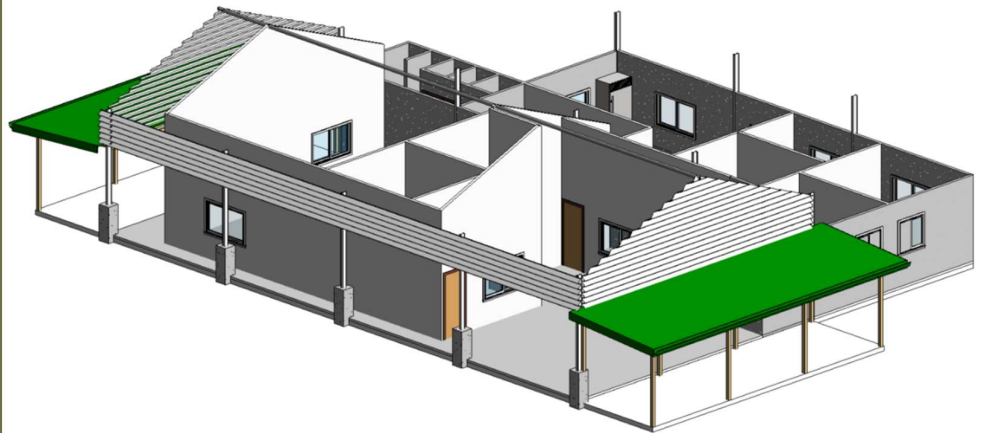


Part 3. Technical Specifications

MTEC SNESI KONDRE

Client/Owner: EMSAGS



Project # : EMSAGS-0824-C

Document # : TS-EMSAGS-0824-C

Project Manager

Ashvin Pancham BSc.

PART 3

TECHNICAL SPECIFICATIONS

PREFACE

This document, the “Technical Instructions” is the third part in the set of the tender documents. This part lays down the technical specifications for this particular project.

To make the documents easy to read and understandable it’s been chosen to write in the imperative mood where the subject (the Contractor) is implied, and the verb expresses the command. See example below of the traditional indicative mood and the imperative mood.

Traditional indicative mood:

1. **The CONTRACTOR shall DELIVER and INSTALL the block pavement according to drawing #...**
2. **The contractor is liable for any damage to the squash court during installation and construction phase of the project.**

Imperative mood:

1. **DELIVER and INSTALL block pavement according to drawing #...**
2. **Any damage to the squash court during installation and construction phase of the project shall be repaired or replaced at own expense.**

COLOFON

Document title : TECHNICAL SPECIFICATIONS MTEC SNESI KONDRE

Project : MTEC SNESI KONDRE

Project number : EMSAGS-0824-C

Document number : TS-EMSAGS-0824-C

Client/owner : EMSAGS

Contractor :



CODECO
CONSTRUCTION DESIGNERS & CONSULTANTS N.V.

Kwattaweg 717

Paramaribo

Tel.: (+597) 895-1776

Tel.: (+597) 855-4345

Content : Sandhesa Rathipal

Drafter : SRA

Structural Engineer : Ir. Amrit W. Dassasingh

Authorization : Ashvin A. Pancham BSc.

Issue date : 11 December 2024

Issue date Revision :

Additional Documents: : -----

Document Distribution list			
No.	Function title	Name	Date
1			
2			
3			

Table of Contents

INTRODUCTION	10
1. TIME CONTROL & PROGRESS.....	11
1.1 PROGRAM/CONSTRUCTION SCHEDULE	11
1.2 EXTENSION OF THE INTENDED COMPLETION DATE.....	11
1.3 ACCELERATION	11
1.4 MANAGEMENT/CONSTRUCTION MEETINGS	12
1.5 EARLY WARNINGS	12
1.6 VARIATIONS	12
1.7 PAYMENT CERTIFICATES	12
1.8 DECLARATION FORM (DF).....	13
2. HEALTH SAFETY & ENVIRONMENTAL TERMS.....	14
2.1 HSE PLAN OF CONTRACTOR.....	14
2.2 LEGAL REQUIREMENTS AND REGULATION.....	14
2.3 COMPLAINCE	14
2.4 HSE MANAGEMENT	15
2.5 HSE AWARENESS	15
2.6 SAFETY EQUIPMENT	16
2.7 PERSONAL PROTECTIVE EQUIPMENT (PPE).....	16
2.8 HOUSEKEEPING.....	16
2.9 ACCIDENT, INCIDENT AND NEAR MISS REPORTING.....	16
3. QUALITY CONTROL.....	17
3.1 QUALITY CONTROL SCHEDULE (QCS)	17
3.2 COMMUNICATION FORM (CF).....	17
3.3 TECHNICAL INSTRUCTION (TI)	18
3.4 SPECIFICATION SUBMITTAL (SS)	18
3.5 IDENTIFYING DEFECTS & TESTS	18
3.6 CONSTRUCTION DEFICIENCIES	18
3.6.1 DEFICIENCY IDENTIFICATION	18
3.6.2 NON-CONFORMANCE REPORT.....	19
3.6.3 QUALITY CONTROL DEFICIENCY CORRECTION	19
3.6.4 PREVENTIVE ACTION.....	19
3.7 INSPECTION	20
3.7.1 PREPARATORY INSPECTION	20
3.7.2 INITIAL INSPECTION	20
3.7.3 FOLLOW-UP INSPECTION	20
3.7.4 COMPLETION INSPECTION	21
3.7.5 QC TESTING	21
3.8 MATERIAL IDENTIFICATION AND TRACEABILITY	21
3.9 DOCUMENTATION	21
3.9.1 DAILY RECORD KEEPING.....	21
3.9.2 DAILY CONSTRUCTION REPORT.....	22

3.9.3 INSPECTION AND TESTING REPORT FORMS.....	22
3.9.4 RECORD DRAWINGS/As-Built drawings	22
3.9.5 CONTROL OF QUALITY RECORDS	22
3.10 FIELD REVISIONS	23
4. SITE PREPARATION	24
4.1 SETTING OUT	24
4.2 EARTHWORKS GENERAL	24
4.3 TEMPORARY FENCE	24
4.4 CLEARING AND GRUBBING OF VEGETATION	24
5. DEMOLITION	26
5.1 PLANNING	26
5.2 PRECAUTIONS AND PROTECTION.....	26
5.3 PERFORMANCE METHODS	26
5.4 DISPOSAL AREA	27
5.5 OWNERSHIP OF MATERIALS	27
6. EARTHWORKS	28
6.1 MATERIALS	28
6.2 EXCAVATION AND BACKFILL	28
6.2.1 EXCAVATION	28
6.2.2 POOR FOUNDATION MATERIAL.....	30
6.2.3 DISPOSAL OF EXCAVATED MATERIAL.....	30
6.2.4 BACK-FILLING	30
6.3 CONSTRUCTION METHOD	31
7. DRAINAGE WORKS	32
7.1 MATERIALS	32
7.2 PVC PIPE	32
7.2.1 DESCRIPTION.....	32
7.2.2 MATERIALS.....	32
7.2.3 JOINTS.....	32
7.2.4 INSTALLATION	32
8. FORMWORK	33
8.1 DESCRIPTION	33
8.2 MATERIALS	33
8.3 CONSTRUCTION METHOD	33
8.3.1 FORMWORK FOR EXPOSED SURFACES	34
8.3.2 FORMWORK FOR NON-EXPOSED CONCRETE SURFACES	35
8.3.3 FORMED SURFACES AND FINISH.....	35
8.3.4 TOLERANCES	35
8.3.5 PREPARATION OF FORMWORK.....	35
8.4 WOODEN FORMWORK PARTS	36
8.4.1 PARTS TO BE FORMED	37
8.4.2 REMOVAL OF FORMWORKS.....	37
8.4.3 DEFECTS IN FORMED SURFACES	38

8.4.4 HOLES TO BE FILLED	38
9. REINFORCING STEEL	40
9.1 DESCRIPTION	40
9.2 MATERIALS	40
9.3 STORAGE AND CARE	40
9.4 CUTTING AND BENDING	40
9.5 PLACING AND FIXING	41
9.6 SURFACE CONDITION	42
9.7 COVER	42
9.8 LAPS AND JOINTS	42
9.9 SPACING OF REINFORCEMENT	42
9.10 SPLICING.....	43
9.11 PLACING AND FIXING.....	43
9.12 SUBSTITUTIONS.....	43
9.13 INSPECTION	44
9.14 WELDING	44
9.15 TOLERANCES	44
10. CONCRETE	46
10.1 GENERAL	46
10.2 DEFECTS	46
10.3 MATERIALS.....	47
10.4 COARSE AGGREGATE	47
10.5 CONCRETE	47
10.6 UNREINFORCED CONCRETE, GRADE C12/15	48
10.6.1 HAND MIXING	49
10.6.2 HANDLING AND PLACING OF CONCRETE	49
10.6.3 COMPACTION OF CONCRETE	51
10.6.4 PROTECTION OF CONCRETE FROM ADVERSE CONDITIONS.....	52
10.6.5 PERFORATIONS AND EMBEDDING OF SPECIAL DEVICES.....	53
10.6.6 CURING OF CONCRETE.....	53
10.6.7 FINISH AND FINISHING.....	54
10.6.8 CONCRETE SURFACE FINISHING.....	55
10.6.9 BACK-FILL TO STRUCTURES.....	55
10.6.10 CLEANING UP	56
10.7 QUALITY CONTROL OF CONCRETE	56
10.7.1 GENERAL	56
10.7.2 SLUMP TESTS.....	56
10.7.3 COMPRESSIVE STRENGTH	56
10.7.4 FAILURE TO PASS TESTS	57
10.7.5 TESTING HARDENED CONCRETE	57
10.8 TOLERANCES	57
11. CONSTRUCTION JOINTS.....	59
11.1 GENERAL	59
11.1.1 Preparation of Surfaces.....	59

11.1.2	Placing Fresh Concrete at Construction Joints	59
12.	JOINTS IN CONCRETE	60
12.1	CONSTRUCTION JOINTS	60
12.2	BONDING	60
12.2.1	BONDING AND DOWELING TO EXISTING STRUCTURES	61
12.2.2	FORMS AT CONSTRUCTION JOINTS	61
12.2.3	INSTALLATION	61
13.	MASONRY WORKS	63
13.1	MATERIALS	63
13.2	CONSTRUCTION METHOD	63
13.3	TOLERANCES	64
14.	METAL CONSTRUCTION	69
14.1	GENERAL	69
14.2	PERFORMANCE OF WORKS	69
14.2.1	SHOP WELDING	69
14.2.2	SITE WELDING	69
14.2.3	ERECTION OF STEELWORK	70
14.2.4	BOLTED CONNECTIONS	70
14.2.5	TRANSPORTATION AND STORAGE	70
14.2.6	PAINT AND PROTECTION	70
15.	PAINT SYSTEMS	72
15.1	PAINTING GENERAL	72
15.2	MATERIALS	72
15.3	SURFACE PREPARATION	73
15.4	PAINT SYSTEMS	73
16.	SUSPENDED CEILINGS	75
16.1	MATERIAL	75
16.2	PROJECT CONDITIONS	75
17.	TILEWORK	76
17.1	PRE-TREATMENT SUBSTRATE	76
17.1.1	TILING, SUBSTRATE WATERPROOF LAYER	76
17.2	INNER WALL TILING, GLUED, CERAMIC TILE	76
17.2.1	WALL TILING, GLUED, CERAMIC TILE	76
17.2.2	WALL TILING GLUED	76
17.3	PORCELAIN TILE	76
17.3.1	FLOOR TILING GLUED, PORCELAIN TILE	76
17.3.2	TILE ADHESIVE	77
17.3.3	GLUE	77
17.3.4	INNER WALL	77
17.3.5	CEMENT SCREEDS	77
18.	WOOD WORKS	78

18.1 GENERAL.....	78
18.2 MATERIALS	78
18.3 EXECUTION.....	78
18.4 INSPECTION AND DELIVERY	78
19. GYPSUM WALLS	79
20. FRAMES, WINDOWS AND DOORS	80
20.1 FRAMES.....	80
20.2 QUALITY CLASS WOOD	80
20.3 COMPOUNDS	80
20.4 WOODEN FAÇADE/FRAME	80
20.4.1 WOODEN FRAME.....	80
20.4.2 INTERIOR DOORS WOODEN DOORS	80
21. GUTTERS AND RAINWATER DRAINS	82
21.1 ALUMINUM DAKGOOTELEMENT	82
21.2 GUTTER	82
21.3 CONSTRUCTION OF PLASTIC PIPELINE, PLASTIC PIPE	82
21.4 PLASTIC PIPE, UNPLASTICIZED PVC (NEN 7016-81)	82
21.5 RAINWATER DRAINAGE SYSTEM.....	82
22. INDOOR SEWERAGE	83
22.1 DESCRIPTION, INSTALLATION COMPONENTS INDOOR SEWER SYSTEM.....	83
22.2 WORKING DOCUMENTS, DRAWINGS AND CALCULATIONS	83
22.3 PLASTIC PIPELINES	83
22.3.1 CONSTRUCTION OF PLASTIC PIPELINE, PLASTIC PIPE.....	83
22.3.2 PLASTIC PIPE.....	84
22.3.3 INDOOR SEWERAGE: Installation Parts:.....	84
23. SANITARY	85
23.1 GENERAL.....	85
23.2 WATERTIGHTNESS TEST	85
23.3 MANUFACTURER/SUPPLIER PROCESSING INSTRUCTIONS	85
23.4 APPLIANCES	85
24. ELECTRICAL INSTALLATIONS	86
24.1 TECHNICAL SPECIFICATIONS.....	86
24.1.1 Responsibility and capacity of the products.....	86
24.1.2 Material	86
24.1.3 Materials and tools	86
24.1.4 Execution planning.....	86
24.1.5 Dimensions.....	87
24.1.6 Delivery of the works.....	87
24.1.7 Maintenance period.....	87
24.1.8 Repair, cleaning and polishing work.....	87
24.2 IMPLEMENTATION ELECTRICITY WORKS	87
24.2.1 Electricity in general.....	87

24.2.2 Switches and sockets.....	87
24.2.3 EXISTING SYSTEM.....	88
24.2.4 New system.....	88
24.2.5 Transition plan	88
24.3 SOLAR INSTALLATION	89
24.3.1 BATTERY INVERTERS	89
24.3.2 INSTALLATION REQUIREMENTS	90
24.3.3 PV CHARGE CONTROLLERS.....	90
24.3.4 PV PANELS.....	91
24.3.5 PV-MODULES	92
24.3.6 PV MOUNTING STRUCTURE	93
24.3.7 LI-ION BATTERY	94

INTRODUCTION

The MTEC Snesi Kondre mining school is located at Snesikondre alongside the west bank of the Marowijne river in the district Sipaliwini. The area covering 2000 m² on which the School of Mining is located can be reached by the Langatabiki road and is located approximately 30 km southeast of Merian operations of Newmont Goldcorp. The intention is to use the "School of Mining" building in Snesi Kondre, under the management of the "Stichting School of Mining and Mineral Processing" (Stichting SMMP), for the MTEC. The project seeks to improve the environmental management of mining in Suriname, particularly small-scale gold mining. A result of the uptake of environmentally responsible artisanal and small-scale gold mining practices, is to establish Mining Training and Extension Centers (MTECs). Codeco N.V. has been awarded the contract to encapsulate this objective in a mining school design in specifications and drawings.

This document is the third part of the tender documents and includes the technical specifications for the structural part.

1. TIME CONTROL & PROGRESS

1.1 PROGRAM/CONSTRUCTION SCHEDULE

1. At the kick-off meeting, submit an updated detailed Program showing the general methods, arrangements, order, and timing for all the activities in the Works to the Engineer for approval. In the case of a lump sum contract, the activities in the Program shall be consistent with those in the Activity Schedule.
2. An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work, including any changes to the sequence of the activities.
3. Submit to the Engineer for approval an updated Program at intervals no longer than ten (10) days or as decided in the kick-off meeting. In case of not submitting an updated Program within this period, the Engineer may withhold the amount of 0.5% per day from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Program has been submitted. In the case of a lump sum contract, provide an updated Activity Schedule within 14 days of being instructed to by the Engineer.
4. The Engineer's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Engineer again at any time. A revised Program shall show the effect of Variations and Compensation Events.
5. Estimated construction period in days/months, refer to the Data Sheet.

1.2 EXTENSION OF THE INTENDED COMPLETION DATE

1. Extension of the Intended Completion Date can be given if a Compensation Event occurs or a Variation is issued which makes it impossible for Contractor to achieve the intended completion date without the Contractor taking steps to accelerate the remaining work, which would cause the Contractor to incur additional cost.
2. The Engineer shall decide whether and by how much to extend the intended completion date within ten (10) days after submission of the request to the Engineer for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. Failure to give early warnings of a delay or failure to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new intended completion date.

1.3 ACCELERATION

1. When the Employer wants the construction to finish before the Intended Completion Date, the Engineer shall obtain priced proposals for achieving the necessary acceleration. If the Employer accepts these proposals, the Intended Completion Date shall be adjusted accordingly and confirmed by both the Employer and the Contractor.
2. An accepted priced proposals for an acceleration will be incorporated in the Contract Price and treated as a Variation.
3. The Engineer may instruct to delay the start or progress of any activity within the Works.

1.4 MANAGEMENT/CONSTRUCTION MEETINGS

1. Either the Engineer or the Contractor may require the other to attend a management/construction meeting. The purpose of a management meeting is to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.
2. The Engineer shall record the business of management/construction meetings and provide copies of the record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken shall be decided by the Engineer either at the management/construction meeting or after the management/construction meeting and stated in writing to all who attended the meeting.
3. The management/construction meetings shall be held every 2 weeks and if one of the parties considers it necessary the meeting can be planned weekly.

1.5 EARLY WARNINGS

1. Warn the Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price, or delay the execution of the Works. The Engineer may require to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate shall be provided as soon as reasonably possible.
2. The Contractor shall cooperate with the Engineer in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer.

1.6 VARIATIONS

1. If the Engineer decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall be given, and the Variation shall be treated as a Compensation Event.

1.7 PAYMENT CERTIFICATES

1. Submit a monthly statement of the estimated value of the work executed less the cumulative amount certified previously to the Engineer.
2. The Engineer shall check the monthly statement and certify the amount to be paid. For project less than 1 month the period is stated to 2 weeks.
3. The value of work executed shall be determined by the Engineer. Payments will be made only for the quantity of works and goods delivered and approved till date of submission. No advance payment is made.
4. The value of work executed shall comprise:
 - In the case of an admeasurement contract, the value of the quantities of work in the Bill of Quantities that have been completed; or
 - In the case of a lump sum contract, the value of work executed shall comprise the value of completed activities in the Activity schedule.

1.8 DECLARATION FORM (DF)

1. The declaration form should be issued by the contractor to the supervisor to approve or in case of nonconformance reject the declaration.
2. Before the employer will perform any payment to the contractor it should have an approved DF form.
3. The DF will be processed within 7 days after submission to the Engineer.

2. HEALTH SAFETY & ENVIRONMENTAL TERMS

Paragraph 38 of the UWS will be amended as follows:

Health Safety and Environment (HSE) responsibilities are integral to the way CODECO N.V. does business, and Company management at all levels is dedicated to protecting the environment and to preventing harm to employees, owners, communities, and all others who could be affected by our activities.

2.1 HSE PLAN OF CONTRACTOR

1. Develop a project-specific HSE plan (including requisite and appropriate forms) and maintain this at all times during performance of the Work.
2. The HSE plan must be submitted to the Engineer for approval prior to implementation. The HSE plan shall incorporate the listed information in this chapter.
3. The HSE plan shall address the risks specific to the Work and the management and implementation of control measures to eliminate, reduce or mitigate those risks throughout the full lifecycle of the Contract.

As a minimum, the HSE plan shall include the following:

- A project organization chart identifying the HSE responsible person.
- A section identifying any Contractor HSE plans, procedures, rules and working practices to be applied throughout the Contract.
- A description of the HSE reporting and management arrangements.

2.2 LEGAL REQUIREMENTS AND REGULATION

Ensure to undertake all activities in relation to the Works to be done comply with all applicable international, national, regional, local and other legislative requirements and regulations, particularly those relating to the protection of the HSE. Contractor warrants that it is familiar with the contents and implications of all applicable HSE legislation and regulations.

2.3 COMPLAINTS

1. Ensure safe working conditions for all Contractors personnel and others during the execution of the works.
2. Any breach of the HSE requirements shall be deemed by the Engineer/Employer to be a breach of the terms of the contract and shall be entitled to take appropriate action including instructing Contractor to:
 - Remedy the breach,
 - Suspend the Work or
 - Terminate the Contract.

3. The Engineer/Employer reserves the right to suspend the Work or any part thereof without compensation if the Engineer/Employer becomes aware that the Works performed is imminently unsafe, in breach of this chapter or otherwise deemed unsafe by the Engineer/Employer for HSE reasons. Before the Work is suspended, the Engineer/Employer shall liaise with the opportunity to rectify any non-conformances within an acceptable timescale.
4. The works can be suspended at any time for HSE reasons; in such event however immediately inform the Engineer/Employer in writing of those reasons and details of actions to be taken before Work can be resumed.
5. Should any individual personnel not comply fully with the HSE requirements of the Contract then it is expected to apply appropriate disciplinary procedures. Engineer/Employer in its sole discretion may request any personnel to be removed from the Work Site on the grounds of failure to comply with the HSE requirements.

2.4 HSE MANAGEMENT

1. Ensure that all activities undertaken in relation to the Work by Contractor are carried out in such a manner as to:
 - Protect the health and safety of all people involved and other stakeholders.
 - Safeguard the environment.
 - Protect the property of the Owner, Work Site, Contractor and all third parties.
2. Co-operate with the Engineer/Employer to ensure that the roles and responsibilities in the HSE system are clearly defined and allocated and are clearly understood by all parties.
3. Provide sufficient and competent manpower and supervision within the Works Site to manage the HSE aspects of the Work to be undertaken. Keep the Engineer/Employer informed of all HSE matters including meetings, activities, initiatives and incidents. In addition, adhere the Safety Rules and relevant HSE requirements of the client, and also ensure that all subcontractors are aware of, and follow, their requirements.

2.5 HSE AWARENESS

1. Maintain and enhance the HSE awareness of personnel including arranging regular HSE meetings and participating training/emergency drills organized by the Engineer/Employer of any of the other Contractors.
2. Copies of minutes of HSE meetings and records of emergency drills shall be sent to The Engineer/Employer upon request. Personnel are required to actively contribute to the HSE meetings and to identify for inclusion in the agenda for an HSE meeting.
3. A HSE/Toolbox meeting is mandatory to be held every week. If failed the Engineer reserve the rights to suspend all works without letting these days count as non-workable days.

2.6 SAFETY EQUIPMENT

1. Provide adequate first aid equipment on site at own expense, fire extinguishers and other safety equipment of an approved type and appropriate amount, as may be specified (or expected in accordance with good working practice), in connection with the Work and shall maintain this equipment in a professional manner as indicated by recognized international legal and industry standards. Do keep up-to-date records of all said equipment.

2.7 PERSONAL PROTECTIVE EQUIPMENT (PPE)

1. Supply every personnel with adequate protective clothing and other protective equipment, required in connection with the safe performance of the Work, and maintained in good condition during construction.
2. PPE must be worn on all relevant occasions as indicated by notices, instructions and good practice.

2.8 HOUSEKEEPING

1. Maintain a good housekeeping continuously throughout the duration of the Work with due regard being paid to access ways, disposal of waste and scrap material and general tidiness.
2. Remove all rubbish and debris from the Site and dispose at a safe distance as per direction of the Engineer or to a landfill so as not to create any obstruction to Work or give rise to health hazards.
3. Keep a roll of bin on site in which the construction debris is disposed and a garbage bin for waste produced by construction personnel.

2.9 ACCIDENT, INCIDENT AND NEAR MISS REPORTING

1. Maintain an accident, incident and near miss reporting system which shall be compatible with the Engineer/Employer reporting and investigation system.
2. Do report every incident occurred on site to the Engineer.

3. QUALITY CONTROL

1. Take full responsibility for the quality of the delivered Works. In subsequent paragraphs some tools will be presented to assist in establishing a method for communication and quality control management of all Works.
2. Communicate all dates and time of the tests to be done to the Engineer. This to make sure that the tests are fully witnessed by the Supervisor.

3.1 QUALITY CONTROL SCHEDULE (QCS)

1. Quality control to be performed by the Supervisor, will be conducted by means of a QCS with inspection forms corresponding to the technical specification for this project. The QCS is a table stating all tests and inspections to be performed. It will also include a table stating the responsibilities of all relevant parties involved.
2. An important part of the QCS are the "Hold points" whereby written permission is required from the Supervisor for commence of the Works. Furthermore, the table addresses which verification document is required for approval by the Supervisor. A verification document is an appendix noting the findings of the Contractor. This document requires the written approval of the Supervisor.
3. Conduct all inspections which are required and written down in the technical specs to ensure the specified quality of the works.
4. Submit all tests results and reporting as prove that all Works have been executed in accordance with the Scope of Works. Keep good administration of all documents.

3.2 COMMUNICATION FORM (CF)

1. Use the Communication Form (CF) for any questions, clarifications or to make note of all relevant occurrences during the execution of the Works. Proposed variations to the Scope of Works will be submitted through written CF to the Supervisor who will either approve or reject said proposal for variation.
2. Also, any occurrence that may be influential to the progress of the execution of the Works may be brought to the attention of the Supervisor by use of the CF.
3. The CF is simply designed to promote, streamline and document all communications between Contractor and Supervisor. The CF is beneficial in enabling the Contractor to submit any and all queries regarding project execution. Through the CF all communication with the Supervisor is well documented.
4. CF's are submitted by the Contractor by a unique serial number. An example of a CF is included in de attachments.

3.3 TECHNICAL INSTRUCTION (TI)

1. If the Supervisor deems it necessary to issue a technical instruction it will do so by means of a Technical Instruction (TI) form. In this TI the technical instruction will be formulated and will be written prove of issuance of said instructions to both the Supervisor and the Contractor.
2. Unlike the CS and the SS, the TI is submitted by the Supervisor to the Contractor.

3.4 SPECIFICATION SUBMITTAL (SS)

1. Make sure that at all times used materials comply with the quality requirements set forth in the Scope of Works. Usage of materials will however require preapproval by the Supervisor.
2. Use a Specifications Submittal (SS) form to offer other materials than specified in the SOW to be used in the execution of Works. An example of an SS is supplied in the attachments. The SS will be returned by the Supervisor with an approval or rejection of the offered materials, after which appropriate measures can be taken purchase of approved materials or submission of alternative materials in case of rejection.

3.5 IDENTIFYING DEFECTS & TESTS

1. The Engineer shall check the work and notify for any Defects that are found. Such checking shall not affect contractor's responsibilities. The Engineer may instruct to search for a Defect and to uncover and test any work that the Engineer considers may have a Defect.
2. If the Engineer instructs to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect, the test shall be a Compensation Event.

3.6 CONSTRUCTION DEFICIENCIES

1. This section provides procedures for tracking construction deficiencies (non-compliance) from identification through acceptable corrective action. It defines the controls and related responsibilities and authorities for dealing with noncompliant products or services.

3.6.1 DEFICIENCY IDENTIFICATION

1. Deficiency occurs when a material, performed work, or installation does not meet the plans and/or specifications for the project.
2. When material, performed work, or installation is found deficient, the Engineer shall ensure that the non-conforming material, work, or installation is identified and controlled to prevent unintended use or delivery. The Engineer will notify of non-compliance with any of the foregoing requirements. Take corrective action after receipt of such notice, immediately.
3. Minor deficiencies noted during test or inspection are verbally reported to the personnel and noted. Minor deficiencies are items that do not require significant rework or repair work to correct and will not result in significant deviations from required quality standard if corrected immediately.
4. Ideally, such minor deficiencies can be corrected on the spot by agreement of both parties.

5. Non-conformances are major deviations from the contract requirement and/or accepted standard of quality, which shall be formally documented for corrective action by the Engineer. Failure to correct a minor deficiency after having been put on notice will also result in a non-conformance if it is not corrected within 5 days of notification.
6. Non conformances will be formally documented on the example Non-Conformance Report (NCR) by the supervisor and will be distributed to the Contractor.
7. The Engineer shall follow up on the Non-conformance report as required to verify that corrective action has been completed.
8. As long as the Non-Conformance issues have not been remedied, the contractor cannot get pay for that part of the work.

3.6.2 NON-CONFORMANCE REPORT

1. The Non-Conformance Report (NCR) is a formal notification to the contractor that the work does not meet the plans or the specifications for the project. Any item of work found to be deficient out of conformance with the construction drawings and/or specifications will be identified by the Engineer on the nonconformance report as described in this section.

3.6.3 QUALITY CONTROL DEFICIENCY CORRECTION

1. When material, performed work or installation is found to be deficient and/or does not meet the project specifications, the Engineer will assure deficiency correction is implemented. The Engineer designee shall ensure that the non-conforming material, work or installation is identified and controlled to prevent unintended use or delivery. Tag and segregate the non-conforming material or item, when practical, from conforming material or items to preclude their inadvertent use. The Engineer is responsible for documenting the non-conformance in a Non-Conformance Report.
2. Implement corrective actions to remedy work that is not in accordance with the drawings and specifications. The corrective actions will include removal and replacement of deficient work using methods approved by the Engineer. Removal shall be done in a manner that does not disturb work that meets Quality Control criteria; otherwise, the disturbed material shall also be removed and replaced. Replacement shall be done in accordance with the corresponding technical specifications.
3. Replacement will be subjected to the same scope of Quality Control as the original.
4. If the replacement work is not in accordance with the drawings and specifications, the replacement work will be removed, replaced, re-inspected, and re-tested. All this without claiming additional payments.
5. Every time a notice of a Defect/deficiency is given, correct the notified Defect within the length of time specified by the Engineer's notice. If not corrected within specified days, the Engineer may withhold the amount of 0.5% per day from the next payment certificate and continue to withhold this amount until the next payment after the date on which the correction has been done.

3.6.4 PREVENTIVE ACTION

1. Ensure to take preventive actions to eliminate the cause of a potential non-conformity. For example, defects that appear on the surface of concrete during construction or within a relatively short time after completion are usually caused by poor quality materials, improper mix design,

lack of proper placing and curing procedures, or poor workmanship. Take preventive actions as necessary to eliminate the causes of potential deficiencies so as to prevent their occurrence.

3.7 INSPECTION

Perform all the inspections and tests as prescribed in this document at own cost. Establish a program for inspection of activities affecting quality and cover all construction site and laboratory operations, including both onsite and offsite operations. Perform inspections to verify compliance with documented instructions, drawings, procedures, and specifications as required by the contract. Document all inspections as required by this document.

A four-phase inspection program shall be followed for each definable feature of the work.

The four phases of inspection are described in the following paragraphs.

3.7.1 PREPARATORY INSPECTION

1. Inform the Supervisor and together perform preparatory inspections prior to beginning any work on any definable feature of the work.
2. Submit all technical specifications of materials to be used for this project to the Supervisor for verification and approval.
3. Ensure that preparatory inspections include a review of contract requirements.
4. Ensure that all materials and /or equipment have been tested, submitted, and approved.
5. Ensure that provisions have been made to provide required testing.
6. Examine work area to ascertain that all preliminary work has been completed.
7. Examine materials, equipment, and samples to ensure that they conform to approved shop drawings or submittal data, that all materials and/or equipment are on hand, and that all monitoring and measuring equipment is properly calibrated and in proper working condition.

3.7.2 INITIAL INSPECTION

1. Inform the Supervisor and together perform an initial inspection as soon as a representative portion of the particular feature of work has been accomplished.
2. Examine the quality of workmanship.
3. Review control testing for compliance with contract requirements.
4. Review dimensional aspects of the work.

3.7.3 FOLLOW-UP INSPECTION

1. Inform the Supervisor and together perform follow-up inspections daily.
2. Ensure continuing compliance with Contract requirements.
3. Ensure continuing compliance with control testing until completion of particular feature of work.
4. Contractor Quality Control Manager records follow-up inspection in daily QC reports.
5. The Supervisor inspection staff records follow-up inspections in their daily inspection report.
6. Conduct final follow-up inspections and correct test deficiencies prior to the addition of new features of work.

3.7.4 COMPLETION INSPECTION

1. Inform the Supervisor and together perform a completion inspection of the work.
2. Develop a list of items that do not conform to the approved plans and specifications.
3. Include the list in the construction QC documentation, also include the estimated date by which the deficiencies will be corrected.
4. Perform a second completion inspection after the list items have been completed and the Supervisor has been notified.
5. The daily inspection reports shall identify inspections conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective action taken or proposed.

3.7.5 QC TESTING

1. As required by the contract specifications, establish a test program to ensure that all required testing is properly identified, planned, documented and performed under controlled and suitable environmental conditions, including cleanliness.

3.8 MATERIAL IDENTIFICATION AND TRACEABILITY

The Supervisor will monitor the process to ensure that identification and traceability requirements are met. Products and materials shall be traced from receipt through all project stages to installation. Documentation such as project control checklists, material receipts, material tracking forms, procedures, sample and test documentation, and reports will ensure that the applicable material item traceability is maintained. Project specifications and/or procedures define product identification and traceability requirements, which generally include the following:

- Materials or equipment intended for use in construction are identified and segregated until inspection confirms that they conform to technical and quality requirements, and
- Materials are traceable to documents attesting to their conformance with technical requirements that are stated in specifications or drawings. Testing of materials will also be conducted as necessary to verify conformance with material specifications.

3.9 DOCUMENTATION

Contractor's QC documentation must cover all aspects of QC program activities and includes Daily Inspection Reports and Daily Test Reports.

3.9.1 DAILY RECORD KEEPING

1. Sufficient records shall be prepared and maintained as work is performed to furnish documentary evidence of the quality of construction and laboratory analysis and of activities affecting quality.
2. Each contractor QC technician shall maintain a daily log of all inspections performed for both contractor and subcontractor operations on a form acceptable to the Supervisor.
3. Provide at least one copy of each daily inspection and test report on the workday following the day of record.

3.9.2 DAILY CONSTRUCTION REPORT

1. Keep note of daily progress of the project. The report will include a summary of the contractor's daily construction activities. Supporting inspection data sheets will be attached to the daily report where needed.
2. Submit a summary of construction reports to the Supervisor every 2 weeks.

3.9.3 INSPECTION AND TESTING REPORT FORMS

1. Report forms will be completed for inspections and tests conducted. The forms vary depending on inspection or test type. Representative forms for several types of inspection and testing reports are included in Appendix D.

These forms include:

- Description or title of the inspection activity
- Location of the inspection activity or location from which the sample was obtained
- Recorded observation or test data
- Results of the inspection activity
- Personnel involved in the inspection activity
- Signature of the inspector

3.9.4 RECORD DRAWINGS/AS-BUILT DRAWINGS

1. Contractors will submit draft record drawings to the Supervisor for review and prepare final record drawings based on Supervisor comments. The draft record drawings shall be submitted as a hard copy and a soft copy version.
2. At the end of the project a final as-built drawing must be submitted to the Supervisor in hard copy and soft copy (CAD Version)

3.9.5 CONTROL OF QUALITY RECORDS

Verify QA record accuracy and maintain copies of all quality-related documentation. This includes, but may not be limited to:

- Daily construction QA logs and records.
- Inspection checklists and reports.
- Surveillance reports.
- Non-conformance reports.
- Material receiving reports.
- Monitoring and test data.

3.10 FIELD REVISIONS

1. Field revisions for Quality Control will be done according to the Quality Control Schedule but is not limited to this.
2. The Contractor or Engineer may initiate revisions when it becomes apparent that the Quality Control Schedule is inadequate to support the work being carried out in accordance with the specified quality requirements or are deemed to be more excessive than required to support work being produced in conformance with the specified quality requirements.
3. Changes to the Quality Control Schedule may only be carried out after proper written approval from the Engineer.

4. SITE PREPARATION

1. This item of work shall consist of clearing the Site, undertaking general type of earthworks, setting out, etc. as shown on the Drawings, stated in the BOQ and/or as instructed by the Engineer.
2. Inform the Engineer at least 7 (seven) days written notice of his intention to commence work on any part of the Site. Works shall not be commenced until written approval has been received from the Engineer.
3. The works are to be carried out in accordance with the Drawings and as directed by the Engineer. It may become necessary or desirable, during the progress of the Work, to change any feature shown on the Drawings in accordance with the actual field conditions. Whenever this may occur, perform the required works to the revised dimensions in accordance with the written instructions of the Engineer.

4.1 SETTING OUT

1. Prior to the commencement of the Works, study the Drawings and fully understand all aspects of the Work and co-relate the same with the dimensions shown on the Structural Drawings and shall fix up the alignment, set the Benchmark pillars, levels, pegs etc.
2. Check all the vital measurements of the layout plan of the building/structure and submit a report to the Engineer the deviation, if required any from the dimensions shown in the approved Drawings for the building/structure before starting construction works. In case of any deviation of unacceptable amount, the Engineer will propose the remedial measures, which may be necessary under a particular situation.

4.2 EARTHWORKS GENERAL

1. Earthwork shall be undertaken to the lines and levels shown on the Drawings unless directed otherwise by the Engineer. In carrying out the earthworks, take all necessary precautions to avoid damage to or deterioration of the earthwork materials and existing ground.

4.3 TEMPORARY FENCE

1. This work consists of constructing, maintaining, and removing temporary fences, gates, and gateways as shown or directed.
2. Gates to the construction site shall be marked with sign boards.
3. The fences to be used shall be prefab steel wire mesh fences provided by non-see-through nettings.

4.4 CLEARING AND GRUBBING OF VEGETATION

1. This work shall include the removal from the work areas of all encroaching vegetation, trees, shrubs, grass and other undergrowth as designated by the Engineer. Clearance of vegetation

from shall be limited in general to a maximum dimension equal to the proposed construction area or as designated by the Engineer.

2. In areas designated by the Engineer, take responsibility to protect existing shrubs, trees and grassed surfaces. Upon completion of the Works these areas will be returned to the Client in the same condition as before and any damage due directly or indirectly to the Construction works operations shall be remedied at no additional cost to the Client.

5. DEMOLITION

This item of work shall consist of satisfactory dismantling, removal and disposal of salvage, wholly or in part, of all existing structures and sub-structures within the Site as indicated on the Drawings or in the BOQ and/or as instructed by the Engineer. This item of Work shall also include taking all safety and precautionary measures so as to protect the adjoining properties and the public from any possible accidents.

5.1 PLANNING

1. Engage one experienced Engineer who shall carry out a detailed survey work and a study of the structures to be demolished and the structures in their surroundings before commencing the demolition work. He shall then plan the sequence of operations. The plan shall be approved by the Engineer before any works starts.

5.2 PRECAUTIONS AND PROTECTION

1. Under all circumstances preserve and protect the adjoining plots, buildings or structures from any damages or injuries. This shall be done at his own expenses.
2. When damage to the adjoining property is imminent, the demolition operation shall be stopped forthwith and shall not be re-started until the necessary measures to prevent such damage have been taken.
3. Workmen shall be provided with all necessary safety appliances prior to the start of works. Safety precautions for fire shall be provided.
4. Take all suitable arrangements to control dust. He shall ensure necessary stacking of all materials and debris in a way as have been stated in the relevant Section/Sub-sections of this Specification.
5. Protect all existing features required during demolition operations with substantial covering to the entire satisfaction of the rules and regulations of the undertakings or they shall be temporarily relocated.

5.3 PERFORMANCE METHODS

1. The structure may only be demolished after approval of the Engineer.
2. Heavy equipment shall be used to break down the structure and cut of all necessary reinforcement.
3. All materials so removed/salvaged shall be the property of the Employer unless otherwise specifically stated in the Contract. Any materials, not required by the Employer, shall be classed as waste.

5.4 DISPOSAL AREA

1. All waste materials shall be disposed of in own areas provided by the Contractor or client and approved by the Engineer within a radius of 10km
2. Materials may be disposed of on private property, provided the Engineer is furnished with a written statement from the owner of the property giving permission for the disposal of the materials there.
3. Any material designated to remain the property of the Client will stacked in neat piles at the designated storage area.

5.5 OWNERSHIP OF MATERIALS

1. All removed materials shall remain the property of the Client unless instructions are issued to dispose them.
2. Neatly store all re-usable materials at area designated by the Client or Engineer.

6. EARTHWORKS

This work shall consist of filling any place by furnishing, placing, compacting and shaping suitable earth material of acceptable quality obtained from approved sources to make up levels to the lines, levels, grades, dimensions and cross sections in accordance with these specifications and as shown on the Drawings and/or as instructed by the Engineer.

6.1 MATERIALS

1. All fill materials shall be free from roots, sods or other deleterious materials.
2. All fill materials shall be stockpiled outside the working areas. Materials shall be tested and submit results to the Engineer for approval. The test to be performed are the Density test (modified proctor tests) and Sieve analyses.
3. Inform the Engineer prior to perform the tests to make sure it is witnessed and approved.
4. The dry density after compaction in layers more than 300mm below top level shall not be less than 98% of the maximum dry density.
5. Field density tests to be done by Nuclear or Electrical density gauge.
6. The dry density after compaction within 300mm below the top level (or such greater depth if shown on the plans and drawings) shall not be less than 100% maximum dry density.

6.2 EXCAVATION AND BACKFILL

1. This item of work shall consist of excavation in any type of soil/material for the foundation of structures, disposal of excavated materials, construction and removal of cofferdams, sheeting and other temporary works in protecting the stability and safety of the excavated foundations, pumping, de-watering/bailing water from foundations, back-filling of completed structures with suitable back-fill.
2. No separate payment shall be made for the excavation and back-fill for structures when the works will involve use of cofferdams. The costs of this temporary work shall be deemed included as part of the Tender sum.
3. The Work shall be carried out at the locations and according to the lines, levels, grades and dimensions shown on the Drawings.
4. The Engineer shall classify all excavated materials either as suitable for fill or as waste.

6.2.1 EXCAVATION

1. Notify the Engineer before commencing excavation of the foundation trenches so that the cross-section, elevations and measurements of the undisturbed ground may be taken. The natural ground adjacent to the structure shall not be disturbed without taking any permission from the Engineer.
2. Prior to any excavations make sure to obtain information of any underground cables and lines in specific area. Dig trial trenches prior any excavations works are carried out to prevent damage of underground lines.

3. Trenches and foundation pits for structures shall be excavated to the lines, grades and elevations as shown on the Drawings or as directed by the Engineer. The elevations of the bottom of the foundations shown on the Drawings are approximate only and the Engineer may order such changes as deemed necessary to provide a secured foundation.
4. Where unstable soil is encountered at the bed level, it should be brought to the notice of the Engineer and all such unstable soil shall be removed as directed and replaced with suitable materials to provide adequate support for the structure.
5. On acceptance of the materials forming the bottom of any excavation by the Engineer subsequently becoming unacceptable to him due to exposure to weather condition or due to flooding or have become puddled, soft or loose during the work process, remove such damaged, soft, or loose materials and make additional excavation as per requirement. Such additional excavation shall be held as excess excavation and the cost of the excess excavation and subsequent replacement with a suitable back-fill shall be at own expenses.
6. Any erroneous excavation or excess excavation for own conveniences, or over excavation performed for any purpose or reasons shall be at own expenses. If the excavation for foundations exceeds the depths specified, bring it back to the specified levels with sand, mass concrete or other approved materials conforming Standard Specifications at own expenses.
7. Excavation shall be sufficiently large to provide necessary working space, shuttering and any other Temporary Works required during construction.
8. Boulders, roots and any other objectionable materials encountered in excavation, shall be removed. The excavated foundation shall be cleared of all loose materials and cut to a firm surface.
9. When the footing is to rest on the ground and not on piles, special cares shall be taken not to disturb the bottom of the excavation and excavation to final grade shall be deferred until immediately before the footing is placed. If foundation fill material is required, it shall be placed and compacted in layers not more than 150mm thick or as directed by the Engineer. The dry density on compaction within 300mm below the top level shall not be less than 100% of the laboratory modified proctor test.
10. Density tests shall be done by the nuclear density gauge or the electrical density gauge. Both shall be operated by trained and skilled personal.
11. In excavating foundation trenches, the last 150mm layer shall not be excavated until immediately before commencing the construction work except that the Engineer shall instruct otherwise. Any damages to the work due to the operation shall be repaired at own expenses.
12. Take full responsibility for the safety and stability of the excavation and provide all protective supports, bracing, sheet piles, shoring etc. as required. Shoring should be adequate to provide enough safety to all the adjacent structures and land.
13. Excavated materials, classified as suitable for fill, shall be stockpiled. Waste materials and suitable fill materials in excess of requirement, shall be disposed of outside the limits of the Site.
14. The foundation material shall be cleared of all loose and displaced materials and cut to a firm surface, either leveled, stepped or serrated, as specified or shown on the Drawing or directed by the Engineer leaving a smooth solid bed to receive foundation.
15. No footing, bedding material or structure shall be placed on any foundation until the Engineer has inspected and approved the depth of excavation and the foundation materials.

6.2.2 POOR FOUNDATION MATERIAL

1. When, in the opinion of the Engineer, the bottom of any excavated foundation is of soft or otherwise unsuitable material, he can instruct to remove the unsuitable material and fill with sand or blinding concrete at the direction of the Engineer. The sand or concrete shall be placed following specified procedures

6.2.3 DISPOSAL OF EXCAVATED MATERIAL

1. All excavated materials, so far accepted by the Engineer as suitable, shall be utilized as back-fill or embankment-fill. The surplus materials shall be termed as waste.
2. Excavated materials, suitable for use as back-fill, shall be deposited in spoil heaps at points convenient for re-handling of the materials during the back-filling operations.
3. Excavated materials shall be deposited in such places and in such a manner as not to cause damage to roads, services or properties either within or outside the project area and so as to cause no impediment to the drainage of the Site or surrounding areas. The location of spoil heaps shall be subject to the approval of the Engineer.
4. Waste materials shall be disposed of in accordance with the instruction of the Engineer.
5. Any surplus materials shall remain the property of the Client and will be disposed or stored at an area designated by the Client or Engineer within a radius of 10km.

6.2.4 BACK-FILLING

1. All excavated spaces shall be backfilled around the permanent structure to original ground level. Prior to placing back-fill, all trash, metal, debris, lumber, bricks, soft materials and similar objectionable foreign materials shall be removed from the area to be back-filled. No back-fill shall be placed against any structure without the prior permission of the Engineer.
2. Any protective support, bracing or shoring shall be removed, as the back-filling progresses in such a manner as to prevent caving-in.
3. Back-fill shall be of approved materials that will produce a dense and well-compacted filling. The material shall be free from large lumps, organic or extraneous materials.
4. Ordinary fill placed as back-fill shall be laid and compacted. The moisture content of the fill materials, before compaction, shall be within + 5% of the Optimum Moisture Content. Each layer of materials shall be compacted uniformly using approved compaction equipment and procedures. The materials shall be compacted to achieve not less than 98% of the laboratory modified proctor density as determined by AASHTO T180. The dry density, after compaction within 300mm below the top level, shall not be less than 100% laboratory modified proctor density. The compacted layer shall be approved by the Engineer before starting with a new layer.
5. Layers of filling shall be tested as directed by the Engineer. Each compacted layer shall not be covered until the Engineer is satisfied that the specified degree of compaction has been achieved.
6. If, following approval by the Engineer, a Nuclear Density Gauge is used, the in place density of each layer shall be determined as specified by the ASTM Standards D2922, D 3017 and/or C1040 at least 100% of the maximum modified proctor density as determined by AASHTO T 99, Method C.

7. In placing back-fill, the materials shall be placed in, as far as possible, to approximately the same height on each side of the structure. If conditions require appreciable higher back-filling on one side, the additional materials shall not be placed until permission is given by the Engineer on being satisfied by himself that the structure has enough strength to withstand any created pressure.
8. Adequate provisions shall be made for drainage during back fill operations.

6.3 CONSTRUCTION METHOD

Spreading and compaction of earth fill

1. Earth carried from outside shall be placed on the land to be developed in horizontal layers and each layer shall not exceed a loose thickness that is required to obtain a compacted thickness of 200mm. The earth of each basket is to be placed near to the earth placed before it and spread systematically. Throwing earth in heaps is not allowed.
2. The materials to be compacted shall be deposited in horizontal layers on the land to be developed with a loose thickness as stated above. The clods of earth shall be broken down to a maximum size of 25mm by striking the clods with the back of a spade or by using wooden drag or ladder or by any other suitable means before the next basket of earth is thrown close to it. Distribution of materials shall be made in such a way that the compacted materials will become homogeneous and free from lenses, pockets, streaks or other imperfections. Excavating and placing operations shall be such that the materials, when compacted, will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability and for this purpose the preceding compacted layer shall be scarified before placing a new layer.
3. All fill materials shall generally be compacted mechanically. However, under some special circumstance and when specifically allowed under the BOQ, the fill may be allowed to be compacted manually.
4. If the density measurement checks fall below the specified density level, re-compacting shall be required.
5. Earth fill materials, which does not contain sufficient moisture requirement for compaction in accordance with the requirements of this Sub-section shall be reworked and watered as per direction of the Engineer. The works shall be done at own expenses.
6. Earth fill materials containing excess moisture shall be reworked and dried prior to or during compaction. Propose methods for drying of wet materials at own expense to be approved by the Engineer.
7. Compaction of every layer shall have to be approved by the Engineer. In the event of failing to obtain the approval of the Engineer of a fill layer, the materials above the unsatisfactory layer shall be removed and the unsatisfactory layer shall be re-compacted to satisfy the specifications at own expenses.
8. Compaction shall be done by the terms in the method statement submitted to the Engineer and approved.

7. DRAINAGE WORKS

The works to be performed under this section include but is not limited to the furnishing and installing of all drainage works consisting of culverts, siphon and rainwater drainage, in the kinds, sizes, and lengths and at the locations shown in the technical drawings.

7.1 MATERIALS

1. All materials shall be of new stock and of the best commercial quality for the indicated purpose. Materials and strength shall be as specified for the particular kind of pipe and fittings required.
2. Use flexible elastomeric gasket joints on all pipes and fittings. Furnish caps or plugs with each fitting, outlet or stub as required, with the same type gasket or joint as the pipe.
3. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered.
4. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.
5. Cap or plug all fittings and provide gaskets of the same material as used in the pipe joint. Fit with an approved mechanical stopper or install an integrally cast knockout plug. The cap or plug shall be capable of withstanding test pressures without leaking and, when later removed, shall permit continuation of piping with jointing similar to joints in the installed line.
6. Pipe Anchors - Use pipe anchors conforming to the Standard Drawings and as shown. Metal bands shall conform to the material Specifications for the metal pipe to which they are attached.

7.2 PVC PIPE

7.2.1 DESCRIPTION

This item shall govern for furnishing and placing of PVC pipe as shown in the drawings.

7.2.2 MATERIALS

1. The polyethylene pipe and fittings shall conform to the requirements of ASTM D2241.
Bedding and Structural backfill shall meet the requirements of AASHTO M145, and the requirements of this Specification.

7.2.3 JOINTS

1. The joints shall be watertight and shall incorporate a bell and spigot connection with rubber gasket to ASTM F-477.

7.2.4 INSTALLATION

1. The PVC pipe shall be installed in accordance with the manufacturer's instructions.
Foundation and bedding shall be carried out in accordance with the requirements of this Specification.
A minimum depth of cover shall be maintained above the pipe before allowing vehicles to traverse the pipe trench. The minimum depth of cover shall be to the approval of the Engineer.

8. FORMWORK

8.1 DESCRIPTION

1. This section covers the design, supply and erection of all falsework and formwork used in the construction of permanent work.
2. This section also describes the classes of concrete surface finishes on formed and unformed concrete surfaces.

8.2 MATERIALS

1. Formwork shall be constructed from sound materials of sufficient strength, properly braced, strutted and shored as to ensure rigidity throughout the placing and compaction of the concrete without visible deflection. The materials used need be of "betonplex" and wood and shall be mortar tight.
2. Formwork shall be so constructed that it can be removed without shock or vibration to the concrete. Where timber is used, it shall be well seasoned, free from loose knots, projecting nails, splits or other
3. Form ties shall be prefabricated rod, flat band, or wire type, or threaded internal disconnected type, of sufficient tensile capacity to resist all imposed load of freshly placed concrete and having external holding devices of adequate bearing area. Ties shall permit tightening and spreading of forms and shall leave no metal closer than 25mm from surface.
4. Ties shall fit tight to prevent mortar leakage at holes in forms. Removable ties shall be coated with non-staining bond breaker. All ties shall be protected from rusting at all times. No wire ties or wood spreaders shall be permitted. Cutting ties back from concrete face will not be permitted.
5. Wooden fillets used to form chamfers and recesses on exposed surfaces shall be of new material.

8.3 CONSTRUCTION METHOD

1. Submit for the approval of the Engineer details of the methods and materials proposed for formwork to each section of the Work (werktekening van de bekisting). Details of all proposed wrought formwork and formwork to produce special finishes are to be submitted for approval in writing to the Engineer before any material is hauled at Site. If the Engineer so requires, samples of formwork shall be constructed, and concrete be placed so that the proposed methods and finish effect can be demonstrated.
2. All joints shall be sealed with appropriate silicone to prevent leakage of grout. At construction joints the formwork shall be tightly secured against previously cast or hardened concrete in order to prevent stepping or ridges to exposed surfaces.
3. Where proposed to make the formwork from standard sized manufactured formwork panels, the dimensions of such panels shall be approved by the Engineer before they are used for construction of the Work.
4. The finished appearance of the entire elevation of the structure and the adjoining structures shall be considered when planning the patterns of joint lines caused by the formwork and by construction joints to ensure continuity of horizontal and vertical lines.

5. Formwork shall be constructed to provide the correct shape, lines and dimensions of the concrete shown on the Drawings. Due allowance shall be made for any deflection, which will occur during the placing of concrete within the formwork. Panels shall have true edges to permit accurate alignment and provide a neat line with adjacent panels and at all construction joints. All panels shall be fixed with their joints either vertical or horizontal, unless otherwise specified or approved.
6. Formwork shall be provided for the top surfaces of sloping work where the slope exceeds 15° with the horizontal and shall be anchored to enable the concrete to be properly compacted and prevent floating.
7. Care shall be taken to prevent air being entrapped. Openings for inspection of the inside of the formwork and for the removal of water used for washing shall be provided and so formed as to be easily closed before placing concrete.

8.3.1 FORMWORK FOR EXPOSED SURFACES

1. All exposed concrete surfaces are to be 'form finish' and shall be cast in betonplex formwork and shall be free from honeycomb, fins, projections and air holes. All external angles to form finish concrete surfaces shall be chamfered as directed.
2. Forms for concrete surfaces exposed to view shall produce a smooth surface of uniform texture and color.
3. Panels lining such forms shall be arranged so that the joint lines form a symmetrical pattern conforming to the general lines of the structure.
4. The same type of form lining material shall be used throughout each element of a structure. Such forms shall be sufficiently rigid so that the undulation of the concrete surface shall not exceed 3mm when checked with a 1.5m long straight edge or template.
5. Submit shuttering Drawings and details of pattern and the method of forming joints in the exposed (form finish) concrete to the Engineer for his approval. All changes and modification made by the later shall be appropriately incorporated by the former and final approval whereof be obtained from the Engineer.
6. Unless otherwise stated on the Drawings, wrought formwork shall be used for all permanently visible concrete surfaces. Wrought formwork shall be such as to produce a smooth and even surface free from perceptible irregularities. Tongues and grooved paneled boards, plywood or steel forms shall have their joints flushed with the surface.
7. The formwork shall be formed with approved standard size panels. The panels shall be arranged in a uniform approved pattern, free from defects likely to be detected in the resulting concrete surface.
8. In all types of formworks to form finished exposed concrete, only non-staining mold oil shall be used as approved by the Engineer.
9. The respective usage of the same formwork to cast form-finished exposed concrete shall be as decided by the Engineer and in no case the formwork, not guaranteed to produce the required form-finish to the satisfaction of the Engineer, shall be used.
10. The exposed concrete shall have a uniform finish. The finish of the concrete when shuttering and formwork are removed will generally be without any blemish and will be such as will not require touch up.
11. Slight touch up for a small spot or two, if necessary, shall be carried out skillfully so as to be synonymous with the entire surfaces.

12. The finished surfaces shall be within the specified tolerances and full cover to the reinforcement steel shall be maintained.

8.3.2 FORMWORK FOR NON-EXPOSED CONCRETE SURFACES

1. Rough formwork may be used for all surfaces, which are not permanently exposed. Rough formwork may be constructed of plain butt-joined sawn timber but ensure that all joints between boards shall be grout-tight.
2. The finished surfaces shall be within the specified tolerances and full cover to the reinforcement steel shall be maintained.

8.3.3 FORMED SURFACES AND FINISH

1. The formwork shall be lined with a material approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so joined and fixed to its backing as not to impart any blemish.
2. It shall be of the same type and obtained from only one source throughout the construction of any individual structure. Make good any imperfection in the finish as required by the Engineer. Internal ties and embedded metal parts will be allowed only with the specific approval of the Engineer.

8.3.4 TOLERANCES

1. The formwork shall be made so as to produce a finished concrete true to shape, lines, levels, plumb and dimensions as shown on the Drawings subject to the following tolerances unless otherwise specified in this document or Drawings or as directed by the Engineer.
 - Sectional dimension ± 5 mm
 - Plumb ± 1 in 1000 of height
 - Levels ± 3 mm before any deflection has been taken place
2. Tolerances given above are specified for local deviations in the finished concrete surface and should not be taken as tolerance for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Errors, if noticed in any lift/tilt of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

8.3.5 PREPARATION OF FORMWORK

1. The formwork shall be arranged in a manner as to readily be dismantled and removed from the cast concrete without shock, disturbance or damage. Where necessary, the formwork shall be so arranged that the soffit form, properly supported on props only, can be retained in position for such period as may be required by maturing conditions or Specification.
2. The surfaces of formwork shall be free from foreign matters, projecting nails and the like, splits or other defects, and all formwork shall be cleaned and made free from standing water, dirt, shavings, chippings or other foreign matter before concrete is placed.
3. Before placing concrete, all built-in reinforcement bars, anchoring, steel beams, cables, fixing truss, bolts, pipes or conduits or any other fixtures shall be fixed in their correct positions. The cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without the approval of the Engineer. All

exterior and interior angles on the finished concrete of 90° or less shall be given 12mm – 20mm chamfers unless otherwise shown on the Drawings or directed by the Engineer.

4. When chamfers are to be formed, the fillets shall be accurately cut to size to provide a smooth and continuous chamfer.
5. No ties or bolts or other devices shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer. The whole or part of any such support embedded in the Reinforced Concrete shall be capable of removal so that no part, remaining embedded in the concrete, shall be nearer than 75mm from the surface. Holes left after removal of such supports shall be neatly filled with well-reamed dry-pack mortar following the procedures described in the relevant Sub-section of this Specification.
6. All rubbish shall be removed from the interior of the forms before the concrete is placed. After cleaning and prior to placement of reinforcing steel, the formwork in contact with the concrete shall be treated with a suitable non-staining mold oil or suitable approved release agent to prevent sticking of the concrete.
7. Such works shall not discolor or otherwise injure the surface of the concrete. Care shall be taken to prevent the oil from coming in contact with the reinforcement or mixing with the concrete. At construction joints, surface-retarding agents shall be used only where ordered by the Engineer.
8. All formwork shall be inspected and approved by the Engineer before concrete is placed in it. However, this does not relieve from the requirements as to soundness, finish and tolerances of the concrete specified in this Specification or elsewhere acknowledged as Standard.
9. If, at any period of the work during or after placing the concrete, the forms show signs of sagging or bulging, the concrete shall be removed to the extent directed by the Engineer, the forms brought to the proper position and new concrete placed. No allowance shall be made for such extra works.

8.4 WOODEN FORMWORK PARTS

1. The Contractor must apply new or intact concrete plywood, i.e. plasticized plywood, for all the concrete work to be delivered clean from the formwork indicated on the drawing, for the approval of the Project Manager.
2. Completely update the starting seams of the formwork before pouring to the satisfaction of the Project Manager. Any pouring seams should be determined in consultation with the Project Manager.
3. Install the necessary water holes, chamfered edges, etc. in the concrete work as indicated on the drawing or on the instructions of the Project Manager.
4. Formwork and support structures must be sufficiently rigid and stable to withstand their own weight, payloads and all other forces to which they are subjected during the execution of the work, in particular those caused by the pouring and compaction of the concrete, without subsidence or deformation.
5. Execution: all concrete structures are formed with wooden parts.
6. Dimensions (mm): according to the dimensions of the parts to be poured as shown on the drawing.

7. Accessories: sufficient bracing.

8.4.1 PARTS TO BE FORMED

- Both sides of the strips of foundation
- The edge joists and floor joists to be poured in the work
- The foundation piles and columns to be poured in the work
- The roof beams to be poured in situ
- At the location of recesses
- The concrete roofs, gutters and platform for air conditioning, water storage and gen house
- Other parts resulting from the work

8.4.2 REMOVAL OF FORMWORKS

1. Forms shall not be removed without the approval of the Engineer. In the determination of the time for the removal of forms, consideration shall be given to the location and character of the structure, the weather, the materials used in the mix and other conditions influencing the early strength of the concrete. Extreme care shall be taken to ensure that the method of removal shall not cause overstressing of the concrete or damage to its surface.
2. Forms shall be removed in such a manner as to permit the structure to uniformly and gradually take the stresses due to its own weight as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
3. Forms shall not be removed in the cases of footing forms where the removal would endanger the safety of the cofferdams, forms from enclosed cells where access is not provided, deck forms in the cells that do not interfere with the future installation of utilities shown on the Drawings, or other works.
4. Except for concrete being post-tensioned, no concrete shall be subjected to loading which will induce a compressive stress in it exceeding one-third of its compressive strength at the time of loading, or one third of the specified characteristic strength whichever is less. It may be possible to use shorter periods before striking forms by determining the strength of the concrete in the structural element.
5. Forms on upper sloping faces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any repair or treatment required on such sloping surfaces shall be performed at once.
6. If the floor is to be used to support construction loads, props should be retained for 28 days unless the requisite concrete strength can be proven to the Engineer.
7. The form shall be removed slowly, as the sudden removal of wedges is equivalent to a shock load on the partly hardened concrete.
8. Materials and plants shall not be stacked on any newly constructed floor unless sufficient support is maintained to withstand such loads without damaging the floor.
9. The following table is a guide to the minimum periods that must elapse between the completion of the concreting operations and the removal of formwork. No formwork shall be removed

without the permission of the Engineer and such permission shall not relieve the responsibilities regarding the safety of the structure.

Type and position of formwork	Approximate period (days)
Side of beams, walls and columns (unloaded)	5
Slab soffits (props supporting)	14
Removal of props to slabs	21
Beam soffits (props supporting)	21
Removal of props to beams	28

- Notwithstanding the foregoing, any damages arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading shall be repaired/reconstructed at own expense.

8.4.3 DEFECTS IN FORMED SURFACES

- Workmanship in formwork along with concrete placing shall be such that concrete shall normally require no repair to surfaces being perfectly compacted and smooth.
- If any blemish is revealed after removal of formwork, obtain immediate Engineer's decision concerning remedial measures to be undertaken. Such measures may include but shall not be limited to the following:
- Fins, pinholes, bubbles, surface discoloring and mirror defects may be rubbed down with sacks immediately on removal of the form.
- Abrupt and gradual irregularities may be rubbed down with carborundum stone and water after concrete has been fully cured.
- Deep honeycombed concrete shall be repaired within 24 hours of striking the formwork by cutting back to sound concrete. The concrete shall be cut back at least 50mm behind face reinforcement. Cut edges shall be regular and not feathered. Recasting shall be with the same concrete as the original casting. The Engineer shall approve the formwork and its method of placing in this case also.
- Under some circumstances, abrupt and gradual irregularities of shallow honeycombed concrete may be repaired by cutting back and reforming with an approved epoxy resin or mortar in accordance with the manufacturer's instructions.
- Regardless of the above repairing measures, any structure containing excessive honeycomb, as would be termed by the Engineer, shall be subject to rejection by the Engineer. On receipt of written orders from the Engineer, remove and rebuild such portions of the structure at own expenses.

8.4.4 HOLES TO BE FILLED

- Holes on the concrete surfaces formed by formwork supports or the like shall be filled with dry pack mortar made from one part by weight of ordinary Portland cement and three parts of specified fine aggregate approved by the Engineer. The mortar shall be mixed with sufficient water only to make the materials stick together when being molded in the hands. All construction materials shall conform to the requirements as described previously and under the relevant Sub-sections of the Section on 'Construction Materials' of this Specification.

-
2. Thoroughly clean any hole that is to be filled and break out any loose, broken or cracked concrete or aggregate and remove any dry cement from the hole. The surrounding concrete shall be soaked until the whole surface that will come into contact with the dry pack mortar has been covered and darkened by absorption of the free water by the cement. The surface shall then be dried so as to leave a small amount of free water on it.
 3. The dry pack material shall then be placed and packed in layers having a compacted thickness of not more than 10mm. Compaction shall be carried out by using a hardwood stick and a hammer and shall extend over the full area of the layer. Special cares should be taken to compact the dry pack against the sides of the holes.
 4. After compaction, the surface of each layer shall be scratched before further loose material is added. The holes shall be slightly overfilled. The surface shall be finished by laying a hardwood block against the dry pack fill and striking the block several times.

9. REINFORCING STEEL

9.1 DESCRIPTION

1. Works covered by this item shall consist of supplying and placing of steel reinforcement in the different types of concrete structures.
2. The works shall conform to the specifications, the types, sizes and positions of reinforcement requirements shown on the Drawings and this specification.
3. The engineer may require submission of a bar bending schedule for approval.

9.2 MATERIALS

Steel reinforcement

1. Reinforcing bars shall comply with NEN 6008:2008
2. Steel fabric reinforcement shall comply with EUROCODE 2.

Mechanical couplers

1. Mechanical couplers may only be used with the approval of the Engineer.

Binding wire

1. Reinforcement binding wire shall be the best black annealed mild steel wire and not less than 1.6mm in diameter in approximation.

Concrete cover blocks

1. In case of fabricating own concrete cover blocks, it shall be made of concrete having 1 part cement, 1 part sand and 2-part coarse aggregate. The blocks would be cast in mold and continuously cured for 21 days before use. Wire shall be cast in the block for the purpose of tying it to the reinforcement. The wire must not be closer than 30mm from the concrete surface. The use of small stones or wood blocks shall not be permitted.

9.3 STORAGE AND CARE

1. All reinforcing steel when received at the Site, prior to its use, shall be stacked off the ground on platforms, skids or any other support and shall be kept free from dirt, oil and grease. All cares shall be taken to prevent the steel reinforcement from any mechanical injury and surface loss resulting from its exposition to weather conditions that produce rust. It shall be clean and kept free from loose rust and loose mill scale at the time of fixing in position and subsequent pouring of concrete.
2. Reinforcement shall be handled and stored in a manner that will prevent bending out of the desired shape and any accumulation of dirt, oil and paint. When placed in the works, it shall be free from dirt, oil, grease, paint, mill scale and loose or thick rust.

9.4 CUTTING AND BENDING

1. All reinforcement bars shall be cut and bent cold to the specified shape and pertinent dimensions shown on the Drawings using a proper bar bender, operated by hand or power to attain proper radius of bends.
2. The equipment used and methods followed for this purpose shall get the approval of the Engineer.
3. Bars shall not be bent or straightened in a manner that will injure the material. Bars partially embedded in concrete shall not be field bent unless otherwise shown on the Drawings or directed by the Engineer.
4. Take responsibility for the accuracy of cutting, bending and placing of the reinforcement.
5. No flame-cutting of high tensile steel bars shall be permitted except with the approval of the Engineer.
6. Except as provided for below, all bars shall be bent cold and bending shall be done slowly, a steady, even pressure being used without jerk or impact.
7. If approved, hot bending of bars of at least 32 mm diameter will be permitted, provided that the bars do not depend for their strength on cold working. When hot bending is approved, the bars shall be heated slowly to a cherry red heat (not above 840°C) and after bending shall be allowed to cool slowly in air. Quenching with water shall not be permitted.
8. Reinforcing bars that have already been bent shall not be re-bent at the location of the original bend without the permission of the Engineer.

Minimum diameters of Bend

Bar size	Minimum diameter of bend
$10\text{mm} \leq d_b \leq 25\text{mm}$	$6d_b$
$25\text{mm} < d_b \leq 40\text{mm}$	$8d_b$
$40\text{mm} < d_b \leq 55\text{mm}$	$10d_b$

* d_b is the nominal diameter of bar, mm

9.5 PLACING AND FIXING

1. Errors in alignment of reinforcement partially embedded in hardened concrete shall not be corrected by bending in place, except as permitted by the Engineer.
2. Before the reinforcement is placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy rust, loose mill scale, dirt, grease and other objectionable foreign substances.
3. Reinforcement shall be accurately placed in the position shown on the Drawings and/or as directed by the Engineer and shall be securely held by blocking against the forms, by supporting on concrete or approved metal or plastic chairs.
4. Bars shall be tied at all intersections except where spacing is less than 300mm in any direction when alternate intersections shall be tied.

9.6 SURFACE CONDITION

1. After being placed, the reinforcing bars shall be maintained in a clean condition, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance, until they are completely embedded in the concrete.
2. Heavy flaky rust, which can be removed in firm rubbing with hessian or equivalent treatment, shall be considered objectionable.

9.7 COVER

1. The term "cover" in this context shall mean the minimum clear thickness of concrete between the surface of the reinforcement and face of the concrete.
2. The minimum cover shall be as shown on the Drawings. Where no cover is indicated, the minimum thickness provided shall be not less than the appropriate values shown in table 3.1.
3. Reinforcement supports shall be strong enough to withstand the imposed loads without movement of the reinforcement. They shall be positively attached to the reinforcement and of such size and number as to maintain the specified cover.
4. The cover shall be increased by the expected depth of any surface treatment, e.g., when concrete is bush hammered or when rebates are provided.
5. Additional cover as directed by the Engineer shall be provided if porous aggregates are used.

9.8 LAPS AND JOINTS

1. Welding of crossing bars shall not be permitted for assembly of reinforcement unless authorized by the Engineer.
2. Platforms for the support of workers and equipment and machines shall be placed directly on the forms without any disturbance of the reinforcing steel during concrete placement.
3. Laps, joints, splices and mechanical couplings shall be made only by the methods specified and at the positions shown on the Drawings or as agreed to by the Engineer.

9.9 SPACING OF REINFORCEMENT

1. The minimum clear spacing between parallel bars in a layer shall be equal to one bar diameter, but not less than 25mm.
2. Where parallel reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above those in the bottom layer with clear distance between layers not less than 25mm.
3. For compression members, the clear distance between longitudinal bars shall be not less than 1.5 bar diameters or 35mm.
4. There shall be a clear distance of at least 25mm between the bars and any adjacent embedded metal works. Ensure that there is no disturbance of the reinforcing bars in concrete that has already been placed.

9.10 SPLICING

1. All reinforcement shall be furnished in the full lengths indicated on the Drawings unless otherwise permitted by the Engineer.
2. Where the Drawings do not detail laps that will be necessary, furnish working Drawings to the Engineer for his approval. If such additional lap splices are approved, the extra weight occasioned by such lap splices shall not be included in the measurement of reinforcement for payment unless provided for in these Specifications.
3. All splices for mild steel shall have a lap length as shown on the Drawings or if not shown therein, of not less than 47x diameters of the smaller bar.
4. Lap splices of bundled bars shall be based on the lap splice length required for individual bars within the bundle, increased in accordance with development of bundled bars. Individual bar splices within a bundle shall not overlap. Entire bundles shall not be lap spliced.

9.11 PLACING AND FIXING

1. Reinforcement shall be positioned as shown on the Drawings and accurately secured in these positions within the tolerance given in Subclause 10.03(f) by tying with 1.6- or 1.25-mm diameter galvanized annealed wire or by the use of suitable clips or, where permitted by the Engineer, by tack welding.
2. Spacers shall be proprietary plastic spacers to the approval of the Engineer. Concrete or steel spacer blocks are not permitted.
3. Projecting ends of ties or clips shall not encroach into the concrete cover.
4. Where protruding bars are exposed to the elements for an indefinite period the bars shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.
5. In members that are formed with sliding formwork, spacer "ladders" for the placing and fixing of the wall reinforcement shall be used at intervals indicated on the Drawings or as directed by the Engineer. The ladders shall consist of two 3.7 m long bars with lateral ties of 4 mm diameter welded to them in the form of a ladder. The ties shall be spaced at multiples of horizontal bar spacing in the wall and be used to secure the horizontal reinforcement. The laps in the horizontal reinforcement shall be staggered to ensure that no part of two laps in any four consecutive layers lie in the same vertical plane.

9.12 SUBSTITUTIONS

1. Substitutions of different size bars shall be permitted only with specific authorization by the Engineer and at no additional cost to the Employer. If bars are substituted, they shall have a cross-sectional area equivalent to the design area or larger.
2. Provide, in case of substitutions, at own expenses and to the approval of the Engineer, such necessary detailing of the reinforcement as required for the execution of the work to the Engineer's satisfaction.

9.13 INSPECTION

1. Notify the Engineer when the steel has been placed in position and ready for concrete placing. No concrete shall be placed until the Engineer inspected the steel and given his approval in writing.
2. Reinforcement will be inspected for compliance with the requirements as to grade, size, shape, length, splicing locations, overlapping length and position after it has been placed.
3. Before any steel reinforcement is embedded in the concrete, any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete, which may adhere to the exposed bars during concrete placing operations, shall also be removed.

9.14 WELDING

1. Welding of reinforcement shall only be carried out where shown on the Drawings or agreed to by the Engineer.
2. Flash butt welding shall only be carried out with the combination of flashings; heating, upsetting and annealing to the Engineer's approval, and only those machines that automatically control this cycle of operations shall be used.
3. Metal-arc welding of reinforcement shall be carried out in accordance with BS5135 and the recommendations of the reinforcement manufacturer subject to the approval of the Engineer and the satisfactory performance of trial joints.
4. Other methods of welding e.g. resistance welding may be used subject to the approval of the Engineer and to their satisfactory performance of trial joints.
5. Welded joints shall be full strength welds, and their strength shall be the assessed by tests to destruction on samples selected by the Engineer.

9.15 TOLERANCES

Except for the requirements given hereunder no tolerances are given for the placing and fixing of reinforcing steel. Steel shall, however, be neatly and accurately fixed in a manner that is consistent with proper workmanship and the structural integrity of the member. Specifically, the following requirements shall apply:

- *Tension steel*

The actual position of tension steel shall not deviate from the true position by an amount that would reduce the effective lever arm by more than 2% of the overall depth of the member or 10 mm, whichever is the greater.

- *Concrete cover*

The concrete cover on reinforcing steel shall nowhere be less than the specified cover.

- *Spacing between bars*

The spacing between closely spaced parallel bars, especially in beams and columns, shall, unless otherwise detailed, be not less than 1.25 times maximum size of aggregate used in the concrete.

- *Bending of reinforcement*

The requirements of BS 4466 regarding dimensional tolerances for the cutting and bending of reinforcing steel shall apply with the provision that the other requirements stated in this clause must be met even if the tolerances in BS 4466 are not exceeded.

10. CONCRETE

Concrete for construction C20/25 or as specified in the drawings.

Concrete for blinding floors C12/15 (werkvloer beton)

Concrete for small works shall be mixed at site with permission of the Engineer.

10.1 GENERAL

1. The Contractor must provide the following information to the Project Manager:
 - Strength data of the mortar in accordance with (NEN 3502)
 - Proof of origin
 - Pouring slips from the concrete supplier
2. Portland cement class A to be used for the concrete work, which complies with NEN 3550 or equivalent.
3. During pouring operations, the Contractor shall produce a number of test cubes specified by the Project Manager. These test cubes shall be kept under the same conditions as the concrete of the component in question until such time as they are tested in a laboratory to be approved by the Project Manager. The results of the tests carried out by the laboratory should be submitted to the Project Manager in duplicate within two to three days.
4. The Contractor should assume that at least 6 cubes will be made per pouring part. The costs for the manufacture, testing and transport of the test cubes and any other tests to check the concrete quality shall be borne by the Contractor.
5. The pouring of concrete only takes place after approval of reinforcement and formwork.
6. All concrete parts to be executed must be manufactured in accordance with drawings.
 - Foundations
 - Stairs
 - Concrete floors
 - Concrete roofs
 - Beams
 - And other concrete parts included in the specification drawings

10.2 DEFECTS

1. If, during the execution of the project, it appears that the material used, or part thereof, does not meet the requirements, the Project Manager may, regardless of previous approval of the material, still reject it and demand its replacement within a period to be determined by it.

10.3 MATERIALS

Cement

1. Cement used for concrete shall be Portland cement or rapid hardening Portland cement conforming to the requirements of ASTM C 150 Type 1.

Aggregates

Coarse aggregates (stone) and fine aggregates (sand) shall comply with the requirements of ASTM C 33 and be subject to the following:

- Proof to the Engineer that the shrinkage of the fine and coarse aggregate is not such as to cause excessive shrinkage of the concrete. Where required by the Engineer submit certificates from an approved laboratory giving the shrinkage characteristics of the aggregate.
- Aggregates shall not contain deleterious amounts of organic materials such as grass, timber or similar materials.
- Where 40 mm aggregate is used in 30 MPa and stronger concrete the aggregate shall be supplied in two nominal sizes, the larger of which shall be 40 mm and the smaller of which shall be 20 mm or 14 mm. The relative proportions of large and smaller aggregate used shall be determined by the mix design.
- If there is a potential danger of alkali aggregate reaction the Engineer's decision as to the suitability of the aggregate shall be final and binding.

Water

1. Water shall be clean and free from detrimental concentration of acids, alkalis, salts, sugar and other organic or chemical substances. If the water used is not obtained from a public drinking water main the Engineer may require to have the suitability of the water proved by tests carried out by an approved laboratory. Such tests shall comply with the requirements of AASHTO T 26.

Admixtures

1. Admixtures shall not be used in concrete without the approval of the Engineer who may require tests to be made before their use to prove their suitability.

Admixtures, if allowed, shall comply with ASTM C 494, or BS1014, BS3892, or BS5075.

10.4 COARSE AGGREGATE

1. Coarse aggregate for all types of Concrete with the exception of blinding concrete shall conform to the requirements of NEN-EN 12620-1:2002.
2. Coarse aggregate shall be hard, durable, clean, free from dust and other deleterious materials. The grading of the coarse aggregate shall be such that when combined with the approved fine aggregate and cement, it shall produce workable concrete of maximum density.

10.5 CONCRETE

1. The Contractor must ensure timely delivery of the materials for the concrete.

2. For every 10 m³ of concrete or from each pouring, 6 test cubes must be made. Of these 6 test cubes, 2 are kept at work until they are 28 days old. The cubes should be stored, wrapped in plastic foil. The remaining 4 must be taken to a laboratory equipped for this purpose, after which 2 are tested after one week and 2 after two weeks. The 2 cubes, hardened at work, must be taken to the aforementioned laboratory for testing after four weeks. The costs for the manufacture, testing and transport of the test cubes and any other tests to check the concrete quality shall be borne by the Contractor.
3. The concrete is supplied by a concrete mortar plant to be approved by the Project Manager.
4. Concrete pouring must not be started until the formwork and reinforcement of the part to be poured have been fully assembled and approved by the Project Manager. The method of transport and pouring of the concrete must be such that no segregation takes place, at the discretion of the Project Manager.
5. The Project Manager determines where and under what conditions the deposit may be interrupted. If, during the pouring process, there is any movement in the set-up, the Contractor is obliged to take all measures deemed necessary by the Project Manager, without prejudice to the Project Manager's authority to require that the improper work be demolished and replaced by new ones.
6. During pouring, the poured concrete must be vibrated by means of mechanically moved vibrators of sufficient capacity.
7. In addition, the Project Manager may require that during pouring and, if necessary, one hour thereafter, personnel be employed puncturing and stirring the concrete and tapping the formwork.
8. After the concrete has been poured, it must be temporarily protected from drying out and kept wet for 14 days.
9. The Contractor must also take all measures during and after pouring that the Project Manager deems necessary to protect the concrete against segregation, leaching, drying out, etc.
10. Top surfaces should be carefully levelled under profile and sanded flat as soon as possible after pouring.
11. After the concrete has been demolded, gravel nests, which may have been created despite precise processing, must be carefully cut out and the holes sealed with a mortar consisting of 1 cement to 3 sands in measured parts. Unevenness in the surfaces caused by inadequate closure of the formwork or other causes must be cleaned up.

10.6 UNREINFORCED CONCRETE, GRADE C12/15

1. A work floor must be installed underneath all parts to be poured on sand.
2. The work floors under all foundations for the fence, the building and others must be 50 mm thick B5 quality.
3. Material: cement: sharp sand 1:4 (1 part cement to 4 parts sharp sand) or concrete C12/15

4. The work floors of sewage drains with a size of 600 x 600 mm must be made of B5 concrete.

10.6.1 HAND MIXING

The Engineer shall normally not allow any hand mixing in the preparation of concrete. However, under some special circumstances, emergencies and for small works, it may be compelling to allow hand mixing while preparing the concrete. In the case hand mixing is allowed, the procedures stated below shall be followed in a chronological order:

- Water-tight platform should be constructed with cement concrete or bricks. The size of the platform shall be such that it will be possible to accommodate the requisite quantity of mixture in a single batch. The materials of a single batch should be calculated out carefully.
- The mix proportions shall be as instructed by the Engineer.
- The requisite quantity of sand, being determined at a certain proportion, should be measured in a wheelbarrow of specified size and to be spread on the platform with uniform thickness and the top is to be leveled. The requisite quantity of cement should also be measured and spread with uniform thickness over the stack of sand.
- The mixing shall be continued till the mixture takes a uniform color and density. The mixture shall invariably be conveyed, placed, compacted and to be given the final shape within 45 minutes on mixing.

10.6.2 HANDLING AND PLACING OF CONCRETE

1. Concrete placing shall not be commenced without the written approval of the Engineer. This approval shall be in the form of a standard checklist approved by the Engineer prior to the commencement of the Work. The checklist shall be filled in and approved by the Engineer during his inspection and acceptance of materials, plant and equipment, concrete pouring arrangements, the positioning, fixing and condition of reinforcement and any other items to be embedded including the cleanliness, alignment and suitability of the containing surfaces or formwork.
2. The temperature of concrete at the time of placing shall not exceed 35°C.
3. In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall entirely be removed from the forms and not be buried in the concrete.
4. The concrete shall be placed in the position and sequences indicated on the Drawings, and Specification or as directed by the Engineer.
5. The concrete shall be placed in clean, oiled formwork and compacted before initial set has occurred. In any event concrete shall not be placed later than 30 minutes from the time of mixing.
6. Concrete shall be placed in horizontal layers and each layer shall not be more than 600mm thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer that has not taken the initial set.

7. The concrete shall be deposited as far as possible in its final position without re-handling or segregation and in such a manner so as to avoid displacement of the reinforcement and other embedded items or formwork.
8. Open troughs and chutes shall be of metal or metal line. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the Engineer. Where chutes are used to convey the concrete, their slopes shall not be such as to cause segregation. Where long steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuation of their use and the installation of a satisfactory method of placing.
9. Placement of concrete by pumping shall be permitted only if authorized by the Engineer. The equipment should be so arranged that vibrations do not damage freshly placed concrete. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there is no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.
10. For simple spans, concrete shall preferably be deposited by beginning at the center of the span and working from the center towards the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. For continuous spans, the concrete placing sequence shall be as shown on the plans or agreed by the Engineer.
11. Concrete in slab and girder haunches less than 1m in height shall be placed at the same time as that in the girder stem.
12. Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided.
13. Concrete in T-beam or deck girder may be placed in one continuous operation, if permitted by the Engineer.
14. Concrete in columns and pier shafts shall be placed in one continuous operation unless otherwise directed.
15. Unless otherwise permitted by the Engineer, no concrete shall be placed in the superstructure until the column forms have been stripped off sufficiently to determine the character of the concrete in the columns. The load of the superstructure shall not be applied to the supporting structures until they have been in place at least 14 days unless otherwise permitted by the Engineer.
16. When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable materials to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, an inset form shall be used to produce a blocked-out portion in the preceding layer which shall produce an edge thickness of not less than 150mm in the succeeding layer.
17. Work shall not be discontinued within 450mm of the top of any face unless provision has been made for a coping less than 450mm thick, in which case, if permitted by the Engineer, a construction joint may be made at the underside of the coping.

18. Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement steels.
19. Where concrete is required to be placed against undisturbed ground, the entire space between the finished concrete surface and the ground, including any over-break, is to be completely filled with concrete of the specified class. The concrete shall be well rammed and compacted to ensure that all cavities are filled, and the concrete is everywhere in contact with the ground. Where permitted by the Engineer, any extensive patches of over-break may first be filled with concrete belonging to the appropriate Class as directed by the Engineer.
20. Where concrete is required to be placed against a metal surface to which it is required to adhere, care shall be taken to work the concrete well into the re-entrant angles and to ensure contact by hammering the metal part on its free side provided that this is done without damaging the metal or its protective coating, if any.
21. Concrete shall not be dropped through a height greater than 1200mm except with the approval of the Engineer who may order the use of bankers and the turning over of the deposited concrete by hand before being placed.
22. When placing operations would involve dropping the concrete more than 1200mm, it shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars, which are projected.
23. All chutes, troughs and pipes shall be kept clean and free from coatings of harden concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clean.
24. The laying of concrete shall be carried out in such a way that the exposed faces of concrete shall be plain, smooth, sound and solid, free from honeycomb and excrescencies. After compaction the exposed concrete surface shall be struck off smoothly with hand held steel floats. No plastering of imperfect concrete faces will be allowed. Any concrete that is defective in any way shall, if so ordered by the Engineer, be cut out and replaced to such depth or be made good in such manner as the Engineer may direct.
25. Construction joints shall be formed in the work where indicated on the Drawings or as previously approved by the Engineer. Where necessary, permission will be granted to work beyond ordinary working hours to allow each section of concrete to be completed in a continuous pour with the placing of concrete carried up to each construction joint.

10.6.3 COMPACTION OF CONCRETE

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

- The vibration shall be internal unless special authorization of other methods are given by the Engineer or as provided herein.
- Mechanical vibrators of the capacity as approved by the Engineer shall be used in conjunction with or without hand rammers, pokers or any other means as directed by the Engineer.
- Vibrators shall be of a type and design as approved by the Engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.

- The intensity of vibration shall be such as to visibly affect a mass of concrete of 20mm slump over a radius of at least 450mm.
- Vibrators must be operated by skilled workmen engaged/appointed mainly for this job.
- Surface vibrators of the type of Pan-vibrators, or vibrating screens shall be used for compacting castings of shallow depth as directed by the Engineer.
- Provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms. Spare vibrators shall be readily on hand in case of breakdown.
- Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms.
- Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point, to the extent that localized areas of grout are formed.
- While using immersion vibrators in walls, these should be lowered to the bottom of the wall before depositing of concrete is started and pulled up as it proceeds. When using vibrators, concrete can be placed from bottom to top of wall in one process, provided it is laid in regular layers. Cares should be taken to ensure that vibrators are not trapped under a great depth of concrete.
- Application of vibrators shall be at points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective.
- Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete, which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.
- Vibration shall be supplemented by such spading as is necessary to ensure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.
- In columns, deep beams and walls mild striking by mallets at the outer faces of the form works should also be done simultaneously during use of vibrator for compaction.

10.6.4 PROTECTION OF CONCRETE FROM ADVERSE CONDITIONS

1. Concrete shall be protected from damage from the effects of sunshine, dry wind, rain, running water or mechanical damage for a continuous period, until the concrete has reached at least three quarters of its 28-days strength, but for not less than 10-days.
2. Temperature of the concrete mixture shall require to be maintained between 10°C and 32°C unless otherwise provided herein. Submit proposals to achieve this protection for the Engineer's approval.
3. Damaged concrete shall be removed and replaced generally. However, it may be repaired to an acceptable condition if found appropriate by the Engineer.
4. During rainy weather, proper protection shall be given to ingredients, production methods, handling and placing of concrete. If required in the opinion of the Engineer, the concrete depositing operation shall be postponed and newly placed concrete shall be protected from rain after forming proper construction joint for future continuation.

5. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure.
6. Under a temperature above 32°C surfaces of forms, reinforcing steel, steel beam flanges etc. that remain in contact with the mix shall be cooled down below this temperature by means of water spray or by any other appropriate methods.
7. High quality surface finishes are susceptible to damage during subsequent construction operations and temporary protection may have to be provided in vulnerable areas. The protective measures, among others, include the strapping of laths to arrises and the prevention of rust being carried from exposed starter bars to finished surfaces.

10.6.5 PERFORATIONS AND EMBEDDING OF SPECIAL DEVICES

1. Determine in advance of making any concrete pours, all requirements for perforation of concrete sections or embedding therein of special devices of other trades, such as conduits, pipes, weep holes, drainage pipes, fastenings, etc.
2. Any concrete, poured without prior provision having been made, shall be subject to correction at own expenses.
3. Devices to be embedded in the concrete shall be shown on the Drawings or directed by the Engineer.
4. Conduits, pipes and sleeves of any material not harmful to concrete and within the limitations specified herein shall be permitted to be embedded in concrete with the approval of the Engineer, provided they are not considered to replace structurally the displaced concrete.
5. Conduits, pipes, and sleeves passing through a slab, wall, or beam shall not impair significantly the strength of the construction.
6. Piping and conduit shall be so fabricated and installed that cutting, bending, or displacement of reinforcement will not be required.

10.6.6 CURING OF CONCRETE

1. In order to prevent loss of water, all newly placed concrete shall be cured by use of one or more of the methods specified herein. The Engineer shall select the method that should be followed for curing a concrete of particular type of work or member. Curing shall commence immediately after the free water has left the surface and finishing operations are complete. In the case the concrete surface begins to dry before the selected cure method is applied, the surface of the concrete shall be kept moist by a fog spray application so as to prevent any damages to the surfaces.
2. During periods of hot weather, water shall be applied to the concrete surfaces being cured by the liquid membrane method or by the forms-in-place method, if considered necessary by the Engineer, the process shall continue for a period that the Engineer determines a cooling effect is no longer required.
3. Water used in curing of concrete shall be subject to approval and shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other injurious substances. Water shall be tested in accordance with and shall meet the suggested requirements of NEN206-1/NEN8005. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

One of the following methods shall be used for curing:

Forms-in-place method

- Formed surfaces of concrete may be cured by retaining the forms in place for the required time.
- Concrete surface shall be kept continuously wet by ponding, spraying or covering with materials that are kept continuously and thoroughly wet. Such materials may consist of cotton mats, multiple layers of burlap or other approved materials, which do not discolor or otherwise damage the concrete.

Waterproof cover method

This method shall consist of covering the surface with a waterproof sheet material so as to prevent moisture loss from the concrete. This method may be used only when the covering can be secured adequately to prevent moisture loss. The concrete shall be wet at the time the cover is installed. The sheets shall be of the widest practicable width and adjacent sheets shall overlap a minimum of 150mm and shall be tightly sealed with pressure sensitive tape, mastic, glue, or other approved methods to form a complete waterproof cover of the entire concrete surface. The paper shall be secured so that wind will not displace it. Should any portion of the sheets be broken or damaged before expiration of the curing period, the broken or damaged portions shall be immediately repaired. Sections that have lost their waterproofing qualities shall not be used.

Membrane Curing Compound Method:

- Apply clear membrane curing compound or white pigmented curing compound as directed by using a hand sprayer. Apply a single coat continuous film at a uniform coverage of at least 0.2 L/m²).
- Immediately recoat any cracks, checks or other defects appearing in the coating. Thoroughly agitate the curing compound in the drum prior to application and during application as necessary to prevent settlement of the pigment.

Polyethylene Sheeting Method

Place polyethylene sheeting, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 150 mm. Hold the sheeting securely in place and in continuous contact with the concrete at all times.

10.6.7 FINISH AND FINISHING

1. Surface irregularities shall be classified as "abrupt" or "gradual". Offsets caused by displaced or misplaced form sheathing or lining of form sections, or loose knots in forms or otherwise defective formwork, will be considered as "abrupt" irregularities. All other irregularities will be considered as gradual irregularities.
2. Where a surface is partly below and partly above the final ground level, the finish for the exposed surface shall extend for 0.15m below the ground level.
3. The formed surfaces, which will be permanently buried under earth, will require no treatment for abrupt or gradual irregularities. However, repair of defective concrete and filling of holes left by the removal of fasteners from the ends of tie rods shall be undertaken.
4. All abrupt and gradual irregularities on all exposed surfaces shall be removed by sack rubbing or sand blasting or grinding or by all these methods or any other methods approved by the Engineer, which is not harmful to the concrete. The permissible surface irregularities shall not exceed 3mm for abrupt irregularities and 9mm for gradual irregularities. The permissible

irregularities may be reduced at places of the surface where, in the opinion of the Engineer, the formed finish does not provide the desired effect and no extra payment shall be permissible for such work. Holes, honeycombs, or other defects left by forms shall be promptly repaired in accordance with the relevant Sub-section of this document.

5. All surfaces such as blinding concrete, opening for second stage concrete etc. on which concrete is to be placed subsequently, shall not be finished for abrupt or gradual irregularities.
6. Generally, concrete surface shall remain as cast and no plastering work will be performed on it. The formwork shall be lined with a material approved by the Engineer to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure.
7. Repair any imperfections in the resulting finish as required by the Engineer for which no extra payment shall be made. Internal ties and embedded metal parts will be allowed only with the Engineer's specific approval.

10.6.8 CONCRETE SURFACE FINISHING

1. Skilled workmen shall perform finishing of concrete surfaces to the satisfaction of the Engineer. Exposed flat concrete surfaces shall be screeded to produce an even and uniform surface and then they shall be given a trowel finish unless otherwise specified on the Drawings. All exposed and unprotected edges shall be given 20mm x 20mm chamfers.
2. The Concrete surface finish on upward facing, horizontal or sloping faces shall be, except for blinding concrete or otherwise stated on the Drawings, a "fair" surface. A 'fair' surface shall be obtained by screeding and trowelling with a wood float.
3. Screeding shall be carried out following compaction of the concrete by the slicing and tamping action of a screed board running on the top edges of the formwork or screeding guides to give a dense concrete skin true to line and level.
4. Leveling of floor surface shall be done by bull floats after compaction.
5. Unless otherwise required or directed by the Engineer all the floor surfaces shall receive a Type U1 broom textured surface finish.
6. Where a "fine" surface is indicated on the Drawings, this shall be obtained in a similar manner to "fair" surface except that a steel float shall be used in lieu of the wood float.

Formed surface for painting exposed to view shall be smooth and free from projections and shall be rubbed smooth immediately after the forms are removed. Formed surfaces shall be classified as follows:

- Unexposed concrete surfaces upon or against which backfill or concrete is to be placed, require no treatment except the removal and repair of defective concrete.
- Exposed surfaces shall have a very smooth, sound surface by control of formwork, concrete placement and repair of abrupt surface irregularities by grinding or rubbing of high spots and filling of voids.

10.6.9 BACK-FILL TO STRUCTURES

All spaces, which have been excavated but are not occupied by the concrete structure shall be backfilled and compacted with materials acceptable to the Engineer or as shown on the Drawings and/or as per the directions of the Engineer.

10.6.10 CLEANING UP

1. Upon completion of structure and before final acceptance, remove all forms and scaffoldings, etc. down to 0.5m below the finished ground line.
2. Excavated or garbage materials, rubbish etc. shall be removed from the Site, which shall be left in a neat condition satisfactory to the Engineer.

10.7 QUALITY CONTROL OF CONCRETE

10.7.1 GENERAL

1. Assume the full responsibility that the quality of the concrete conforms to the Specifications and this responsibility shall not be waived by the tests carried out and the test results approved by the Engineer. Establish additional testing procedures at own discretion as necessary.
2. Provide samples of concrete and its constituent materials either for testing or for testing at the Engineer's laboratory or laboratory designated by the Engineer.
3. For this purpose, concrete test cylinders, which shall be made in accordance with EN 13791 shall be deemed to be 'Samples'.
4. All sampling of constituent materials shall be carried out in accordance with the provisions of the appropriate British/American Standard and all sampling of fresh and of hardened concrete shall be carried out in accordance with the provisions NEN-EN 206-1 unless such provision is at variance with the Specification.
5. The tests, which is required to undertake on behalf of the Engineer, are those to be carried out on fresh concrete at the place of final deposit, or elsewhere at Site as directed by the Engineer.

10.7.2 SLUMP TESTS

1. Slump testing of concrete shall be carried out as required by the Engineer. The minimum is one test per truck, and one each time a strength test specimen is taken.
2. Make available a slump cone at Site and the testing shall be carried out in accordance with NEN-EN 206-1.
3. The slump of concrete to be used in the works shall not exceed the maximum specified ratio.
4. The slump test results for normal structures shall be between 9cm and 15cm.
5. The Engineer can specify different slumps for special structures before ordering the ready-mix.

10.7.3 COMPRESSIVE STRENGTH

1. Sample concrete for testing from the truck mixer at the time of pouring of concrete into the forms or elsewhere in the presence of the Engineer. Samples shall be obtained at uniform intervals throughout the production or delivery of concrete for a given placement. Carry out cylinder testing of concrete strength as required by the Engineer.

2. Make available 2 sets of three test molds (cylinder or cubes) at Site. Samples for testing shall be taken in the presence of the Engineer and shall be dated. Test cylinder shall be tested for 7 days and 28 days compressive strength.
3. A strength test result shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:
 - Average of three consecutive strength tests equals or exceeds the specified strength.
 - No individual strength test (average of two cylinders) falls below the specified strength by more than 3.5 N/mm².

10.7.4 FAILURE TO PASS TESTS

1. If cylinders taken at Site during the progress of the works fail to reach the specified strength, no further pouring of concrete shall take place until the cause of the failure has been established and corrective measures have been taken to the satisfaction of the Engineer.
2. The Engineer may require that core samples are taken and tested in accordance with NEN-EN 206-1, or similar standard or other tests be performed on sections of the works made from the suspect concrete. If such tests fail to demonstrate the integrity of the sections of the works, all sections made with the suspect concrete shall be removed from the Site. Costs of all such tests and removal of concrete including the cost of the concrete shall be at own expense.

10.7.5 TESTING HARDENED CONCRETE

1. Testing of hardened concrete shall be done by nondestructive tests with Schimdt hammer and shall be performed according to EN12504-2.
2. The nondestructive test shall be done on every structure after 7 days and 28 days, location of testing will be assigned by the Engineer as specified below.
 - 1 test per 10m strip foundation
 - 1 test per 10m beam
 - 1 test per 4 columns
 - 1 test per 15m² of concrete flooring
 - For other structures take into account 1 test per 5m³ or 1 test per item.
3. If such tests fail to demonstrate the integrity of the sections of the works, all sections made with the suspect concrete shall be removed from the Site. Costs of all such tests and removal of concrete including the cost of the concrete shall be at own expense.

10.8 TOLERANCES

Footings

Position 15 mm

Thickness ± 25 mm - 15 mm

Levels: Average level of slabs, footings, etc. ± 25 mm

Columns, walls, piers, etc.

Position: 5 mm

Dimensions:

Leading dimensions of walls and piers. ± 25 mm

Thickness of walls and cross-sectional dimensions of columns: Plus tolerances 25 mm

Minus tolerance: 3% of the specified dimensions within the range 5 mm to 25 mm

Levels:

Average levels of finished or trimmed/cut

columns, piers, walls, abutments, etc. ± 10 mm

Verticality:

Using ordinary formwork: 1 in 4000. Max 25 mm.

Chamfers

Fillets used to form chamfers shall be made of hardwood, plastic or metal to a tolerance of 1 mm in cross sectional dimensions and the actual chamfer, by diagonal measurement, on the concrete shall not vary by more than 3 mm from the specified dimensions.

Kerbs, copings, sidewalks, bridge railings, parapets, etc.

The elements shall be constructed to the specified dimensions within a tolerance of ± 5 mm on any dimension. The alignment shall not deviate from the true alignment by more than 10 mm in any place nor shall the alignment deviate by more than 5 mm from the true alignment over any length of 5 m.

11. CONSTRUCTION JOINTS

11.1 GENERAL

1. Concreting shall be carried out continuously up to the construction joint shown on the working drawings or as approved, except that is, because of an emergency (such as breakdown of the mixing plant or the occurrence of unsuitable weather), concreting has to be interrupted, a construction joint shall be formed at the place of stoppage in the manner which will least impair the durability, appearance, and proper functioning of the concrete.
2. Unless otherwise shown on the drawings the exact position of horizontal construction joints shall be marked on the formwork by means of grout checks in order to obtain truly horizontal joints.

11.1.1 PREPARATION OF SURFACES

When the concrete has set and while it is still green the surface film and all loose material shall be removed, without disturbing the aggregates, by means of a water jet assisted by light brushing to expose the aggregate and leave a sound, irregular surface. Where this is not possible the surface film shall be removed after the concrete has hardened by mechanical means appropriate to the degree of hardness to the concrete so as to expose the aggregate and leave a sound, irregular surface. The roughened surface shall be washed with clean water to remove all laitance, dirt and loose particles.

11.1.2 PLACING FRESH CONCRETE AT CONSTRUCTION JOINTS

1. When fresh concrete is placed the same day as the construction joint was formed the fresh concrete shall be cast directly against the face of the construction joint.
2. When concreting recommences a day or more after the forming of the construction joint the following procedure shall be followed:
3. The construction joint shall be kept continuously wet for a period of at least two hours before concreting starts but shortly before concreting recommences, further application of water shall cease so that the surface is just damp.
4. Any dirt, excess water and loose particles shall be removed prior to recommencing concreting.
5. For horizontal construction joint surfaces, a freshly mixed slurry consisting of sand, cement and water mixed in the same proportions as used in the concrete shall be applied approximately 10 mm thick in the construction joint surface immediately ahead of concreting. The slurry must still be in a plastic state when applied. For vertical construction joint faces a thin coat of a freshly mixed paste of neat cement and water, using a little water as practical, shall be applied to the construction joint immediately ahead of concreting.
6. Epoxy resins specially designed for bonding old concrete to new shall be used at construction joints where so directed by the Engineer. The preparation of the construction joint surface and the application of the epoxy resin shall be strictly in accordance with the manufacturer's recommendations and the Engineer's instructions. The actual brand and type of resin used shall be subject to the Engineer's approval.

12. JOINTS IN CONCRETE

12.1 CONSTRUCTION JOINTS

1. Construction joints are defined as concrete surfaces upon or against which concrete is to be placed and to which new concrete is to be placed, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed.
2. Construction joints shall be formed wherever there is a discontinuity in placing concrete in external elements of concrete structures. Formed vertical or inclined construction joints as well as unformed joints, which are due to interruption of concrete placement, shall be made only where located on the Drawings or shown in the pouring schedule or as directed by the Engineer. All exposed faces of construction joints shall be made absolutely straight, leveled or plumbed and normal to the finished surface.
3. Spacing of construction joints shall be in accordance with good concreting practice as defined in this document or equivalent and enabling adequate precautions to be taken against shrinkage cracking. Placing of concrete shall be carried out continuously. The joints shall be at right angle to the general direction of the member and shall take due account of shear and other stresses.
4. All planned reinforcing steel shall extend uninterrupted through joints. Additional reinforcing steel dowels shall be placed across the joints, if and when directed by the Engineer. Furnish such additional steel for dowels.

12.2 BONDING

1. Unless otherwise shown on the Drawing, horizontal joints may be made without keys and vertical joints shall be constructed with shear keys. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and intentionally left in a rough condition.
2. Shear keys shall consist of formed depressions in the surface covering approximately one-third of the contact surface. The forms for keys shall be beveled so that removal will not damage the concrete.
3. Surfaces of construction joints shall be prepared as early as possible after casting. The preparation shall consist of the removal of all laitance, loose or defective concrete coatings, sand and other deleterious materials. Preparation shall be carried out preferably when the concrete has set but not hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without it is being disturbed. Where this treatment is impracticable and work is resumed on a surface, which has set, the whole surface shall be thoroughly roughened or scrapped with suitable tools so that no smooth skin of concrete that may be left from the previous work is visible.
4. The prepared joint face shall be thoroughly cleaned by compressed air and water jets or other approved means, brushed, vacuumed and watered immediately before depositing concrete. The cleaned and saturated surfaces that also include vertical and inclined surfaces, shall first be thoroughly covered with a thin coating of mortar or neat cement grout against which the new concrete shall be placed before the grout has attained its initial set.
5. The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints, which are exposed to view, shall be carefully finished true to line and elevation.

6. Construction joints in floors shall be located within the middle third of spans of slabs, beams and girders.
7. Joints in girders shall be offset a minimum distance of two times the width of intersecting beams.

12.2.1 BONDING AND DOWELING TO EXISTING STRUCTURES

1. When reinforcing dowels grouted into the holes drilled in the existing concrete is required at such construction joints, the holes shall be drilled by methods that will not damage the concrete around the holes. The diameters of the holes shall be 6mm larger than the nominal diameter of the dowels unless shown otherwise on the Drawings.
2. The dowel bars shall be round mild steel bar of the diameter and length as indicated on the Drawings and/or as per the directions of the Engineer.
3. The grout shall be a neat cement paste of Portland cement and water or an epoxy. Immediately prior to placing the dowel bars, the holes shall be cleaned off dust and other deleterious materials, shall be thoroughly saturated with water, have all free water removed and shall be dried to a saturated surface dry condition. Sufficient grout or an epoxy shall be placed inside the holes so as not to remain any void after the dowels are inserted. Grout shall be cured for a period of at least 3 (three) days or until dowel bars are encased in concrete. When an epoxy is used, the mixing and placing shall conform to the manufacturer's recommendations.

12.2.2 FORMS AT CONSTRUCTION JOINTS

1. When forms at construction joints overlap previously placed concrete, they shall be re-tightened before depositing new concrete. Exposed face edges of all joints shall be neatly formed with straight bulkheads or grade strips, or otherwise properly finished true to line and elevation.
2. The new form or other supporting structures may not be nailed to the existing new structures. Nailing in concrete structures is not allowed.

12.2.3 INSTALLATION

Open joints

- Open joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. When not protected by metal armor, open joints in slabs shall be finished with an edging tool. Upon completion of concrete finishing work, all mortars and other debris shall be removed from the open joints.

Filled joints

- When filled joints are shown on the Drawings or asked by the Engineer, pre-mold type fillers shall be used unless Poly Styrene board is specifically called for. Filler for each joint shall consist of as few pieces of material as possible. Abutting edges of filler material shall be accurately held in alignment with each other and tightly fit or taped as necessary to prevent the intrusion of grout. Joint filler material shall be anchored to one side of the joint by waterproof adhesive or other methods so as to prevent it from working out of the joint but not interfere with the compression of the material.

Sealed joints

- Prior to installation of the pourable joint sealants, all foreign materials shall be removed from the joint.

- The filler material shall be cut back to the depth shown or approved and the surface of the concrete, in contact with the sealant, be cleaned by light sand blasting. When required, a Polyethylene foam strip shall be placed in the joint to retain the sealant and isolate it from the filler material. The sealant materials shall then be mixed and installed in accordance with the manufacturer's directions. Any material that fails to bond the sides of the joint within 24 hours after placement shall be removed and replaced.

13. MASONRY WORKS

This item of work shall consist of constructing brick masonry work in cement mortar with specified proportion in required thickness and height. The work shall include supply of all labor, materials, tools and equipment, carriage and the performance of all works necessary for the construction of the brick or concrete block masonry.

13.1 MATERIALS

1. Bricks shall be of First Class in quality unless otherwise required and shall comply with the requirements as stated under the relevant Sub-section of the Section on 'Construction Materials' of this Specification.
2. Cement mortar for brick masonry works shall generally consists by volume of one-part Ordinary Portland cement and four parts screened sand or one-part Ordinary Portland cement and six parts screened sand unless otherwise required by the Drawings or instructed by the Engineer. In each mortar, just enough water shall be added and the components mixed and thoroughly incorporated together to give workability appropriate to its use. Mortar shall be used whilst freshly mixed and no softening or re-tampering will be allowed.
3. Only a sufficient quantity of sand and cement shall be mixed with water that can be used within 30 minutes after water is added. The adding of additional water and re-tempering (cement mortar that stiffened because of evaporation of water) shall be permitted only within 30 minutes from the time of addition of water at the time of initial mixing.

13.2 CONSTRUCTION METHOD

1. The bricklaying of the bricks must be carried out in half-brick bond. The bricks to be used for the building are solid 4" concrete blocks with ribbon and butt joints of up to 20mm. The shape, height and depth are carried out in accordance with the drawing and, if necessary, on the instructions of the Project Manager.
2. The masonry of the fence must be carried out in half-brick bond. The stones to be used are solid 4" with ribbon and butt joints of up to 20mm. The shape, height and depth are carried out in accordance with the drawing and, if necessary, on the instructions of the Project Manager.
3. The masonry mortar should consist of 1 part Portland cement and 3 parts river sand. The plaster mortar should consist of 1 part Portland cement and 3 parts sanding sand.
4. The masonry should be erected evenly. A maximum of 4 rows per day may be bricked, with the corners and/or wall encounters being grouted immediately.
5. The suppliers for the masonry bricks must be BEM or KULDIPSINGH. The quality of the bricks requires approval from the Project Manager. The masonry must be carried out with the concrete blocks that are at least 28 days old and have a compressive strength of min. 5N/mm².
6. The topographer must lay out the necessary recesses, holes and trenches, etc., for the passage of pipes, drains, cables, casing pipes (e.g. for the installation of electronic security by third

parties) in accordance with the drawing and, if necessary, on the instructions of the Project Manager.

7. All electrical installation, data installation, security, communication installation, water pipes, etc. must be installed before plastering.
8. Unless otherwise specified, all visible masonry must be scraped and plastered flat and plastered inside and out.
9. Wall surfaces should be thoroughly moistened before plastering.
10. The plaster is touched up with a wooden sanding board after this layer has been slightly stiffened, the surface is then evenly finished with a plastic or rubber sponge.
11. The maximum thickness of the plaster is 10mm.
12. The masonry that comes into contact with soil must be heavily covered on both sides with mortar consisting of 1 part Portland cement and 2.5 parts sand, then covered twice (2x) with INERTOL , NITROPROOF or equivalent.
13. As long as the work is not approved by the Project Manager, the Contractor may not start the next part.
14. The Contractor must submit proof of origin to the Project Manager at the time of each delivery.

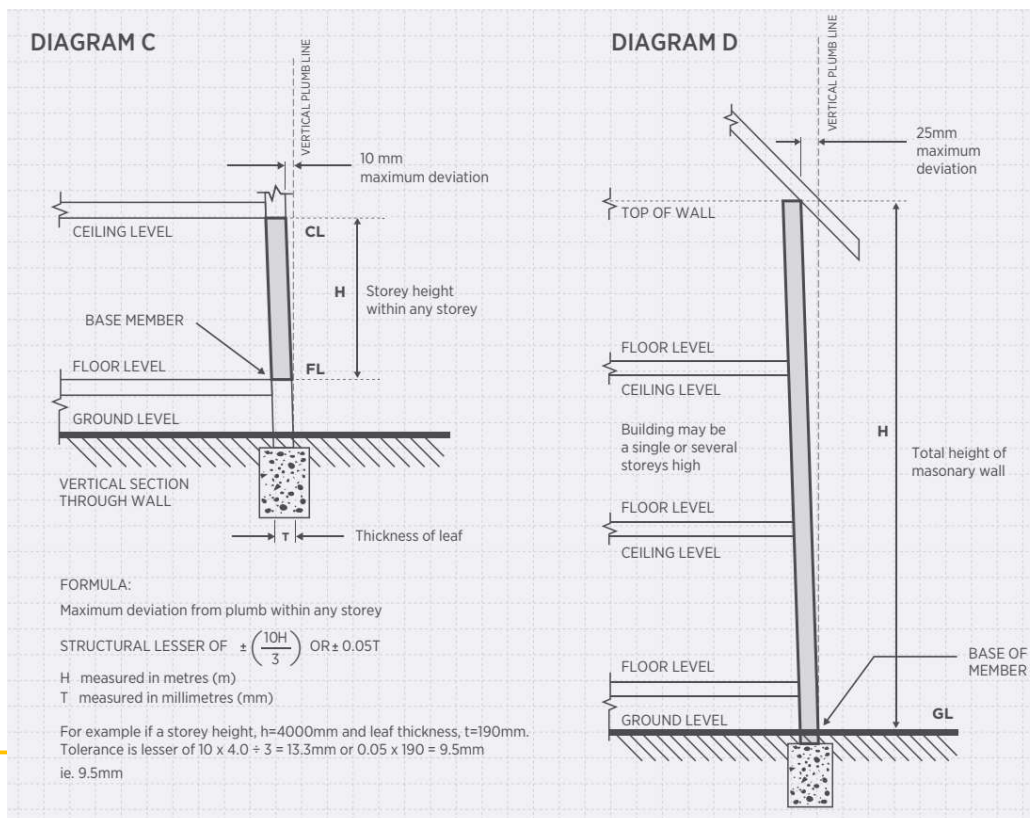
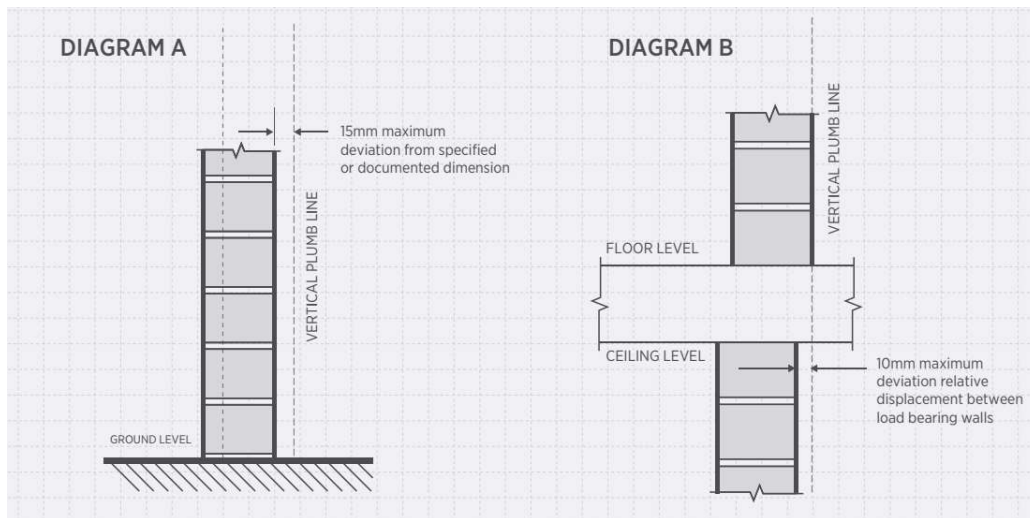
13.3 TOLERANCES

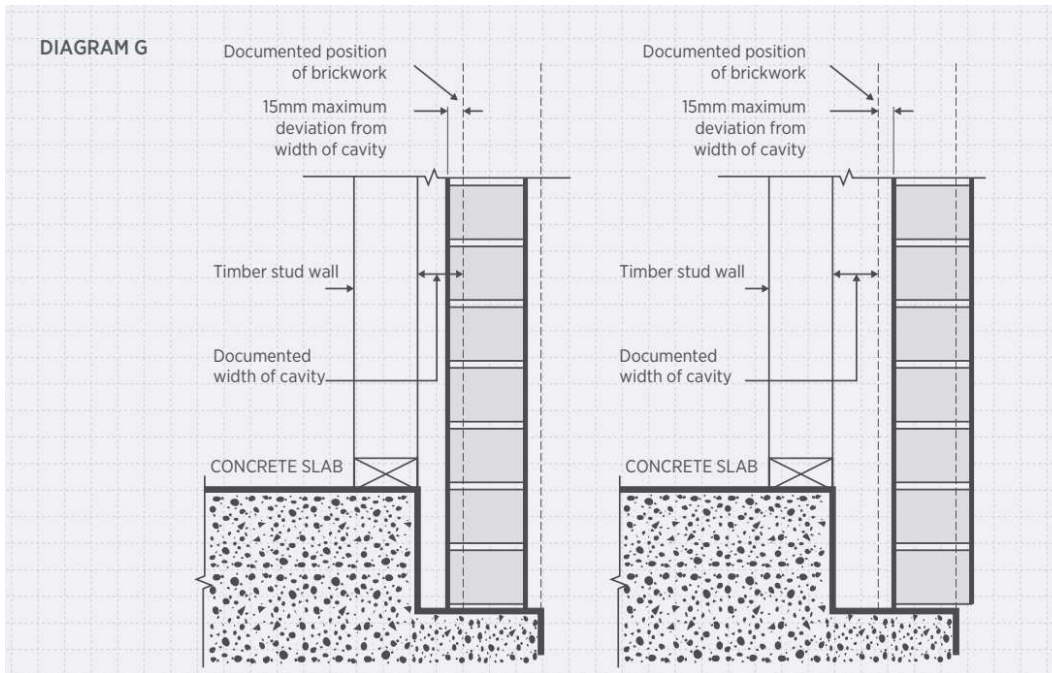
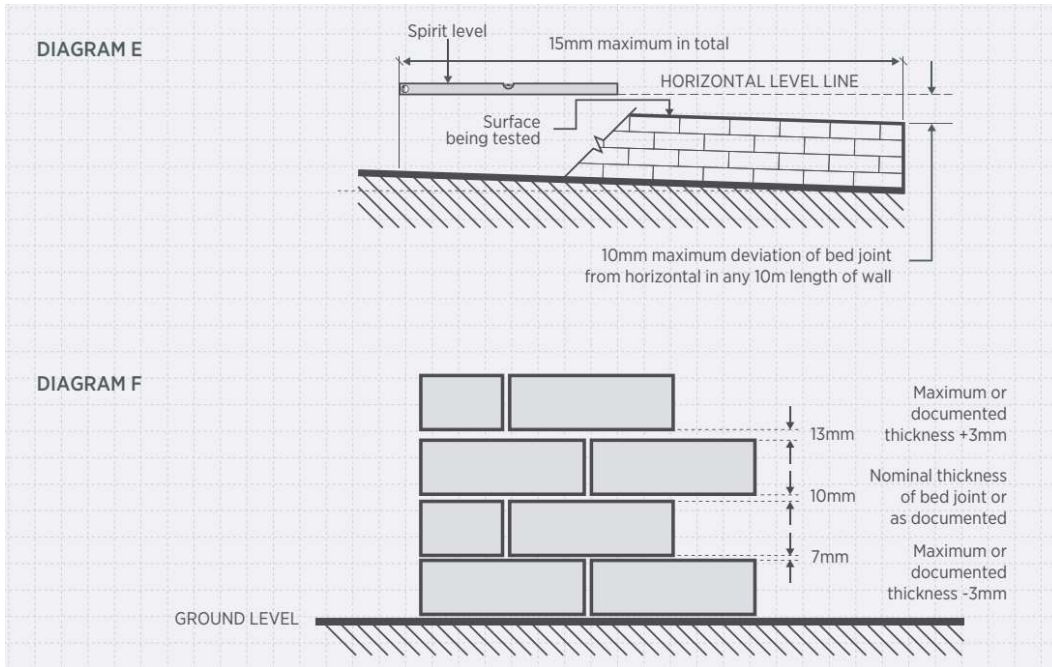
This section includes structural tolerances for concrete block construction.

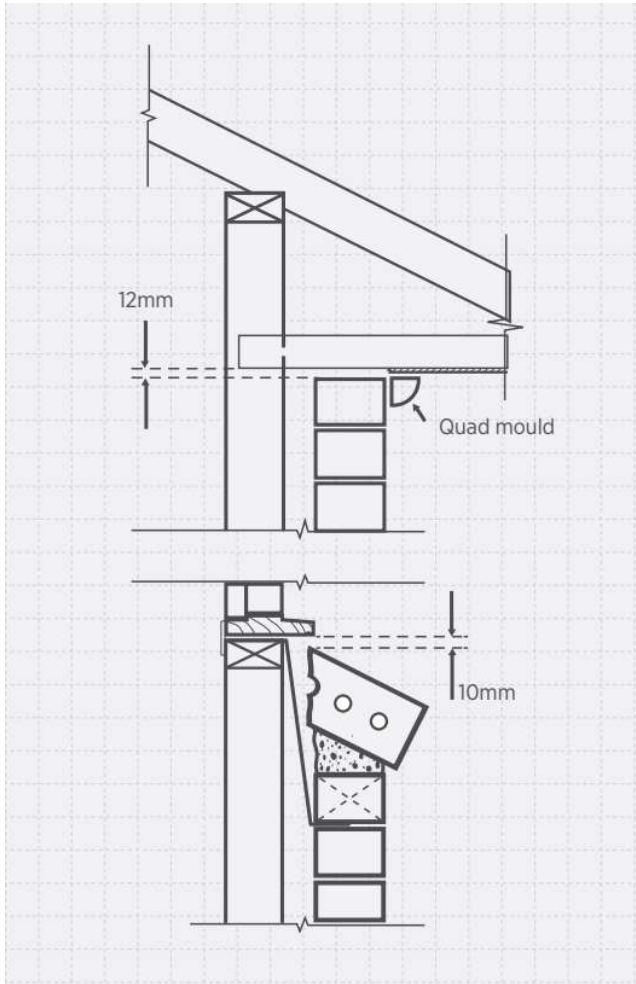
CLASSIFICATION OF DAMAGE WITH REFERENCE WALLS	
DESCRIPTION OF TYPICAL DAMAGE AND REQUIRED REPAIR	APPROX. CRACK WIDTH LIMIT
Hairline cracks	< 0.1mm
Fine cracks that do not need repair	< 1mm
Cracks noticeable but easily filled. Doors and windows stick slightly	< 5mm
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather tightness often impaired	5mm to 15mm (or a number of cracks 3mm or more in one group)
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15mm to 25mm but also depends on number of cracks

TOLERANCES IN MASONRY CONSTRUCTION		
	ITEM	TOLERANCE
a	Horizontal position of any masonry element specified or shown in plan at its base or at each story level	±15mm (diagram A)
b	Relative displacement between loadbearing walls in adjacent stories intended to be in vertical alignment	±10mm (diagram B)

c	Maximum deviation from plumb within a storey from a vertical line through the base of the member	The lesser of $\pm 10\text{mm}$ per 3m of height or 0.05 times the thickness of the leaf (diagram C)
d	Maximum deviation from plumb in the total height of the building (from the base)	$\pm 25\text{mm}$ (diagram D)
e	Maximum horizontal or vertical deviation of a surface from a plane surface (bow)	$\pm 5\text{mm}$
f	Deviation of bed joint from horizontal, or from the level specified or shown in elevation	$\pm 10\text{mm}$ in any 10m length, $\pm 15\text{mm}$ in total (diagram E)
g	Deviation from specified thickness of bed joint	$\pm 3\text{mm}$ (diagram F)
h	Minimum perpend thickness	5mm
i	Deviation from specified thickness of perpend	$\pm 10\text{mm}$ max
j	Deviation from specified width of cavit	$\pm 15\text{mm}$ (diagram G)







14. METAL CONSTRUCTION

14.1 GENERAL

INFORMATION TRANSFER, DRAWINGS AND CALCULATIONS

1. Drawings to be produced by the Contractor:
 - The drawings of the roof construction
2. Number of copies to be provided:
 - For approval: 2
 - Approved: 2
3. The drawings must be submitted to the Project Manager no later than 4 weeks before the start of the production work.
4. The Project Manager shall pass on her comments on the drawings submitted for approval to the Contractor within a period of 2 working weeks.
5. The steel roof trusses must be delivered prefabricated to the site.

14.2 PERFORMANCE OF WORKS

14.2.1 SHOP WELDING

1. Metal-arc welding of steel shall be in accordance with the requirements of BS5130.
2. Run-on/off plates shall be used during butt-welding.
3. Fillet welds shall be continuous to form a complete seal where two members join or abut.
4. Welders employed on the work shall be competent to Codes and Standards. Welding shall be carried out under the supervision of a competent welding technologist.
5. Welding electrodes shall comply with BSEN 499 and shall give a weld deposit with mechanical properties no less than the minimum specified for the parent metal. Hydrogen-controlled electrodes shall be used for butt-welding of steel over 25mm thick.

14.2.2 SITE WELDING

1. All site welding shall be carried out by the electric arc process with coated electrodes and in accordance with Specification for the process of arc welding of carbon and carbon manganese steels to Codes and Standards
2. The welding plant shall be of modern design and of ample capacity to provide the required current to each welding point without appreciable fluctuations.
3. The welding procedure for making each point shall be approved by the Project Manager before the work is started. Whenever possible all welding shall be done in the down-hard or horizontal-vertical positions.

4. All parts to be welded shall be accurately prepared so that on assembly they will fit closely together. After assembly and before the general welding commences the parts are to be tack-welded with small fillets welds. The tack welding must be strong enough to hold the parts together but small enough to be covered by the general welding.
5. Electrodes used for welding mild steel shall comply with the requirements of Covered electrodes for the manual metal-arc welding of carbon and carbon manganese steels of Codes and Standards.

14.2.3 ERECTION OF STEELWORK

1. Erection of steelwork shall comply with the requirements of Codes and Standards.
2. A detailed method statement shall be submitted by the Contractor to the Project Manager for approval prior to the placing of the beams. The statement shall include lifting details, crane locations and loading, details of temporary supports, supervision and safety precautions. The Contractor should allow sufficient time for the Project Manager to comment on his proposals and to make amendments if necessary.
3. Beams shall be set true to line and level during the erection process.

14.2.4 BOLTED CONNECTIONS

1. Bolts shall be threaded only over the length of shank, which is outside the parts bolted together. The bolt shall protrude by at least two complete threads and not more than four complete threads beyond the outer faces of the tightened nut.
2. Holes shall not be distorted by the use of drifts.
3. High strength friction grip bolts shall be fitted in accordance with Codes and Standards.
4. Load-indicating washers shall be installed in accordance with the manufacture's recommendations.

14.2.5 TRANSPORTATION AND STORAGE

1. Steelwork and protective coatings shall be protected from damage during packing, handling, transportation and storage. The Contractor shall ensure that members are not subjected to greater stresses than those allowed in BS 5400 Part 6 during fabrication, transportation, storage and erection.
2. Stored items shall not be in contact with each other and shall be clear off the ground.
3. Steelwork considered beyond repair in transit shall be replaced at the Contractor's expense. The Contractor shall obtain prior approval for remedial work to damaged material.

14.2.6 PAINT AND PROTECTION

The specific conditions that the protection materials must meet are reflected below:

- a) The paint will be received and stored in closed and sealed containers, with the manufacturer's label.
- b) If the project does not specify otherwise, the paint on the structural elements covered by other materials or exposed to the air indoors will ensure protection not less than that provided by two coats

of traditional paint, containing 30% oil. of cooked linseed, and in elements exposed to the elements, not less than that provided by three coats of the same paint.

c) Before painting, paint samples will be presented to carry out the analyzes and tests prescribed in the project, and samples will be painted to judge the color and finish.

d) The types of protection of the steel, classes and characteristics of the paints to be used, number of layers, colors, finishes, etc., can be consulted in the specific Specifications of the paints.

In the definition of the painting, the conditions of use indicated by the paint manufacturer will be taken into account, it is necessary to present to the Facultative Direction a sheet of compliance with the system that will be applied according to the category of atmospheric corrosivity defined in the UNE- EN ISO 12944-2. Some general reference criteria are indicated below.

Three types of environments are defined and together with the specifications of the maintenance plan defined in the structural report, an average durability criterion is set between 5 to 15 years

- Low corrosivity (C1 to C2) Building interiors or non-aggressive exteriors.
- Medium corrosivity (C3 to C4) Interiors and exteriors, not very aggressive.
- High corrosivity (C5-I to C5M) Indoors and outdoors, very aggressive

15. PAINT SYSTEMS

15.1 PAINTING GENERAL

1. Work may not be carried out in the following circumstances:
 - During rain or forecast of rain
 - If dust is present
 - At high surface temperatures during hot weather, which can cause air bubbles to form on the painted surface.
2. The surface conditions for the paintwork are as follows: the work must not be carried out or appropriate measures must be taken in certain situations:
 - If the surface is damp and wet.
 - If condensation may form on the surface.
 - All nail holes on veneers, sheet material, etc., must be covered with appropriate anti-rust paint before the next painting is carried out according to this specification.
3. Grit blasting and painting must be done on the jobsite.
4. If there are no other instructions, the color of the intermediate and/or final coat should match what is indicated by the project manager.
5. Everyone who works with Sigma Coatings must follow the contractor course given by Varossieau Suriname N.V.

15.2 MATERIALS

1. The project manager must approve all paint types to be used on the project by color, quality, and type. The paintwork must meet the specifications of the paint manufacturer, unless otherwise indicated by the project manager.
2. For the project, all paints and finishes must be from one of the following brands, depending on the material or space to be used.
 - Berger paint - for wood/masonry exterior walls, interior walls and wet rooms.
 - Coral - for wood/masonry exterior walls, interior walls and wet areas.
 - Historex Matt - for wood/masonry and interior walls.
 - Sigma, Hempel or Hammerite - for steel coatings and finishing.
3. Before painting begins, the brand and specifications of the paint should be submitted to the project manager
4. Paints from brands not listed above may only be used with the prior written approval of the project manager.
5. Only use additives, thinners, solvents, etc. recommended by the paint manufacturer.
6. Do not use thinners to extend the shelf life of paint.
7. Mix the paint well with an electric mixer until it reaches an even consistency.

15.3 SURFACE PREPARATION

1. Before starting the preparation of the surface, the surface should be completely dry and free of burrs, welding spatter, flux, loose deposits, dirt, oil, grease and other foreign matter.
2. Solvent cleaning must comply with the standards of SSPC-SP1. If necessary, detergent can be used to remove oil or grease.
3. The surface preparation shall meet the minimum degree of preparation according to ISO 8501-1, NACE or SSPC for each paint system specified in this specification and/or the recommendation of the paint manufacturer.
4. Once the specified standard is reached, all dust, debris and abrasive residues should be removed from the blasted surface, cleaned by hand or with a power tool, and the surface should be painted before contamination or flash rust occurs.
5. Sand down all rough welds, sharp edges, etc., before blasting.
6. One of the following abrasives is used for grit blasting:
 - Chopped steel wire.
 - Steel and wrought iron grit.
 - Chilled iron grit or shot.
 - Silica sand.
7. Blasted surfaces should provide a good primer anchor pattern but should not show excessive roughness.
 The anchor pattern should be:
 - Rz: 40-70 μm for inorganic zinc primer.
 - Rz: 35-50 μm for other primers.
8. Blasting should not be performed when:
 - The surface temperature is less than 3°C above the dew point.
 - The relative humidity is higher than 90%.
 - There is a possibility that the surface will be wet before the first coat is applied.
 Apply primer to steel within 2 hours of blasting.

15.4 PAINT SYSTEMS

Painting on steel – Shop applied				
Minimum total Dry Film Thickness (DFT)	Preparation	Primer coat	Intermediate coat	Finish coat
285 μm	Grit-blasting to Sa 2½ according to ISO 8501-1	Zinc rich epoxy primer. Sigma (DFT 100 μm)	High build MIO epoxy. Sigma (DFT 125 μm)	Polyurethane. Sigmadur 550 (DFT 60 μm)

Painting on steel – Field applied/Touch-up				
Minimum total Dry Film Thickness (DFT)	Preparation	Primer coat	Intermediate coat	Finish coat
285 µm	Degrease to SSPC-SPI solvent cleaning. Hand or power tool clean to St.2-3 according to ISO 8501-1	Surface tolerant, high solids epoxy. Sigmacover 630 (DFT 100 µm)	High build MIO epoxy. Sigmacover 410 (DFT 125 µm)	Polyurethane. Sigmadur 550 (DFT 60 µm)

16. SUSPENDED CEILINGS

16.1 MATERIAL

1. Supply of gypsum panels from panel ray. The contractor shall be responsible for the supply, installation and coordination of all works. Install ceiling according to manufacturers' specifications and recommendations while taking into account the references listed below.

16.2 PROJECT CONDITIONS

1. Environmental requirements: Building shall be enclosed with all windows and exterior doors in place and glazed, and the roof watertight before installation of ceiling system. Wet work shall be in place, completed, and nominally dry with HVAC system in continuous operation. Maintain climate conditions to range from 16-29 °C and relative humidity of not more than 85% before installation of system.
2. Coordination with other work:
 - a. General: Coordinate with other work supported by or penetrating through ceiling, including mechanical and electrical work and partition systems.
 - b. Mechanical work: Ductwork above the ceiling system shall be complete and permanent cooling systems operating
 - c. Electrical work: Installation of conduit above suspension system shall be complete before installation of suspension system.
3. Protection: Protect completed work above the ceiling system from damage during installation of suspension system components.

17. TILEWORK

17.1 PRE-TREATMENT SUBSTRATE

17.1.1 TILING, SUBSTRATE WATERPROOF LAYER

1. Substrate: cement stone, plastered
2. Seeing through the corners between walls and between floors and partitions and all around an elastic sealing tape.
3. Manufacturer to be decided during execution.
4. From the sanitary areas and the kitchen

17.2 INNER WALL TILING, GLUED, CERAMIC TILE

17.2.1 WALL TILING, GLUED, CERAMIC TILE

17.2.2 WALL TILING GLUED

1. Pattern: Project Manager Approval
2. Joint width(s) (mm): 3
3. Joint Type: Cement /Synthetic Resin Bonded
4. Manufacturer: and type to be approved by the Project Manager
5. Color: Project Manager Approval
6. Joint width of 3 mm:
 - In the inner corners connection to window frames
 - Connection to floor tiling
7. Tile height (mm.):
 - Toilets: up to doorframe height.
 - Joint seams of façade wall tiles can be determined according to the chosen type of tiles.

17.3 PORCELAIN TILE

17.3.1 FLOOR TILING GLUED, PORCELAIN TILE

1. Surface: concrete floor.
2. Pattern: Project Manager Approval
3. Joint width (mm): 3

4. Manufacturer: Project Manager for approval.
5. Dimensions (L x W x D) (mm): Project Manager approved.
6. Color and type to be determined by the Project Manager.
7. Unglazed non-slip. (double hard baked tile).
8. Hardness: class 5

17.3.2 TILE ADHESIVE

1. Type: Subject to Project Manager approval.
2. Pre-treatment of bonding surfaces: cleaned.
3. Joining surface: flush with adjacent tiling.

17.3.3 GLUE

1. Material: acrylic sealant
2. Color and type: to be approved by the Project Manager.
3. Anti-fungal version.
4. Belong:
 - Primer/adhesive

17.3.4 INNER WALL

1. The joints:
 - In connection between wall tiling and window frames.
 - In connection between wall tiling and floor tiling.
 - In the inner corners of the wall tiling.
 - Between the wall tiling and the kitchen worktop.

17.3.5 CEMENT SCREEDS

1. All concrete floors will be provided with a cement screed of a thickness according to the drawing.
2. Tolerance: 3mm per 3m
3. Leveling the cement floor in connection with the application of tile adhesive.

18. WOOD WORKS

18.1 GENERAL

1. The contractor must carry out all wood works according to the drawings and specifications, as provided by the Project Manager.
2. All work must comply with the applicable building regulations and standards of Suriname.
3. The contractor is responsible for providing all materials, tools, and labor necessary to complete the work.

18.2 MATERIALS

1. All types of wood must be of first quality, free of defects such as knots, cracks, bends and mold. Sustainable wood species that are suitable for the tropical climate, such as Surinamese hardwood (e.g. Basralocus or Gronfalo), should be used.
2. For load-bearing structures, locally available C24 class wood or equivalent must be used.
3. The moisture content of wood should be less than 12%.
4. All fasteners, such as nails, screws and bolts, should be made of stainless steel or galvanized steel to prevent corrosion from the tropical climate.

18.3 EXECUTION

1. All wood works must be carried out by skilled carpenters with demonstrable experience in similar projects in Suriname.
2. Structural components such as beam layers, roof constructions and floor constructions must be placed and fixed according to the drawings and calculations.
3. All connections must be made accurately and sturdily, so that the construction meets the requirements of strength and stability.
4. Openings for windows and doors must be made exactly according to the specified dimensions, including the required lintels and supporting structures.
5. All exposed wooden parts should be finished with a suitable protective layer, such as paint, varnish or stain, depending on the specifications and the local climate.

18.4 INSPECTION AND DELIVERY

1. The Contractor must carry out regular checks during the execution to ensure the quality of the work.
2. Before completion, the contractor must carry out a final inspection and repair any defects.
3. The delivery takes place after approval by the Project Manager, during which a delivery report is drawn up and signed by both parties.

19. GYPSUM WALLS

1. Delivery and installation of non-load-bearing plaster walls according to the specifications and drawings.
2. Moisture Resistant Plasterboard with a minimum thickness of 9.6mm.
3. Metal profiles for the structure of the walls, in accordance with the standards in force.
4. Insulation material, if applicable according to thermal and acoustic requirements.
5. The plaster walls must be installed in accordance with the manufacturer's guidelines and the applicable standards for building constructions.
6. Finishing of the seams and any screw holes with plaster grout, smooth and tightly finished.
7. Final finishing of the walls: Level 5 for interior walls and Level 3 for exterior walls.
8. Provide a flat, dry and load-bearing surface on which the plaster walls are placed.
9. Installation of any insulation according to the requirements.
10. Assemble the metal profiles according to the prescribed center-to-center distance.
11. Attach the plasterboard to both sides of the wall structure.
12. Make sure there is sufficient fastening to prevent bending, with special attention to corner reinforcements.
13. Apply plaster grout and fiberglass taping to the seams and screw holes, ensuring a smooth and seamless finish.
14. Inside corners with paper tape and outside corners with PVC corner profiles
15. Deviations from inside and outside corners will not be accepted.

20. FRAMES, WINDOWS AND DOORS

20.1 FRAMES

REQUIREMENTS AND IMPLEMENTATION: GENERAL

1. The visible woodwork should be smooth and sleek in finish, without blows and with tight joints.
2. The timber from the carpentry must remain dry during transport and storage.
3. Screws in the work that will remain visible must be sunk in by means of drilling, pre-drilling, etc.
4. Frames without a wooden threshold or adjustable threshold must be provided with a coupling slat of sufficient weight.
5. Wood profiles with chamfered edge of 2 mm.

20.2 QUALITY CLASS WOOD

The wood must be of quality class A according to KVH 1980 (Quality Requirements for Wood).

20.3 COMPOUNDS

1. The wood joints in the windows, doors and frames to be carried out with mortise and tenon joints according to KVT 1995 (Quality of Carpentry). The mortise and tenon joints are glued with a suitable wood glue.

20.4 WOODEN FAÇADE/FRAME

20.4.1 WOODEN FRAME

1. Layout: according to drawing.
2. Size: according to drawing.
3. Stud and sill profiles: corresponding drawing.
4. Wood: to be specified.
5. Surface Treatment: Pickled
6. Belong:
7. sealing/connection device.
8. Fasteners.

20.4.2 INTERIOR DOORS WOODEN DOORS

1. Model: Flat

2. Type of wood lattice: wana / pisi coated on both sides with 4 mm. plywood
3. Size: according to drawing
4. Lace version: blunt.
5. Sustainability: inside plywood 2 layers of wood.
6. Surface treatment: all sides laminated with plastic laminate.
7. Colour: Project Manager for approval.
8. Belong:
 - Hinges and locks

21. GUTTERS AND RAINWATER DRAINS

21.1 ALUMINUM DAKGOOTELEMENT

1. Shape: in accordance with drawings
2. Dimensions (mm): according to drawings
3. Material: Aluminum
4. Surface Treatment: Coated
 - Exhaust nozzles (diam. 110 mm) PVC

21.2 GUTTER

1. From the click roofing sheets and aluzinc zinc sheets as shown on the drawings.

21.3 CONSTRUCTION OF PLASTIC PIPELINE, PLASTIC PIPE

1. Connection mode:
 - Cuff Connection
2. Attachment method:
 - Braced: max. distance 1.5 m.
 - hot-dip galvanized steel brackets

21.4 PLASTIC PIPE, UNPLASTICIZED PVC (NEN 7016-81)

1. Make: Dyka or equivalent
2. Size: 3" and 4"
3. Outer diameter (mm): 110
4. Colour: grey
5. Accessories: fasteners

21.5 RAINWATER DRAINAGE SYSTEM

1. The connection of the gutters to the outdoor sewer system.

22. INDOOR SEWERAGE

22.1 DESCRIPTION, INSTALLATION COMPONENTS INDOOR SEWER SYSTEM

1. Segregated system
2. Gravity: 5 mm per meter
3. Execution: according to drawings

22.2 WORKING DOCUMENTS, DRAWINGS AND CALCULATIONS

1. Drawings to be produced by the Contractor:
 - The complete indoor sewerage system
2. Number of copies to be provided:
 - For approval: 2
 - Approved: 2
3. The drawings must be submitted to the Project Manager no later than 4 weeks before the start of the installation work.
4. The Project Manager shall pass on her comments on the drawings submitted for approval to the Contractor within a period of 2 weeks.

22.3 PLASTIC PIPELINES

22.3.1 CONSTRUCTION OF PLASTIC PIPELINE, PLASTIC PIPE

1. Mooring method:
 - Location: on the underside of the concrete floor, anchored to the concrete floor.
 - Slope: 5 mm per meter
 - Cover pipe penetrations in plain sight with rosettes.
2. Connection mode:
 - Adhesive Connection
3. Attachment method:
 - Pipes under the floor with galvanic strips which are poured into the ground floor.
4. Connections:
 - Disposal points for sanitary appliances: installation height in relation to finished floor (m): in accordance with the drawings.

22.3.2 PLASTIC PIPE

1. Manufacturer: COBO
2. Material: PVC
3. Diced: 3.2 mm
4. Dimensions (mm): according to drawing

22.3.3 INDOOR SEWERAGE: INSTALLATION PARTS:

- Lying pipes floor
- Connection to the outdoor sewerage system:
 - toilets
 - Washbasins

23. SANITARY

23.1 GENERAL

1. The Contractor will install the sanitary facilities as indicated on the drawings.
2. All connections to water pipes and drains must be made in advance and in accordance with the drawing and temporarily sealed.

23.2 WATERTIGHTNESS TEST

1. The connections from the sanitary facilities to the indoor sewer system must be tested for watertightness.

23.3 MANUFACTURER/SUPPLIER PROCESSING INSTRUCTIONS

1. Processing must be carried out in accordance with the processing rules to be provided by the manufacturer/supplier at the time of delivery.

23.4 APPLIANCES

1. Numbers:
 - Floor mounted duravit including all accessories
 - Duravit urinal including all accessories
 - Toilet paper holder grohe
 - Toilet brush set grohe
 - Duravit countertop washbasin including all accessories
 - Mirror Dim. 800x700mm
 - dustbins
 - washbasin hansgrohe tap
 - Hansgrohe shower complete

24. ELECTRICAL INSTALLATIONS

24.1 TECHNICAL SPECIFICATIONS

24.1.1 RESPONSIBILITY AND CAPACITY OF THE PRODUCTS

All goods to be offered must be of genuine quality, data sheets and specifications must be provided for all goods, together with the warranty period and conditions. Offers without certifications and real quality are considered unusable. For all materials and/or rented materials, the contractor must provide the owner with a copy of the receipts, which clearly shows the origin of the materials.

If the contractor has processed goods without permission, the owner is entitled to demand their removal and replacement with the correct goods, i.e. materials, at the expense of the contractor. The contractor must provide a certificate of origin to the owner of all building and installation materials. If the Owner deems it necessary to have details of the characteristics of the building and installation materials and other relevant data, the Contractor is obliged to provide them to the Owner.

24.1.2 MATERIAL

The contractor must supply all materials. These materials must be of good quality. Working and processing of materials must be carried out in accordance with the manufacturer's instructions. The contractor must provide all the necessary equipment and resources. The equipment and resources must be sufficient and of good quality to carry out the work. Rejected equipment and resources should be replaced immediately. Equipment and equipment brought to the site may not be removed from the site until all the work for which they have been supplied has been completed. In order to complete the works described in the specifications within the established construction time and according to the conditions and facilities set, the contractor must provide:

- the necessary tools
- equipment
- transport

For all materials and/or rented materials, the contractor must provide the owner with a copy of the receipts, which clearly shows the origin of the materials.

24.1.3 MATERIALS AND TOOLS

The Contractor must carry out all necessary work, supply the necessary materials, use the necessary tools and equipment and carry out all transports for the proper execution of the work as laid down in these specifications and the accompanying drawings under the terms and conditions. within the set construction time.

24.1.4 EXECUTION PLANNING

The contractor's schedule must contain at least the following information.

- Realistic timetable with the order of activities
- Workforce planning

- Sketch layout of construction site (location of warehouses, storage, etc.)
- Subcontractor Entry
- Critical Points for Owner Approval
- Environmental, health and safety planning, including waste management

24.1.5 DIMENSIONS

The contractor must verify all the dimensions specified in the specifications. Deviations in dimensions in the plans do not entitle the contractor to compensation.

24.1.6 DELIVERY OF THE WORKS

The contractor must submit a written request to the owner, specifying when the work will be completed. After receipt of the request, the Owner will inform the Contractor in writing of the day and time on which the delivery will take place no later than three days before the date and time of delivery determined by the Owner. After the completion of the work, the owner-engineer must report to the contractor within three working days whether the delivery of the work has been approved. If the work is rejected, the contractor must carry out the repair work within a period to be determined by the owner. The contractor is obliged to observe this period. After written approval of the work, this counts as the first delivery.

24.1.7 MAINTENANCE PERIOD

After the work has been designated as the first delivery, the contractor must keep the work in good condition for a period of twelve months. After the maintenance period has expired, the work must be delivered in good condition for the second delivery. The fact that the work or parts thereof have been put into use by the Client does not affect the Contractor's maintenance obligation insofar as it concerns reasonable use.

24.1.8 REPAIR, CLEANING AND POLISHING WORK

All demolished surfaces must be cleaned, purified and polished.

After cleaning and polishing the surfaces, the owner must check and approve the work. The owner must inspect the demolition work.

24.2 IMPLEMENTATION ELECTRICITY WORKS

24.2.1 ELECTRICITY IN GENERAL

All electricity supplies and installations must be delivered installed and ready for use. The installation work must be carried out in accordance with NEN 1010 and the most recent rules of the N.V. EBS. All installation work must be carried out assembled. The execution of each part must be approved in writing in advance by the owner. The contractor must provide receipts for all materials used to the owner. Installation to be carried out by certified company (valid certificate to be submitted with proposal). All electrical work must be carried out with US (USA) outlets.

24.2.2 SWITCHES AND SOCKETS

Switches and sockets should be fitted to the walls and/or concrete ceilings. Switches should be mounted so that in the on position, the bottom of the control switch is depressed. All switches, sockets, facilities and installations must be delivered ready for use. Circuit breakers must be of the ETIMAT, OEZ or equivalent type. The circuit breaker box must be of the IDE type or equivalent.

Type of lighting according to the lighting plan must be of the LED type.

24.2.3 EXISTING SYSTEM

Only limited information is available from the existing system. No layout plans, no electrical plans. No supply plan.

24.2.4 NEW SYSTEM

The new system is designed see electrical documents

The contractor must verify the existing system (cable, junction box, pipes, etc.). A detailed list of materials should be presented with the materials that have been demolished and reinstalled.

24.2.5 TRANSITION PLAN

For the transition, the power cable to the specific building must be used. The extension of each section consists of lighting and sockets, in such a way that the functionality of the building is met.

Instructions:

1. All lamps can be replaced by LED lamps
2. All non-professional extension cords must be removed

24.3 SOLAR INSTALLATION

24.3.1 BATTERY INVERTERS

24.3.1.1 COMPONENT REQUIREMENTS

- Battery inverters must comply with IEC 62109.
- All battery inverters must be new.
- Battery inverters of all locations must have a rated battery voltage of 48 Vdc.
- The manufacturer and model of the chosen battery inverter must have been present on the international market for at least 5 years.
- The design must take into account a possible system expansion in the future. The total battery inverter capacity must be able to be expanded by at least 25%.
- Battery inverters must be compatible with the battery type and must provide means to protect the battery by implementing an interface to the BMS or by implementing a battery control on its own, which serves the same purpose. When using lead-acid batteries, the inverters must include the battery charge/discharge control function through suitable algorithms with different charging states, through adjustable voltage thresholds and status duration. The algorithms must be temperature-compensated, and the system must include an external battery temperature sensor and all associated accessories. When using Li-ion batteries, the battery BMS manufacturer and inverter manufacturer must certify the compatibility of their equipment, and the inverter must arrange the battery according to the battery manufacturer's specifications.
- The battery inverters can be single-phase or three-phase, as long as the whole of all battery inverters forms a three-phase grid with a nominal frequency of 60 Hz and the same nominal power is allocated to each phase.
- Battery inverters must be able to operate in parallel with other battery inverters, PV inverters and the diesel generator. The design should include all the necessary components and accessories for proper synchronization between all components.
- Battery inverters must be able to charge the batteries via the diesel generator and/or via the main AC bus.
- Battery inverters should be able to start the diesel generator automatically, depending on the SoC of the battery. When the diesel generator is on, the battery inverters must be able to operate in parallel with the diesel generator.
- Deep discharge protection must be included. The inverter must stop any operation other than charging if the battery voltage or the SoC is below the minimum allowable threshold. The threshold value must be programmable.
- An overload protection must be included. The inverter must stop any charging operation if the voltage of a battery cell is higher than the maximum allowable voltage. If excess power comes from the PV inverters, the system must limit the output power of the PV inverters to protect the batteries from overcharging. This can be done by increasing the line frequency or by using external controllers.
- Insulation protection must be included. The inverter should be disconnected if a loss of insulation on the DC side is detected.

- An overcurrent protection must be included. The inverter must not exceed the maximum charge/discharge current specified by the battery manufacturer.
- Battery inverters must have an ambient temperature range that is at least between 15 °C and 45 °C. The manufacturer shall provide a temperature derating curve taking into account an ambient temperature range of 15 °C to 45 °C. It is required to use this derating curve in the design process.
- The continuous power at an operating temperature of 40 °C must not be less than 80% of the rated continuous power at an operating temperature of 25 °C.
- The maximum total harmonic distortion (THD) should not exceed 5%.

- Battery inverters must be able to configure their shutdown and alarm levels based on battery voltage or SoC.
- The maximum efficiency must be equal to or greater than 95%. The manufacturer shall specify the efficiency at different power points, including at least 5%, 20%, 50% and 100% of the rated continuous output power at 25 °C.
- The IP protection must be at least IP20 according to IEC 60529.
- The product warranty must be at least 5 years.
- Indicate the manufacturer:
- Specify the model:
- Indicate the continuous power per inverter at 25°C in kVA:
- Indicate the voltage output

24.3.2 INSTALLATION REQUIREMENTS

- Battery inverters should be installed as close as possible to the batteries and the DC main board to avoid energy loss and voltage drop in the DC line. Do not expose the inverters to direct sunlight.
- Adequate ventilation and ease of replacement in the event of inverter failure must be taken into account. The inverter heat sink plate should be free of obstructions to facilitate the cooling of the inverter. The distances recommended by the manufacturer must be observed.
- Ensure that the ambient temperature remains within the specified range under all conditions.
- Inverters must not be installed near flammable objects. Explosive and/or corrosive fumes should be kept away from the inverter.
- The mounting structure for the installation must be strong enough to support the weight of the inverter.
- The inverter must be mounted vertically. The installation of other equipment in the vicinity of the inverter must always comply with the manufacturer's instructions, so as not to disturb the cooling air flow.

24.3.3 PV CHARGE CONTROLLERS

24.3.3.1 COMPONENT REQUIREMENTS

- Charge controllers must comply with IEC 62109-1 and/or UL 1741.
- All charge controllers must be new. For all locations, except the Cluster, all charge controllers must be from the same manufacturer and model. If the Cluster location has DC-coupled SBUs, the charge controllers may be from a different manufacturer and/or model than those of the rest of the locations.
- The manufacturer must have been present on the international market for at least 5 years.
- Charge controllers must be based on Maximum Power Point Tracking (MPPT) technology.
- Charge controllers must be able to work with lead-acid batteries and must integrate the charge/discharge control function of the battery via suitable algorithms with different charge phases (Bulk, Absorption, Floating, Equalization).
- Charge controllers must be able to work with Li-ion batteries and their associated BMS.
- The algorithm must be able to compensate for the battery temperature. A battery temperature sensor must be properly supplied, configured, and installed.
- Charge controllers must be able to configure their shutdown and alarm levels based on the battery SoC.
- For all locations, except the Cluster, the maximum PV voltage must be equal to or lower than 150 V.
- The maximum efficiency should be higher than 97%.
- The IP protection must be at least IP20 according to IEC 60529 or equivalent.
- Charge controller must be protected from short circuits, overheating, and reverse polarity.
- Charge controller must have an ambient temperature range that is at least between 15 °C and 45 °C.
- The standby self-consumption must be less than 5 W.

- The product warranty must be equal to or greater than 5 years.
- Indicate the manufacturer:
- Specify the model:
- Specify the maximum PV voltage in V:
- Indicate the maximum continuous output current in A per charge controller.

24.3.3.2 INSTALLATION REQUIREMENTS

- The charge controllers must be installed in a dry and protected area. Do not expose the charge controllers to direct sunlight.
- Adequate ventilation and ease of replacement in the event of a charge controller failure must be taken into account. The charge controller cooling plate should be clear of obstructions to facilitate cooling. The distances recommended by the manufacturer must be observed.
- The ambient temperature must remain within the specified range under all conditions.
- Charge controllers should not be installed near flammable objects. Explosive and corrosive fumes should be kept away.

- The mounting structure must be strong enough to support the weight of the charge controller.
- The charge controllers must be mounted vertically. When installing other equipment in the vicinity of the controller, always follow the manufacturer's instructions so as not to disturb the cooling air flow.

24.3.4 PV PANELS

24.3.4.1 COMPONENT REQUIREMENTS

- Charge controllers must comply with IEC 62109-1 and/or UL 1741.
- All charge controllers must be new. For all locations, except the Cluster, all charge controllers must be from the same manufacturer and model. If the Cluster location has DC-coupled SBUs, the charge controllers may be from a different manufacturer and/or model than those of the rest of the locations.
- The manufacturer must have been present on the international market for at least 5 years.
- Charge controllers must be based on Maximum Power Point Tracking (MPPT) technology.
- Charge controllers must be able to work with lead-acid batteries and must integrate the charge/discharge function of the battery via suitable algorithms with different charge phases (Bulk, Absorption, Floating, Equalization).
- Charge controllers must be able to work with Li-ion batteries and their associated BMS.
- The algorithm must be able to compensate for the battery temperature. A battery temperature sensor must be properly supplied, configured, and installed.
- Charge controllers must be able to configure their shutdown and alarm levels based on the battery SoC.
- For all locations, except the Cluster, the maximum PV voltage must be equal to or lower than 150 V.
- The maximum efficiency should be higher than 97%.
- The IP protection must be at least IP20 according to IEC 60529 or equivalent.
- Charge controller must be protected from short circuits, overheating, and reverse polarity.
- Charge controller must have an ambient temperature range that is at least between 15 °C and 45 °C.
- The standby self-consumption should be less than 5 W.
- The product warranty must be equal to or greater than 5 years.
- Specify the manufacturer (Cluster site):
- Indicate the model (Cluster site):
- Specify the maximum PV voltage in V (Cluster site):
- Specify the maximum continuous output current in A per charge controller (Cluster site):
- Indicate the manufacturer (rest of sites):

- Indicate the model (rest of sites):
- Indicate the maximum PV voltage in V (rest of sites):
- Indicate the maximum continuous output current in A per charge controller (rest of sites):

24.3.4.2 INSTALLATION REQUIREMENTS

- The charge controllers must be installed in a dry and protected area. Do not expose the charge controllers to direct sunlight.
- Adequate ventilation and ease of replacement in the event of a charge controller failure must be taken into account. The charge controller cooling plate should be clear of obstructions to facilitate cooling. The distances recommended by the manufacturer must be observed.
- The ambient temperature must remain within the specified range under all conditions.
- Charge controllers should not be installed near flammable objects. Explosive and corrosive fumes should be kept away.
- The mounting structure must be strong enough to support the weight of the charge controller.
- The charge controllers must be mounted vertically. The installation of other equipment in the vicinity of the controller must always comply with the manufacturer's instructions, so as not to disturb the cooling airflow.

24.3.5 PV-MODULES

24.3.5.1 COMPONENT REQUIREMENTS

- The PV modules must have the following certificates from an independent laboratory: IEC-61215, IEC 61730-1, IEC 61730-2 and IEC TS 62804. Compliance with these standards must be documented through a certificate from an independent certification body.
 - All PV modules must be new and from the same manufacturer and model, and therefore have the same characteristics. Modules with manufacturing defects such as breaks, stains, cells that are misaligned or cracked, bubbles in the envelope film, etc., will not be accepted and must be replaced.
 - The manufacturer must be quality certified by an internationally recognized certification body (TUV, UL or similar) in ISO9001 and ISO14001.
 - The manufacturer must have been active in the PV production market for at least the last 10 years.
 - The PV cell technology must be polycrystalline or monocrystalline silicon.
 - The PV modules must consist of 60, 72, 120 or 144 PV cells.
 - The rated power under STC conditions must be equal to or greater than 280 Wp, with a positive power tolerance.
 - The efficiency under STC conditions must be greater than or equal to 16%.
 - The bidder must provide a flash list with the results of the I-V test of each module (Pmp, Voc, Isc, Vmp, Imp). The test must be performed under STC conditions with a Class AAA flasher and according to IEC 60904-1.
 - The PV modules must have an anodized aluminum frame. The front glass must be made of tempered glass with a low iron content, with a minimum thickness of 3 mm.
 - The PV module must be able to withstand a maximum system voltage of 1000 Vdc.
-
- All modules must be equipped with connectors (MC4 or equivalent), a junction box with a minimum IP65 rating and at least 3 bypass diodes. The cross-section of the conductors must be at least 4 mm².
 - The PV module label must contain the following information: manufacturer's name, model number, serial number, Isc, Voc, Imp, Vmp, Wp, maximum system voltage.
 - The bidder must provide a power guarantee that guarantees a maximum STC power degradation of 10% for the first 10 years and 20% for a period of 25 years.

- The bidder must provide a minimum product warranty of 10 years.
- PV strings in a DC-coupled SBU must not have Voc above 150 V at a temperature of 15 °C.
- PV strings in an AC-coupled SBU must not have Voc above 1000 V at a temperature of 15 °C.
- If the charge controller does not have surge protection, PV strings in a DC-coupled SBU must have a Voc at a temperature of 15°C, which is lower than 95% of the maximum input voltage allowed by the charge controllers.
- PV strings in an AC-coupled SBU must have a Voc at a temperature of 15°C, which is lower than 95% of the maximum input voltage allowed by the PV inverter.
- PV strings in an AC-coupled system must have a Vmp at a temperature of 25°C and at a temperature of 60°C that are within the MPPT range of the PV inverter.
- Manufacturer:
- Model:
- Cell type: (polycrystalline / monocrystalline)
- Number of cells:
- Rated power (Wp @STC):
- Power tolerance (%):
- Efficiency (% @STC):

24.3.6 PV MOUNTING STRUCTURE

24.3.6.1 COMPONENT REQUIREMENTS

- The structures should be designed to support the proposed PV modules.
- The structures must take into account the terrain: available space, security, access for assembly, as well as free spaces for cleaning and maintenance activities. The layout drawings in Annex B define the available areas and can serve as a reference.
- All materials and components must be new and from the same manufacturer.
- The structure can be made of hot-dip galvanized steel or anodized aluminum alloy. Hop-dip galvanized steel structures must have an anti-corrosion coating of at least 60 µm. Galvanized steel structures must be tested by a standard certification such as ASCE 7/10. All bolts and nuts used must be made of stainless steel, with a grade of 304 or 316. All materials used for the structure must be corrosion resistant.
- Aluminium profiles must be pre-cut to the final size before anodising, to avoid sharp edges without coating.

- To prevent corrosion, metals of different types must be separated by suitable materials (e.g. rings made of synthetic materials such as fluorocarbon polymer, phenolic, neoprene rubber or equivalent).
- The structure must be designed to withstand a minimum wind speed of 100 km/h.
- The foundations can consist of reinforced concrete, weighted with weights on the ground or screwed to the ground. The foundation design must take into account the existing soil properties.
- Welding is not allowed on site. All parts must be sized to fit all their sections and lengths, avoiding welded joints.
- In the case of a welded structure, galvanizing must be carried out after production.
- The product warranty is at least 10 years.
- Indicate the manufacturer:
- Specify the model:

24.3.6.2 INSTALLATION REQUIREMENTS

- The slope should be 10 degrees to the horizontal. If the conditions on site do not allow the PV structure to be installed at this optimal angle, a small deviation can be considered acceptable. The derogation must be explained and justified in a technical note.
- The structure can be south-facing or have a double orientation (east-west structures), as long as the bidder proves that the loss of the annual energy yield (kWh/year) of the PV system is less than 3% compared to the annual energy yield of the south-facing system. The proof must be provided through simulations with PV-specific software such as PVSYSY or equivalent.
- The structure should be designed to mount 2 rows of PV modules in portrait position (vertical) or 3 rows in landscape position (horizontal).
- The distance between the structures and the perimeter fence must be equal to or greater than 4 m.
- South-facing structures and East-West structures must have a minimum separation distance between the structures of 1.5m and 1m respectively, as shown in the layout proposal drawings in Appendix B. The separation distance must be sufficient to facilitate the cleaning and inspection process of the PV module.
- The structures must have a minimum height between the ground level and the lowest point of the PV modules of 1 m.
- The separation between the PV modules and the fastening system must allow thermal expansion without transmitting stresses that may damage their integrity or cause deformation.
- The design must leave sufficient clearance for a possible future expansion of PV capacity, taking into account the sites specified in Appendix B. A minimum expansion of 10% of PV capacity should be considered.
- The design should minimize the risk of theft of PV modules as much as possible (e.g. tamper-resistant screws).
- Indicate the orientation (single orientation/double (East-West) orientation):

24.3.7 LI-ION BATTERY

- Batteries must comply with relevant standards, including IEC, UL, and transportation standards such as UN38.3.
- All battery components must be new. The battery from both locations must be from the same manufacturer and model.
- The rated voltage of the battery must be 48 Vdc. The rated voltage of the battery of the Cluster location must be less than 1000 Vdc.
- Lithium iron phosphate (LFP) batteries are preferred.
- The energy density of the battery cell must be higher than 110 Wh/kg.
- The maximum charging current of the cell must be equal to or greater than 0.5C.
- The maximum continuous discharge current of the cell must be equal to or greater than 0.5C.
- The operating temperature range of the batteries must be at least between 0°C and 45°C.
- At a depth of discharge (DoD) of 85%, the number of cycles must be equal to or greater than 3000 at a temperature of 20°C and a charge/discharge rate of 0.25C.
- The self-discharge must not exceed 4% per month at a temperature of 20°C.
- The battery must contain a BMS with at least the following functionalities:
 - Control and balance of each individual battery cell.
 - Management of the charge/discharge profile based on the type of battery.
 - Protections: overcharging, undercharging, over-temperature, overload and a possible explosion.
 - Setting critical thresholds.
 - Alarm management system.
- The integration of the BMS into the control and monitoring system of the power plant must include at least the following parameters:
 - Soc
 - Accuspanning
 - Accutemperaturen

- Over or under voltage (min, max, nominal)
- Over or under temperature (min, max, nominal)
- Each battery polarity must be protected by an overcurrent protection device (DC circuit breaker or DC fuse) for paralleling the batteries on the common DC main bus.
- All bare live parts must be properly insulated.
- The product warranty is at least 2 years.
- Each battery module must be identified with at least the following information:
 - Manufacturer and model
 - Serial number
 - Manufacture

- Rated voltage (V)
- Nominal capacity (kWh)
- Indicate the manufacturer:
- Specify the model:
- Specify the rated voltage: