

TECHNICAL SPECIFICATION

PROJECT: PROPSOED LPG STATION AT GDH. THINADHOO

**CLIENT:
MALDIVES GAS**

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1. PRELIMINARIES

1.1 Standard and Codes

1.1.1 The Contractor shall, perform the Works in compliance with all regulations, standard specifications or statutes of the Government of Maldives unless otherwise conform to this specification.

1.1.2 The current British Standard Specifications and Codes of Practice shall apply to and form part of these specifications unless otherwise specified in respect of all materials and works to which they have application.

1.2 Drawings and Specifications

1.2.1 Drawings and Specifications are intended to complement each other, so that if anything is shown on the Drawings, but not mentioned in the specifications or vice versa, it is to be furnished and built as though specifically set forth in all three. If any discrepancies, errors, ambiguities or omissions occur in the Drawings or Specifications, the same shall be referred to the Consultant before proceeding with the Works, and the Consultant decision on such discrepancies, errors, ambiguities or omissions shall be final.

1.2.2 In addition to the Drawings and Specifications attached hereto, the Consultant will during the progress of the Works furnish additional Drawings, Specifications, and instructions as may be necessary, in the opinion of the Consultant for the purpose of the proper and adequate execution and maintenance of the Works, and the Contractor shall make his work conform. Such drawings and instructions shall be deemed to be part of the Contract Documents.

1.3 Transportation to the Site

1.3.1 The Contractor shall provide all necessary transport, handling and storage of all materials, components and the like to their points of installation on site including transport to and from storage. The Contractor shall provide all necessary transport of labour to and from the site.

1.4 Schedule and Execution Plan

1.4.1 The Contractor shall prepare and submit to the Consultant for approval the construction schedule and an execution plan of temporary facilities, stock yards, etc., before the start of the Works.

1.5 Repairing and Correction

1.5.1 Any breakage(s) or defect(s) of existing buildings, roads utilities, or part(s) of them caused by the Works including transportation for the works shall be repaired or corrected by the Contractor with his responsibility.

1.6 Workmanship and Materials

1.6.1 All workmanship shall be of the best standard. All goods and materials to be incorporated in the Works must be new, unused, of the most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the contract.

1.7 Obvious Work

1.7.1 Where an item of work is obviously required for the type of work being undertaken then it shall be deemed to have been included even though the item is not specifically mentioned or shown in the Drawings or Specifications.

1.8 Protection

1.8.1 The Contractor shall have the Works and adjoining properties protected from inclement weather. Any loss or damage caused by weather, carelessness or lack of skill of workers, accident or otherwise shall be of such property that are affected.

1.8.2 The work shall be suspended for such time as may be directed and/or approve by the Consultant if the specified quality of work is difficult to maintain during inclement weather.

1.9 Scaffolding

1.9.1 The Contractor shall provide all scaffolding necessary for the proper execution of the Works.

1.9.2 The scaffolds shall be erected safely and convenient for the execution and supervision of the Works and maintained and inspected periodically for safety.

1.10 Construction Machine

1.10.1 All necessary construction machines shall be provided and maintained by the Contractor and shall be approved by the Consultant.

2. SITE WORKS

2.1 Site Clearing

2.1.1 The Site shall be cleared of all vegetation, rock, boulders, etc. and surface soil shall be removed as directed by the Consultant. The trees which are to be retained shall be protected from damage.

2.1.2 Spreading, leveling and consolidating on site where required, shall be made with suitable surplus excavated material obtained from the Site. Other soils used for filling shall be approved by the Consultant.

2.1.3 The Contractor shall dispose all unsuitable and surplus excavated material.

2.1.4 The Contractor shall tidy up and leave the Site in a clean and sanitary condition at all times during the execution of the Works.

2.2 Excavation

2.2.1 Excavation shall be performed to the required depth as shown in the Drawings.

2.2.2 Excavation area shall be protected from any water flowing in. Sides of excavations shall be shored or inclined to retain excavation unless otherwise specified.

- 2.2.3 Excavation near adjoining structures shall be executed with care so as not to damage those structures.
- 2.2.4 Excavated material shall be deposited within specified areas as directed unless otherwise specified.
- 2.2.5 The Contractor is deemed to have inspected the site and to have ascertained for himself as to the nature of the soil, etc. and also the areas where to collect and stack the materials for which necessary site clearance shall have to be made at his own cost.
- 2.2.6 Stacking or excavated materials shall be done at places approved by the Consultant and the original ground levels of such places shall have been recorded by him jointly with the Contractor before commencement of stacking operation.
- 2.2.7 Extra excavation and allied lead/lift required specifically for providing working space to workmen or shuttering to walls of basement etc. shall be measured for payment, no extra claim being allowed for such work incidental to development and executions of allied jobs. Only authorized excavation approved by the Project Architect shall be paid for.
- 2.2.8 Sufficient clear working space shall be left all around excavated area. The disposal of waste/unserviceable materials may be in filling and/or in embankment according to nature of place of disposal. The appropriate specifications for filling and/or embankment shall apply.
- 2.2.9 All foundation trenches shall be excavated to the full widths and depths shown on the drawings or to such greater or smaller depths as may be found necessary in the opinion of the Consultant and so ordered by his representative.
- 2.2.10 Should any excavation be taken down below the specified levels, the Contractor shall fill in such excavation at his own cost with cement concrete specified for foundations, well rammed in position until it is brought up to the level.
- 2.2.11 The Contractor shall notify to the Consultant when the excavation is completed and no concrete or masonry shall be laid until the Consultant has approved of the soil for each individual footing.
- 2.2.12 All foundation pits shall be refilled to the original surface of the ground with approved materials, which shall be well consolidated as directed by the Consultant.
- 2.2.13 The Contractor shall erect temporary barricades around the excavations and if necessary make provisions of red lamps.
- 2.2.14 The Contractor shall remove/maintain/restore all service lines like telephone, water supply, electricity etc. without any extra charges.

2.3 Backfill

- 2.3.1 All earth used for filling shall unless otherwise stated, be selected hard dry material from the excavation.
- 2.3.2 The backfill of excavations shall be placed in horizontal layers not exceeding 300mm in thickness. Each layer shall be compacted by hand or other mechanical means to the required density before the next layer is added.
- 2.3.3 The Contractor shall dewater the excavations and maintain them dry for stability and especially at the time of concreting. The scheme of dewatering shall be approved by the Consultant.

- 2.3.4 Bailing, pumping out or otherwise removing all water which may accumulate in the excavation from all causes.
- 2.3.5 Provision of adequate barriers, lighting, gangways across open trenches, etc. for protection of workmen and public.

3. CONCRETE WORKS

3.1 General

3.1.1 Materials used in the Works shall be new, of the qualities and kinds specified herein and equal to approved samples. Delivery shall be made sufficiently in advance to enable further samples to be taken and tested if required. No materials shall be used until approved and materials not approved shall be immediately removed from the Works.

3.1.2 Materials shall be transported, handled and stored on the site or elsewhere in such a manner to prevent damage, deterioration or contamination.

3.1.3 The following admixtures or equivalent approved by the consultant shall be used in all concrete works

Lean concrete	Conmix MegaFlow SP4 or equivalent
Foundation concrete / any underground concrete	Conmix MegaAdd WL2 and Megaflo Flow SP4 or equivalent
Slabs / beams / Lintel beams / Columns / Stiffener columns	Conmix MegaFlow SP4 or equivalent
Concrete gutters and roof slab	Conmix Mega Add WL2 and Megaflo SP4 of equivalent
For ready mix concrete use	Conmix Mega Flow SP4

Note : All underground concrete and masonry works shall be applied with Conmix MoyaShield RBE bituminous surface / Duproof R100 coating or equivalent as per manufacturers or consultants instructions.

3.2 Cement

3.2.1 Cement shall be Ordinary Portland cement.

3.2.2 Cement shall conform to the appropriate Speciation listed below:

3.2.3 Portland cement - BS 12 (British standard)

3.2.4 Other kinds of cement shall not be used unless otherwise approved by the Consultant.

3.3 Aggregate

3.3.1 Fine aggregate shall be river sand.

3.3.2 Coarse aggregate shall be crushed stone excluding limestone or derivatives of limestone.

3.3.3 Aggregate shall not contain injurious amount of rubbish, dirt, organic impurities and other foreign matters.

3.3.4 Strength of aggregate shall be more than that of hardened concrete paste.

3.3.5 Shape of coarse aggregate shall not be flat or slender.

3.3.6 Aggregate to be used in concrete shall possess the qualities indicated in the following tables.

Quality of Aggregates

Aggregate type	Open dry specific gravity	Percentage of water absorption (%)	Percentage of solid volume for the evaluation of particle shape (%)	Clay lump (%)	Loss in washing test (%)	Organic impurity (%)	Water soluble chloride (%)
Coarse aggregate	≤ 2.5	≤ 3.0	≥ 55	≤ 0.25	≤ 1.0	0	≤ 0.25
Fine aggregate	≥ 2.5	≤ 3.5	-	≤ 1.0	≤ 3.0	0	≤ 0.01

* Colour of test solution not to be darker than standard solution

Grading requirements for aggregates

Percentage passing each sieve by weight (%)

Agg.	Max. size (mm)	Nominal sieve size (mm)	40	30	25	20	15	10	5	2.5	1.2	0.6	0.3	0.15
Coarse	25	100	100	90 ↓ 100	60 ↓ 90			20 ↓ 50	0 ↓ 10	0 ↓ 5				
	20			100	90 ↓ 100			20 ↓ 55	0 ↓ 10	0 ↓ 50				
Fine								100	90 ↓ 100	80 ↓ 100	50 ↓ 90	25 ↓ 65	10 ↓ 35	2 ↓ 10

3.3.7 Manufactured sand and blast-furnace slag to be use in concrete shall not be used unless otherwise specified or approved by the Consultant.

3.3.8 In case of using fine aggregate of 0.01% or more water soluble chloride content, the necessary measures for corrosion inhibiting of reinforcement shall be instructed by the Consultant.

3.3.9 The maximum size of coarse aggregate shall be 25 mm.

3.4 Water

- 3.4.1 Water shall not contain injurious amount of impurities which may adversely affect concrete and reinforcement.
- 3.4.2 Ground water shall not be used for concrete works.
- 3.4.3 Water shall be obtained from a public supply where possible, and shall be taken from any other sources only if approved by the Consultant. Only water of approved quality shall be used for washing out formwork, curing concrete and similar surfaces.

3.5 Handling and Storage of Material

3.5.1 Cement

3.5.1.1 Cement shall be stored in a manner to prevent weathering.

3.5.1.2 Bagged cement shall be piled no more than 10 bags so as to permit easy inspection

3.5.2 Cement caked even to the slightest extent shall no be used. Such cement and rejected cement shall be immediately separated from other bags of cement so that they shall not be mistaken for others.

3.5.3 Aggregate

3.5.3.1 Aggregate shall be stored in a manner effectively separating coarse and fine aggregate according to type and shall be prevented from inclusion of dirt, rubbish and other undesirable foreign matters.

3.5.3.2 Coarse aggregate shall be unloaded and piled in a manner not to cause segregation of small and large particles. Aggregate to be stored in piles shall be in mounds of moderate height and at a location where good drainage is provided.

3.6 Mix Proportion and Strength

3.6.1 ¹Mix ratio for reinforced concrete shall be in the proportion 1:2:3 (cement: fine aggregate: coarse aggregate) by dry volume.

3.6.2 Mix ratio for lean concrete shall be in the proportion 1:2:6 (cement: fine aggregate: coarse aggregate) by dry volume.

3.6.3 Water-cement ratio for concrete shall be 0.4% to 0.45%

3.6.4 The specified design strength of reinforced concrete shall be 30 N/mm²

3.6.5 The required slump of concrete shall be 100 mm.

3.6.6 Design mix proportion shall be to obtain required workability, consistency and durability.

3.7 Production of Concrete

3.7.1 Field-mixed Concrete Plant

3.7.1.1 The Contractor shall select the necessary facilities for storage, batching, mixing and transporting of each of the materials and submit them for approval of the Consultant prior to start work.

3.7.2 Measuring

3.7.2.1 All materials shall be measure by volume for each batch and water may be measured volumetrically.

3.7.2.2 Cement shall be measured by number of bags unless automatic cement weight measure is in use.

3.7.3 Mixing Control

3.7.3.1 Concrete mixture shall be constantly controlled to obtain required workability and mixed strength. Mixing time for each batch shall be not less than 3 minutes.

3.7.4 Quality Control

3.7.4.1 The Contractor shall conduct tests for quality control toward insuring that concrete of the required quality is constantly produced.

3.7.4.2 The Contractor shall have all quality control test report ready for submission as required by the Consultant.

3.7.5 Quality Inspection of Concrete at the Point of Placement

3.7.5.1 The Contractor shall conduct tests on concrete at the point of placement. When test results meet the tolerances given below, the concrete shall be qualified to have passed the tests.

(a) The tolerance between actual slump and required slump of the concrete shall be ± 2.0 mm

(b) All tests shall be carried out with the guidelines issued or presence of the consultant.

(c) Time and number of tests shall be notified by the consultant to the contractor.

3.7.5.2 For the estimation of compressive strength of concrete in compressive strength tests, when the average value of compressive strength of concrete obtained in a test is not less than the specified design strength, it shall be qualified to have passed the test. In case of failure to the above requirements, the Contractor shall take necessary measures such as to perform appropriate test as instructed by the Consultant.

3.8 Transporting and Placing

3.8.1 General

3.8.1.1 The Contractor shall establish manner and schedule for transporting and placing of concrete and obtain approval of the Consultant.

3.8.1.2 Concrete shall be transported in a manner to minimize segregation, spill, age and other changes in quality thereof.

3.8.1.3 Concrete shall be placed and consolidated in a manner to insure uniformity and optimum density.

3.8.1.4 In case of rain or other conditions which may affect the quality of concrete during concreting, the Contractor shall take necessary measures as instructed by the Consultant.

3.8.2 Time Limit

3.8.2.1 The time limit from start of mixing to completion of placing of a batch as rule, shall be 30 minutes.

3.8.3 Preparation Prior to Placing.

3.8.3.1 The place where concrete is to be deposited shall be cleaned and sheathing shall be sprinkled with water. Subsequently, water accumulated in the form shall be removed.

3.8.4 Construction Joint

3.8.4.1 Joint surfaces shall be cleaned, made free of laitance and other foreign matters, and wetted prior to concreting. Joint surface shall be roughened if directed by the Consultant.

3.8.4.2 The locations of shapes of construction joints shall be consulted and approved by the Consultant.

3.8.5 Concrete Placing

3.8.5.1 Concrete placing shall be proceeded to keep the surface of placed concrete as horizontal as possible.

3.8.5.2 Concrete shall be continuously poured to compact around reinforcing bars and corners of formwork..

3.8.5.3 The maximum time interval between placement of continuous concreting shall not exceed 0.5 hours. However, when special measure are taken this time limit may be changed according to instruction or approval of the Consultant.

3.8.6 Consolidation

3.8.6.1 Vibrating of concrete and tapping of formwork shall be performed to wall, column and other places difficult for concrete to proceed. Proper number of workers for placing and compacting concrete shall be arranged.

3.8.6.2 Vibrator shall be operated for concrete called for water tightness, difficult portion for concrete to proceed and other cases directed by the Consultant. However, vibrator shall not be touched reinforcing bars and shall not be operated more than 30 seconds at same spot.

3.8.6.3 Concrete shall be placed 300 - 600 mm thickness at once in case vibrator is performing. In case flexible-insert-vibrator is called for, concrete shall not be placed thicker than the length of the insert or vibrator at one pouring.

3.8.7 Placing Speed

3.8.7.1 Concrete shall be placed at the speed suited for the workability of the concrete and condition of the place of placement, which insures proper consolidation of concrete.

3.9 Concrete Curing

3.9.1 Curing Method

3.9.1.1 After concrete has been placed, the concrete surface shall be kept moist by sprayed with water or by other appropriate methods, and shall be protected from direct sunlight and rapid drying. This curing period shall be for not less than 14 days.

3.9.1.2 As a rule, no foot traffic nor loads shall be permitted on concrete for at least 24 hours after placement.

3.10 Test

3.10.1 General

3.10.1.1 The contractor shall be required to conduct all tests according to British standard method and procedure when the consultant determines.

3.10.1.2 Test, as a rule, shall be conducted at the locations directed or at the testing institutions approved by the Consultant.

3.10.1.3 Test, as a rule, shall be conducted by the Consultant with the employer's approval.

3.10.1.4 In case of failure in test, measure shall be taken as instructed by the Consultant.

3.10.1.5 The Contractor shall keep test records during the work and for 2 years after completion of the contracted work.

3.10.2 Material

3.10.2.1 Cement Test

(1) Setting test.

(2) Soundness test.

(3) Compressive strength test.

Note: Item (1) shall be conducted once in every manufacturer.

Item (2) & (3) shall be conducted once in every 2,000 bags.

3.10.2.2 Aggregate test:

(1) Grading and fineness modules.

3.11 Concrete

3.11.1 Fresh concrete

Slump, air content, shall be conducted daily, and more often at request of the Consultant.

3.11.2 Compressive strength test of concrete

Test for estimation on strength of concrete in structure:

3.11.2.1 In order to assume estimated strength of concrete in structure, compressive strength test shall be conducted for prepared test pieces on the 17th day and 28th day and those test pieces shall be made for sampling at placing of concreting.

3.11.2.2 Strength test shall be conducted for each of the following conditions: each days pour, each class of concrete, each change of supplies or source and each 100 cubic meter of concrete or fraction thereof. The number of test pieces to be used in a test shall be not less than 3 for each test the 7th day and the 28th day unless otherwise instructed by the Consultant.

3.11.2.3 Test pieces shall be made in accordance with British Standards, and sampling shall be taken as near as possible at the point of placement.

3.11.2.4 Test pieces shall be stored without being disturbed and shall be covered during the first 24 hours, and carefully transported specimens to the testing laboratory. Test pieces shall be cured in water after demoulding. The temperature of test pieces shall be kept as close as possible to the temperature of the concrete in structure until the time of testing.

3.11.2.5 The test results shall be expressed in the average value by calculating the average compressive strength of all test pieces. The average value must be equal to or greater than the specified strength.

3.12 Defective Concrete and Finishes

3.12.1 Honeycombed surfaces shall be made good or on the instruction of the Consultant be cut out by the Contractor and by using Conmix ReCon GP or approved concrete repair mortar as approved by consultant.

3.12.2 Concealed concrete faces shall left as from the formwork except honeycombed surfaces shall be made good. Faces of concrete intended to be rendered shall be roughened by approved means to form a key. Faces of concrete that are to have finished other than those specified shall be prepared in an approved manner as instructed by the Consultant.

Concrete formwork

3.13 Structure and Material

3.13.1 Structure

3.13.1.1 Formwork shall be performed to obtain accurate concrete in accordance with the designated drawings.

3.13.1.2 Formwork shall be firmed and secured to bear the force of concreting and tightened to avoid cement paste seeping.

3.13.2 Materials

3.13.2.1 Sheathing for formwork shall be waterproof plywood of not less than 12 mm thick. Joint of sheathing shall be butt joint and firmly assembled. In case of using wood board for sheathing, boards shall be 15 mm thick and applied planer. Joint shall be tongued and grooved unless otherwise approved by the Consultant.

3.13.2.2 Form liners shall be sound and suitable materials to accurately and safely cast the insitu concrete structure as shown on the Drawings.

3.13.2.3 Timber form boards for sheathing where used for fair-faced concrete shall be of such new materials as not to cause any defects to the surface of the concrete. Special care shall be taken in fabrication, storage and protection of these boards.

3.13.3 Other Material

3.13.3.1 Fastening hardware to be used shall be those with allowable tensile strength guaranteed by manufacturer through strength tests.

3.13.3.2 Form application shall not have injurious effects on quality of concrete nor to bonding of surface finishing materials and shall be subject to approval of the Consultant.

3.13.3.3 Form work application shall be Conmix Reform S or equivalent compound that is approved by the consultant.

3.14 Performance

3.14.1 Design of formwork

3.14.1.1 Formwork shall be designed to withstand construction loads during concreting, lateral pressure of fresh concrete, shock and vibrators due to concrete placing.

3.14.1.2 Formwork shall be free of injurious leakage of water, easy to remove, and shall not damage concrete at removal.

3.14.1.3 Supports shall be provided with the adequate horizontal and diagonal bracing and/or stays to prevent collapsing, heaving and twisting of formwork due to horizontal loads working during concrete placing.

3.14.2 Tolerance

3.14.2.1 The dimensional tolerances in location and cross section of concrete member used for designing and construction of formwork shall conform to the following table

Standard Values of Dimensional tolerances

Item	Tolerance (mm)
Tolerance in distance from datum line of each floor to respective members	+ 20
Tolerance in cross section of columns, beams and walls	- 5 , + 15
Tolerance in thickness of floor and roof slabs	0, +20

3.14.3 Fabrication and Erection

3.14.3.1 Erection of formwork, and transportation and storage of materials thereof shall be started only after previously placed concrete has reached an age which acceptance of these loads will not have any adverse effect on the concrete.

3.14.3.2 Sheathing shall be fabricated and installed accurately to match the locations, shapes and dimensions of members called for in the Drawings.

3.14.3.3 Sheathing shall be installed tightly so as not to permit cement paste or mortar to escape from joints.

3.14.3.4 Pipes, boxes and other embedded hardware shall be properly secured to sheathing or others so that they will not move during concrete placing.

3.14.3.5 Supports shall be erected plumb. Supports at any two vertically consecutive floors shall be erected as near as possible to identical locations on a common plane.

3.14.3.6 Shoring shall be erected paying special attention to safety.

3.14.3.7 If sheathing is reused, the surface in contact with the concrete shall be thoroughly cleaned off and sufficiently repaired before reuse. In case of using for fair-faced concrete, the same sheathings shall be used twice after approval of the Consultant.

3.14.4 Inspection

3.14.4.1 Formwork shall be inspected by the Consultant prior to concrete placing.

3.14.5 Striking of forms

3.14.5.1 The minimum period for keeping the forms in position and for watering after laying the concrete shall be as per the following table, except otherwise specified in RCC drawings. Forms shall be removed in such a manner as to ensure the complete safety of the structure, so that there is no shock or vibration as would damage the reinforced concrete. The responsibility for the safety of the concrete shall rest entirely with the Contractor and the Contractor shall be held liable for any damage done and shall have to make good the same at his own expenses. The Contractor shall inform the Consultant when he intends to remove shuttering and shall obtain his consent, but the consent of the Consultant shall not relieve the Contractor of his responsibility.

3.14.5.2 The minimum time for formwork to remain in place shall be as per the following table.

Vertical sides of beams, slabs and columns	48 hours
Soffits of slab	21days
Soffits of beams	21 days
Cantilevers	28 days

3.14.6 Relocation of Support

3.14.6.1 Supports under concrete shall be not relocated

3.14.7 Removal of formwork

3.14.7.1 Formwork shall be removed gently, after the Consultant has approved its removal.

3.14.7.2 Inspection by the Consultant shall be obtained immediately after the removal of sheathing and defects shall be immediately remedied according to instruction of the Consultant.

3.14.7.3 After shorings have been removed, members shall be carefully observed for cracking and deflection, when found, they shall be reported immediately to the Consultant for his instruction.

4. STEEL REINFORCEMENT

4.1 Material

4.1.1.1 Reinforcing steel shall be of the dimensions given in the Drawings.

4.1.1.2 Reinforcing bars shall comply with the requirement of B.S.4449. And welded wire fabric, square bar fabric and expanded metal shall comply with appropriate part of B.S.4483.

4.1.1.3 Dia 6mm reinforcing steel shall be a round mild steel bar, and 12mm and 16mm shall be deformed high strength bars.

4.1.1.4 Any other non-specified reinforcing steel shall be used only with the approval of the Consultant.

4.1.1.5 All reinforcing steel and binding wire shall be stored under cover and shall be at least 250mm above the ground.

4.2 Cleaning

4.2.1 Reinforcing shall be cleaned before use so that it is free from rust, oil, dirt or other coatings that reduce bond.

4.3 Bending and Laps

4.3.1 The reinforcement shall be bent cold in an approved bar bending machine. Preferably bars of full length shall be used. Lapping of bars where necessary shall conform to the following table, otherwise conforming to BS1487 'Bending Dimensions of Bars of Concrete reinforcement.'

4.4 Reinforcement Cover

4.4.1 Concrete cover for reinforcement shall not be less than 45mm for substructure and shall not be less than 40mm for super-structure concrete.

4.5 Placing

4.5.1 Reinforcement intended for contact when passing each other shall be securely tied together with binding wire.

4.5.2 Binders and stirrups shall tightly embrace the longitudinal reinforcement to which they shall be security bound or spot-welded.

4.5.3 Binding wire shall be turned in from the formwork and shall not project beyond reinforcing bars.

4.5.4 All reinforcement shall be inspected by the Consultant and approved before concrete is placed in the forms.

5. STRUCTURAL STEEL

5.1 Scope

This section shall apply to the work involved with structural steels. All incidental items of structural steel shall be stated in the particular specification.

5.2 Materials

5.2.1 Steel

5.2.1.1 Shape of steel shall be precise and straight and free of injurious scratches and rust.

5.2.1.2 All steel sections shall be of strength class 43 A.

5.2.1.3 Dimensions of steel section and tolerance of dimension shall conform to standard dimension of steel regulated in BS standard.

5.2.2 Bolt

5.2.2.1 Shape of bolt, nut, and washer shall be in accordance with requirement of BS 4190 & BS 3692.

5.2.2.2 Quality of bolt shall be SC 43 A.

5.2.3 Welding Rod

5.2.3.1 Arc welding rod shall conform to materials to be welded, and position.

5.2.4 Material Test

5.2.4.1 Material test may be omitted with the approval of the Consultant for standard materials with mill certificates.

5.2.4.2 Tension and flexure tests shall be conducted on materials exceed the above.

5.2.4.3 The Consultant shall hold material test at_€ the government and public laboratory approved.

5.2.4.4 Number of steel materials to be tested shall be one in every different section. Number shall be increased by one in every 20-ton or a fraction of it.

5.3 Fabrication

5.3.1 Main fabrication shall be done in workshop unless otherwise specified or approved by the Consultant.

5.3.2 Full scale drawing of each section shall be drawn prior to fabrication and checked bthe Consultant.

5.3.3 Section of each material shall be cut perpendicular to axis unless otherwise specified in the drawing.

5.3.4 Saw and angle cutter shall be used for cutting, and cut section shall be free of any noticeable defect.

5.3.5 Deformation caused by cutting shall be corrected.

5.3.6 Bending process shall be done by normal temperature or hot drawn process. Steel shall be red heat in hot drawn process.

5.3.7 Those directed in the drawing shall be chiseled finish and completely attached.

5.3.8 Materials shall be checked for bend, distortion, warp, etc. before fabrication.

5.4 Bolt

5.4.1 Bolt Hole

5.4.1.1 Spacing of bolt holes shall be as directed in the following table.

Diameter of Bolt	Standard Pitch	Minimum Pitch	End Distance	Edge Distance
12	50	30	30	25
16	50	40	40	30

5.4.1.2 Minimum pitch and end distance for lightweight steel shape shall be more than 3 times and 2.5 times a Bolt diameter respectively.

5.4.1.3 Diameter of hole shall not be over 0.5 mm larger than bolt diameter. However, for anchor bolt 5mm clearance shall be allowed between bolt diameter and diameter of hole unless otherwise specified.

5.4.1.4 Bolt hole shall either be drilled open or reamed after sub punching. Punching can only be permitted for a material thickness less than 13 mm.

5.4.1.5 Rolled edge around a hole shall be removed.

5.4.1.6 Position of a bolt hole shall be precise so that the center of all holes aligns.

5.4.2 Protection against loosening of Nuts

5.4.2.1 Nuts shall be protected against loosening by concrete covering, double nuts or other proper means.

5.4.3 Shear Bolt

5.4.3.1 Shear bolt shall be provided with washers to keep the nut outside of grip.

5.5 Welding

5.5.1 Welding

5.5.1.1 Welder shall have an authorized qualification in Maldives and approved by the Consultant.

5.5.1.2 Other tests shall be conducted to confirm welders' skill in accordance with type of work.

5.5.1.3 Tack welding shall be carried out by the welder approved by the Consultant.

5.5.2 Welding Machine

5.5.2.1 Arc welding machine shall be alternate or direct current type which provides sufficient and adequate current.

5.5.2.2 The field arc welding machine shall be provided with remote control for easy control of current.

5.5.3 Preparation

5.5.3.1 Welding shall be done as much downward as possible using a jig such as Rotary frame.

5.5.3.2 Welding rod shall be always kept in a dry area and if necessary, dried by drying equipment.

5.5.3.3 Welding surface shall be free of water, scale or others injurious to welding work. Slag appeared on the created surface in the middle of welding shall be cleaned before starting again.

5.5.4 Fabrication

5.5.4.1 Welding edge shall be smoothed by automatic gas cutting or other proper finishes.

5.5.5 Built - up

5.5.5.1 Jig shall be used to keep mutual position of materials in assembly.

5.5.5.2 Temporary bolt hole for assembly shall be bored with approval of the Consultant.

5.5.5.3 Proper amount of construction, predistortion or restraint shall be added to welding parts to attain precise finish dimensions and shape.

5.5.5.4 Welding materials shall be properly met in fillet welds.

5.5.6 Tack

5.5.6.1 Short bead shall be avoided for tack welding. The minimum length of tack welding shall be as follows. Plate thickness under 3.2 mm Bead length over 30 mm, from 3.2 to 25 mm - 40 mm.

5.5.6.2 The end of joint, corner angle , beginning and ending point of final welding shall be avoided for tack welding.

5.5.6.3 Tack welding as a part of final welding shall be perfectly done.

5.5.7 Work

5.5.7.1 Type of welding rod, rod diameter, current, voltage and welding speed shall be selected in accordance with type of welding work.

5.5.7.2 Order of welding and movement of rod shall be determined so as that there shall be no deformation after welds.

5.5.7.3 Welding shall be carefully done in concealment in raining and strong wind.

5.5.8 Finishes

5.5.8.1 Surface of welds shall be as smooth as possible and size and length of welds shall not be less than designed dimensions.

5.5.8.2 Reinforcement of weld shall not exceed $0.1s + 1$ mm (s: Designated size) in fillet welds.

5.5.8.3 Welded parts shall be free of undercut, overlap, crack, blow hole, lack of welds, lack of weld settlement, rolled up slag or other defects.

5.5.8.4 Crater at the end of bead shall be carefully heaped up and slag, sputter, etc. shall be completely removed after welds.

5.5.9 Safety

5.5.9.1 Safe scaffoldings shall be provided for the field welds work.

5.5.9.2 Welding facilities shall be such that there shall be no electric leakage of electric shock. There also shall be sufficient protection for fire.

5.5.9.3 Electric shock protection device shall be used and also care shall be taken not to get suffocated or intoxicated by gas when welding in small area.

5.5.10 Inspection

5.5.10.1 Welding parts shall be inspected before, during after welding in accordance with work schedule.

5.5.11 Correction

5.5.11.1 Welding parts having injurious defects shall be removed and rewelded.

5.5.11.2 When deposited metal gets cracked, at least 50 mm from the edge of crack shall be cut off and rewelded.

5.5.11.3 When base metal gets cracked, it shall be replaced.

5.5.11.4 Under cut parts shall be corrected by attaching deposited metal.

5.5.11.5 Injurious deformation left on welding material shall be corrected or reinforced.

5.6 Transportation

5.6.1 Materials shall be marked for easy fabrication.

5.6.2 Small items such as gusset plates, bolts, etc. shall be packed in adequate size, and the contents shall be identified.

5.6.3 Material list shall be made before transporting so that material number, quantity, etc. shall be easily identified.

5.6.4 While transporting materials, care shall be taken for preventing from defect.

5.7 Erection

5.7.1 Erection

5.7.1.1 Erection procedure shall be prepared by the contractor and be approved by the Consultant prior to the erection.

5.7.1.2 Material shall be stored on flat surface in order not to get distortion, twist or other defects. Correction shall be made to those distortion or twisted before erection.

5.7.1.3 Horizontal reinforcement and bracing shall be placed and bolts are temporary tightened as trusses are put up.

5.7.1.4 Connection of materials by bolts, etc. shall be made after distortion on plumb is thoroughly corrected.

5.7.1.5 Temporary bracing or other reinforcement shall be placed to resist wind pressure or other loads erection.

5.7.1.6 When heavy objects are placed an a horizontal element in the course of erection, they shall be reinforced with prior approval of the Consultant.

5.7.1.7 Care shall be taken on all facilities so that there is no accident.

5.8 Anchor Bolt

5.8.1 The other methods for movable burying shall be as directed by the Consultant.