

Design Criteria and Standards

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1 Introduction and General Stipulations

1.1 General

- This is the Design Criteria and Standard document for the **civil works**.
- The requirements in the **Particular Design Criteria and Standards** overrule the general requirements in of the **Design Criteria and Standards**, in case of discrepancies.

2 Definitions

2.1 The following words and expressions shall have the meanings hereby assigned to them:

Term	Explanation
Contractor	Means the entity named as contractor in the main contract.
Employer	Means the entity named as employer in the main contract.
DCS	Or “ Design Criteria and Standards ” means the documents as referred to in Annex 5 or the Employer requirements hereof, and including any specifications and other Employer requirements in respect of the Works to be carried out by the Contractor, if any, and any Variation to such document.
PDCS	Or “ Particular Design Criteria and Standards ” means the documents as referred to in Annex 4 or the Employer requirements hereof, and including any specifications and other Employer requirements in respect of the Works to be carried out by the Contractor, if any, and any Variation to such document.
Site	Means the construction site named in the main contract.

3 Codes and Standards

- a) The design, manufacturing, provisions, installation and construction of all works, shall conform to the local Codes and Standards of the country of the works and shall conform to the Codes and Standards mentioned in the DCS.
- b) The design and construction of the Works must be carried out in accordance with the regulations and requirements of all relevant legal authorities, including the Employee Health and Job Safety Regulations.

4 Scope of Work & Engineering Concept

4.1 General

- a) In order to achieve proper constructions, the following requirements shall be fulfilled:
 - Resistance and stability;
 - Hygiene, health and environment,
 - Safety in exploitation,
 - Protection against noise,
 - Energy efficiency

- Fire protection
- b) All requirements within this document take in consideration the **minimum requirements**.
- c) If any country code requires a higher or stricter requirement the Contractor must comply with, including all regional and site specific safety regulations.
- d) The Employer establishes a design review and should have the right to accept or reject the proposed design.

4.2 Work, Material and Conditions

- a) Building materials, working methods, site equipment, etc., must applicable for the condition at Site.
- b) All materials and manufactured items are included in the project shall be new and unused.
- c) All works shall be executed in a safe and clean way in a high-quality workmanship.
- d) Work of the contractor, equipment, labor, etc., must be of adequate size and of such capacity, that all work in a timely and efficient manner than through the project construction schedule is defined and carried out in complete accordance with the applicable rules

5 General Requirements

5.1 Site Inspection and Infrastructure before preparing an offer

- a) The Contractor has examined the site and identified all conditions, accessibility, the full extent and nature of operations, the nature of the soil, environmental conditions, due to the limitations of existing structures and services for the general conduct of the contract.
- b) The Contractor has checked the availability of building materials, the availability of water and electricity, availability of land for fabrication and construction yard, labour colony, housing for construction employers, etc.
- c) The contractor checked all possible conflicts between the plant operations and the executions of the Works in advance and have been included in this contract if any.

5.2 Site Inspection and Working methods during erection

- a) The Contractor is responsible for notifying the Employer's personnel for site inspections, at least 48 hours in advance, if the work is ready for inspection. It does not exempt the Contractor from performing all required quality control inspections of its own and does not relieve the Contractor from his responsibility.
- b) The interfaces and conflicts between the Works to be executed and the plant operations should be analysed from the Contractor. The Contractor ensures that the chosen execution method avoids any obstacle or hindrance of the plant operations.

5.3 Contractor's survey

- a) The Contractor is responsible for all necessary survey work, including but not limited to:
 - Locating and measuring
 - Construction control
 - Survey checks and documentation on buildings and structures after completion (as built)
 - Survey checks and documentation on underground utilities and infrastructure after completion (as built)

5.4 Checking of Dimensions and Levels

- a) All dimensions and levels of new and existing works are shown in the drawings to be checked on site by the Contractor as early as possible.

- b) The Constructor is responsible for the accuracy of all dimensions and setting out on the site.
- c) The Contractor must verify “as-built” drawings and “as-built” works to assure proper fit of all new facilities and equipment.

5.5 Controls and Requirements during Construction

5.5.1 Settlement Survey Control

- a) The Contractor will provide a settlement survey for all settlement sensitive buildings and constructions, as defined by the Employer before contracting, during execution and the warranty period with measurements minimum every 6 month.
- b) The Contractor shall ensure that the settlements will meet the requirements given by the equipment suppliers and plant serviceability.
- c) Estimations of the short and long-term settlements will be provided for all process buildings with the design proposal.

5.5.2 Dust, Vibration and Noise

- a) The Contractor will minimize Dust, Vibrations and Noise.
- b) The Contractor must keep the Dust, Vibrations and Noise out of his operation within the accepted limits out of the permission and the regulations of the Public, Health and Safety Authorities.
- c) All conditions imposed by law on Contractor's operations are included in the Contractor duty and costs and without of extending the deadline.

5.5.3 Cleanliness of the building site

- a) The Contractor will ensure all the time that the working and storage areas are in a clean and non- hazardous condition.
- b) The site shall be free from debris caused by waste or waste from execution. After the completion of the work, the Contractor will remove all waste, rubbish, tools, equipment, temporary buildings or structures and all surplus materials.
- c) The Contractor will leave the work area clean and in a state made fit for immediate use.
- d) All surplus materials will be removed by the Contractor to such places on the Site, as determined by the Employer. All temporary foundations for temporary buildings, cranes, etc. will be removed and filled up with clean suitable material on costs of the Contractor.
- e) The Contractor will make a proper drainage concept/plan for the construction period. The Contractor will make, at his own cost, all necessary drainage and pumping, so that the work stay dry during the execution of the works and until Final Acceptance of works by the Employer.

5.6 Protection of the Works

- a) The Contractor will, if necessary or as instructed by the Employer, protect all buildings, works, facilities and equipment from damage by frost, heat, water, excessive moisture, extreme weather conditions or other causes. Construction will be secured or protected from any event until Final Acceptance of works by the Employer.
- b) Costs out of damages before Final Acceptance of work are to be borne by the Contractor.

5.7 Safety and Security

- a) The Contractor will ensure at all times the safety of all people and the safety of work.
- b) The Contractor will follow and enforce all Country, Region and company safety guidelines and codes.

- c) The Contractor will always have the responsibility for his own security arrangements within the site area of the works at all time.
- d) The Work must be physically barricaded from plant operations and each interface must be carefully coordinated with the plant. The Contractor will ensure at all times that the safety of construction works within the site of the works in relation to the prevailing rules of the security of the Country, Region and safety guidelines of the Employer.
- e) It is Contractor's work to barricade his working area and plan construction traffic in a manner as to give minimum disturbance to Plant operations.
- f) During all execution of Works, especially during deep excavation or blasting for excavation purposes, the security of neighbouring structures is the responsibility of the Contractor. If necessary, an adequate monitoring of the adjacent structures according to the statement made by the Employer shall be performed by the Contractor on his own expense.
- g) The Contractor will ensure that all appropriate training and inspection records maintained and available for review by Authorities or Employer upon request. Any and all fines that are issued as a result of safety infractions or citations are to the Contractor's account.

5.8 Temporary works

- a) The Contractor will design temporary works like shoring and strutting of deep excavation works, temporary slopes, culverts, scaffolding/support system for heavy parts at heights and obtain acceptance of the Employer before execution.
- b) The acceptance of the Employer will not relieve the Contractor from his responsibility.

5.9 Method Statements

- a) The Contractor will ensure all the time the safety of the design and construction works. The regulations of the country's security and security policies of the Employer have to be respected.
- b) A work method statement should describe a safe working method statement or a secure workflow and will be prepared by the Contractor to a document with detailed instructions on how to safely perform a work task.
- c) Method statement will be submitted by the Contractor to Employer at the beginning of the project for consideration, review and acceptance. This statement will be submitted latest three weeks before the Contractor starts the activity on site. The method statement will include the following statements:
 - purpose
 - extent/scope
 - references
 - definitions
 - responsibilities
 - equipment
 - backups
 - risk assessment
 - safety and security
 - safety controls
 - procedure
 - attachments (if applicable)
- d) Details of all temporary installations will be presented to the Employer for review prior to installation.
- e) If necessary, an adequate monitoring of the adjacent structures is carried out as per instruction of the Employer on expense of the Contractor.

5.10 Material Supplies, Sampling, Inspections, Tests and Approvals

- a) The Contractor will provide the Employer a list of suppliers intended for delivery the ready mix concrete with the detail information about the supplier for the cement and for the aggregates.
- b) HeidelbergCement Group is interested to use for their own building projects their own building materials, if possible.
- c) Before the contracting a single vendor for supply of ready mix concrete, any cement and aggregates will be agreed between the Contractor and the Employer.
- d) Materials for the Works will be tested as required in this specification and the design. All materials must be new. Only acceptable materials in according with the applicable standards will be used in the Works. A continuous program of sampling will be needed during construction to ensure consistent quality.
- e) The Contractor will cooperate and provide the Employer or his representative free access to examine all the tests, as required by this specification. The Contractor shall give sufficient notice to the Employer of his plan to carry out any and all tests in connection with the work.
- f) Manufactured materials, equipment etc, will be marked or labeled with the applicable Standard prior shipment.
- g) Materials and processes in the manufacture in the workshop and field service subject to inspection and tests conducted by or required by the Employer. The inspections and tests will not relieve the Contractor from responsibility for the provision of material and workmanship in accordance with specified requirements.
- h) Manufactured materials or components that do not comply with the specified requirements will be immediately removed and replaced without additional cost to the Employer. Retesting costs to confirm repairs/replacement are also to the Contractor's account.
- i) Where any item of this specification is subject to the Employer's comment, the Contractor may proceed with this item only after all matters arising from those comments were taken full into account by the Contractor.
- j) The Employer's acceptance of a sample of materials and/or workmanship does not constitute approval of the actual materials and/or workmanship employed in the works but only consent of the particular sample.
- k) As a guideline, but not limited to the extent of the testing program, the following materials and procedures inspected as a minimum requirement:
 - Fill materials – as supplied and in place
 - Concrete, cement, aggregates, admixtures
 - Concrete – mixing
 - Concrete – plastic and hardened state
 - Concrete Trial Batches – destructive testing
 - Water for concrete
 - Roadway surfacing and foundations
 - Formwork
 - Welding – shop and field – ultrasonic; x-ray
 - Coating measurements – galvanizing
 - Coating measurement – primer and coat paints
 - Bolted connections
 - Steel reinforcement for concrete
 - Pipes – drainage, sewerage and water supply
 - Slip form works / Climbing form works
 - Soil compactions
 - Grounding

5.11 Subcontractors

- a) Prior contracting the Contractor will announce all intended subcontractors. If slip form works are intended and subcontracting is allowed under this contract, the subcontractor for slip form works will be announced.
- b) All subcontractors if allowed by the contract are subject to approval by the Employer, before contracting.
- c) Changes after the contract are permitted only with the written consent of the Employer.
- d) The Employer reserves the right not to allow suppliers, vendors or subcontractors site access unconditionally.
- e) Any reasons for blocking local access have been discussed during the bidding phase. Examples of reasons to deny access are poor safety record, theft, failure of performance according to contract, etc.

5.12 Warranty

- a) The warranty period for all civil- and steel structures is at least **5 years**.

5.13 Discrepancies, Objections and Reservations

- a) Discrepancies, Objections and Reservations to any Employer's requirement or specification have been discussed and resolved before contracting.
- b) No claims from the Contractor in these regard will be accepted by Employer after contracting.

6 Technical Specifications

6.1 General design

- a) All design for walkways, platforms and stairs has to respect the local minimum requirements especially for rescue routes.
- b) Platforms and stairs above roads and public walkways must be closed to have a protection against dropping materials.
- c) The design must meet the relevant codes and standards.

6.2 Walkways and platforms

- a) Platforms will provide access to equipment, which requires periodic inspection, lubrication, adjustment, repair or replacement. All maintenance access, hoist ways, monorail capacity, access doors and locations, etc. must be reviewed and accepted by the Employer during the bid phase of the project.
- b) Main access walkways will have a minimum clear width of 0.8 m and clear height of 2.3 m. Secondary access walkways with infrequent usage will have a minimum clear width of 0.6 m and clear height of 2.3 m.
- c) The clearance all around the mechanical equipment will be at least 1.0 m or more if required by maintenance.
- d) Walkways must be provided along conveyor belts.
- e) Up to a range of a belt width of 630 mm the walkway will be provided along one side with at least 800 mm width.
- f) As of a belt width of more than 630 mm the walkway will be provided along both sides with at least width of 600 mm one side and 800 mm on the other side.

6.3 Stairways

- a) Stairways will be provided for access to platforms and floors where the operation and maintenance personnel must have access on frequent bases.
- b) The minimum width and height clearance is 0.8 m and 2.3 m.
- c) For secondary stairways with infrequent usage the minimum width and height clearance is 0.6 m and 2.3 m.

- d) Stairways will not have any projections into the clear area specified, or reduce in width at any point.
- e) The maximum riser height shall be 200 mm and the minimum tread 230 mm.
- f) The step dimensioning formula of riser (r) and tread (t) will be $2r + t = 630$ mm, but not less than 600 mm and not more than 660 mm.
- g) The ratio of rise (r) to tread (t) shall be $r/t = 0.8$ (200/250 mm), corresponding to an angle of 38.6° .
- h) Stairway angles shall not be more than 45° (only where limited space) nor less than 30° when measured against the horizontal plane.
- i) The slope within one flight of stairs should be constant.
- j) One flight of stairs should not exceed 3 m in height. In case of only one single flight of stairs the height can be maximum 4 m, but only with the acceptance of the Employer.
- k) The number of stairs should be limited to 18 steps in one flight of stairs.
- l) The platform between 2 flight of stairs should be minimum the width of the stair, but not less as 800 mm.

6.4 Stair- Ladders and ladders

- a) Stair- ladders and ladders should be provided at places, where no regular maintenance is necessary and only occasional access is required
- b) For stair- ladders the maximum riser height shall be maximum 250 mm and the minimum tread shall be 80 mm. The minimum width and height clearance is 0.6 m and 2.3 m. The slope within one flight of stairs should be constant. One flight of stairs should not exceed 3 m in height.
- c) Ladders shall be minimum 400 mm wide with horizontal solid rod rungs at 300 mm distance.
- d) For ladders with more than 3.00 m height is a safety cages needed.
- e) The height for a single ladder without platform is maximum 6.0 m.
- f) Alternative stairway or stair ladder design and construction will only be permitted after acceptance by the Employer.

6.5 Design Life

The lifetime is to be at least **50 years**.

6.6 Live Loads and Dead Loads

- a) The static and dynamic loads of the process equipment and machinery including liners and/or insulation have to be respected and taken into account in the design and anchorage detailing.
- b) Floor and roof live loads and dead loads shall be **shown in the drawings**.
- c) The design loads listed are the **minimum requirements** of the Employer. If the **applicable loads or local standards** are higher, the more stringent requirements are to be used for the calculation and design.

6.6.1 Roof Live Loads

- | | |
|--|-------------------------|
| d) Live Load for inaccessible roofs | 1.0 KN / m ² |
| e) Live load for accessible inclined roofs | 2.0 KN/ m ² |
| f) Live load for accessible flat roofs | 3.5 KN/ m ² |
| g) Dust Load | 0.5 KN/m ² |
| h) Utility loads | |

6.6.2 Floor Live Loads

- a) Floor live loads shall be based on probable area loading in addition to equipment loads
 - Operating and maintenance floors 3.5 KN / m²
 - Access platforms and walkways 3.5 KN / m²

- | | | |
|---|----------------------------|-------------------------|
| • Low voltage rooms (< 1 KV) | 5.0 KN / m ² | |
| • Middle voltage rooms | 10.0 KN / m ² | |
| • Conveyor walkways | 2.5 KN / m ² | |
| • Enclosed and chequer plate floor, if spillage can accumulate or higher* | | 5.0 KN / m ² |
| • Open and grated walkway | 3.5 KN / m ² | |
| • Stairways | 3.5 KN / m ² | |
| • Burner floor | 25.0 KN/ m ² ** | |
| | | |
| • Preheater tower | | |
| • Feeding chamber platform (Kiln level) | 25 KN/m ² * | |
| • All areas for transport and storing refractory | 25 KN/m ² ** | |
| • Other areas of Preheater Tower | 5KN/m ² | |

*Reference to 5.6.10 Risk analysis

**Reduced to 15.0 KN/ m² for building columns and foundation systems, if allowed according country codes and PDCS.

- b) All walkways and platform beams to support a moving load of 5.0 KN. This is used for checking single member size. The uniform and concentrated loads described above are not to be applied simultaneously. The 5.0 KN concentrated load is to be applied over an area of 750 mm x 750 mm.
- c) Loads associated with trucks, forklifts and other vehicles have to be considered, if applicable.

6.6.3 Wind Loads and Snow Loads

- a) The wind and snow loads shall be according to country codes and PDCS.

6.6.4 Seismic Loads

- a) The seismic loads shall be according to country codes and the PDCS.
- b) The seismic load design requires prior acceptance by the Employer.

6.6.5 Crane Loads

- a) Based on the given loads from the original equipment manufacturer
- b) Vertical wheel loads
- c) Lateral load
- d) Longitudinal Loads

6.6.6 Equipment Loads

- a) Death loads
- b) Live loads
- c) Static loads
- d) Dynamic loads

6.6.7 Impact Loads

- a) All columns placed near truck, wheel loader, fork lift or other vehicles ways shall be designed for horizontal impact loads according to the relevant standards. Alternatively, impact protection barriers must be foreseen.

6.6.8 Other Loads

- a) Process Duct Loads incl. Dust and Insulation
- b) Expansion and friction loads
- c) Loads due to soil pressure
- d) Loading condition due to sequence of construction
- e) Dynamic pressure loads (at curves, elbows, etc)
- f) Loads out of temperature and temperature differences

- g) Loads out of temperature due to radiation
- h) Critical temperature effects
- i) Emergency loads
- j) Others

6.6.9 Load reduction

- a) Load reduction for the maximum live load capacity at all levels to be considered for the foundations and the supporting structures, based on the codes and standards mentioned in the PDCS and the Country codes.
- b) The reduction of the loads has to be submitted with the offer and have to be accepted by the Employer.

6.6.10 Risk analysis

- a) For spillage or other accumulations a risk analysis has to be done, especially for transfer points and to be submitted to the Employer for acceptance.
- b) For load combinations a risk analysis has to be done and to be submitted to the Employer for acceptance.

6.7 Allowable Displacements and Deflection Limits

- a) The structure must be designed so as to meet the usability requirement of vertical and horizontal displacements of foundations, buildings, floors, facades according to the design standards out of the PDCS and the Country Codes under all conditions.
- b) If the equipment is supported by several supports, the supports must be executed so that detrimental differential settlements are avoided.
- c) Deflections and displacement in structures due to the different loads are not permitted to exceed the values which are specified limits by the equipment and machinery provider or out of the PDCS and the Country Codes.
- d) For each construction the full usability shall be given.
- e) The Employer shall be entitled to claim the verification of serviceability for his acceptance.
- f) Structural vibrations have to be considered according the requirements of the equipment and machinery supplier.
- g) For each construction the full usability shall be given.
- h) The Employer will be entitled to claim the verification of serviceability for his acceptance.

6.8 Vibrating equipment

- a) Contractor shall consider structural vibrations and dynamic loads according the specification of the machinery supplier and shall provide vibration frequency calculations and propose measures for the construction for the acceptance of the Employer.
- b) The foundations shall be sized to restrict accelerations to levels acceptable to the manufacturer and the Employer.
- c) Vibrating equipment must be isolated so as not to pass along the vibration to affect adjacent equipment and office spaces.

6.9 Design Calculations

- a) The Contractor shall make available to the Employer detailed calculations for all structures and all connections, as well as the bearing loads for the substructure or the foundations (divided in the different load combinations). Equipment foundations and floor beams supporting vibrating equipment shall be analysed for dynamic loads and calculations for the same shall be provided.
- b) Design Calculations are to be conducted in an orderly manner and held to be submitted to the local authorities for approval. Calculations must be signed and

sealed by a professional engineer, with a copy provided to the Employer for his records.

- c) The calculation must be done with approved software, which is accepted by the local authorities.
- d) Calculations shall be available in the **Local and English language**.
- e) The design calculation and all related documents will be handed over to the Employer as soon as possible, but not later than 3 months before start of erection.

6.10 Drawings for Review and structural calculations

- a) Design drawings and structural calculations must be provided for the Employers design review and acceptance minimum at least 6 weeks prior to erection. The drawings / calculations will meet the following requirements:
 - Drawings/ load drawings / calculations and schedules shall give complete information necessary for checking the type of construction and the construction method.
 - The drawings /calculations shall show location, size, quality and quantity of materials, details of construction, method of erection and other data to evaluate each item.
- b) The Employer's review, comments and acceptance of the key plans and the shop drawings shall in no way relieve the Contractor of the total responsibility of the works.
- c) **Structural calculations** shall be provided to the Employer at Contractor's costs in Pdf-file. On Employer request the Contractor shall provide the calculation and in another electronic format (e.g. EXCEL).
- d) **General arrangement and detail design drawings** shall be provided to the Employer at Contractor's cost as follows:
 - Two full size hard copy, folded A4 / A3 on request (or bigger on request)
 - Two electronic copies (pdf-file and dwg-file)
- d) **"As built" drawings** shall be supplied at Contractors cost at the end of the contract, in the same formats as follows:
 - Two full size hard copy, folded A4 / A3 on request (or bigger on request)
 - Two electronic files (pdf-file and dwg-file)
- e) All document revisions following the Issue for Construction release need to be identified by an increase in the revision number, the revised portion of the document clouded by a revision cloud with corresponding revision triangle and a reason or explanation for the revision annotated on the document. The drawings and structural calculations shall be in local and English language and shall be in metric system.
- f) All documents provided to the Employer by Contractor shall have a full document list which must include:
 - name of document
 - type of document (drawings, calculations, folders etc.)
 - revision number
 - elaboration date

6.11 Design, Quality Assurance and Quality Control

- a) The design of the various building structures will depend upon their final use.
- b) They shall be designed to allow for quick and easy installation and cost effective maintenance of the relevant process equipment.
- c) The design shall also consider the structural adequacy during erection as it is the erectors responsibility to ensure that all structural components of a system remain sound and safe during the construction sequence. This may require temporary guiding or supports.
- d) All constructions shall be mainly maintenance-free.
- e) The Contractor shall provide the Quality Assurance and Quality Control documentation (QA/QC) in order to ensure the compliance of the materials and the products with the requirements of the Project documentation: This document, the

Design Drawings, the other applicable Specifications, the Contractual Requirements and the Shop Drawings. The Employer will review and have to accept the QA/QC documentation during the bid phase of the project.

- f) The Contractor and its subcontractors and vendors provide free access to the Employer or his inspectors, which allows each inspection, test or survey at any time, any production and manufacturing or assembly operations.
- g) Periodic QA/QC reports (period to be define by the Employer's site team) are required to describe the status and quality of the fabrications.

6.12 Special requirements

6.12.1 Daylight design

- a) All buildings should have a daylight design that all floors are sufficient day lighted, if not mentioned different in the PDCS. The appropriate daylight design shall be in accordance with the relevant industrial standards.

6.12.2 Noise reduction

- a) All the building enveloping such as walls, roofs, doors, gates, windows, louvers and others to respect the limits of the environmental impact study and the noise of all existing and new equipment. Sound calculations have to be submitted to the Employer for acceptance.

6.12.3 Ventilation systems

- a) Suitable ventilation systems and air conditioning systems have to be provided where unwanted internal temperatures and/or air pressure on workplaces and/ or machinery/equipment occurs. Maximum wind speed not more than 0.5 m/s inside buildings and 2.0 m/s trough louvers.
- b) All electrical rooms shall have to be under positive pressure and sufficient cooling to maintain temperatures according to his equipment recommendations.

6.12.4 Sump-pits

- a) In every basement and tunnel should be provided a sump-pit with a metal cover at the lowest point for drainage.

6.12.5 Silos

- a) The Contractor shall provide water and dust tight silos made from reinforced concrete or steel.
- b) The maximum surface crack widths for concrete silos is for generally limited to 0.2 mm and for raw meal and cement silo limited to 0.15 mm.
- c) Asymmetric charge and discharge with eccentric loads have to be considered in the silo design.
- d) Maximum temperature differences out of hot bulk materials due to the process and the lowest ambient air should be respected.
- e) Design temperatures for the structural calculation should be taken from process and presented with the offer to the Employer for acceptance.
- f) The Contractor has to provide adequate manholes and access points and submit the design to the Employer for acceptance.
- g) Concrete silos should respect wear on the wall and the cone and the thickness of the concrete cover should be sufficient.
- h) The Contractor shall indicate the net and the gross volume for each silo.
- i) Specific individual concrete single chamber silos with a diameter greater than 14m should be designed and executed as a post- tensioned construction. If the Contractor plans to design and build silos bigger than 14 m without post-tensioning, he have to indicate this in the offer and this is subject to acceptance by the Employer..

7 Execution of works

- a) A foreman, who is able to communicate in the **local and English language or by means of a skilled translator**, shall be on site at all times during erection until completion of the erection. Specifications and instructions shall also be kept on the site.

7.1 Site Installation

- a) Before starting the execution works, the Contractor have to prepare and submit for Employer's review the method statement with all information about site installations and site infrastructure including provisional access roads. The Contractor has to maintain all necessary infrastructures until end of the project, with adequate safety and cleaning conditions.
- b) After finishing the project all site installation have to be removed and should be restored in the original condition to the satisfaction of the Employer.

7.2 Demolition

- a) The necessary demolition works including disposals shall be part of the scope.

7.3 Piling works

7.3.1 Pile record document

- a) A pile record document should be prepared for each pile.
- b) This document should contain the following item, but not limited for other items:
 - Building
 - Location
 - Construction Company
 - Number of pile
 - Drawing number
 - Installation date with start and end time
 - Length of pile with bottom and top level
 - Quality of reinforcement
 - Quality of concrete
 - Temperature during concreting
 - Remarks

7.3.2 Pile test program

- a) The costs of a suitable pile test program should be included in the offer.
- b) Dynamic pile test must be confirmed with a sufficient number of static pile tests.
- c) The number of static and dynamic tests should be proposed by the Contractor based on local rules and is subject to acceptance by the Employer.
- d) The results of the pile test program must be hand over to the Employer for acceptance before starting the foundation works in this area.
- e) Piles which failed during the testing program must be replaced with a suitable number of additional piles on costs of the Contractor. The structural calculation must be checked and adapted accordingly.

7.3.3 Drilled piles

Reinforcement cages

- a) The reinforcement cages for drilled piles have to be welded to be rigid.

7.3.4 Concrete cover

- a) The concrete cover must be ensured with suitable measures, like welded hooks.
- b) The concrete cover and the measures to ensure the concrete cover should be proposed by the Contractor and is subject to acceptance by the Employer.

7.3.5 Cased and non-cased borehole

- a) The Contractor must announce before contracting, if he wants to bore without cased borehole. This is subject to acceptance by the Employer. Without this acceptance before contracting, only cased boreholes will be allowed.

7.3.6 Driven Piles

Pile driving

- a) The driven piles shall be done with fixed leads to hold the pile in its position and to ensure the alignment. The number of blows has to be reported. If any unexpected ground conditions, unexpected change of drive characteristic or misalignment occurs the Contractor must inform the Employer immediately.
- b) Piles which failed during driving program or are misaligned must be replaced with a suitable number of additional piles on costs of the Contractor. The structural calculation must be checked and adapted accordingly.

7.4 Earthworks

- a) Work Included (but not limited to)
 - Excavation
 - Compaction
 - Backfill
 - Protection of the pits and trenches
 - Health and safety
 - Respect of the maximum angle of the pit based on the material
 - Shoring
 - Drainage
 - Site grating

7.4.1 Excavation

- a) All excavation works have to be done with suitable devices and tools.
- b) Excavations shall be accurately excavated shown on the Contractor's drawings.
- c) The bottom of the excavations shall be undisturbed soil or suitable compacted material.
- d) The maximum slopes of the berm and the number of necessary berms have to be respected. All slopes have to be in a stable condition.
- e) Excavations must be shored or braced, if necessary.
- f) The excavation has to respect adequate working space for installing formworks and for the safety of personnel. To prevent damage to existing underground piping and devices during excavation and backfill care should be exercised.
- g) In case of trench excavation appropriate safety protection has to be in place.

7.4.2 Shoring, sheeting and bracing

- a) Where necessary excavations have to be suitable shored, sheeted and braced.
- b) For all none standardized systems a structural calculation and a design should be provided for the acceptance of the Employer.

7.4.3 Drainage

- a) All holes, pits and trenches must maintain in dry condition.
- b) Suitable drainage or pumping devices should be provided.
- c) Drainage permits and temporary sedimentation basin with outfall monitoring, if required by the local authorities, are within the scope and the costs of the Contractor.

7.4.4 Excavated Materials

- a) The use or disposal of the excavated material decides and approves the Employer.
- b) Suitable material for backfilling should be stockpiled for reusing.
- c) The costs for the transport and stockpiling are within the scope and the costs of the Contractor.
- d) Non suitable material or surplus material should be disposed at locations accepted by the Employer.
- e) The costs for transport and disposal for none- contaminate excavated material are within the scope and the costs of the Contractor.

7.4.5 Fence and Warning Lights

- a) All pits and trenches have to be fenced and equipped with warning lights.

7.4.6 Filling Materials

- a) Filling materials should be suitable for the intended use.
- b) The material should be homogenous and without any contamination.
- c) Materials for the construction of compacted fill areas shall be compactible filling materials without organic pollutions.
- d) In countries where deep temperature can occur, frost resisted material has to be used in areas, where temperatures below 0° C are possible.
- e) The maximum size of lumps or stones of the filling material should be less than 75 mm.
- f) The use of recycled materials is only permitted with the acceptance of the Employer.

7.4.7 Construction of Fill and Backfill

- a) The filling should be done in horizontal layers with 30 cm thickness.
- b) Filling shall not be performed when frost or other conditions prevent proper compaction of the material.
- c) Fill and backfill shall be compacted to not less than:
$$\begin{array}{lcl} E_{V2} & = & 45 \text{ MN/ m}^2 \\ \text{and} & & E_{V2}/E_{V1} < 2,5 \\ (E & = & \text{elastic modulus}) \end{array}$$

7.4.8 In-Place Tests

- a) In-place compaction tests will be performed by the Contractor on his own expense, when required from the Employer.

7.4.9 Site Grading and Surface Drainage

- a) After the completion of the construction works a finish site grading should be done to the final designed elevations and slopes from the Contractor's drawing. The finished surface should have no un- drained area with water accumulation.

7.5 Concrete Works

7.5.1 General

- a) All necessary equipment, material, workmanship and devices related to concrete works should be included and covered by this chapter and shall include the following (but not limited to):
 - Piling and injections
 - Subgrade foundations
 - Building foundations

- Floor slabs, columns and beams in buildings and structures
 - Equipment foundations
 - Conveyor towers and support foundations
 - Silos and Stores
 - Pavements
 - Miscellaneous concrete structures
 - All grouting
 - All anchor bolts
 - Embedded metal
 - Prefabricated concrete part
- a) The concrete specified in this section should be ready-mix concrete supplied from an Employer approved ready-mix plant and approved cement and aggregate suppliers.

7.5.2 Concrete

- a) The **water-cement-ratio** has to be **equal or lower than 0.5**.
- b) Trial mix results for each designated mix shall be submitted to the Employer prior to any concrete being placed in the works.

7.5.3 Strength Requirements and Testing

- a) The characteristic compressive strengths have to be tested in a sufficient number and satisfactory test results have to be achieved in compliance with the Country Codes and PDCS on his own expense.
- b) The Contractor is responsible for ensuring that the compressive strength of the concrete as placed is not less than specified.
- c) The Contractor shall take samples of concrete for testing as specified and requested by Employer, but not less than specified in the Country Codes and PDCS.
- d) The Contractor shall make, cure, store, transport and test the cubes in compression in an approved laboratory in accordance to the Country Codes and PDCS on his own expense.
- e) Concrete tests for suitability and workability are required for the slip form works and for other.

7.5.4 Cement

- a) Cement shall be conforming to the requirements of the country codes and PDCS.

7.5.5 Aggregates

- a) Aggregate consists of crushed, clean, uncoated, hard and sound particles of rock or water-washed gravel, according to the country codes and PDCS.
- b) The maximum diameter is 32 mm. The space between the reinforcement has to be considered for the maximum grain size.
- c) Aggregate must have sufficient strength, must be clean, durable, and free of absorbed chemicals and free of coatings and clay as well as other materials in quantities which could effect the hydration of the cement paste.
- d) The usage of **recycling materials is not permitted**.

7.5.6 Water

- a) Water shall be clear and free of harmful quantities of oil, acid, alkali, salts, organic materials or other hazardous materials.

7.5.7 Admixtures

- a) All admixtures shall be in line with the local regulations and shall have the acceptance of the Employer.

7.5.8 Delivery Tickets

- a) Each portion of concrete used for the project site shall be equipped with duplicate delivery tickets.
- b) Delivery tickets shall provide at least the following information:
 - Contractor
 - Ready-mixed concrete plant
 - Country code plate of truck
 - Date and dispatch time at the mixing plant
 - Build-in location
 - Brand name of cement
 - Classification of cement
 - Amount of cement per m³
 - Size and grading curve of aggregates
 - Water/ cement ratio
 - Kind and amount of admixtures
 - Water and/or admixtures added at job
 - Temperature of concrete

7.6 Reinforcing Steel

7.6.1 General

- a) Reinforcing steel and welded wire mesh shall be detailed, furnished, fabricated and placed in concrete structures as shown on the Contractor's drawings and as specified herein. Special care is to be taken to observe and maintain all design splice lengths and locations.

7.6.2 Materials

- a) Contractor shall supply and apply reinforcing Steel, mesh reinforcement and pre-stressing steel to be supplied conforming to the Country Codes and PDCS.
- b) For each delivery of reinforcement steel at the construction site the Contractor has to submit to the Employer the certifying of the quality of the steel.
- c) Certificate should contain the results of these tests:
 - Resistance to stretching
 - Limits of yielding
 - Longitudinal extension before braking
- d) All steel reinforcement is to be supplied by works or depots must hold a valid Certificate of Approval for the manufacture and/or fabrication of steel reinforcement.

7.6.3 Reinforcing Bars

- a) The Contractor will design and fabricate reinforcing steel in accordance with the requirements of Country Codes and PDCS.
- b) All bars are to bent cold.
- c) Bars shall not be straightened or re-bent again.
- d) Bars with kinks or bends not shown on the Contractor's drawings shall not be used.
- e) Heating of bars will only be permitted with the acceptance of the Employer.
- f) All reinforcing steel as fabricated must be free from loose mill scale, rust, oil and grease and from coatings that destroy or reduce the bond to the concrete.
- g) No cutting of reinforcing bars with a torch is allowed.
- h) Binding wires for slip form works are recommended to be galvanized.

7.6.4 Pre-Stressing reinforcement

- a) Pre-stressing reinforcement is very sensitive against corrosion. It must be protected against humidity and water. After inserting the pre-stressing reinforcement into the ducts the post-tensioning of the pre-stressing reinforcement and the grouting of the ducts must be executed in due time (max. 4 weeks), according to the manufactures regulations, Country Codes and PDCS.
- b) All activities of inserting the strands, post-tensioning and grouting of the ducts must be recorded and submitted to the Employer for acceptance.

7.6.5 Placing of reinforcement

- a) The reinforcing steel should be placed exactly and spaced in accordance with the relevant drawings. Reinforcing steel must be well secured to prevent displacement during installation and placing of concrete by using suitable measures. Sufficient number of supports for reinforcing steel is used to prevent sagging of bars or mesh.
- b) Reinforcement shall be clean of the ground and protected from mud, oil and other substances, which may adversely affect its use in the works
- c) Employer shall review the reinforcing after installation for acceptance.

7.6.6 Cover

The concrete cover shall be in accordance with the soil and environment aggressiveness.

- a) The minimum concrete cover protection for reinforcing steel shall not be less than:
 - Bottoms of footing and other concrete cast against the ground 60 mm
 - Bottoms of footing and other concrete cast against lean concrete 40 mm
 - Surfaces exposed to weather 40 mm
 - Surfaces in contact with the ground after removal of forms 40 mm
 - Slabs and walls not exposed to weather or ground 30 mm
 - Silo walls outside 50 mm
 - Silo walls inside 50 mm

7.6.7 Cleaning

- a) Before any placement of concrete, the reinforcing steel must be inspected and cleaned. All materials and waste that may prevent effective bonding or create voids in the concrete must be removed.
- b) Grout coatings on reinforcing steel from previously placed concrete must be cleaned out.

7.7 Concrete Construction

7.7.1 Formworks

- a) The formwork shall be completed for the complete part to be poured, before casting.
- b) The shape of the formwork is to match the design of the accepted drawings.
- c) Excavated surface will not be used as form without permission of the Employer.

7.7.2 Design of Formwork

- a) The formwork and bracing shall be designed and constructed for the loads, lateral pressures and deflections by the Contractor and is part of his Means and Methods. Allowable stresses, tolerances and the deflection under load shall be taken into account.
- b) In cases where deflections getting to big, the formwork shall be cambered to compensate the deflections due to the load of the fresh concrete.

- c) Execution tolerances out of the Country Codes and Particular Conditions for the final construction have to be considered.
- d) All exposed concrete-edges shall have a 20 to 25 mm chamfer (i.e. be broken with triangular fillets 2.0 cm x 2.0 cm). Excluded are the areas of flush joints between e.g. concrete and masonry or attachment of doors and gates
- e) All pits shall have a sump hole with a metal cover and require the floor slabs to slope to the sump. Any finished concrete floor areas that hold ponded water will have to be removed and replaced. The repair must be acceptable to the Employer and all costs will be to the Contractor's account.

7.7.3 Tolerances

- a) **Formwork shall be constructed to ensure that the concrete surfaces will conform to the all tolerances of the Country Codes and PDCS.**
- b) The requested **accuracy is in general +/- 1 cm in all directions**, if there is no need of more preciseness. Anchor bolts should all have a sole plate that accurately matches the base plate to ensure alignment. Anchor bolt thread must be secured and maintained and shall allow double nutting.

7.7.4 Form surface

- a) The joints of the surfaces shall be butt and linear.
- b) The formwork must be tight to avoid run-out of cement grout. The form must be coated to prevent bond with concrete. The joints of the surfaces shall be butt and linear.
- c) All exposed concrete is to be rubbed smooth and there be one consist colour and texture with all tie rod holes patched.
- d) Slip forms are preferred to be made out of steel with a steel surface.
- e) Slip forms made out of plywood can be used with the acceptance of the Employer.
- f) The internal slip form should have a slight conical form; the external none. The slip form shall rigid with bracing elements to avoid oval shapes.
- g) Additional requirements are in the document **Instruction for slip form works**

7.8 Placing Concrete

7.8.1 Preparation before Placing

- a) The formwork must be completely installed and braced.
- b) Water, snow, ice, frost, dirt or other foreign materials must be removed.
- c) The reinforcement and all built- in parts should be installed like sleeves, joint materials, anchors and other embedded materials must be installed and fixed in precise position.
- d) All surfaces of formworks, the embedded materials, reinforcement as well as the conveying equipment, should be cleaned from concrete previously placed and have to be encrusted from dried mortar. All contact surfaces of old construction which the concrete is to be placed against shall be free from water, mud and foreign debris.
- e) Do not place any concrete on frozen ground, frozen fill material or frozen old construction.

7.8.2 Inspection and Acceptance before Placing

- a) Give the Employer at least 48 hours notice and opportunity before placing concrete to permit proper inspection of forms and reinforcement by the Employer. Pour card must be signed prior to the placement of any concrete.
- b) Pour cards are the Employer's permission to place concrete.
- c) The Contractor, the Electrician (if applicable for earthing and lightning works) and Employer's representative have to sign the pour card prior to any concrete

placement. Failure to comply could result in that the Contractor has to remove and replace the Work at his expense

7.8.3 Conveying

- a) Concrete from the mixer to the place of final pouring shall be moved as fast as possible by methods, which will prevent separation, or loss of ingredients and in a manner, that will assure that the required quality of the concrete remains.
- b) Clean the conveying equipment at the end of any operation or workday.
- c) When pumping or pneumatically conveying, use equipment of suitable pumping capacity. Control the placement so that segregation is not apparent and do not allow the concrete to drop more than 1.2 m. Where greater drops are required use a tremie or elephant trunk for a better control. Control the discharge so that the concrete can effectively be compacted/vibrated in horizontal layers not more than 300 mm. The loss of slump shall not exceed 50 mm. Do not convey concrete through pipe made of aluminium or aluminium alloy.

7.8.4 Pouring

Concrete will be poured continuously in layers of suitable thicknesses.

- a) Placing of the individual layers shall be kept as short as possible to achieve an effective bond between the layers. The new layer has to be placed before the old one sets.
- b) It is not allowed to pour concrete on concrete, which hardening stage is no more plastic, to avoid cold joints.
- c) If a section cannot be placed continuously, construction joints shall be located at points as approved by the Employer.
- d) Concrete, which has partially hardened or has been contaminated by foreign materials, shall not be used.
- e) Concrete should not discharge from the truck longer than after 90 minutes after first water was mixed with the cement. Concrete with admixtures for enlarging the workability should not discharge longer than 180 minutes after first water was mixed with the cement. Exceptions are possible with special measures, but only with an acceptance of the Employer.

7.8.5 Segregation

- a) Concrete will be poured as close as possible in its final position to avoid segregation due to re-handling or flowing. Concrete shall not be handled by any procedure, which will cause segregation. Do not use vibrators to transport concrete within forms. Concrete shall not free fall more than 1.2m. Where greater drops are required the use a tremie or elephant trunk to control decent is necessary.

7.8.6 Consolidation

- a) All concrete shall be consolidated by vibration.
- b) Mechanical vibrators shall have a sufficient minimum frequency and shall be operated by skilled workmen.
- c) The concrete should enclose the reinforcement and the embedded items entirely.
- d) All air on the surface of the formwork, in the concrete and around the reinforcement and embedded items must be eliminated. Honeycombing or pitting of concrete should be avoided.
- e) The use of vibrators to transport concrete within the forms is not allowed.
- f) Vibrators shall be inserted and removed at many points with a distance between 500 to 700 mm.
- g) Each application of the vibrator into the concrete should be approximately 10 sec.
- h) Over vibrating with durations more than 30 sec shall be avoided.
- i) During all concrete placing operations a stand-by vibrator should be on site.

7.9 Atmospheric Conditions

7.9.1 Rain or Snow

- a) Concrete shall not be placed during rain or snow without adequate protection and the acceptance of the Employer. Rainwater or snow shall not increase the mixing water and shall not damage the surface finish.

7.9.2 Cold Weather

- a) Concrete should not be placed against frozen or icy surfaces.
- b) At the time of casting the temperature of concrete shall not be less than 5° C. Pouring of concrete to temperatures less than 5° could be made only with special methods and actions, which have to be accepted by Employer.
- c) After pouring the concrete temperature must be maintained between 10°C and 22°C for the next 7 days. Methods of heating materials and protecting the temperature of concrete shall be considered.

7.9.3 Hot Weather

- a) Concrete cast at hot weather conditions shall have a maximum placing temperature of 32°C. Difficulties like high loss of slump, flash set, or cold joints should be avoided. Methods of using a cooler for the water at the batch plant or other methods may be considered.

7.10 Finishing

7.10.1 Floor Slabs

- a) The coarse aggregate must be away from the top surface. The surface shall be treated with a smoothing tool such as a steel trowel or a screed board.
- b) If a non-skid surface is required for this a light broom finish will be used.
- c) Inside of production buildings or storage halls a finishing with a trowelling machine shall be used.
- d) Floor cover shall meet the functionality of the building. It shall be easy to clean, provide best hygienic conditions, adequate optical impact, meet safety requirements (not slippery when wet) and best lifetime conditions

7.10.2 Foundations

- a) The coarse aggregate shall be away from the top surface. The surface gets a treatment with a smoothing tool like a steel trowel.
- b) In areas where base plates or base frames from equipment to be installed a rough surface can be produced with a scratch in two directions.

7.10.3 Exposed surfaces

Horizontal surfaces exposed to weather shall have an inclination to prevent puddles.

7.11 Curing

7.11.1 General

- a) All concrete must be cured by membrane curing or water curing.

7.11.2 Membrane Curing

- a) The water-retaining sealing compound shall be applied direct after top finishing of the concrete surface. The certification and the manual for application from the manufacturer have to be respected.

7.11.3 Water Curing

- a) Water has to be clear and free of harmful quantities of oil, acid, alkali, salts, organic materials or other hazardous materials.
- b) The water application shall start direct after top finishing of the concrete surface and shall continue at least 10 days. The surfaces should be wet continuously by an approved
- c) method and equipment.
- d) Water curing is not the preferred after treatment measure and has to be accepted by the Employer.

7.12 Protection

7.12.1 Freshly Deposited Concrete

- a) In the time of hardening and curing the concrete shall be protected from hot or cold temperatures, premature drying and rain and running water.

7.12.2 Formwork Surfaces

- a) Due to the heat of hydration and/or the heat from the sun the formworks with contact to the concrete shall kept wet during hot periods during the curing period.
- b) After removal of the formwork during the curing time, the curing of the free concrete surface have to executed immediately.

7.12.3 Injuries by Accidents

- a) The concrete shall be protected during hardening and curing time from any damages.
- b) Stress and shocks out of mechanical or other accidents, heavy vibrations, shocks and load stresses shall be avoided. Suitable measures shall be taken.

7.13 Masonry

7.13.1 General

- a) This work consists of furnishing of all equipment and materials and erecting masonry structures.

7.13.2 Handling and Storage

- a) Masonry stones must be handled carefully to prevent spalling and cracking. Masonry stones should be stored dry to prevent damages caused by weather, traffic or other reasons.

7.13.3 Bricks and Blocks

- a) The building bricks and blocks shall be frost-resistant for areas, where temperatures below 0°C can occur.
- b) All masonry should be from the same production run and should be uniform in colour.

7.13.4 Anchors and Ties

- a) Anchors and ties shall be galvanized. To use different types of anchors and ties are only permitted with the approval of the Employer.

7.13.5 Workmanship

- a) All masonry has to be laid to be uniform, level and plumb, if there is no other specification.
- b) Brickwork which is not intended to plaster must have a uniform joint-forming, without visible grout or mortar stains.

- c) All necessary cuts of the masonry have to be accurate and precise to have a uniform joint width. All openings and cut outs should be properly executed.

7.13.6 Construction

- a) All masonry walls shall be of sufficient strength and thickness to withstand all dead and live load and wind pressure. For bigger walls with bigger height or/and length R.C. columns, beams and frames should be considered.

7.13.7 Atmospheric Conditions

- a) Masonry stones may not be set when the temperature of outside air is lower than 5° C, unless suitable means are provided to heat the masonry material and in order to protect the finished work from freezing.

7.13.8 Scaffolding and Equipment

- a) The Contractor shall provide for the purpose of carrying out the work, install and maintain safe and adequate scaffolding and other equipment. All equipment for mixing and transporting mortar and masonry must be clean and free of the set mortar, dirt or other foreign substances.

7.13.9 Water and Damp Proofing

- a) On the exterior side of the masonry, a layer of clear and water repellent silicone should be applied.

7.13.10 Clean-Up

- a) After completing of the masonry work, the contractor shall dismantle its scaffolding and equipment and remove waste, debris and surplus masonry from the building site

7.14 Grouting works

- a) The base plates of the machines and the construction shall be temporarily supported on steel wedges and shims and properly aligned before grouting.
- b) All pockets and the whole area of the base plate have to be cleaned out.
- c) The surface shall be roughened by chipping, sandblasting or using other mechanical means in order to have a good bond of grout to concrete. Any oil and/or grease soaked concrete and loose, damaged or cracked concrete shall be removed until solid and sound concrete is reached and well visible. Just before grouting all water shall be removed.
- d) For the grouting a suitable non-shrink mortar shall be used.
- e) To ensure that no air pockets are left after grouting additional holes may have to be cut in base plate.
- f) Grouting of Machine foundations shall be done after taking the written instruction and in the presence of Erectors
- g) The instructions of the **supplier** for grouting material have to be respected.

7.15 Roofing and Cladding

- a) Roofing and cladding will be used to cover buildings or structures and for special tasks, like fire resistance, noise reduction, heat insulation or other functions.
- b) The proposed covers of all buildings and structures should be submitted to the Employer during bidding process for approval. Requirements from the **PDCS** should be considered.
- c) The materials have to respect the weather conditions and the chosen solution must be waterproof and weatherproof.
- d) The thickness of the insulation should fit to the requirements out of the special tasks of the cladding.
- e) Vapour barrier should be considered to prevent moisture in the insulation.

- f) The design and construction must take into consideration that pedestrians sometimes walk on the roof for maintenance reasons.
- g) Protective roof coating over concrete roofs shall be applied. The Contractor will provide the selected roof coating in his offer.

7.16 Personnel and Service Doors

7.16.1 Doors

- a) All doors for industrial buildings and the outside doors of ancillary buildings, if not otherwise specified in detail description and/or drawings shall be made of two seamless steel sheets, each min. 1.2 mm thick with a metal door steel frame.
- b) The space between the two sheets shall be filled with appropriate and fireproof insulating material. The overall door thickness shall be not less than 45 mm.
- c) The doors shall be furnished with all necessary hardware and devices for attachment to building structures and shall be set in a structural steel frame.
- d) The outside doors for insulated buildings must be sufficient insulated in a commercial quality made by a reputable manufacturer complete with closers.
- e) Doors must have clear-wired glass vision panels where required.
- f) If necessary, acoustic insulation and/ or thermal insulation are to be considered.
- g) Service doors shall be big enough to allow removal of the largest piece of equipment contained within the room. Service doors may also have removable overhead transoms or can be, provided with suitable cut outs to accommodate hoist beam extensions, and flashed with rubber or similar materials.
- h) A linkage device shall be provided for service doors with difficult access to assist in opening and closing the doors safely from inside of the building.
- i) At elevated doors and gates relative to the outdoor level, safety chains across the opening or other suitable devices shall be provided.
- j) The exterior doors shall always open outward for escape reasons.
- k) Door sizes shall be, if possible, standardised and have to be indicated on the drawings.
- l) Door sizes and door types and related accessories must be reviewed and accepted by the Employer.
- m) The Employer will select the colour for doors.

7.16.2 Hinged Type Doors

- a) Hinged type doors shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of this type of product.
- b) Hinges are generally heavy duty, ball bearing type in sufficient number and spacing for resistance to prolonged wear.
- c) Door frames for all exterior service doors shall be structural steel frames with removable steel doorstops. All doors will be weather and rain proof. All doors will have thresholds or floor elevations designed so that ponded storm water cannot enter the room.

7.16.3 Roll-up Doors

- a) Roll-up doors shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of this type of product and shall be weather proof. Curtain shall be formed of galvanized interlocking steel slats. Roll-up doors may be motorized – defined by Employer's demand.

7.16.4 Hardware Doors

- a) Door furniture, closers, stops, holders, hinges, thresholds, weather-stripping, push and pull plates, kick plates, etc, shall be provided for each door and its intended use. Hardware in general shall be specified as heavy-duty type.
- b) All doors shall be equipped for master key system.

7.16.5 Glass and Glazing

- a) Glass in general will be clear double strength quality sheet glass. Where required, "sandwich type" safety class is to be used, for accident prevention.

7.16.6 Door for electrical rooms

- a) Doors for all electrical rooms must be fireproof for 90 minutes (F90) and will be provided with a panic door-opening system for escape from inside to outside.
- b) Doors for all electrical rooms must be dustproof.

7.17 Roads

7.17.1 Scope

- a) The work covered by this section consists of furnishing all equipment and materials, and performing all work required.
- b) Roads should include shoulders, ditches, culverts, parking areas.
- c) The width of the roads will vary depending upon vehicular usage.
- d) The roads shall be drained.
- e) If there is no other specification, the roads must be designed for maximum imposed loads for heavy vehicles. The width has to be sufficient for all vehicles used at plant side.
- f) Contractor shall provide concrete or asphalt roads and pavements.
- g) The Contractor shall submit with the offer his design proposal, where and what type of road and drainage provided for the acceptance of the Employer.

7.17.2 Concrete or Asphalt for Paved Roads

- a) The sub grade layer of the compacted soil must have a bearing capacity of $E_{V2} = 45 \text{ MN/m}^2$.
- b) The Contractor shall provide additional soil replacement, if the existing soil cannot reach this minimum requirement.
- c) The base course will be generally developed from crushed limestone or from existing local aggregate material.
- d) Above base coarse it is necessary to reach a bearing capacity of $E_{V2} = 120 \text{ MN/m}^2$ and $E_{V2}/E_{V1} < 2.2$, (E = elastic modulus).
- e) The surface course will be a 220 mm reinforced concrete slab or 220 mm layers of asphalt. Necessary joints have to be considered and indicated in the drawings.
- f) All materials and the total construction must reach a frost resistant level in countries and areas where temperatures below 0°C are possible.

7.17.3 Compacted Roads

- a) The sub grade layer of the compacted soil must have a bearing capacity of $E_{V2} = 45 \text{ MN/m}^2$.
- b) The Contractor shall provide additional soil replacement, if the existing soil cannot reach this minimum requirement.
- c) The base course and top hard course will be generally developed from crushed limestone or from existing local aggregate material.
- d) Above base coarse it is necessary to reach a bearing capacity of $E_V = 120 \text{ MN/m}^2$ and $E_{V2}/E_{V1} < 2.2$, (E = elastic modulus).
- e) The design shall be able to pave the compacted road later with a top layer with concrete or asphalt.
- f) All materials and the total construction must reach a frost resistant level in countries and areas where temperatures below 0°C are possible.

7.18 Infrastructure

- a) The work covered by this section consists of furnishing all equipment and materials, and performing all work required.

b) Infrastructure can be necessary for (but not limited to):

- Sewage water
- Rainwater
- Process water
- Cooling water
- Heating water
- Potable water
- Water treatment
- Gas
- Electrical installations
- Lighting for roads

c) The Contractor shall submit with the offer his design proposal, where and what type of infrastructure provided for the acceptance of the Employer.

7.19 Earthing and lightning protection and equipotential bonding

a) All specifications and requirements are shown in the Electrical DCS.

b) All equipment concerning earthing system, lightning protection and equipotential bonding shall be drawn in the civil execution drawings.

c) The grounding system shall be uniform and coordinated for all buildings and structures.

d) For plant grounding a potential equalization between all areas shall be foreseen.

e) If applicable the Contractor shall confirm in the pouring card the proper execution of those works before placing the concrete.

7.20 Remedial measures for defects in executed works

a) In case any defect is observed in construction works before final acceptance the defect shall be repaired by the Contractor at his own cost by dismantling and rebuilding or by any other method accepted by the Employer.