining structures, drains and channel lining, slope and drainage protection works or other works as directed by the Engineer.

Activities involved will include supply of stones, dressed bond stone, cement, sand, water, equipment, tools & plants, preparation of mortar, placing and joining stones dry/with mortar, curing, collection and testing of specimens, etc.

1302 MATERIALS

All requirements in respect of stones and cement sand mortar described herein shall be applicable in all Clauses of this Section, if otherwise not specified.

(1) Stone

The stones to be used shall be durable and angular in shape. If boulders are used they shall be broken into angular pieces. The stones shall be sound, hard, and free from iron bands, spots, sand holes, flaws, shakes, cracks or other defects. The stone shall not absorb water more than 5 per cent. Stones for coursed or uncoursed stone rubble masonry shall have broken face on three sides. Stones for dressed rubble masonry shall have dressed face on all sides. Except otherwise described in the contract, the length of any stone shall not exceed three times its height. The breadth of the stone on the bed shall not be less than 150 mm nor greater than 3/4th thickness of the wall. At least 80% of the stones used in masonry, except those used for chinking as chips or spalls of stones shall have individual volumes of more than 0.01 m³. The chips or spalls used including voids in the dry stone masonry shall not be more than 20% of the stone masonry by volume. In case of mortared masonry. Representative samples of the stones intended for use in the works shall be submitted to the Engineer for prior approval. Further representative samples shall be submitted for approval whenever there is a change in the type or strength of the rock that the Contractor intends to use in masonry work.

(2) Mortar

Mortar shall comply with IS 2250–1981, Code of Practice for preparation and use of masonry mortar. The mortar used in work shall have the strength not less than 5 N/mm² or 7.5 N/mm² at 28 days as specified. For example class MM5 means cement sand mortar in the ratio to attain compressive strength not less than 5 N/mm² at 28 days. The grade of cement sand mortar shall be as specified in the Bill of Quantities.

Sand shall comply with IS 2116. Cement shall be ordinary Portland cement as per IS 8112 or IS 12269.

Water shall be clean and free from detrimental concentration of acids, alkalis, salts, and other organic or chemical substances. If instructed by the Engineer the Contractor shall prove the suitability of the water by tests carried out by an approved laboratory. Such tests shall comply with the requirements of IS: 3029-1964.

The mixing shall be done in a mechanical mixer unless hand-mixing is permitted by the Engineer. If manual mixing is allowed, the operation shall be carried out on a clear watertight platform. The cement and sand shall be first mixed dry in the required proportion to obtain uniform colour. Then required quantity of water shall be added and the mortar shall be mixed to produce workable consistency. The mortar shall be mixed for at least three minutes after addition of water in the case of mechanical mixing. In the case of manual mixing, the mortal shall be hoed back and forth for about 10 minutes after addition of water in order to obtain uniform consistency.

Only that quantity of mortar shall be mixed at a time which can be used completely before it becomes unworkable. Any mortar that has become unworkable due to loss of water before elapsing the initial setting time of cement shall be rewet to make it workable and shall be used in the works. On no account mortar shall be used after elapsing the initial setting time of cement.

1303 CONSTRUCTION

The method of construction described herein shall hold good in all Clauses of this Section, wherever applicable.

(1) General

Construction shall be carried out in accordance with IS : 1597-1992, Code of Practice for construction of stone masonry, Part 1 - Rubble stone masonry or Part 2 - Ashlar Masonry as appropriate. All stratified stone possessing bedding planes shall be laid with its natural bed as nearly as possible at right angles to the direction of load. In the case of arch rings, the natural bed shall be radial. Facework groins shall be built to a height not exceeding one metre in advance of the main body of the work and adjacent walling stepped down on either side. Masonry face work between the groins shall then be built to a height not exceeding 500 mm above the backing which shall then be brought up level with the completed facework. At no time shall the backing be built up higher than the facework.

Except for dry rubble walling, all joints (gaps) shall be sufficiently thick to prevent stone to stone contact and the gaps shall be completely filled with mortar. Stones shall be clean and sufficiently wetted before laying to prevent absorption of water from mortar.

Placing loose mortar on the course and pouring water upon it to fill the gaps in stones shall not be allowed. Mortar shall be fluid, mixed thoroughly and then poured in the joints. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all its faces completely covered with mortar of the thickness as specified for joints.

The bed which is to receive the stone shall be cleaned, wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a wooden mallet immediately after placement and solidly embedded in mortar before it has set. Clean and wet chips and spalls shall be wedged into the mortar joints and bed whenever necessary to avoid thick joints or bed of mortar. When the foundation masonry is laid directly on rock, the bedding face of the stones of the first course shall be dressed to fit into rock snugly when pressed down in the mortar bedding over the rock. For all masonry works, a levelling course of M15/20 concrete 100mm thickness shall be laid to ensure a level and stable foundation.

In case, any stone already set in mortar is disturbed or the joints broken, it shall be taken out without disturbing the adjoining stones and joints. Dry mortar and stones shall be thoroughly cleaned from the joints and the stones shall be reset in fresh mortar. Sliding one stone on top of another which is freshly laid shall not be allowed.

Shaping and dressing of stone shall be done before it is laid in the work. Dressing and hammering of the laid stones which will loosen the masonry shall not be allowed.

Building up face wall tied with occasional through stones and filling up the middle with stones spalls and chips or dry packing shall not be allowed. Vertical joints shall be staggered. Distance between the nearer vertical joints of upper layer and lower layer in coursed rubble masonry shall not be less than half the height of the course.

Masonry in a structure between two expansion joints shall be carried up nearly at one uniform level throughout but when breaks are unavoidable the masonry shall be raked in sufficiently long steps to facilitate jointing of old and new work. The stepping of raking shall not be more than 45 degrees with the horizontal.

Masonry shall not be laid when the air temperature in the shade is less than 3°C. Newly laid masonry shall be protected from the harmful effects of weather.

The holes left in the masonry work for supporting scaffolding shall be filled and finished with M15 grade concrete.

The masonry work in cement mortar shall be kept constantly moist for a minimum period of 7 days, unless otherwise specified.

(2) Concrete Capping

Where masonry structures are constructed to receive a concrete capping the joints to the upper surface of the masonry shall be raked out to a depth of 10 mm prior to placing of the concrete to the capping. The concrete for capping shall be as per the Drawing or as directed by Engineer and shall conform to Section 1600.

(3) Pointing

Where external faces of the mortared masonry work will be backfilled or otherwise permanently covered up, the mortared joint shall be finished flush to the faces of the adjacent stonework.

Where mortared masonry faces will remain exposed, the mortar joints shall be pointed to a consistent style only if shown on the Drawings and/or as directed by the Engineer. Pointing shall be carried out using mortar MM7.5 cement mortar as shown on the Drawing or as directed by the Engineer. The mortar shall be filled and pressed into the raked out joints before giving the required finish. The pointing, if not otherwise mentioned, shall be ruled type for which it shall, while masonry work is still green, be ruled along the centre with half round tools of such width as may be specified by the engineer. The excess mortar shall then, be taken off from the edges of the lines and shall not be unnecessarily plastered over the exposed stone works. The thickness of the joints shall not be less than 3mm for Ashlar masonry.

However, the maximum thickness of joints in different works shall be as follows:

- Random Rubble : 20mm
 - Coursed Rubble : 15mm
- Ashlar Masonry : 5mm

(4) Weep holes

Weep holes shall be provided in solid plain concrete/reinforced concrete, brick/stone masonry, abutment, wing wall or other structures as shown on the Drawing or as directed by the Engineer. Weep holes shall be provided with 100mm diameter polythene pipe for structures in plain/reinforced concrete or brick masonry. In case of stone masonry, weep holes shall be 100 mm wide, 100 mm high or circular with 100 mm diameter. Weep holes shall extend through the full width of concrete/masonry with a slope of 1 vertical 20 horizontal towards the draining face. The spacing of weep holes shall generally be 1 m in either direction or as shown on the drawing with the lowest at about 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer. Surfaces of the weep holes shall be smooth and it shall be ensured that the water is properly drained from the backfill.

1304 ASHLAR

All stones shall be dressed to accurate planes on the beds and joints and they shall be fair and neatly or fine tooled on the face unless otherwise described in the contract.

1305 BLOCK-IN-COURSE

Beds and joints shall be squared and hammer dressed for a distance of at least 220 mm from the exposed face. Bond stones shall form at least one sixth of the area of the exposed face and shall extend at least 900 mm into the wall or for the full thickness of the wall whichever is minimum. Unless described in the contract as tooled or drafted, the exposed face of all stones shall be blocked and left rough. Arises shall be dressed square at all beds and joints.

1306 SQUARE RUBBLE- COURSED OR BROKEN COURSES

All stones shall be truly squared and hammer dressed for a distance at least 120 mm from the face of the wall. Bond stones shall be provided at the rate of at least one to every 0.5 m^2 of exposed face and shall measure not less than 150 mm x 150 mm on the face and not less than 450 mm in length or the full thickness of the wall, whichever is the less. Vertical joints in any layer shall be broken in the next layer and the horizontal lapping of the stones shall not be less than 100 mm.

1307 RANDOM RUBBLE - COURSED OR UNCOURSED

All stones shall be carefully set with bond stones running right through the thickness of walls up to 600 mm thickness and in case of walls above 600 mm thickness a set of two or more bond stones overlapping each other by minimum 150 mm shall be provided in a line from face to back. At least one bond stone or a set of bond stones shall be provided for every 0.5 m^2 of the wall surface. If the bond stone of sufficient length is not available then plain cement concrete (M15 grade concrete) block of cross-section not less than 200x150 mm shall be provided.

In case of highly absorbent types of stones (porous lime stone and sand stones etc) the bond stone shall extend about two third into the wall. The bond stones in such cases may give rise to damp penetrations therefore, for all thickness of such walls, a set of two or more bond stones overlapping-each other by at least 150 mm shall be provided.

For random rubble masonry, the face stones shall be hammer dressed on all beds and joints and the quoins shall be of selected stones neatly dressed with the hammer chisel to form the required angle, and laid header and stretcher alternately.

In case of coursed rubble masonry, the face stones shall be hammer dressed on all beds and joints so as to give them approximately rectangular block shape. The bed joint shall be dressed for at least 80 mm back from the face and side joints for at least 40 mm such that no portion of the dressed surface is more than 10 mm from a straight edge placed on it. The remaining portion of the stone shall not project beyond the surface of bed and side joints. The bushing on the face shall not project more than 40 mm on exposed face and 10 mm on a face to be plastered. The face stones shall be laid alternate headers and stretchers without pinning on the face. Bond stones shall be provided as specified above except that the spacing of a bond stone or set of bond stones shall be about 1.5 m or as directed by the Engineer. The quoins shall be of same height as the course. These shall be minimum 380 mm long and laid alternate header and stretcher.

1308 DRY RANDOM RUBBLE

Dry random rubble masonry shall be constructed generally to the requirements of coursed random rubble masonry as specified in Clause 1307 but with the omission of mortar. All stones shall be carefully shaped to obtain as close a fit as possible at all beds and joints, any interstices between the stones being filled with selected stone spalls. No round stones shall be used in dry stone masonry work. The stones in courses shall be laid perpendicular to the batter face. Bond stones shall be provided at the rate of at least 10 percent of volume of dry stone masonry structure. Bond stones shall measure not less than 150 mm x 150 mm and not less than 450 mm in length or full thickness of wall, whichever is less. The exposed tops or capping of dry rubble structures shall be formed as shown on the Drawing or as directed by the Engineer.

1309 COMPOSITE RANDOM RUBBLE

Materials for composite random rubble shall comply with Clause 1302 and construction with Clause 1303. Mortar masonry shall be coursed and comply with Clause 1307 and the dry stone insets with Clause 1308. The dry stone insets shall be constructed when the level of the surrounding mortared masonry surround has reached the top of the dry stone inset.

1310 STONE PITCHING

(1) General

Stone pitching work shall be required for lining of drains and channels.

(2) Material

The stones to be used shall be durable and angular in shape. If boulders are used they shall be broken into angular pieces. The stones shall be sound, hard, and free from iron bands, spots, sand holes, flaws, shakes, cracks or other defects. The stone shall not absorb water more than 5 per cent. Stones for pitching shall not

be less than 150 mm in minimum dimension. Rounded stones shall not be used in stone pitching. The mortar shall comply with Sub-Clause 1302(1).

(3) Mock-Up

Prior to commencement of any stone pitching work the Contractor shall construct a stone pitching panel of approximately 2000 mm x 1000 mm as a trial. The trial if accepted by the Engineer shall be the sample for actual work.

(4) Construction

Stone pitching shall be done on surface prepared to specified requirements. Stones shall be laid in mortar with their longitudinal axis across to the direction of flow. Thickness of mortar in bed shall be 25 to 35 mm. They shall be well set into the surface. Thickness of pitching will be as shown on Drawings or as directed by the Engineer. Spaces between stones shall be filled with spalls. Finished surface shall present an even, tight and neat appearance with no stones varying by more than 20 mm from specified grades and lines. Joints between the stones shall be completely filled with MM 7.5 mortar. Finished surface shall present an even, tight and neat appearance with no stones varying by more than 20 mm from specified grades and lines.

1311 STONE SOLING

Stone soling are required in the construction of foundation beds for various structures as directed by the Engineer. Stones shall comply with Clause 1302 of this specification. Stone soling shall be done on foundation surface prepared as specified. They shall be well rammed into the surface. Spaces between stones shall be filled with spalls or smaller stones securely rammed into voids. The completed work shall present an even, neat and tight surface.

1312 REPAIRS/REHABILITATION OF EXISTING STRUCTURES

- (1) Dismantling and removal of existing masonry wall /PCC catch pit in cement mortar in drain, wall, culverts etc including stacking of material for reuse and disposal of waste materials shall be carried out as per drawing or as directed by the Engineer. The dismantling may be required either for scrapping of the structures, to extend or to replace the same by new structure.
- (2) Existing structures such as retaining walls shall be cleaned of vegetation, plants and trees and roots uprooted or poisoned to apply a layer of concrete shotcrete of nominal 15 mm thickness.
- (3) Drilling and installation of pipe dowels 32 mm dia. 1 m c/c shall be carried out into existing causeways including grouting as per drawing. This shall be done to construct additional wall over the existing causeways/masonry walls particularly over existing causeways on cross drainage as per drawing or as directed by engineer.
- (4) Extension of masonry wall without any cross drainage works shall be done using standard bond stones.
- (5) The face of the existing masonry wall shall be shotcreted to strengthen the wall. The rate of application shall be in agreement with the engineer after few shotcrete trial works.
- (6) The existing parapets shall be repaired wherever these are damaged or new one constructed as per the direction of the engineer.

1313 TEST AND STANDARD OF ACCEPTANCE

Before laying any mortar, the Contractor shall make three sets of mortar test cubes from each source of sand to demonstrate the compliance of the mix to the specified strength. Each set shall comprise two cubes, one to be tested at 7 days and the other to be tested at 28 days. During construction, the Contractor shall make and test mortar cubes at the rate of three cubes for every 10 m³ of masonry to assess the strength subject to a
minimum of 3 cubes samples for a days work. Testing of cubes shall be in accordance with IS 2250. The stones shall be tested for the water absorption as per IS1124 and it shall not be more than 5 percent. Sand shall be tested as per Clause 211 or as directed by the Engineer. At least 3 set of tests for stone and sand shall be conducted for every source.

1314 MEASUREMENT

Stone work shall be measured in cubic metres. No separate measurement shall be carried out for pointing, if pointing was carried out.

Weep holes shall not be measured separately. No deduction in the volume of structures shall be made for weep holes.

Repairs/rehabilitation of existing structures shall be measured as per their respective unit of measurement. Deductions shall be made for not meeting the thickness of cement grouting at the discretion of Engineer.

1315 PAYMENT

The stone masonry shall be paid at the respective contract unit prices which shall be the full and the final compensation to the Contractor as per Clause 116 to complete the work in accordance with these Specifications. The contract unit rate for respective items shall be deemed to have included costs for labor, materials, tools & plants etc including the costs for providing pointing and weep holes.

SECTION 1400 – BRICK MASONRY WORKS

1401 SCOPE

This Section covers the furnishing of materials and construction of brick works for structures in accordance with the detail shown on the Drawing and these Specifications or as directed by the Engineer.

1402 MATERIALS

(1) Bricks

Burnt clay bricks shall conform to the requirements of IS 1077 and IS 2180 and shall be of the best quality locally available as approved by Engineer. The bricks shall be free from cracks, flaws, grit and other impurities such as lime, iron and deleterious salts. All bricks shall be well burnt, sound and hard with sharp edges giving a ringing sound when struck with a mallet.

Bricks shall not show any signs of efflorescence when dry or subsequent to soaking.

The bricks shall not absorb water more than 7% of its weight after the 5 hour boiling test.

The standard brick sizes shall be 9 $\frac{1}{4}$ " x 4 $\frac{1}{4}$ x 2 $\frac{1}{4}$ " (230mm x 110mm x 55mm). The dimensions for sizes of bricks may be amended by the Engineer to suit the local condition.

The bricks shall have a minimum average compressive strength of 100 kg/cm² and transverse strength of 32 kg/cm². Random compressive strength testing shall be done as prescribed by the Engineer.

Where bricks are to form fair face construction, they shall be individually selected for colour, size, shape, and quality and if required shall match bricks in existing construction. Bricks shall be inspected by the Engineer who may reject any or all bricks before incorporation in the works.

Where the Engineer requires bricks to be classified by their intended use in construction, bricks of each classification shall be stored separately and apart and be clearly identified as instructed. Rejected bricks shall be immediately removed from the site.

Bricks shall not be dumped on the site. Bricks shall be carefully stacked in regular layers and otherwise handled and stored at all times so as to avoid damage.

(2) Mortar

The mortar for brickwork and plastering shall comply with Sub-Clause 1302(2) of the Technical Specifications.

1403 SOAKING OF BRICKS

Bricks shall be soaked in water for a minimum period of one hour before use. When bricks are soaked they shall be removed from the tank sufficiently in advance so that at the time of laying they are skin dry. Such soaked bricks shall be stacked on a clean place where they are not spoilt by dirt, earth, etc.

1404 LAYING OF BRICKS

All bricks work shall be laid in English bond, even and true to line, plumb, level and all joints accurately kept. Whole bricks used on the face shall be selected ones of uniform size and true rectangular face.

Bricks shall be laid with frogs up, if any, on a full bed of mortar. When laying, bricks shall be slightly pressed so that the mortar gets into all the surface pores of bricks to ensure proper adhesion. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left.

Before laying bricks in foundation, a layer of not less than 12 mm of mortar shall be spread to make the surface on which the brick work will be laid even. Immediately thereafter, the first course of bricks shall be laid.

The brick work shall be built in uniform layers. Corners and other advanced work shall be raked back. Brick work shall be done true to plumb or in specified batter. No part of it, during construction, shall rise more than one metre above the general construction level, to avoid unequal settlement and improper jointing.

Toothing may be done where future extension is contemplated but shall be used as an alternative to raking back.

The weep holes shall be provided as per Clause 1303 of the Technical Specifications.

1405 JOINTS

The thickness of joints shall not exceed 10 mm.

1406 JOINTING WITH EXISTING STRUCTURES

When fresh masonry is to be placed against existing surface of structures, the surface shall be cleaned of all loose materials, roughened and wetted as directed by the Engineer so as to effect a good bond with the new work.

1407 CURING

Green work shall be protected from rain by suitable covering. Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water so as not to disturb or washout the green mortar.

During hot weather, all finished or partly completed work shall be covered or wetted in such a manner as to prevent rapid drying of the brick work.

1408 SCAFFOLDING

The scaffolding shall be sound and strong to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one metre in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good.

1409 CONDITION OF EQUIPMENT

All equipment used for mixing or transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

1410 FINISHING OF SURFACES

(1) General

The surfaces can be finished by 'jointing', 'pointing' or 'plastering', as specified. For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.

The mortar for finishing shall be prepared as per Sub-Clause 1302(2).

(2) Jointing

In jointing, the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick-work. The faces of brick-work shall be cleaned to remove any splashes of mortar during the course of raising the brick-work.

(3) Pointing

For pointing, the mortar shall be filled and pressed into the raked out joints, before giving the required finish. The pointing shall then be finished to proper type given on the Drawing. If type of pointing is not mentioned on the Drawing the same shall be ruled pointing. For ruled pointing after the mortar has been filled and pressed into the joints and finished off level with the edges of the bricks, it shall while still green be ruled along the centre with a half round tool of such width as may be specified by the Engineer. The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned of all mortar.

(4) Plastering

The grade and thickness of mortar for plastering shall be as specified on Drawing or as directed by the Engineer. Plastering shall be started from top and worked down. All holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 to 4 metres apart to act as gauges and guides in applying the plaster. The mortar shall be laid on the wall between the screeds using the plaster's float and pressing the mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm or 75 mm at a time. Finally, the surface shall be finished off with a plaster's wooden float. Metal floats shall not be used.

When recommencing the plastering beyond the work suspended earlier the edges of the old plaster shall be scraped, cleaned and wetted before plaster is applied to the adjacent areas.

No portion of the surface shall be left out in a condition to be patched up later on.

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required by the Engineer.

The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness minus 3 mm.

Any cracks which appear in the surface and all portions, which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and re-done as directed by the Engineer.

(5) Curing of Finishes

Curing shall be started as soon as the mortar used for finishing has hardened sufficiently not to be damaged when watered. It shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages.

1411 BRICK SOLING

(1) General

This Clause shall consist of the provision and placing of all materials for the construction of brick soling in foundation to the dimensions and locations shown on the Drawings or as directed by the Engineer. It shall also include preparation of surface to the specified requirements.

(2) Materials

Brick for soling shall be as described in Sub-Clause 1402(1).

(3) Construction

- (a) Foundation bed for brick soling shall be trimmed to the required level and compacted by hand or suitable mechanical equipment to a density of not less than 95% of the maximum dry density of the material as determined by the method described in IS2720-Part 8. The Contractor shall not be permitted to place the brick soling until the Engineer has tested and approved the levels and compaction of the surface.
- (b) Brick for soling shall be laid on edge or flat as shown on Drawings or as directed by the Engineer on foundation bed prepared as above. Shoulder coursing shall be provided at all edge conditions and elsewhere shown on the drawings.
- (c) After completion the brick paving shall have a true and level surface to the required slope. The finished level of the soling at any point shall be within plus or minus 10 mm of the levels shown on the Drawings or as directed by the Engineer.

1412 TEST AND STANDARD OF ACCEPTANCE

Before laying any mortar, the Contractor shall make three sets of mortar test cubes from each source of sand to demonstrate the compliance of the mortar to the specified strength. Each set shall comprise two cubes, one to be tested at 7 days and the other to be tested at 28 days. Testing shall be in accordance with IS 2250. During construction the Contractor shall make and test mortar cubes at the rate of three for every 10m³ or part of the brick work to assess the strength of the mortar subject to a minimum of 3 sample cubes for a days work. The brick shall be tested for compressive strength and water absorption and shall meet the requirement of this Specification. The surface of the brick soling shall show no depression in excess of 5 mm when tested with a 3m straightedge placed anywhere on the completed surface. The Contractor shall remove and replace any work outside the tolerances stated above.

1413 MEASUREMENT

All brick work shall be measured in cubic metres. The work of plastering and pointing shall be measured in square metres separately.

1414 PAYMENT

The brick works, plastering and pointing shall be paid at their respective contract unit rate which shall be the full and the final compensation to the Contractor as per Clause 116 to complete the work as per these Specifications.

SECTION 1500 – GABION WORK

- 1501 SCOPE
- 1502 MATERIALS
- 1503 CONSTRUCTION OF GABIONS
- 1504 TEST AND STANDARD OF ACCEPTANCE
- 1505 MEASUREMENT
- 1506 PAYMENT

SECTION 1500 – GABION WORK

1501 SCOPE

This Clause covers the furnishing of materials and construction of gabion works that may be required to act as buttresses, retaining walls, catch walls, stream or river training structures, check dams within gullies, or where placed as mattresses, to prevent stream or gully erosion.

1502 MATERIALS

(1) Stones

Stones used for filling the gabion boxes or mattresses shall be clean, hard, sound, un-weathered and angular rock fragments or boulders. The specific gravity of the stone shall be not less than 2.50 and the stones shall not absorb water more than 5 percent when tested as per IS:1124. The length of any stone shall not exceed three times its thickness. The smallest dimension of any stone shall be at least twice that of the longer dimension of the mesh of the crate. However smaller size of stones as spalls shall be allowed for filling voids and its volume including voids shall not be more than 20 percent of the total volume of the stones.

Before filling any gabion boxes and mattresses the Contractor shall submit representative samples of the rock he proposes to use in the gabions for approval by the Engineer. Further representative samples shall be submitted for approval each time when there is a change in the type and strength of the rock.

(2) Gabions

Gabions shall consist of steel wire mesh crates. The steel wire shall be mild steel wire complying with IS 280-197. All wires used in the manufacturing of crates and diaphragms, binding and connecting lids and boxes shall be galvanised with a heavy coating of zinc by an electrolytic or hot dip galvanising process. The weight of deposition of zinc shall be in accordance with IS 4826-1979. Zinc coating shall be uniform and be able to withstand minimum number of dips and adhesion test specified in IS 4826-1979. Tolerance on diameter of wire shall be + 2.5 percent. The tensile strength of gabion wire shall be between 300 and 550 N/mm².

All gabions shall be machine made. The wire shall be woven into a hexagonal mesh with a minimum of 3 twists. All edges of the crates shall be finished with a selvedge wire at least 3 gauges heavier than the mesh wire. Gabions shall be manufactured in the standard sizes shown in Table 15.1 with mesh and wire sizes as shown in Table 15.2.

Diaphragms shall be manufactured of the same materials as the parent gabion box and shall have selvedge wire throughout their perimeter. The number and size of diaphragms to be provided with each crate shall be as in Table 15.1. All crates shall be supplied with binding and connecting wire of the gauges shown in Table 15.2 of sufficient quantity to bind all diaphragms and closing edges.

Dimensions in metres Number of		Dimensions of	Volume of crate in cubic				
(Prior to fill)	diaphragms	diaphragms in metres	metres				
1 x 1 x 1	-	-	1				
1.5 x 1 x 1	1	1 x 1	1.5				
2 x 1 x 1	1	1 x 1	2				
3 x 1 x 1	2	1 x 1	3				
1 x 1 x 0.5	-	-	0.5				
2 x 1 x 0.5	1	1 x 0.5	1				
3 x 1 x 0.5	2	1 x 0.5	1.5				
1 x 1 x 0.3	-	-	0.3				
2 x 1 x 0.3	1	1 x 0.3	0.6				
3 x 1 x 0.3	2	1 x 0.3	0.9				

Table 4F 4.	Changel and Cine	f\\/:w- \/-	ah Cahiana
1 2010 15 1	Standard Size	- OT VV IRE IV/E	sh (-anions

Table 15.2: Standard Sizes of Mesh and Wire in Gabions

Mesh opening	Mesh type	Thickness of	Thickness of binding	Thickness of
mm		mesh wire	and connecting wire	selvedge wire
(D x H)		SWG	SWG	SWG
83x114	80x100	9,10,11	11,12,13	6,7,8
114x128	100x120	10,9	12,11	7,6
		1		

The mesh opening shall be as instructed by the Engineer.

Equivalent diameter in mm									
SWG	6	7	8	9	10	11	12	13	14
mm	4.88	4.47	4.06	3.66	3.25	2.95	2.64	2.34	2.03

1503 CONSTRUCTION OF GABIONS

(1) General Requirements

Before filling any gabion boxes and mattresses, the Contractor shall submit samples of gabion boxes and/or gabion mattresses assembled, erected and filled with stones for approval which, when approved, shall be retained for reference and comparison with the gabions built as part of the permanent works. The size, type and location of the samples shall be as directed by the Engineer.

Gabion boxes and gabion mattresses shall be assembled, erected and filled with stones in the dry on prepared surfaces except as may be otherwise approved. Approval for assembling and erecting gabions in water shall be given only, if in the Engineer's opinion such a method will produce work in accordance with the Specification.

(2) Preparation of Foundation and Surface for Bedding

The bed on which the gabion boxes or mattresses are to be laid shall be even and conform to the levels shown on the Drawing. If necessary, cavities between rock protrusions shall be filled with material similar to that specified for gabion filling.

(3) Arrangement of Joints

(a) Walls

In walls, gabion boxes shall be placed such that vertical joints are not continuous, but staggered. Aprons shall be formed of headers. If more than one unit is required to obtain the necessary width, units of unequal length shall be used and the joints between them should be staggered.

(b) Channel linings

In channel linings, gabion box and mattress units shall be laid so that the movement of stone inside the mesh due to gravity or flow of water is avoided. Hence, on side slopes, units shall be placed with their internal diaphragms at right angles to the direction of the slope and, on inverts, as far as possible, at right angles to the direction of flow.

(c) Assembly

Gabion boxes and gabion mattresses shall be assembled on a hard flat surface. After fabrication, unpacking or unfolding, they shall be stretched out and any kinks shall be removed. Creases shall be in the correct position for forming the boxes or mattress compartments. The side and end panels shall be folded into an upright position to form rectangular boxes or compartments. The top corners shall be joined together with the thick selvedge wires sticking out of the corners of each panel. The tops of all sides and partitions shall be

leveled except as may be appropriate to special units. The sides and end panels shall be tied together using binding wire of the thickness given in Table 15.2, starting at the top of the panel by looping the wire through the corner and twisting the wire together. Binding shall continue by looping the wire through each mesh and around both selvedges with three rounds which shall be joined tightly together by twisting and the end shall be poked inside the unit. The diaphragms shall be secured in their correct positions by binding in the same way. The bindings wire shall be fixed using 250mm long nose fencing pliers or equivalent approved tools.

The gabion boxes and gabion mattresses shall be laid in such a manner that the hinges of the lid will be on the lower side on slopes and on the outer side in walls.

Where mattresses are laid horizontally hinges shall not be placed on the downstream side as much as practicable.

(d) Filling

The crates shall be placed in their final position before filling commences. They shall be stretched to their full dimension and securely pegged to the ground or wired to adjacent gabions before filling. The vertical corners shall be kept square and to full dimension by inserting a steel bar of at least 20 mm diameter at each vertical corner, maintaining it in the correct final position throughout the filling process, and removing it when the crate is full. Before filling commences, the selvedges of the crate shall be bound to the selvedges of adjacent crates with binding wire. Where crates are being assembled in position in a wall the binding of the edges of each crate in the assembly process and the binding together of adjacent crates shall be carried out in the same operation.

Before filling with stone, gabions shall be anchored at one end or side and stretched from the opposite end or side by inserting temporary bars and levering them forward. The top and bottom shall be kept stretched by tensioning with tie wires attached to an anchorage or equivalent approved method until the gabion has been filled. The gabions shall be inspected at this stage but before filling with stone to ensure that the tie/wiring has been properly carried out and the gabion boxes or gabion mattresses are not pulling apart. Gabion boxes or gabion mattresses may be tensioned either singly or in the case of a long straight structure by straining a number of units together using an approved tensioning system.

The filling shall be carried out by placing individual stones into the gabion by hand in courses in such a manner that the stones are bedded on each other and bonded as in dry random rubble masonry as per Clause 1308. No loose stones shall be tipped into the crate and the practice of coursing and bonding the outer layer and filling the interior with unlaid stones shall not be permitted.

All 1m deep gabions shall be filled in three equal layers and 0.5m deep gabions in two equal layers. Horizontal bracing wires made with the same bindings wire as used for tying shall be fixed directly above each layer of the stone in the compartments, the wires being looped round two adjoining meshes in each side of the compartment and joined together to form a double tie which shall be tensioned by wind lassing together to keep the face of the gabions even and free from bulges. Bracing wires shall be spaced horizontally along and across the gabions at distances not greater than 0.33m. Where the upper faces of gabion boxes are not covered with further gabions vertical bracing wires shall be fitted between the top and bottom mesh using two tie wires per square metre of surface.

The ties shall be fixed to the bottom of the units prior to filling and tied down to the lid on completion. Where a double layer of gabion boxes is used to form an apron both upper and lower layers shall have vertical tie wires.

(e) Securing Lids

The gabion boxes and mattress compartments shall be over filled by 50mm above their tops to allow for subsequent settlement. The lids shall then be tied down with binding wire to the tops of all partition panels. The lids shall be stretched to fit the sides exactly by means of a suitable tool but due care shall be taken to ensure that the gabions are not so full that the lids are overstretched. The corners shall be temporarily secured first.

(f) Tolerance

On completion, the crates shall be completely and tightly filled, square, true to dimensions and the line and level shown on the Drawing. However the tolerance limit permitted in the length, height and width of the gabion boxes and mattresses as manufactured shall be \pm 3 percent from the ordered size prior to filling. The tolerances on the wire mesh opening shall be \pm 10% on the nominal dimension 'D' values as follows:

Mesh type	Nominal dimension 'D' values
80x100	83
100x120	114

However, the number of opening per gabion box/mattress shall not be less than the nominal length divided by 'D' on horizontal direction and nominal height divided by 'H' in vertical direction where D and H are as per Table 15.2.

1504 TEST AND STANDARD OF ACCEPTANCE

(1) The gabion wire shall be tested for mass, uniformity and adhesion of zinc coating and tensile strength of the wire itself. Failure of test results to comply with the specifications shall lead to the rejection of gabion wires. The test on the samples taken as per Table 15.3 from each lot of the G.I. wire received at the site of the work shall be carried out in accordance with IS 280-197 and IS 4826-1979.

No. of coils in a lot	No. of coils randomly selected	Permissible No. of defective
	for sampling*	coil
Up to 25	2	0
26-50	3	0
51-150	5	0
151-300	8	1
300 and above	13	1

Table 15.3: Scale of Sampling and Permissible Number of Defective coil

* One sample per coil shall be tested in all respect.

(2) The stones shall be tested for water absorption. At least 3 set of tests shall be made for every source of material. The test results shall meet the specified criteria.

1505 MEASUREMENT

Measurement shall be in cubic meters of gabion crates filled with stones and complete in place and the quantity shall be calculated from the dimension of the gabions indicated in the Drawing or ordered by the Engineer.

1506 PAYMENT

Payment shall be made as per respective contract unit rate which shall be the full and the final payment to the Contractor as per Clause 116 to complete the work in accordance with these Specifications.

1600 CONCRETE WORK

- 1601 SCOPE
- 1602 DEFINITIONS
- 1603 MATERIALS FOR CONCRETE
- 1604 THE DESIGN OF CONCRETE MIXES
- 1605 MIXING CONCRETE
- 1606 TRANSPORTATION OF CONCRETE
- 1607 PLACING OF CONCRETE
- 1608 COMPACTION OF CONCRETE
- 1609 CURING OF CONCRETE
- 1610 PROTECTION OF FRESH CONCRETE
- 1611 CONCRETING IN HOT WEATHER
- 1612 CONSTRUCTION JOINTS
- 1613 RECORDS OF CONCRETE PLACING
- 1614 REINFORCEMENT
- 1615 CONCRETE FOR SECONDARY PURPOSES
- 1616 FORM WORK
- 1617 EARLY LOADING
- 1618 PLUM CONCRETE
- 1619 MEASUREMENT
- 1620 PAYMENT

SECTION 1600 – CONCRETE WORK

1601 SCOPE

This Section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete and mortar required in the works. It also covers reinforcement for concrete. This also includes plum concrete work.

1602 DEFINITIONS

Structural concrete is any class of concrete which is used in reinforced or plain concrete construction which is subject to stress.

Non-structural concrete is composed of materials complying with the Specification but for which no strength requirements are specified and which is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

A pour refers to the operation of placing concrete into any mould, bay or formwork, etc. and also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

1603 MATERIALS FOR CONCRETE

(1) General

The Contractor shall submit to the Engineer full details of all materials which he proposes to use for making concrete. No concrete shall be placed in the works until the Engineer has approved the materials of which it is composed. In accordance with Clause 203, approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

(2) Cement

Cement shall be ordinary Portland cement as per IS 8112 or IS 12269. The cement shall also meet the requirements of Clause 212. If required rapid hardening Portland cement as per IS 8041 shall be used for concrete as directed by the Engineer.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed unbroken bags or in bulk. Bagged cement shall be transported in vehicles provided with effective means of ensuring that it is protected from the weather.

Bulk cement shall be transported in vehicles or in containers built and equipped for the purpose.

Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be dry and well ventilated at all times. The floor shall be raised above the surrounding ground level not less than 300 mm and shall be so constructed that no moisture rises through it.

Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation with minimum gap of 500mm from outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. Stack of cement bags shall not exceed 8 bags in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks. Cement in bags shall be used in the order in which it is delivered.

Cement from broken bags shall not be used in the works.

Bulk cement shall be stored in weather proof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity on site to ensure that his anticipated programme of work is not interrupted due to lack of cement.

Cement which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the Site.

All cement for any one structure shall be from the same source as far as possible.

All cement used in the works shall be tested by the manufacturer. The manufacturer shall provide the results of tests as given in Table 16.1 and 16.2 for each supply and for the last six months of his production. The Contractor shall supply two copies of each certificate to the Engineer.

10	Table 10.1. Test Results for Chemical Composition of Cement						
Compounds	s %	Mean	Min.	Max.	Standard deviation		
Lime	CaO						
Silica	SiO ₂						
Alumina	AI_2O_3						
Iron Oxide	Fe ₂ O ₃						
Magnesia	MgO						
Sulphur Trioxide	So ₃						
Soda, Potash	Na ₂ O,K ₂ O						

Table 16.1. Test Desults for Chemical Composition of Coment

Table 16.2: Test Results for Physical Properties of Cement							
Characteristics	Requirements	Nominal	Mean	Min.	Max.	Standard Deviation	
Fineness, M ² /KG : (by Blaine's Air Permeability Method)	225						
Minimum Setting time (initial), minutes	45						
Maximum Setting time (final), minutes	600						
Soundness (by Le Chatelie method) mm, maximum Minimum Average Compressive Strength of three mortar cubes,	10						
(N/mm²)							
3 days	16, 27*						
7 days	22, 37*						
28 days	33, 53*						

*denotes the requirements of High Strength Portland Cement

Each set of tests carried out by the manufacturer on samples taken from cement which is subsequently delivered to site shall relate to no more than one day's output of each cement plant.

The Contractor shall constitute, from each delivery and each type of cement and not less than one sample for every 200 tonnes or part of it, representative samples to be tested when instructed by the Engineer in a laboratory acceptable to him, in case the concrete mixes do not comply with the requirements of this Specification.

Cement which is stored on site for longer than one month shall be tested in such laboratory for every 200 tonnes or part thereof and at monthly intervals thereafter.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and the cement used in the works and shall provide the Engineer with two copies thereof.

(3) **Fine Aggregate**

Fine aggregate shall be clean hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with IS 383. All the material shall pass through a 4.75 mm IS sieve and the grading shall be in accordance with IS 383. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source.

The deviation from the initial fineness modulus shall be no more than \pm 0.30 for ordinary concrete and \pm 0.20 for high quality concrete.

However, in respect of the presence of deleterious materials the fine aggregate shall not contain iron pyrites, iron oxides, mica, shale, coal or other laminar soft or porous materials or organic matter unless the Contractor can show by comparative tests on finished concrete as set out in Clause 213 and as per the direction of the Engineer, that the presence of such materials does not affect the properties of the concrete.

(4) Coarse Aggregate

Coarse aggregate shall be clean hard and durable crushed rock, crushed gravel or natural gravel corresponding to the following classes:

- Class A : Aggregate shall consist of crushed igneous or quartzite rock from an approved source.
- Class B : Aggregate shall consist of crushed quarry rock other than Class A from an approved source.
- Class C : Aggregate shall consist of natural or partly crushed gravel pebbles obtained from and approved gravel deposit. It may contain a quantity of material obtained from crushing the oversize stone in the deposit provided such material is uniformly mixed with the natural uncrushed particles.
- Class D: Aggregate shall consist entirely of crushed gravel. The crushed gravel shall be produce from material retained on a standard sieve having an opening at least twice as large as the maximum size of aggregate particle specified.
- Class E: Aggregate shall consist of an artificial mixture of any of the above classes of aggregate. The use of Class E aggregate and the relative proportions of the constituent materials shall be approved by the Engineer.

Coarse aggregate shall be supplied in the nominal size called for in the contract and shall be of the grading as single sized aggregate or graded aggregate of nominal size 40 mm, 20 mm, 12.5 mm and 10 mm in accordance with IS 383.

Other properties shall be as specified below:

Flakiness Index: When tested in accordance with IS 2386 Part 1, the Flakiness Index of the coarse aggregate shall be not more than 25 and not more than 15 respectively for ordinary concrete and high quality concrete.

If the Flakiness Index of the coarse aggregate varies by more than five units from the average value of the aggregate used in the approved trial mix, then a new set of trial mixes shall be carried out if the workability of the mixes has been adversely affected by such variation.

Water Absorption: The aggregate shall not have water absorption of more than 2 per cent when tested as set out in IS 2386 Part 3.

Los Angeles Abrasion (LAA): The aggregate shall have LAA not more than 45% for ordinary concrete, and not more than 35% for high quality concrete, when tested in accordance with IS 2386 Part 4.

Aggregate Crushing Value (ACV): The aggregate shall have ACV not more than 30% for pavement structure and not more than 45% for other structure when tested in accordance with IS 2386 Part 4.

Alkali Aggregate Reactivity: The aggregate shall comply with IS 383/3.2 notes when tested in accordance with IS 2386 Part 7.

- (5) Testing Aggregates
- (a) Acceptance Testing

The Contractor shall deliver to the Engineer samples containing not less than 50 kg of any aggregate which he proposed to use in the works and shall supply such further samples as the Engineer may require. Each sample shall be clearly labelled to show its origin and shall be accompanied by all information called for in IS 2386 Part 1 to 8.

Tests to determine compliance of the aggregates with the requirements of Sub-clauses 1603(3) and (4) shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer. Acceptance of the material shall be based on the results of such tests.

All the materials shall be accepted if the results of not less than three consecutive sets of test executed in accordance with IS 2386 (Part 1-8) show compliance with the Sub-clauses 1603 (3) and (4).

(b) Compliance Testing/Process Control Testing

The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period that concrete is being produced for the works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to site provided that the set of tests shall represent not more than 100 tonnes of fine aggregate and not more than 250 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality.

•	Grading	:	IS 2386 Part 1
•	Silt, Clay Contents and Organic Impurities	:	IS 2386 Part 2

If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

In addition to the above routine tests, the Contractor shall carry out the following tests at the stated frequencies:

Chloride Content: As frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in the Specification.

Sulphate Content and

Alkali Reactivity: As frequently as may be required according to the variability of sulphate content and alkali reactivity assessed from the laboratory tests carried out during the concrete mix design.

(6) Delivery and Storage of Aggregates

Aggregates shall be delivered to site in clean and suitable vehicles. Different type or sizes of aggregates shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that the contamination of aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be arranged in such a way that drying out in hot weather is prevented in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged in such a way that they can drain sufficiently before use in order to prevent fluctuations in water content of the concrete.

(7) Water for Concrete and Mortar

Water shall be clean and free from harmful matter and shall comply with the requirements of IS 456.

Brackish water containing more than 1000 ppm chloride ion or 2000 ppm sulphate ion shall not be used for mixing or curing concrete.

The Contractor shall carry out tests in accordance with IS: 456 to establish compliance with Specifications.

(8) Admixtures

(a) General

The use of admixtures in concrete may be required under the contract to promote special properties in the finished concrete or may be proposed by the Contractor to assist him in compliance with the Specification.

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it in the mix. The information provided shall include:

- (i) The typical dosage, the method of dosing, and the detrimental effects of an excess or deficiency in the dosage.
- (ii) The chemical names of the main active ingredients in the admixture.
- (iii) Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
- (iv) Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so the extent to which it does so.
- (v) Details of previous uses of the admixture in Bhutan.

The chloride ion content of any admixture shall not exceed 1 per cent by weight of the admixture nor 0.02 per cent by weight of the cement in the mix.

Admixtures shall not be mixed together without the consent of the Engineer.

Admixtures may be supplied as liquid or as powder. They shall be stored in sealed and undamaged containers in a dry, cool place. Admixtures shall be dispensed in liquid form and dispensers shall be of sufficient capacity to measure at one time the full quantity required for each batch.

(b) Workability Agents

Workability agents shall comply with BS 5075 and shall not have any adverse effect on the properties of the concrete.

1604 DESIGN OF CONCRETE MIXES

(1) Classes of Concrete

The classes of structural concrete to be used in the works shall be as shown on the Drawing and designated in Table 16.3, in which the class designation includes two figures. The first figures indicates the characteristic strength f_{ck} at 28 days expressed in N/mm² and the second figure is the maximum nominal size of aggregate in the mix expressed in millimetres. Letter M in the class designation stands for Mix, letters SM stand for Special Mix.

Consistence of the mix, assessed through the Slump Test where the slump is measured in millimetres, is designated as follows:

- S: Stiff consistence, for slump ≤ 40
- P: Plastic consistence, for slump > 40 and \leq 90
- VP: Very Plastic consistence, for slump >90 and \leq 150
- F: Flowing consistence for slump > 150

Table 16.3: Concrete Classes and Strength

			Characteristic	Maximum	Trial	Earl	y works
			Strength	Nominal	mixes	test	cubes
					Minimal		
Classes of	Consistence	Type of uses	f _{ck}	Size of	Target	Any one	Average of 3
concrete	of Mix			Aggregate	Strength	result (aver.	consecutive
			(N/mm²)	mm	f _{ct} =1.1 f _{ck}	of 3 cubes)	results

					(N/mm²)	(N/mm²)	(N/mm²)
M 10/75	S	Ordinary	10	75	11	10	14
M 10/40	S	Ordinary	10	40	11	10	14
M 15/20	S	Ordinary	15	20	16.5	15	19
M 15/40	S	Ordinary	15	40	16.5	15	19
M 20/20	S	Ordinary	20	20	22	20	24
M 20/40	S	Ordinary	20	40	22	20	24
M 25/20	S	Ordinary	25	20	27.5	25	29
M 25/40	S	Ordinary	25	40	27.5	25	29
M 30/40	S	High Quality	30	40	33	30	34
M 30/20	Р	High Quality	30	20	33	30	34
M 35/40	Р	High Quality	35	40	38.5	35	39
M 35/20	Р	High Quality	35	20	38.5	35	39
SM 30/40	VP	Underwater	30	40	33	30	34
SM 30/20	VP	Underwater	30	20	33	30	34

(2) Design of Proposed Mixes

Concrete mixes shall comply with Clause 213.

The Contractor shall design all the concrete mixes called for in the Drawing using the ingredients which have been approved by the Engineer in accordance with Clause 1603 and in compliance with the following requirements:

- (a) The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150 micron size.
- (b) The cement content shall be such to achieve the strength called for in Table 16.3 but in any case not less than the minimum necessary as shown in Table 16.4
- (c) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.
- (d) The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater than 0.5 for classes of concrete above M20 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may in certain cases require the inclusion of a workability agent in the mix.

Classes	Minimum cement content in kg per m ³ of compacted					
of concrete	concrete					
	Moderate	Intermediate	Severe			
	exposure	exposure	exposure			
M10/75, M10/40	125	150	175			
M15/40, M15/20	150	200	225			
M20/40, M20/20	250	300	325			
M25/20, M25/40	300	325	350			
M30/40, M30/20, M30/12						
M35/40, M35/20	325	350	375			
SM30/20, SM30/40	400	400	425			

Table 16.4 Minimum Cement Content

Note: The minimum cement contents shown in the above table are required in order to achieve impermeability and durability. In order to meet the strength requirements in the Specification higher contents may be required.

The categories applicable to the works are based on the factors listed hereunder:

Moderate exposure:	Surface sheltered from severe rain, buried concrete.
Intermediate exposure:	Surface exposed to severe rain; alternate wetting and drying; traffic; corrosive fumes; heavy condensation.
Severe exposure:	Surface exposed to water having a pH of 4.5 or less, groundwater containing sulphates

For each mix of concrete for which the Contractor has proposed a design, he shall prepare the number of concrete batches specified hereunder:

Nominal composition: 3 separate batches

Modified compositions, the quantities of other constituents being unchanged:

Water	:	+10%	1 batch
Water	:	- 10%	1 batch
Cement	:	+15%	1 batch
Cement	:	- 15 %	1 batch

Samples shall be taken from each batch and the following action taken, all in accordance with BS 1881:

- (a) The slump of the concrete shall be determined.
- (b) Six tests cubes shall be cast from each batch. In the case of concrete having a maximum aggregate size of 20 mm, 150 mm cubes shall be used. In the case of concrete containing larger aggregate, 200 mm cubes shall be used and in addition any pieces of aggregate retained on a 50 mm IS sieve shall be removed from the mixed concrete before casting the cubes.
- (c) The density of all the cubes shall be determined before the strength tests are carried out.
- (d) All faces shall be perpendicular to each other.
- (e) Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.

Concrete Class	Characteristic Strength N/mm ²	Cement (kg)	Total aggregates (kg)	Fine aggregate/ Total Aggregate %	Water (max) I	Workability
M 15/40	15	250	1900	35-45	160	Stiff-Plastic
M 20/20	20	300	1875	35-45	165 - 170	Stiff
M 30/40	30	350	1825	35-45	170	Stiff
M 30/20	30	350	1825	35-45	175	Plastic
M 35/20	35	350	1825	35-45	175	Plastic

For smaller works, the following composition is suggested for the laboratory trials:

A "result" being the average strength of the three cubes from one batch, the average of the three results from tests at 28 days for the nominal composition shall not be less than the Minimal Target Strength shown in Table 16.3.

One result from the modified compositions shall not be less than the nominal strength as shown on Table 16.3.

(4) Site Trials

At least six weeks before commencing placement of concrete in the permanent works, site trials shall be prepared for each class of concrete specified.

For each mix of concrete for which the Contractor has proposed a design and successfully tested in Laboratory, he shall prepare three separate batches specified hereunder using the materials which have been approved for use in the works and the mixing plant which he proposes to use for the works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the action taken similar to the above Sub-clause 1604 (3) (a) to (e).

The average of the three results of tests at 28 days shall not be less than the Minimal Target Strength shown in Table 16.3.

The Contractor shall also carry out tests to determine the drying shrinkage of the concrete unless otherwise directed by the Engineer.

Based on the results of the tests on the Laboratory trial and site trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, and the results of the tests on the trial mixes.

If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the works without the written consent of the Engineer.

(5) Quality Control of Concrete Production

(a) Sampling

For each class of concrete in production at each plant for use in the works, samples of concrete shall be taken at the point of mixing or of deposition as instructed by the Engineer, all in accordance with the sampling procedures described in BS 1881 and with the further requirements set out below.

Six 150 mm or 200 mm cubes as appropriate shall be made from each sample and shall be cured and tested in accordance with BS 1881 three at seven days and the other three at 28 days. Where information samples are required, such as for post-tensioning operations, three additional cubes shall be made.

The minimum frequency of sampling of concrete of each grade shall be as following:

For 1-5 m ³ quantity of work -	1 sample
For 5-20 m ³ quantity of work -	2 samples
For 20 m ³ and more quantity of work -	3 samples plus one additional for each 20m ³ or part thereof

At least one sample shall be taken from each shifts of work.

Until compliance with the Specifications has been established the frequency of sampling shall be three times that stated above; and minimum 3 samples/day for each class of concrete production in each plant or such lower frequency as may be instructed by the Engineer.

(b) Testing

(i) The slump of the concrete shall be determined for each batch from which samples are taken and in addition for other batches at the point of production and deposition or at the frequency instructed by the Engineer.

The slump of concrete in any batch shall not differ from the value established by the trial mixes by more than 25 mm or one third of the value whichever is the less.

- (ii) The air content of air entrained concrete in any batch shall be within 1.5 times of the required value and the average value of four consecutive measurements shall be within the required value expressed as a percentage of the volume of freshly mixed concrete.
- (iii) Early Works: Until such time as sufficient test results are available to apply the method of control described in (iv) below, the compressive strength of the concrete at 28 days shall be such that no single result (average of 3 cubes) is less than the characteristic strength f_{ck} as shown in Table 16.3 under the heading "early works test cubes" and also that the average of three consecutive results is not less than f_{ck} +4 as shown in Table 16.3 under the same heading.

The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

(iv) When at least 20 consecutive results on tested batches are available for any class of concrete mixed in any one plant, no single result shall be less than f_{ck} -4 (N/mm²) and also the average of any group of three consecutive results shall not be less than f_{ck} +4 (N/mm²).

In addition the Coefficient of Variation shall be less than the figure given below:

Number of batches	Maximum coefficient of variation		
	Ordinary concrete	High quality concrete	
After 20 tested batches	18%	15%	
After 50 tested batches	15%	12%	
After 20 tested batches After 50 tested batches	Ordinary concrete 18% 15%	High quality concrete 15% 12%	

where, Coefficient of Variation = Standard Deviation of results/Average value of results

(v) Failure to comply with Requirements

If any one result in a group of three consecutive results is less than f_{ck} -4 (N/mm²), but the other results of group satisfy the strength requirement, then only the batch from which the failed result was obtained shall be deemed not to comply with the Specification.

If the average strength of the group is less than the strength requirement then all the batches between those represented by the first and the last result shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the production procedure or the mix design subject to the agreement of the Engineer to restore compliance with the Specification. If adjustment of the mix design is agreed, the Contractor shall again be required to comply with Sub-clauses 1604 (3) and (4).

1605 MIXING CONCRETE

Before any batching, mixing, transporting, placing, compacting and finishing and curing the concrete ordered or delivered to site, the Contractor shall submit to the Engineer full details including Drawing of all the plant which he proposes to use and the arrangements he proposes to make.

Concrete for the works shall be batched and mixed in one or more plants or concrete mixer unless the Engineer agrees to some other arrangement. If concrete mixers are used, there shall be sufficient number of mixtures including stand by mixers.

Batching and mixing plants shall be comply with the requirements of IS 1791 and capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixers shall comply with the requirements of IS 4925 and shall only be used with the prior approval of the Engineer. If the plant proposed by the Contractor does not fall within the scope of IS 1791 it shall have been tested in accordance with IS 4634 and shall have a mixing performance within the limits of IS 1791.

All mixing operations shall be under the control of an experienced supervisor.

The aggregate storage bins shall be provided with drainage facilities arranged so that the drainage water is not discharged to the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt shall be removed.

Cement and aggregates shall be batched by weight. Water may be measured by weight or volume.

Mixers shall be fitted with an automatic recorder registering the number of batches discharged.

The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter at least once per hour and for each delivery of aggregates during concreting. When the correct quantity of water, determined as set out in the Specifications, has been added to the mix, no further water shall be added, either during mixing or subsequently.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Mixers shall be cleaned out before changing to another type of cement.

1606 TRANSPORTATION OF CONCRETE

The concrete shall be discharged from the mixer and transported to the works by means which shall prevent adulteration, segregation or loss of ingredients, and shall ensure that the concrete is of the required workability at the point and time of placing. The loss of slump between discharge from the mixer and placing shall be within the tolerances specified in Sub-clause 1604 (5) (b) (i).

The capacity of the means of transport shall not be less than the full volume of a batch.

The time elapsing between mixing transporting placing and compaction altogether of a batch of concrete shall not be longer than the initial setting time of the concrete. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the works.

1607 PLACING OF CONCRETE

(1) Consent for Placing

Concrete shall not be placed until the Engineer's consent has been given in writing. The Contractor shall give the Engineer at least two full working day notice of his intention to place concrete.

(2) Preparation of Surface to Receive Concrete

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 200.

Existing concrete surfaces shall be prepared as set out in Clause 1612. Before deposition of further concrete they shall be clean, hard and sound and shall be wet but without any free-standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump or be removed by other suitable method which will prevent washing away the freshly deposited concrete or any of its constituents. Any under drain constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

Unless otherwise instructed by the Engineer surfaces against which concrete is to be placed shall receive prior coating of cement slurry or mortar. The mortar shall be kept ahead of the concrete. The mortar shall be placed into all parts of the excavated surface and shall not be less than 5 mm thick.

(3) Placing Procedures

The concrete shall be deposited as nearly as possible in its final position. It shall be placed so as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items or formwork. It shall be brought up in layers approximately parallel to the construction joint planes and not exceeding 300 mm in compacted thickness unless otherwise permitted or directed by the Engineer, but the layers shall not be thinner than four times the maximum nominal size of aggregate.

Concrete shall not be placed during rain which is sufficiently heavy or prolonged to wash mortar from coarse aggregate on the exposed faces of fresh concrete. Means shall be provided to remove any water accumulating on the surface of the placed concrete. Concrete shall not be deposited into such accumulations of water.

In dry weather, covers shall be provided for all fresh concrete surfaces which are not being worked on. Water shall not be added to concrete for any reason.

When it is necessary to place concrete under water the Contractor shall submit to the Engineer his proposals for the method and equipment to be employed. The concrete shall be deposited either by bottom-discharging watertight containers or through funnel-shaped tremies which are kept continuously full with concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation.

During and after concreting under water, pumping or de-watering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete.

1608 COMPACTION OF CONCRETE

Concrete shall be fully compacted throughout the full extent of the placed layer. It shall be thoroughly worked against the formwork and around any reinforcement and other embedded item, without displacing them. Care shall be taken at arises or other confined spaces. Successive layers of the same pour shall be thoroughly worked together.

Concrete shall be compacted with the assistance of mechanical immersion vibrators, unless the Engineer agrees another method.

The vibrators shall be inserted vertically into the concrete to penetrate the layer underneath at regular spacing which shall not exceed the distance from the vibrator over which vibration is visibly effective and some extent of vibration is overlapped.

Vibration shall not be applied by way of reinforcement nor shall the vibrators be allowed to touch reinforcement, sheathing ducts or other embedded items.

1609 CURING OF CONCRETE

Concrete shall be protected during the first stage of hardening from loss of moisture and from the development of temperatures differentials within the concrete sufficient to cause cracking. The methods used for curing shall not cause damage of any kind to the concrete.

Curing shall be continued for as long as may be necessary to achieve the above objectives but not less than seven days or until the concrete is covered by successive construction whichever is the shorter period. The curing process shall commence as soon as the concrete is hard enough to resist damage from the process. The Contractor shall keep the exposed surfaces continuously wet by means of water spray or by covering with water absorbent material which shall be kept wet. Water used for curing shall be of the same quality as that used for mixing.

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances.

1610 PROTECTION OF FRESH CONCRETE

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from these causes.

Concrete placed in the works shall not be subjected to any loading including traffic until it has attained at least its characteristic strength as defined in Clause 1604.

1611 CONCRETING IN HOT WEATHER

The Contractor shall prevent damage to concrete arising from exposure to extreme temperatures, and shall maintain in good working order all plant and equipment required for this purpose.

In the event that conditions become such that even with the use of equipment the requirements cannot be met, concrete placing shall immediately cease until such time as the requirements can again be met.

During hot weather the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the works does not exceed 30°C and that the concrete does not lose any moisture during transporting and placing.

Surfaces in which concrete is to be placed shall be shielded from direct sunshine and surfaces shall be thoroughly wetted to reduce absorption of water from the concrete placed on or against them.

After concrete has been placed, the selected curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

1612 CONSTRUCTION JOINTS

Whenever concrete is to be bonded to other concrete which has hardened, the surface of contact between the Sections shall be deemed a construction joint.

Where construction joints are shown in the Drawing, the Contractor shall form such joints in such positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the approval of the Engineer. Construction joints shall be in vertical or horizontal planes except in sloping slabs where they shall be normal to the exposed surface or elsewhere where the Drawing requires a different arrangement.

1613 RECORDS OF CONCRETE PLACING

Records of the details of every pour of concrete placed in the works shall be kept by the Contractor in a form agreed by the Engineer. These records shall include class of concrete, location of pour, date and duration of pour, ambient temperature and concrete temperature at time of placing and all relevant meteorological information such as rain, wind etc., moisture contents of the aggregates, details of mixes, batch numbers, cement batch number, results of all tests undertaken, part of the structure and place where test cube samples are taken from.

1614 REINFORCEMENT

(1) General

Reinforcement as plain bars and deformed bars and steel fabric shall comply with the following Standards:

- IS 1786 for high strength deformed steel bars
- IS 432 mild steel and medium tensile steel bars

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit the ISI certification mark or other test certificate from the manufacturer acceptable to the Engineer.

All reinforcement not complying with the Specification shall be removed from site.

(2) Storage of Reinforcement

All reinforcement shall be delivered to site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been transported bent over double.

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather so as to avoid corrosion and pitting. Reinforcement shall be stored at least 150mm above the ground on a clean area free of mud and dirt and sorted out according to category, quality and diameter.

(3) Bending Reinforcement

Unless otherwise shown on the Drawing, bending and cutting shall comply with IS 2502. The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the Drawing.

Bars shall be bent mechanically using appropriate bar benders. Bars shall be bent cold by the application of slow steady pressure. At temperatures below 5°C the rate of bending shall be reduced if necessary to prevent fracture in the steel.

Bending reinforcement inside the forms shall not be permitted except for mild steel bars of diameter equal to or less than 12 mm, when it is absolutely necessary.

After bending, bars shall be securely tied together in bundles or groups and legibly labelled as set out in IS 2502.

(4) Fixing Reinforcement

Reinforcement shall be thoroughly cleaned. All dirt, scale, loose rust, oil and other contaminants shall be removed before placing it in position. If the reinforcement is contaminated with concrete from previous operations, it shall be cleaned before concreting in that section.

Reinforcement shall be securely placed and fixed in position as shown in the Drawing or directed by the Engineer.

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer.

All reinforcement shall be checked for shape, size, diameter and number where necessary. Reinforcement shall be rigidly fixed so that it remains intact during placing of concrete. Any fixers made to the formwork shall not remain within the space to be occupied by the concrete being placed.

No splices shall be made in the reinforcement except where shown on the Drawing or agreed by the Engineer. Splice lengths shall be as shown on the Drawing or directed by the Engineer.

The Contractor shall ensure that reinforcement left exposed in the works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Bars complying with IS 1786 or other high tensile bars shall not be bent after placing in the works.

1615 CONCRETE FOR SECONDARY PURPOSES

(1) Non–structural Concrete

Non-structural concrete shall be used only for non structural purposes where shown on the Drawing or as directed by the Engineer. This shall be compound of ordinary Portland cement and aggregates complying with this Specification.

The weight of cement mixed with 0.3 cubic metres of combined aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40 mm nominal. The concrete shall be mixed by machine or by hand in accordance with Sub-clause 1615 (3) to a uniform colour and consistency before placing. The quantity of water used shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

The concrete shall be compacted by hand towels or rammers or by mechanical vibration as approved by the Engineer.

(2) No Fines Concrete

No Fines concrete is intended for use where a porous concrete is required and shall only be used where shown on the Drawing or instructed by the Engineer.

The mix shall consist of Ordinary Portland cement and aggregate complying with this Specification. The aggregate size shall be 40 mm to 10 mm only. The weight of cement mixed with 0.3 cubic metres of aggregate shall not be less than 50 kg. The quantity of water shall not exceed that required to produce a smooth cement paste which will coat evenly the whole of the aggregate.

(3) Hand Mixed Concrete

Concrete for structural purposes shall not be mixed by hand. Where non structural concrete is required, hand mixing may be carried out subject to approval of the Engineer.

For making hand mixed concrete, cement, sand and aggregate shall be batched separately by volume or by weight as applicable. Then cement and sand shall be mixed dry to uniform colour. The aggregate shall be stacked in a proper shape upon which cement sand mix shall be spread and whole mix shall be turned up and down to have uniform mix of all ingredients. Then water shall be added as specified in Sub-clause 1615 (1) and shall be mixed to uniform consistency.

For hand mixed concrete the specified quantities of cement shall be increased by 10% and not more than 0.25 cubic meter shall be mixed at one time. During windy weather precautions shall be taken to prevent cement from being blown away in the process of gauging and mixing.

1616 FORMWORK

(1) Scope and Definitions

This Clause covers the preparation, construction and removal of falsework and formwork for concrete structures. It also covers the quality requirements for surface finish on formed and unformed surfaces.

Definitions used in this Clause and other relevant Sections of these Specifications are as follows:

- Formwork means the surface against which concrete is placed to form a face. All the immediate supports necessary to retain the surface in position while concrete is placed, shall be treated as an integral part of formwork.
- Falsework means the structural elements supporting both the formwork and the concrete until the concrete becomes self supporting.
- A formed face is one which has been casted against formwork.
- An unformed surface means a horizontal or nearly horizontal surface which is not casted against formwork.
- An exposed face is one which will remain visible when construction has been completed.

The Contractor shall be responsible for designing and constructing falsework and formwork so that they will support the loads imposed on them by the fresh concrete together with additional stresses imposed by vibrating equipment and by construction traffic.

(1) Construction of Formwork

Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous in a regular pattern.

All joints in formwork shall be water tight. Where reinforcement projects through formwork, the form shall fit closely round the bars.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. It shall also incorporate provisions for making minor adjustments in position, if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for movement and settlement under the weight of fresh concrete.

Surfaces at slopes less than 20° may be formed by screeding. Surfaces at slopes between 20° and 30° shall generally be formed if the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against uplift due to the pressure of fresh concrete. Formwork shall also be tied down or otherwise secured against floating within the body of the concrete.

The internal and external angles on concrete surfaces shall be formed with fillets and chamfers of the sizes shown on the Drawing unless otherwise instructed by the Engineer.

Supports for formwork may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, the metal left in shall not be close to the face of the concrete. It shall be shorter to the face of the concrete by 50mm.

Formwork shall not be re-used after it has suffered damage which has potential to impair the finished surfaces of the concrete.

Where circumstances prevent easy access within the form, temporary openings shall be provided through the formwork for cleaning and inspection.

Shear keys of the size and shape as indicated on the Drawing shall be provided in all construction joints.

Where precast concrete elements are specified for use as permanent formwork, or proposed by the Contractor and agreed by the Engineer, they shall comply with the requirements of formwork as specified in the Specifications in respect of surface finish, strength and rigidity. Such elements shall be set true to line and level within the tolerances prescribed in the relevant clauses of this Specification and fixed so that they do not move when concrete is placed against them.

(3) **Preparation of Formwork**

Before any reinforcement is placed into position within formwork, the latter shall be thoroughly cleaned and then dressed with a release agent. The agent shall be either suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or low viscosity oil containing chemical agents. The Contractor shall not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete or affects the strength of concrete.

In order to avoid colour differences on adjacent concrete surfaces, only one type of release agent shall be used in any one section of the works.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from within the placing area.

Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs. If any movement is noticed, the formwork shall be set right immediately.

(4) Removal of Formwork

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand any stresses safely to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in Table 16.5 and apply to ambient temperatures higher than 10°C. At lower temperatures or if cement other than ordinary Portland are used in concrete work the Engineer may instruct longer periods for removal of formwork.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table 16.5, provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until the removal can be completed without damage to the concrete.

As soon as the formwork has been removed, bolt holes in concrete faces other than construction joints which are not required for subsequent operations shall be completely filled with mortar sufficiently dry to prevent any slumping at the face. The mortar shall be mixed in the same proportions as the fine aggregate and cement in the surrounding concrete and with the same materials and shall be finished flush with the face of the concrete.

After removal of the formwork, the date of casting of concrete shall be marked on the surface of related concrete by water proof paint/marker for estimation of curing time.

Position of Formwork	Minimum period for temperatures over 10° C	Strength to be attained	
Vertical or near vertical faces of mass concrete	24 hours	0.2 f _{ck}	
Vertical or near vertical faces of reinforced walls, beams, columns	48 hours	0.3 f _{ck}	
Underside of arches beams and slabs (formwork only)	4 days	0.5 f _{ck}	
Supports to underside of arches, beams and slabs	14 days	f _{ck}	
Arched linings in tunnels and underground works	24 hours	4 N/mm ²	

Table 16.5: Minimum Periods for Formwork Removal

Note: f_{ck} is the Characteristic Strength for the class of concrete used.

(5) Surface Finish on Formed Surfaces

(a) Classes of Finish

The surface finish to be achieved on formed concrete surfaces shall be as shown on the Drawing and are defined hereunder:-

(i) Class FI Finish

This finish is for surfaces against which backfill or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of laitance from the concrete being placed.

(ii) Class F2 Finish

This finish is for surfaces which are permanently exposed to view but the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought thickened tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them.

Joints between boards or panels shall be horizontal and vertical unless otherwise directed. In this type of finish pitting, fins, surface discoloration and other minor defects shall be remedied at the time and by methods agreed by the Engineer.

(iii) Class F3 Finish

This finish is for surfaces which will be in contact with water flowing at high velocity, and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface.

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

1617 EARLY LOADING

No load shall be applied to any part of a structure until the specified curing period has expired, and thereafter loading shall be allowed after approval by the Engineer. The Engineer's decision shall be based on the type of load to be applied, the age of concrete, the magnitude of stress induced and the propping of the structure.

No structure shall be opened to traffic until test cubes have attained the specified minimum 28 days strength as defined in Clause 1604.

1618 PLUM CONCRETE

(1) General

This work shall be required to provide lining of drains and drainage structures or other works as shown on the Drawings or as specified by the Engineer.

(2) Materials

The concrete shall comply with the requirements of Section 1600. The grade of concrete shall be as shown on Drawings or as directed by the Engineer. The stone shall comply with the requirements of Section 1300.

(3) Composition

Composition of plum concrete shall be 60 to 70 percent of concrete and 30 to 40 % percent of stones by volume or as instructed by the Engineer. About 3% non-shrinking agent by weight of cement shall be added to concrete at the time of mixing.

(4) Mock-up

Prior to commencement of plum concrete the Contractor shall construct a plum concrete panel of approximately 2000 mm x 1000 mm for inspection and approval of the Engineer. The thickness of mock-up shall be according to use of plum concrete in designated work.

(5) Construction

The place to be filled up with the plum concrete shall be cleaned and chipped for adhesion with the concrete. Following completion of form work a layer of concrete minimum 100mm thick shall be laid upon which clean

and moist stones shall be placed at a distance of min 100mm measured from face to face in any direction. The distance between the outer edge of the concrete mass and the nearest face of the stone to the edge shall not be less than 100 mm. Then another layer of concrete having thickness not less than 100mm measured from the top of the stone to the top surface of the layer shall be laid and compacted.

In case the proportion of concrete to stones is to be changed, the clear space between stones shall be adjusted as directed by the Engineer.

After compaction, again stones shall be placed on the layer as described above and the process shall be continued until the top layer of the concrete is completed. The placing of stones shall be staggered both in horizontal and vertical directions.

(6) Tests and Standards of Acceptance

Stones shall be tested for water absorption. The test results shall meet the requirements as specified in these Specifications. Concrete shall be tested as specified in Section 1600.

1619 MEASUREMENT

(1) Concrete

Concrete laid in place as specified in the Drawing or directed by the Engineer shall be measured in cubic metre separately for each class. No deduction shall be made in the measurement for:

- (a) bolt holes, pockets, box outs and cast in components provided that the volume of each is less than 0.15 cubic metres;
- (b) mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 100 mm total width or less;
- (c) reinforcement bars

(2) Blinding Concrete/Non Structural Concrete

Blinding concrete laid in place shall be measured in cubic metre. No deduction shall be made for openings provided that the area of each is less than 0.5 square metres. Blinding concrete over hard material shall be measured as the volume used provided that the maximum thickness of 150 mm allowed for overbreak is not exceeded.

(3) Admixtures, Workability and Hardening Agents

No separate measurement of these items shall be carried out.

(4) Reinforcement

All types of reinforcement shall be measured in metric ton in the ranges as given below:

- Diameter equal to or less than 8mm
- Diameter above 8mm up to 16mm
- Diameter above 16mm

Only that reinforcement which is required and placed in work as per Drawing or as directed by the Engineer shall be measured. Other reinforcement not shown on the Drawing or directed by the Engineer such as splices, chairs, cap lengths hangers and the like and the reinforcements not conforming to shape, size and length as shown on the Drawing or as directed by the Engineer shall not be measured.

(5) Formwork

Except as stated otherwise, formwork shall be measured in square metre of formwork actually in contact with the finished face of the concrete. The measurement of formwork shall be inclusive of the measurement for formwork finished surface, shoring, staging, scaffolding and other accessories required for erection and removal of the formwork. No deduction shall be made in the measurement for openings, pipes, ducts and the like, provided that the area of each is less than 0.5 square metres. Unless otherwise stated, if the volume or area of concrete has not been deducted when measuring the concrete, formwork to form box or the void shall not be measured.

Formwork less than 300 mm high to edges of slabs shall be measured in linear metre.

(6) Plum Concrete

The plum concrete shall be measured in cubic metre. Form work shall be measured in sq.m separately. Struts, bracing supports etc. shall not be measured separately. They are deemed to be included in the measurement of form work.

1620 PAYMENT

(1) Concrete

Every class of concrete shall be paid as per respective contract unit rate. The contract unit rate for respective concrete class shall be deemed to have included costs for labor, materials, tools & plants etc including any incidental costs. In addition to those specified in Clause 116 the respective rate shall also include the cost of:

- (a) admixtures and workability agents including submission of details unless specified.
- (b) surface finish as per Sub-Clause 1616(5).
- (c) laying to sloping surfaces not exceeding 15° from the horizontal and to falls.
- (d) placing and compacting against excavated surfaces where required including any additional concrete to fill overbreak and working space.
- (e) complying with the requirements of Clauses 1601 to 1618.

(2) Reinforcement

The reinforcement shall be paid at contract unit rate. In addition to those specified in Clause 116 the rate shall also include compensation for the cost of providing, cutting to length, splice lengths additional to those shown on the Drawing, laps, bending, hooking, waste incurred by cutting, cleaning, spacer blocks, provision and fixing of chairs or other types of supports, welding, fixing the reinforcement in position including the provision of wire or other material for supporting and tying the reinforcement in place, bending reinforcement aside temporarily, and straightening, placing and compacting concrete around reinforcement and for complying with Clause 1614.

(3) Formwork

The formwork shall be paid as per the contract unit rate. In addition to those specified in Clause 116 the rates for formwork shall include the cost of submission of details, transportation and use of all materials for formwork and false work, erection including provision of supports, fillets and chamfers 75 mm and less in width, bolts, ties, fixings, cutting to waste, drilling or notching the formwork for reinforcement where required, working around pipes, ducts, conduits and water stops, temporary openings, cleaning, dressing, removal of formwork and false work, filling bolt holes and any remedial work and for complying with Section 1600 including all incidental works required to complete the work as per Specification.

(4) Plum Concrete

The plum concrete shall be paid at contract unit rate which shall be full and final compensation to the Contractor as per Clause 116 to complete the work in accordance with these Specifications.

SECTION 1700 - Water Supply System

The Contractor shall be fully responsible for the arrangement of necessary facilities for water supply. The Contractor shall design, construct, equip, operate and maintain two separate water installations at the Site necessary for the adequate supply of:

- a) Raw water: for general construction use, treated to the extent necessary to meet specified requirements (e.g. for concrete),
- b) Potable water: for supply to all buildings and plants requiring high quality water meeting relevant requirements for drinking water.

The Contractor shall furnish, install, operate and maintain all pumps, piping, fittings, valves, storage tanks for the water supply and distribution systems, adequate in quantity and pressure. Raw water shall be used for construction purposes only if of adequate quality. There shall be no cross connections of any kind between the raw and potable water supply systems. Only potable water shall be piped into buildings.

Water supply & Sewerage

1.0 RCC PIPE

1.1 Trenches

Trenches shall be so dug that the pipes may be laid to the required alignment and at required depth. Cover shall be measured from top of pipe to the surface of the ground. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stones or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand and compacted so as to provide smooth bedding for the pipe. Where excavation requires blasting operation, it shall be ensured that no pipes have been stacked in the vicinity and completed pipeline in the vicinity has already been covered before starting of blasting operations, this is necessary to prevent damage to the exposed pipes in the vicinity by falling stones as a result of blasting.

After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces are left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe. Roots of trees within a distance of 0.5m from the side of the pipeline shall be removed or killed.

The excavated material shall not be placed within one metre or half of the depth of the trench whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be re-laid and compacted in the same order to the satisfaction of the Engineer-in-Charge.

The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches. Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All pipes, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cables met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-Charge.

The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipeline is under a roadway, a minimum cover of 90cm is recommended for adoption but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of the pipe laying as specified by the Engineer-in-Charge. The excavation shall be carried out with manual labour or with suitable mechanical equipment as approved by the Engineer-in-Charge. Unless otherwise specified by the Engineer-in-Charge, the width at the bottom of trenches for different diameters of pipes laid at different depths shall be as given below:

- a) For all diameters, upto an average depth of 120cm, width of trench in cm= diameter of pipe +30cm.
- b) For all diameters for depth above 120cm., width of trench in cm= diameter of pipe +40cm.
- c) Not with-standing (a) and (b) the total width of the trench shall not be less than 75cm for depth exceeding 90cm.

1.2 Laying

Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.

In case where the foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks, manholes etc. the pipe shall be encased all-round in 15 cm thick cement concrete 1:3:6 (1 cement: 3 sand: 6 graded stone aggregate 20 mm nominal size) or compacted sand or gravel. In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia. of the pipe subject to the minimum of 10 cm and a maximum 30 cm. The concrete shall extend up the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over in dia. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material. When the pipes are laid completely above the ground the foundations shall be made even and sufficiently compacted to support the pipeline without any material settlement. Alternatively the pipeline shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipeline in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joint come outside of the supports. Care shall be taken to see that superimposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted. Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

1.3 Socket and spigot joint

The spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in the correct position with the spigot of the pipe accurately centered in the socket. A ring of gaskin or tarred rope yarn shall be inserted in the socket of each pipe previously laid and driven home with a wood caulking tool and wooden mallet; such yarn when in position shall not occupy more than one quarter of the total depth of the socket. The socket shall then be completely filled with cement mortar 1 (cement):2 (sand) and a fillet shall be bevelled off and extend for a length not less than 50 mm from the face of the socket. The newly made cement fillet shall be protected by means of a cover of damp hessian, which shall be kept moist for at least 24 hours after forming.

1.4 Testing of joints

Stone ware pipes used for sewers shall be subjected to a test pressure of 2.5m head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

If any leakage is visible, the defective part of the work shall be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

Any joint found leaking or sweating, shall be rectified or embedded into 15 cm layer of cement concrete (1:2:4) 30 cm in length and the section retested.

1.5 Refilling

In cases where pipes are not bedded on concrete special care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The filling shall be done in layers, not exceeding 200mm in each layer. Each layer shall be watered, rammed and consolidated before the succeeding one is laid. The back filling materials shall be packed by hand under the

around the pipe, and rammed with a shovel and light tamper. This method of filling with shall be continued upto the top of pipe. The refilling shall rise evenly on both sides of the pipe and continued upto 60 cm above the top of pipe so as not to disturb the pipe. No tamping should be done within 15 cm of the top of pipe. The tamping shall become progressively heavier as the depth of the backfill increases.

1.6 Measurements

The lengths of pipes shall be measured in running metres nearest to 10mm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bend, junctions, etc., which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

1.7 Rate

The rate shall include the cost of materials and labour involved in all the operations described above excluding the cost of Excavation, refilling, shoring and timbering in trenches, and cement concreting.

2.1 GI & HDPE pipe and fittings

2.1.1 GI Pipe

The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) screwed and socketed conforming to the requirements of IS 1239 (Part. I) for medium grade. These shall be of the diameter (nominal bore) specified in the description of the item. Galvanizing shall conform to IS 4736. The zinc coating shall be uniform, adherent, reasonably smooth and free from imperfections as flux, ash and dress inclusions, bare patches, black spots, pin holes, lumpings, runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads. All tubes shall withstand a test pressure of 50 kg/cm2 without showing defects of any kind. The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part II). The fittings and sockets shall be designated by the respective nominal bores of the pipes for which these are intended.

The details of pipes and sockets shall be as per the Table **2.1**.

Nominal	Dimension of pipes		Dimensions of Ord. Sockets		Weight of	
bore	Outside Diameter		T 1 • 1	Approx.	Min	Pipe (Plain
	Max	Min	Inickness	O.D.	Length	end)
mm	mm	mm	mm	mm	mm	mm
15	21.8	21.0	2.65	26.90	34	1.22
20	27.3	26.5	2.65	33.70	36	1.58
25	34.2	33.3	3.25	42.60	43	2.44
32	42.9	42.0	3.25	51.00	48	3.14
40	48.8	47.9	3.25	57.00	48	3.61
50	60.8	59.7	3.65	70.00	56	5.10
65	76.6	75.3	3.65	88.90	65	6.51
80	89.5	88.0	4.05	101.60	71	8.47

Table 2.1 PARTICULARS OF MEDIUM GRADE G.I. PIPES

Tolerance on Thickness and Weight

(a) Thickness1. Medium tubes Butt welded	+ not limited- 10 percent.
2. Medium tubes Seamless(b) Weight	+ not limited - 12.5 percent.
1. Single tube (irrespective of quantity)	+ 10 percent - 8 percent

2. For quantities of less than 150 m of one size.	+10 percent
	- 8 percent
3. For quantities of 150 m and over of one size.	+ 4 percent

2.1.2 GI Union

The G.I. union shall conform to IS 1239 (Part-II). The size shall be as specified.

2.2 HDPE Pipe & Pipe fittings

2.2.1 HDPE Pipe

The pipes shall confirm to IS 14333:1996. It shall be designated according to the pressure rating given below:

Pressure Rating of Pipes	Max. Permissible Working Pressure, MPa
PN 2.5	0.25
PN 4	0.40
PN 6	0.60
PN 8	0.80
PN 10	1.00
PN 12.5	1.25
PN 16	1.60

The nominal diameter of pipes shall be:

125,140,160,180, 200, 225, 250,280, 315, 355, 400 and 450.

The colour of the pipes shall be black. The HDPE used for the manufacture of pipes shall conform to designation PEEWA-45-T-066 of IS 7328.

The outside diameters of pipes, tolerance on the same and ovality of pipes shall be as given in Table **2.2**

	Table 2.2 OUTSIDE DIAMETER.	TOLERANCE ANI	DOVALITY	OF PIPES
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Nominal Dia.	Outside Dia	Tolerance	Ovality
DN	mm	mm (only +ve tolerance)	mm
125	125	1.2	2.5
140	140	1.3	2.8
160	160	1.5	3.2
180	180	1.7	3.6
200	200	1.8	4.0
225	225	2.1	4.5
250	250	2.3	5.0
280	280	2.6	9.8
315	315	2.9	11.1
355	355	3.2	12.5
400	400	3.6	14.0
450	450	4.1	15.6
The outside diameter of the pipe shall be taken as the average of two measurements taken at right angles for pipes up to 110 mm diameter. Alternatively and for higher sizes, the diameter shall be measured preferably by using a flexible P tape or a circometer, having an accuracy of not less than 0.1 mm.

The length of straight pipe shall be 5m to 20m. Short lengths of 3m (minimum) upto a maximum of 10 % of the total supply may be permitted.

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented.

The internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be clearly cut and shall be square with axis of the pipes. Each straight length of pipes shall be clearly marked in indelible ink/paint with Manufacturers name/Trade Mark, Designation of pipe and Lot number/Batch Number.

Each pipe may also be marked with the Standard Mark.

2.3 Laying of Pipes

The specified pipes and fittings shall be laid in trenches. The width and depths of the trenches of different diameters of the pipes shall be as shown in the **Table 2.3**

Dia. of pipe	Width of trench	Depth of trench
15mm to 50mm	30 cm	45 cm
65mm and above	60 cm	75 cm

Table 2.3

At joints, trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earthwork in trenches. In case of GI pipes, the pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality. The pipes shall be laid in a layer of 7.5 cm sand and filled upto 20 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed off as directed by the Engineer-in-Charge.

When excavation is done in rock, the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand of minimum 7.5 cm. In case of bigger diameter pipes where the pressure is very high thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends to transmit the hydraulic thrust without impairing the ground and spreading it over a sufficient area.

2.4 Testing the Joints

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6kg/cm2 (60 metres). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off takes and the stop-cocks shall then be closed and specified hydraulic pressure shall be applied

gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped the test pressure should be maintained without loss for atleast half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

2.5 Measurements

The lengths shall be measured in running metre correct to 10 mm for the finished work, which shall include pipe and fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples, flanges, nuts, etc. but exclude brass or gun metal taps (cocks), valves, lead connection pipe and shower rose. The length shall be taken along the central line of the pipe and fittings. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. The diameter shall be the nominal diameter of the internal bore. The pipe shall be described as including all cuttings and waste. In case of fittings of equal bore, the largest bore shall be measured. Digging and refilling of trenches shall be measured separately.

2.6 Rate

The rate shall include the cost of labour and material involved in all operations described above (excluding the cost for excavation in trenches, refilling of trenches, painting of pipes and sand filling all-round the pipes).

3.0 Ductile iron Pipe & fittings

Ductile Iron Pipe shall be of class K-9 with inside Cement Mortar lining as IS: 9329 -2000 where as fittings for Ductile Iron Pipe shall be as per IS: 9523:2000. Cement lining shall have thickness of 5mm.

All pipes specials and valves shall be of relevant Bureau of Indian Standard grade. These should have IS certification mark.

Joint of Ductile Iron Pipe shall be push on type. Rubber gasket shall be of SBR quality and satisfy Hardness and other criteria as specified in IS: 5382-1985

3.1 Excavation and Preparation of Trenches

The width of trench at the bottom between faces of sheeting shall be such as to provide not less than 200mm clearance on either side of the pipe except where rock excavation is involved. In agricultural land, the depth must not be less than 900mm, while it may be necessary to increase the depth of pipeline in the vicinity of land drains, roads, railways and other crossings.

When pipes are directly bedded on the bottom of the trench, it should be trimmed and leveled, and where excavation is through rocks or boulders, the pipeline should be bedded on concrete bedding or on at least 150mm or fine grained soil or other means to protect the pipe and the coating.

3.2 Back filling

For the purpose of back filling the depth of the trench shall be considered as divided into the following three zone from the bottom of trench to its top.

Zone 'A': From the bottom of trench to the level of centre line of pipe.

Zone 'B': From the level of the centreline of pipe to a level 300 above the top of pipe.

Zone 'C': From a level 300 mm above the top of the pipe to the top of trench.

3.2.1 Back fill Material

All backfill material shall be free from cinder, slag, refuse, rubbish vegetable or organic material, lumpy or frozen material boulder rock or other stone, material which in the opinion of Engineer-in-charge is unsuitable or deleterious. However, material containing stones upto 200 mm as their greatest dimension may be used in zone 'C' unless otherwise specified herein.

3.2.2 Back fill sand

Sand used for back fill shall be natural sand complying above, graded form fine to coarse. The total weight of loam or clay in it shall not exceed 10%. All material shall pass through a sieve of aperture size 0.63mm.

3.2.3 Back – filling gravel

Gravel used for back fill shall be natural gravel complying criteria mentioned in above having durable particle, graded from fine to course in a reasonable uniform combination with no boulder or stone larger than 50 mm in size. It shall not contain excessive amount of loam and clay and not more than 15% shall remain on a sieve of aperture size 75 micron.

Backfilling in zone 'A' shall be done by hand with sand, fine gravel or other approved material placed in layer of 150mm and compacted by tamping. The back filling material shall be deposited in trench for its full width of each side of the pipe filling and appurtenance simultaneously.

Backfilling in Zone 'B' shall be done by hand or approved mechanical methods in layers of 150mm, special care being taken to avoid injuring or moving the pipe. The type of back fill material to used and the method of placing and consolidating shall be prescribed by the Engineer-in-charge to suit individual locations.

Back filling Zone 'C' shall be done by hand or approved mechanical methods the type of backfill material and method of filling shall be as prescribed by the Engineer-in-charge.

3.3 Laying of pipes

3.3.1 Laying Underground

Pipes should be lowered into trench with tackle or rope suitable for the weight of pipe. All construction debris should be cleared from the inside of pipe either before or just after joint is made. This is done by passing a pull-through in the pipe or by hand depending upon the size

of the pipe. When laying in not in progress a temporary end closure should be securely fitted to the open end of the pipeline.

On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe does not move into or out of the socket of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position while the trench is backfilled over the barrel of the pipe. The backfill should be well compacted.

3.3.2 Laying above ground

The ground should be dressed to match the curvature of pipe shell for an arch length subtending an angle of 120^{0} at the centre of the pipes. Alternatively, the pipeline should be laid either on saddle, roller or rocker supports as specified by Engineer-in-charge. The pipes may be allowed to rest on ground if the soil is non-aggressive.

3.3.3 Pipe support

Pipe supports shall be provided in such a manner that there should not be any deflection at joints, here each pipe shall be well supported as shown in drawing. Pipes should be fixed to supports with weld steel straps so that axial movement due to expansion or contraction resulting from temperature fluctuation is taken up at individual joints in the pipeline. In addition, joints should be assembled with the spigot end withdrawn 5 to 10 mm from the bottom of the socket to accommodate these thermal movements.

3.3.4 Cutting of pipes

The cutting of pipe for inserting valves, fittings, etc, shall be done in a neat and workman like manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe. Methods of cutting ductile iron pipe is explained as:

3.3.4.1 By Hacksaw

Hand or power operated hacksaw should be used without blades having teeth at a pitch of 1 mm.

3.3.4.2 By Manually Operated Wheel Cutter

If approved by Engineer-in-charge manually operated wheel cutter with wheel specifically designed for use in ductile iron pipes may be used.

3.3.4.3 By Pipe Cutting Machine

Machines with cutter heads or abrasive wheels shall be used. Cutter head should have a front rake angle of 7^0 .

3.3.4.4 End Preparation of Cut Pipes for Jointing

The burr left after cutting should be trimmed off of light grinding or by filling.

3.4 Wrapping

When ductile iron pipes are to be laid in aggressive soils, the pipes should be wrapped externally with protective coatings, such as bitumen or coaltar sheathing protective tapes or by loose polythene sleeving, or in certain circumstances, concrete before laying. At joints, bends and valves, precautions should be taken to provide sufficient overlaps of the wrapping sleeve so that no pipeline is exposed to the aggressive soil.

3.5 Anchorage

Pipe line should be securely anchored at dead ends ties, bends tapes and valve to resist thrust arising from internal pressure. Concrete and earthwork shall be done as mentioned in specification.

3.6 Joints

Joints between two pieces of ductile iron pipe shall be push on joint and joint between pipe and valves shall be mechanical joints.

Spigot and socket flexible joint should be laid to permit angular deflection in direction and axial movement to compensate for ground movement and thermal expansion and construction.

All points shall be thoroughly cleaned before jointing Spigot and socket shall be in true alignment. Instructions of manufacture for jointing shall be strictly complied with.

The inside of sockets and the outside of spigots should be cleaned and wire brushed for a distance if 150 mm to 225 mm. Gland and gaskets should be wiped clean and inspected for damage. A gap should be left between the end of the spigot and back of the socket to accommodate such movement.

3.7 Transportation Handling and Inspection

3.7.1 General

All precautions shall be taken while lowering the pipe to avoid the damage of pipe or coating caused due to impact.

3.7.2 Transportation

Pipes should be loaded in such a way that they are secured and that movement should take place on vehicle during transit.

The pipes should be loaded on vehicle in pyramid or straight sided formation. In case of pyramid loading the pipe in bottom layer should be restrained by use of wooden wedge secured to vehicle being loaded. The pyramid is to be formed by resting pipe between pan of pipe in preceding layer with socket in layer reversed.

The pipes should be transported in such a way that there is no damage to protective coating and brushing or no damage of jointing surfaces.

3.8 Offloading

Pipe shall be offloaded using nominal bore, skid timbers and ropes. The pipes should be lifted smoothly without any jerking motion and pipe movement should be controlled by the use of guide roper in order to prevent damage caused by pipes bumping together or against surrounding objects.

3.9 Stacking

Pipes shall be stacked in the manner specified in I.S code 12288: 1989. Special precautions shall be taken for handling Bitumen – sheathed pipe. They should not be stacker but laid in single layer supported on timber placed under uncoated portion of the spigots a socket.

3.10 HYDRAULIC TESTING

After a new pipeline is laid and jointed, testing shall be done for:

Mechanical soundness and leak tightness of pipes and fittings. Leak tightness of joints; and Soundness of any construction work, in particular that of the anchorages.

3.10.1 General

The completed pipeline may be tested either in one length or in sections; the length of section depending upon:

- a. Availability of suitable water,
- b. Number of joints to be inspected, and
- c. Difference in elevation between one part of the pipeline and another.

Where the joints are left uncovered until after testing, sufficient materials should be back filled over the centre of each pipe to prevent movement under the pressure.

It is prudent to begin testing in comparatively short length of test section. Progressively as experience is gained, lengths of about 1.5 km or more, are tested in one section, subject to consideration of length of trench which can be left open in particular circumstances.

Each section should be properly sealed-off, preferably with special stop ends secured by adequate temporary anchors. All permanent anchors should be in position and, if of concrete, should have developed adequate strength before testing begins. The section under test should be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere.

3.10.2 Test pressure

The test pressure to be applied should be not less than any of the following:

The maximum sustained operating pressure, The maximum static pressure plus 5 N/mm², and The sum of the maximum sustained operating pressure (or the maximum static pressure) and the maximum calculated surge pressure.

After filling, the pipeline should be pressurized to the specified operating pressure and left for a period of time to achieve stable conditions.

The length of this period of time depends on many factors such as slight movement of the pipeline under pressure whether air is trapped in the pipeline has a concrete lining which absorbs water.

The pipelines are then pressurized up to the full test pressure and the section under test completely closed off. The test should be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages.

The test pressure should be measured at the lowest point of the section under test or alternatively an allowance should be made for the static head between the lowest point and the point of measurement to ensure that the required test pressure is not exceeded at the lowest point.

In case of extreme temperature conditions, there may be a tendency of hydraulic pressure building up inside the pipeline because of expansion of water during the high day time. This should normally not be of any major concern as the joints and the pipes are manufactured to resist a much high pressure. However, sufficient care should be taken to prevent floating bulging of the pipeline because up of such high pressure during the temperature rise.

If the test is not satisfactory, the fault should be found and rectified. Where there is difficulty in locating a fault, the section under test should be sub-divided and each part tested separately.

3.10.3 Methods employed for finding leaks

Visual inspection of each joint if, not covered by the backfill; Use of a bar probe to detect signs of water in the vicinity of joints if backfilled; Aural inspection using a stethoscope or listening stick in contact with the pipeline; Use of electronic listening device which detects and amplifies the sound or vibrations due to escaping of water actual contact between the probe and the pipe is not essential;

Injection of dye into the test water particularly suitable in water logged ground; and Introduction of nitrous oxide in solution into the test water and using an infra- red gas connection indicator to defect the presence of any nitrous oxide that has escaped through the leak.

After all Sections have been joined together on completion of section testing, a test on the complete pipeline should be carried out. This test should be carried out at a pressure not less than the maximum sustained operating pressure or the maximum sustained operating pressure or the maximum static pressure of the pipeline and during the test, inspection made of all work which has not been subject to section tests. During the test, the pressure at the lowest point in the pipeline should not exceed the maximum given in **Table 3.1**

TABLE 3.1 MAXIMUM FIELD HYDROSTATIC TEST PRESSURE FOR DUCTILE IRON PIPELINES WITH FLEXIBLE JOINTS

Nominal Borein mm	Maximum Field Hydrostatic Test Pressure in N/mm ²
Upto 300	4.5
350 to 600	3.0
700 to 1200	2.1

Note 1-The above pressures are 0.5 N/mm^2 higher than the pressure ratings for ductile iron pipes and fitting with flexible joints. It is not considered necessary to field test ductile iron pipelines to 1 time the design operating pressure as is often the practice with grey iron pipelines.

Note 2- The field test pressure is applied to ductile iron pipelines only when the pipeline and its fittings are properly anchored.

It is important to ensure that proper arrangements are made for the disposal of water from the pipeline after completion of hydrostatic testing and that all consents which may be required from authorities have been obtained. In some case, for example heavily chlorinated water, some treatment may be necessary before final disposal.

4.0 FLUSHING AND DISINFECTION OF MAINS BEFORE COMMISSIONING

The mains intended for potable water supplies should be disinfected for commissioning them for use.

4.1 Distribution System Chlorination of New Mains

Special care should be taken to ensure disinfection of new mains. Among possible sources of contamination are sewer drainage, contaminated soil in the trench, contamination from workmen and or their equipment and, unavoidable foreign material present in the trench during construction.

All sewers, water mains and other underground conduits should be located prior to construction and relocated, if necessary to prevent contamination during construction. Pipe should be stung on high ground. At all times when construction is not actually in progress, watertight plugs should be installed in all pipe openings. Gunny sacks and rags are not adequate. Provision should be made to pump any other water that might have collected in the trench. Special care should be taken to avoid contamination of valves, fittings, and pipe interiors both before and during construction, each should be inspected and, if necessary, cleaned before installation.

After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and other foreign materials. When this process has been completed, disinfection (using liquid chlorine, sodium or calcium hypochlorine) is preceded by one of the recommended methods as described.

4.2 Continuous Feed

In this method, water from the distribution system or other approved source and the chlorine from selected source are fed at constant rate into the new main at a concentration of at least 20 to 50 mg/litre. A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump may be used. The chlorine residual should be checked at intervals to ensure that the proper level main is filled. All valves, hydrants, etc, along the main should be operated to ensure their proper disinfection. The water should remain in the main for a minimum of 24 hours. Following the 24 hour period, no less than 10 mg/1 chlorine residual should remain in the main.

4.3 Slug Method

In this method, a continuous flow of water is fed with a constant dose of chlorine with rates proportioned to give a chlorine concentration of at least 300 mg/1. The chlorine isi applied continuously for a period of time to provide a column of chlorinated water that will contact all interior surfaces of the main for a period of at least three hours. As the slug passes, tecs, crosses, etc, valves should be operated to ensure their disinfection. This method is used principally for large diameter mains where continuous feed is impractical.

Regardless of the method used, it is necessary to make certain that backflow of the strong chlorine solution into the supplying line does not occur. Following the prescribed contact period, the chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating that throughout the rest of the system. Bacteriological tests as prescribed by the Engineer-in-charge should be taken, and if the results fail to meet minimum standards, the disinfecting procedure should be repeated and the results again tested before placing the main in service.

5.0 Manholes

5.1 Excavation

The manhole shall be excavated true to dimensions and levels shown on the plans or as directed by the Engineer-in-Charge.

5.2 Bed Concrete

The manhole shall be built on a bed of cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) unless required by local authorities. The thickness of the bed concrete shall be 20 cm for manholes upto 4.25 m depth and 30 cm for depths beyond 4.25 m unless otherwise specified or directed by the Engineer–in-Charge. In bad ground, special foundations as suitable shall be provided.

5.3 Brick Work

The brickwork shall be with bricks in cement mortar 1:3 (1 cement: 3 fine sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. The walls shall be built of one brick thickness for

depths upto 4.25 m. Below the depth of 4.25 m in ordinary subsoil the wall thickness shall be increased to one and half brick and at 9.75 m below ground two brick thick walls shall be built.

5.4 Plastering & pointing

The walls of the manholes shall be plastered inside with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth. Where the saturated soil is met with also the external surface of the walls of the manholes shall be plastered with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth upto 30 cm above the highest sub-soil water level. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications. For earthwork excavation, bed concrete, bed concrete brickwork, plaster and pointing, R.C.C work and refilling of earth, respective specifications shall be followed.

5.5 Benching

The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The depth of channels and benching shall be as given below.

Size of drain	Top of channel at the centre above bed concrete	Depth of benching at side walls above bed concrete
mm	cm	cm
100	15	20
150	20	30
200	25	35
250	30	40
300	35	45
350	40	50
400	45	55
450	50	60

5.6 Foot Rests

All manholes deeper than 0.8 m shall be provided with M.S. footrests. These shall be embedded 20 cm deep with 20 x 20 x 10 cm blocks of cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size). The block with M.S. foot rest placed in its centre shall be cast in-situ along with the masonry and surface finished with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth. Footrests shall be fixed 30 cm apart vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top footrest shall be 45 cm below the manhole cover. Foot rests shall be painted with coal tar, the portion embedded in the masonry or cement concrete block being painted with thick cement slurry before fixing.

5.7 Manhole Covers and Frames

The frame of manhole shall be firmly embedded to correct alignment and levels in 150mm th. R.C.C slab (1:1.5:3) on the top of the masonry. The specified cover and frame shall be fixed. After completion of the work, manhole covers shall be sealed by means of thick grease.

5.8 Measurements

Manholes shall be measured in numbers under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

5.9 Rate

The rate shall include the cost of materials and labour involved in all the operations described above but exclude the cost of M.S. foot rests and 12 mm thick cement plaster with water proofing material applied at the external surface of the manhole if required. These items shall be paid for separately under relevant items of work.

Payment for extra depth of manholes shall be made separately under relevant item of work.

6.0 Fire Hydrants

The hydrants shall be controlled by a cast iron valve/butterfly valves. Hydrants shall have instantaneous type 63 mm dia outlets. The hydrants shall be of gunmetal and flange inlet and single outlet conforming to I.S 5290-1975 with G.I duck foot bend and flanged riser of required height to bring the hydrant to correct level above ground.

Contractor shall provide for each external fire hydrant two nos. of 63 mm dia. 15 meter long Hose pipe with gunmetal male and female instantaneous type couplings machine would with copper wire hose to IS 636 type A and couplings to IS 903 with IS certification), gunmetal branch pipe with 16 mm nozzle to IS 903 as shown on the drawings/BOQ

7.0 Removal, restoration and maintenance of paved footpaths, etc, after laying of pipe

7.1 Allowable Removal of Pavement

Pavement and road surfaces may be removed as a part of the trench excavation, and the amount removed shall depend upon the width of trench specified for the installation of the pipe and the width and length of the pavement area required to be removed for the installation of gate valves, specials, manholes or other structures. The width of pavement removed along the normal trench for the installation of the pipe shall not exceed the width of the trench specified by more than 150 mm on each side of trench. The width and the lengths of the area of pavement removed from the installation of gate valves, specials, manholes or other structures should not exceed the maximum linear dimensions of such structures by more than 150 mm on each side. Wherever, in the opinion of the Engineer-in-charge, existing conditions make it necessary or advisable to remove additional pavement, it shall be removed as directed by the Engineer-in-charge.

7.2 Restoration of Damaged Surface and Property

Where any pavement, shrubbery, fences poles or other property and surface structure have been damaged, removed or disturbed during the course of work, such property and surface structures shall be replaced or repaired after completion of work. All pavements, paved for paths, curbing, gutters, shrubbery, fences, poles sod or other property and surface, structures removed or disturbed as a part of the work shall be restored to a condition equal to that before the work began, furnishing all labour and materials incidental thereto. In restoring the pavement, sound stone blocks, sound brick or asphalt pavement shall be restored unless and untill, in the opinion of the authority, the condition of the backfill is such as to property support the pavement.

7.3 Cleaning up

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by the authority. All dirt, rubbish and excess earth from the excavation shall be hauled to a dump and the construction site left dam