Footing F1

Project: Gas power plant

MATERIALS:

Concrete Grade	=	25 N/mm^2
F_y	=	415 N/mm^2
F_{yv}	=	250 N/mm^2

Try base of,

Length (x-x direction)	=	1.200 m
Breadth (y-y direction)	=	1.200 m
Depth	=	0.300 m
Weight of Base	=	10.37 KN

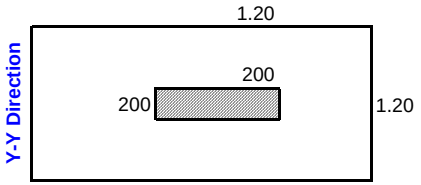
New Area Required = 1.39 m^2 => 1.16 m ***Ok***

Ultimate Pressure = 208.33 KN/m^2

Design of Square Footing

Height of Column	=	200.00 mm
Width of Column	=	200.00 mm
Ultimate Load	=	300.00 KN
Service Load	=	200.00 KN
Bearing capacity	=	151.00 KN/m^2
Area Required	=	1.32 m^2 => 1.15 m

X - X Direction



Preliminary check for shear

Checking overall Depth = 138.56 mm ***Overall Depth Ok***

Bending Moment (x-x direction)

Norminal Cover	=	40.00 mm
Assumed bar Diameter, (1st Layer), ***B1***	=	T10 mm
Effective Depth	=	235.00 mm
Bending Moment at the face of the column	=	31.25 KNm
k	=	0.02
z_1	=	229.97 mm
z_2 (0.95d)	=	223.25 mm
Use the lesser of two(z_1 and z_2)	=	223.25 mm
As Required	=	387.70 mm^2

As Provided = T10 @120 654 mm^2 OK

Vertical Shear

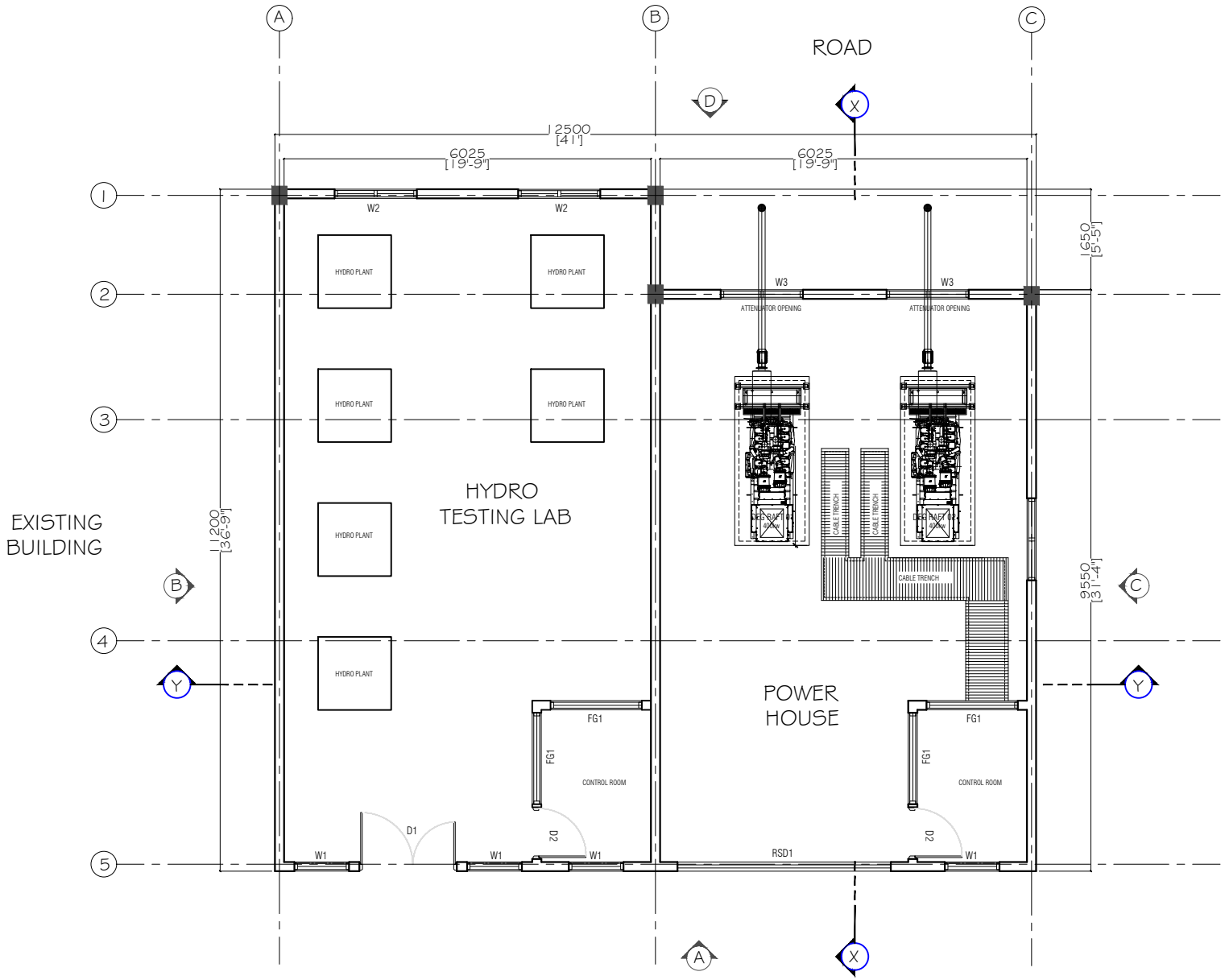
Ultimate Shear Force, (V)	=	***66.25 KN***
Design shear stress, ***(v)***	=	0.23 N/mm^2
$(100xA_s)/(bxd)$	=	0.23
Ultimate shear stress, ***(v_c)***	=	0.39 N/mm^2 ***Shear Stress OK***

Punching shear

1.5d	=	352.5 mm
Critical Perimeter	=	***905.00*** => ***3620 mm***
Shear Force	=	***129.37 KN***
Design shear stress, ***(v)***	=	0.15 N/mm^2 ***Shear Stress OK***

Shear at the face of the column

Ultimate Shear Force, (V)	=	***291.67 KN***
Design shear stress, ***(v)***	=	1.55 N/mm^2
		4.00 N/mm^2 ***Shear Stress OK***



FLOOR PLAN

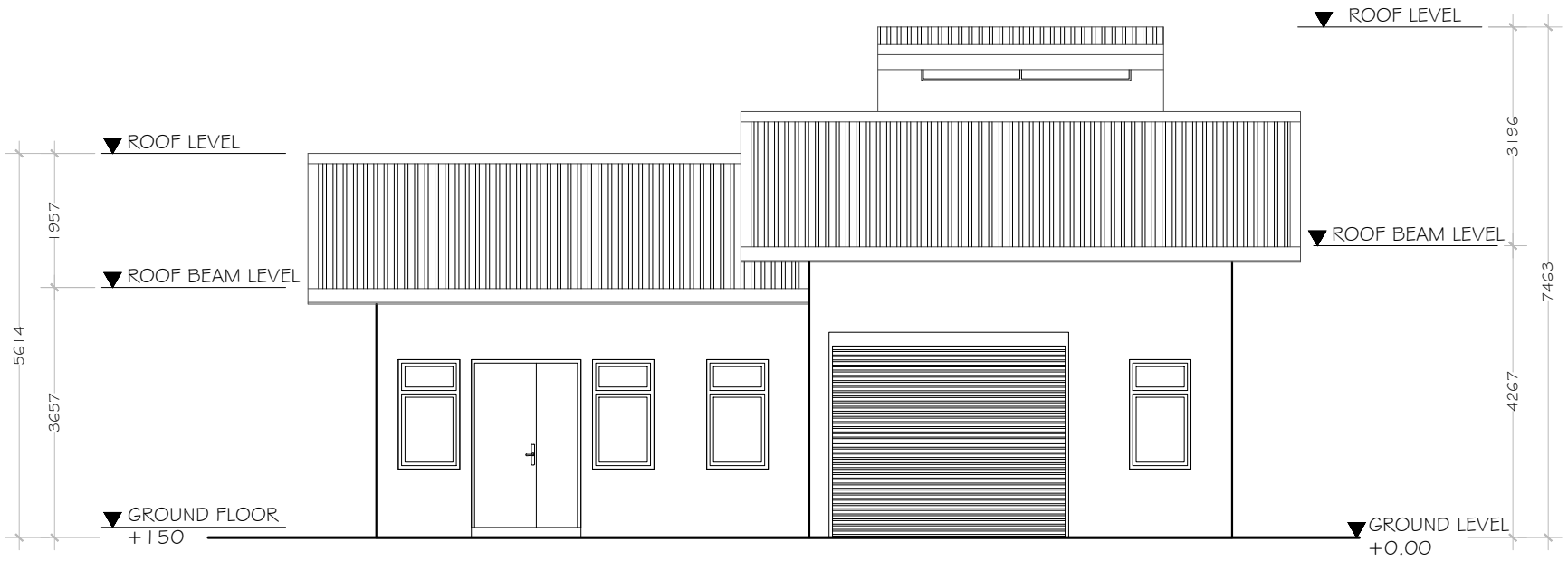
SCALE 1:100

0 1m 2m 3m 4m 5m

NOTE:

BUILDING FOOTPRINT AREA = 1397 SQFT

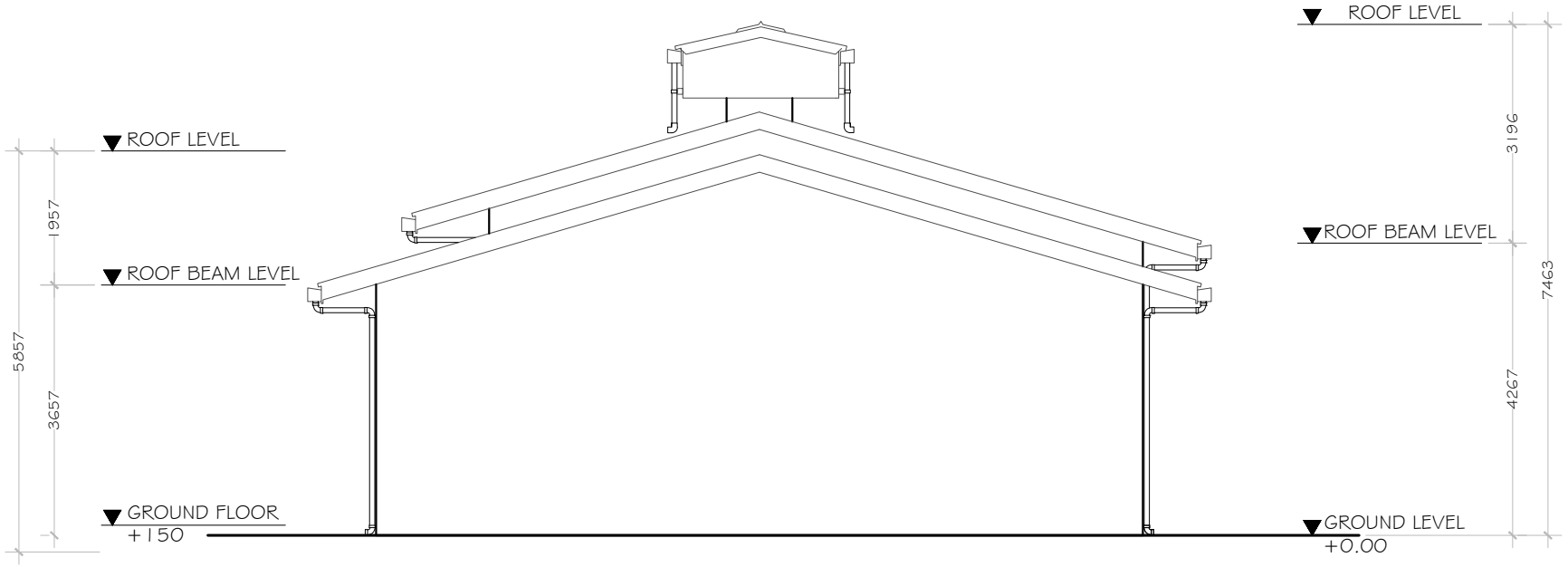
TOTAL FLOOR AREA = 1397 SQFT



ELEVATION - A

SCALE 1:100

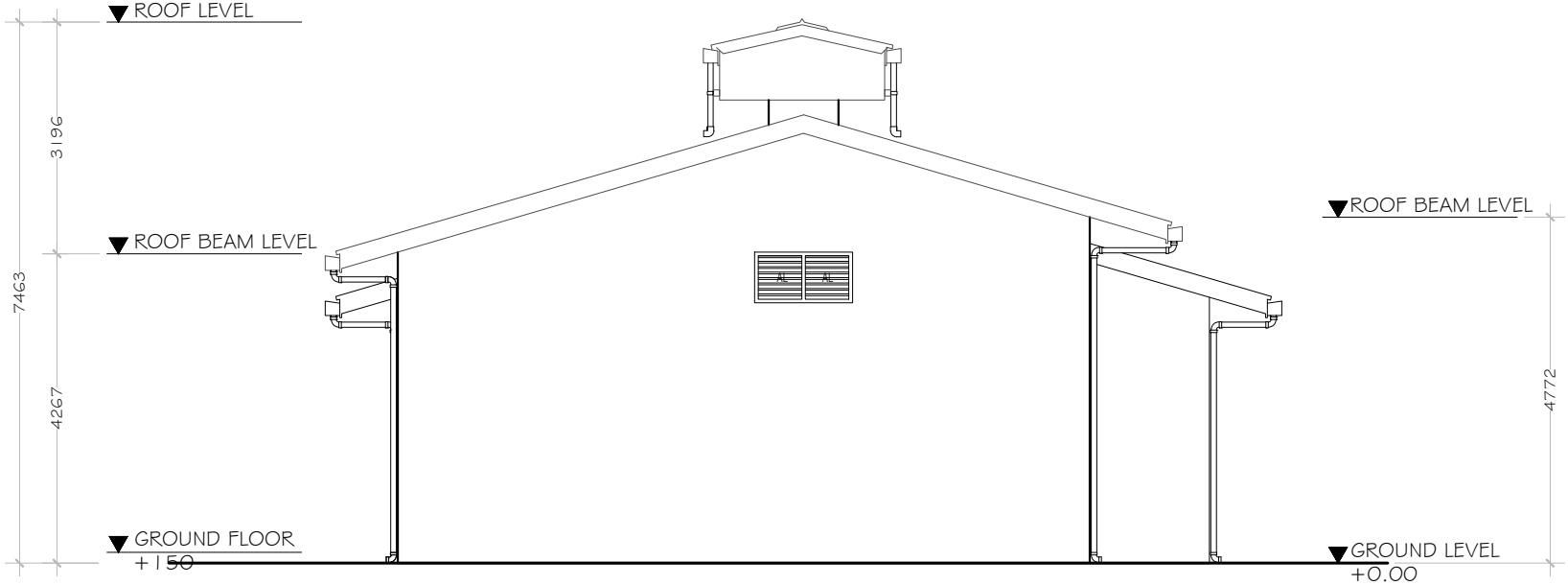
0 1m 2m 3m 4m 5m



ELEVATION - B

SCALE 1:100

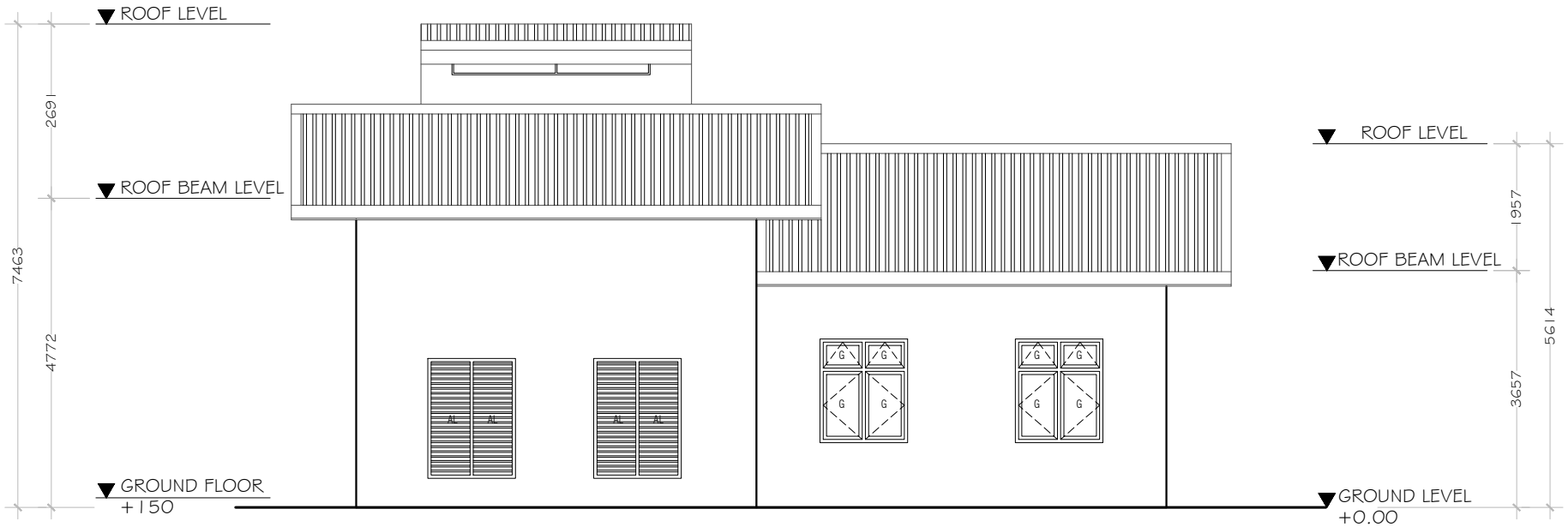
0 1m 2m 3m 4m 5m



ELEVATION - C

SCALE 1:100

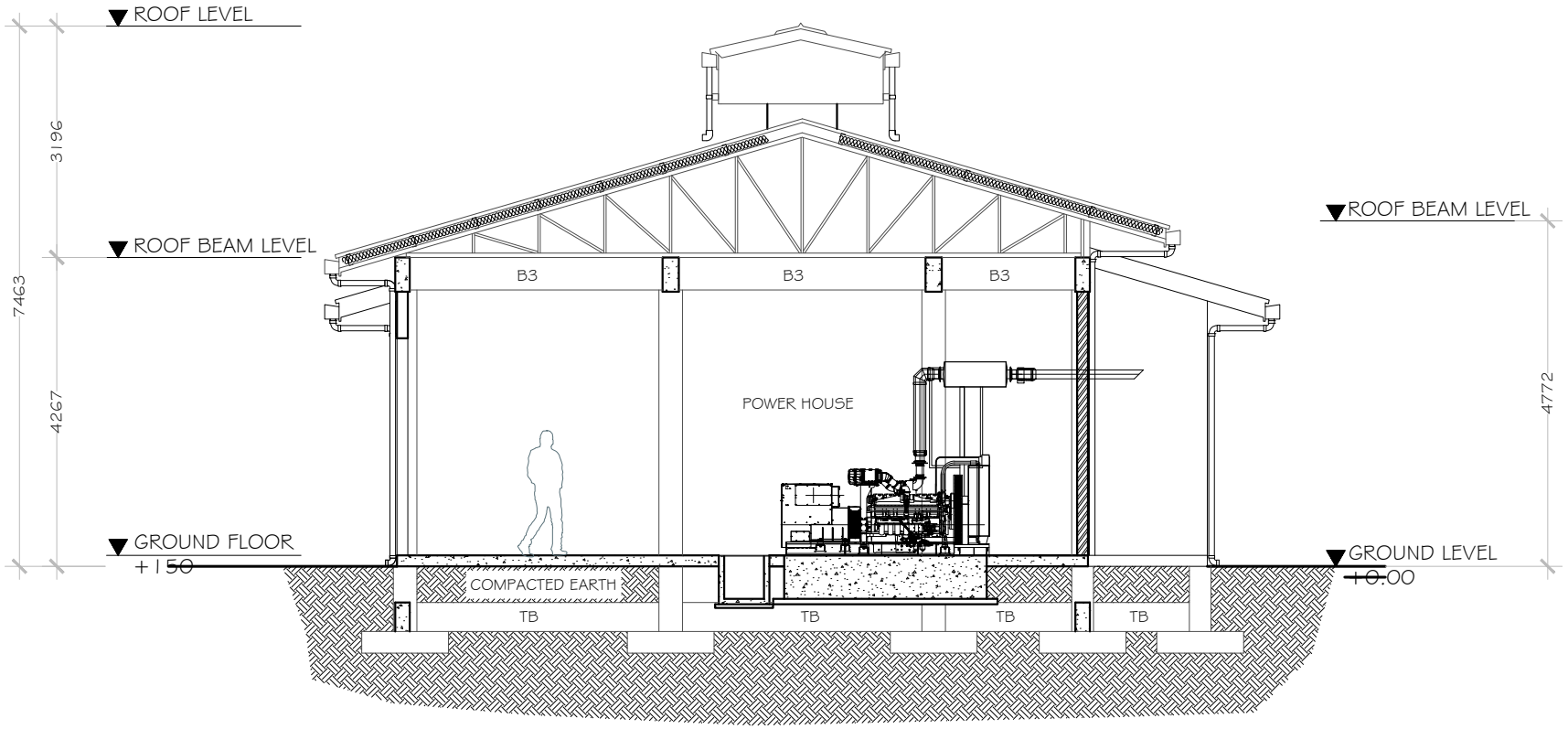
0 1m 2m 3m 4m 5m



ELEVATION - D

SCALE 1:100

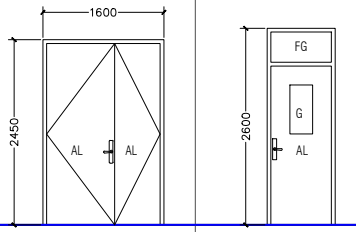
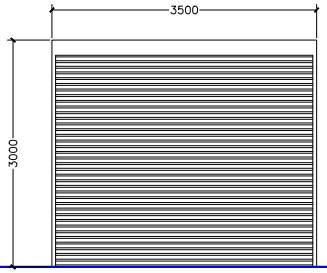
0 1m 2m 3m 4m 5m

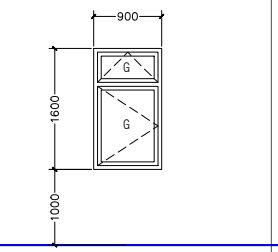
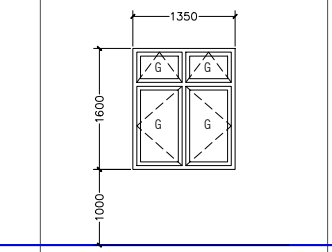
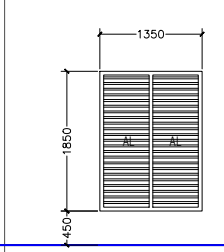
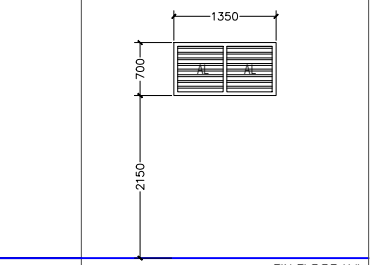


SECTION - XX

SCALE 1:100

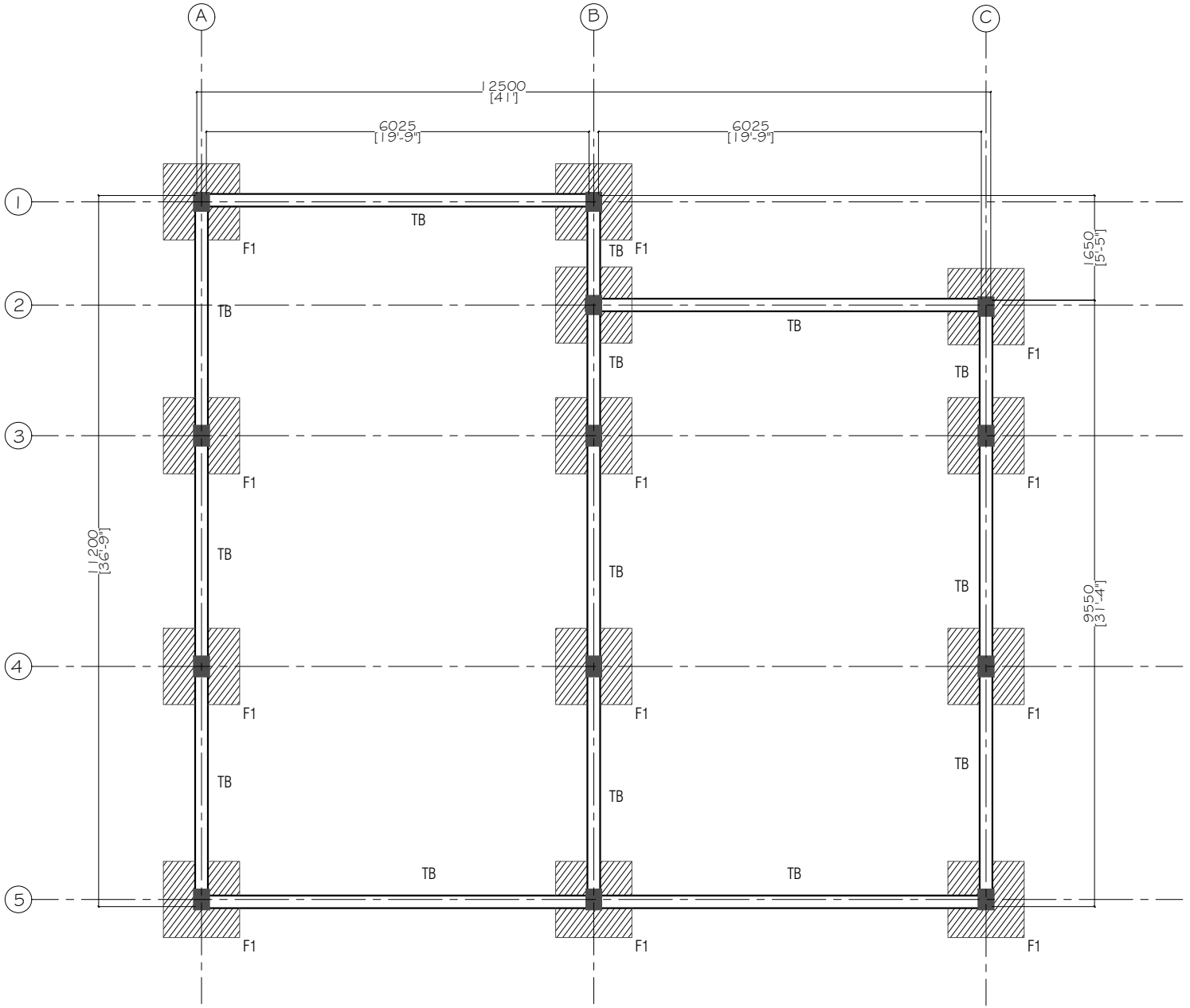
0 1m 2m 3m 4m 5m

			 FIN FLOOR LVL
	D1	D2	R5D1
FRAME FINISHING	6MM THK ALUMINIUM WHITE POWDER COATED CLADDING WHIT ROCKWOOL FILLED	6MM THK ALUMINIUM WHITE POWDER COATED CLADDING WHIT ROCKWOOL FILLED	ROLLER SHUTTER DOOR

				 FIN FLOOR LVL
	W1	W2	W2	W3
FRAME FINISHING	ALUMINUM WHITE POWDER COATED WITH 6MM THICK BLACK TINTED GLASS	ALUMINUM WHITE POWDER COATED WITH 6MM THICK BLACK TINTED GLASS	ALUMINUM WHITE POWDER COATED WITH LOUVERED VENTS	ALUMINUM WHITE POWDER COATED WITH LOUVERED VENTS

DOOR WINDOW SCHEDULE

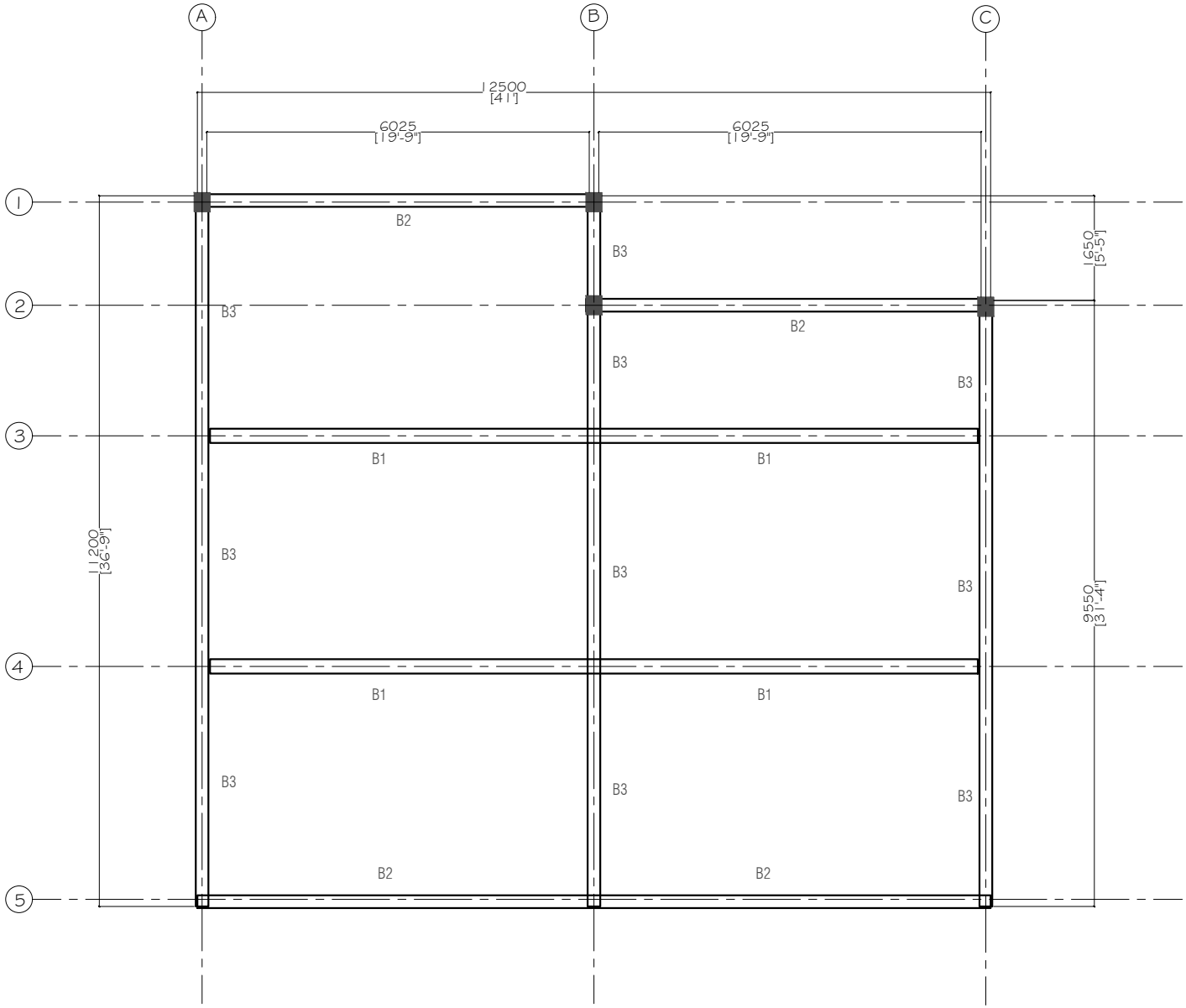
SCALE 1:100



FOUNDATION PLAN

SCALE 1:100

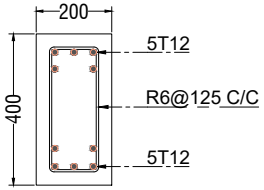
0 1m 2m 3m 4m 5m



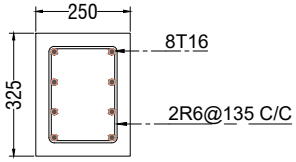
ROOF BEAM PLAN

SCALE 1:100

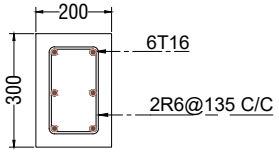
0 1m 2m 3m 4m 5m



TB



C1

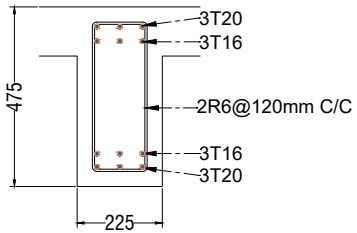


C2

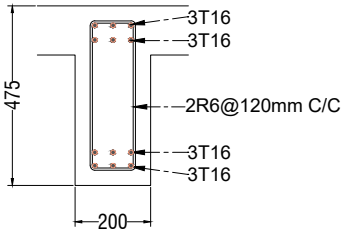
COLUMN DETAILS

SCALE 1:20

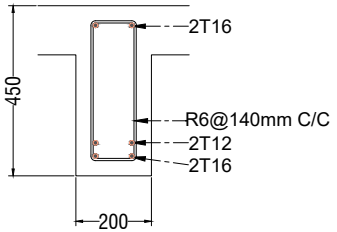
0 0.25m 0.5m 1m



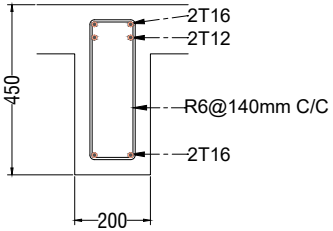
B1



B2



MID SPAN

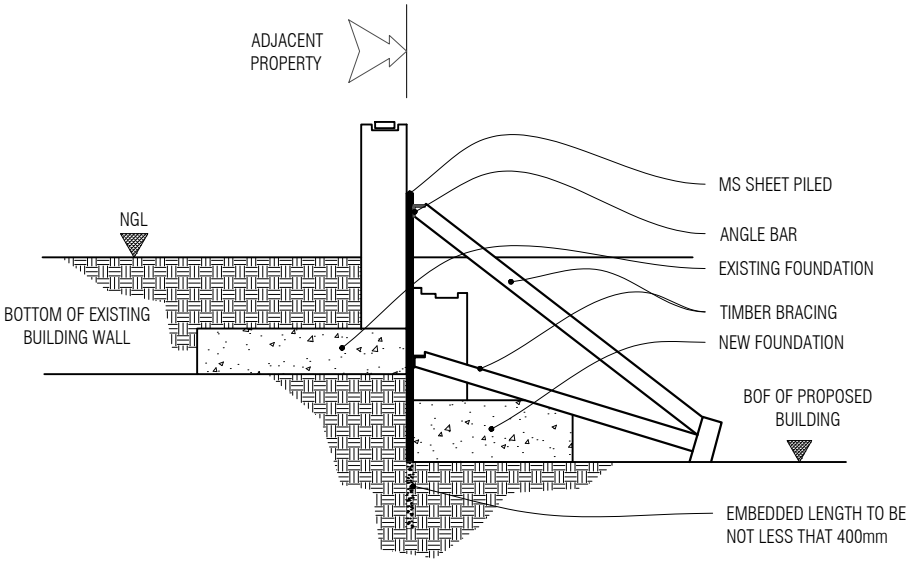


B3 SUPPORT

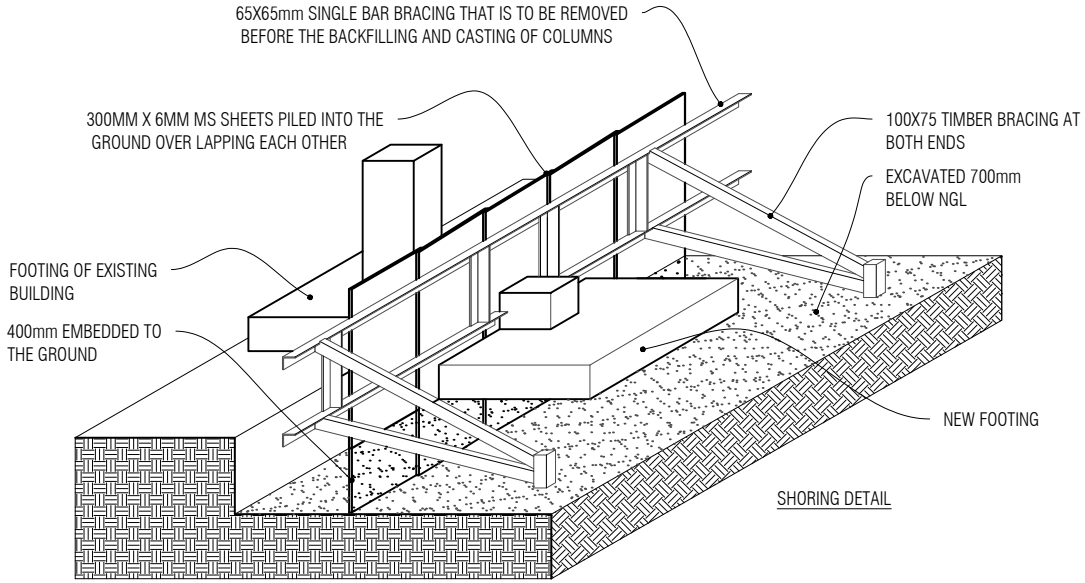
BEAM DETAILS

SCALE 1:20

0 0.25m 0.5m 1m



WHERE FOOTINGS CONCIDE OR FALL ON THE SAME GRID



SHORING DETAIL

NOTE:

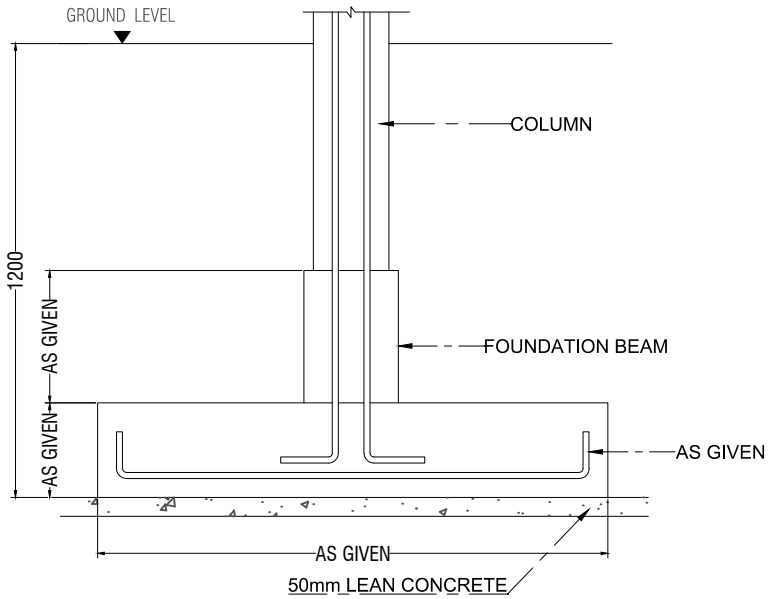
1-FOUNDATION PROTECTION & EXCAVATION IS SHOW IN THE PROPOSED BUILDING PLOT ARE.
2-PROPOSED EXCAVATION DOSE NOT GO IN TO THE ADJACENT BUILDING BOUNDARY LINE.

EXCAVATION ALONG THE ADJACENT BUILDINGS SHALL BE DONE IN PARTS SO AS TO PREVENT LOOSENING OF SOIL FROM THE BOTTOM OF EXISTING FOUNDATIONS. NO PARTIAL EXCAVATION SHALL EXCEED A WIDTH OF 0.6M AT A TIME & MASONRY RETAINING WALL MUST BE COMPLETED IMMEDIATELY AFTER THE EXCAVATION. ALLOW AT LEAST 24HR INTERVALS BETWEEN EACH EXCAVATION.

FOUNDATION PROTECTION MWTHOD

SCALE 1:20

0 0.25m 0.5m 1m



TYPICAL FOOTING DETAIL

FOUNDATION DETAILS

SCALE 1:20

0 0.25m 0.5m 1m

NOTE :

FOUNDATION DEPTH : -1200mm BELOW GROUND LEVEL

FOUNDATION FOOTING DETAILS	FOUNDATION FOOTING DIMENSION	FOUNDATION FOOTING RFMT
F1	1200mm X 1200mm X 300mm	T10 @ 120 BW BOTTOM

Project:	Gas power plant	**Designed By:**	Hassan Nihad	**Date:**	10-Oct-21
Beam No:	**B1**	**Licence No:**	DPR2019028LE		

Material Properties:

Concrete Strength (fcu):	25	(N/mm²)
Maint Reinforcement (fy):	415	(N/mm²)
Shear Reinforcement (fyv):	250	(N/mm²)
Unit weight of Concrete (γ):	24	(kN/m³)

Beam Properties:

Depth	=	475	mm
Width	=	225	mm
Cover	=	40	mm
Effective depth (d)	=	396.50	mm
(d')	=	46.00	mm
Span (L)	=	6.00	m
Wall Length	=	6.00	m
Slab Thickness	=	135	mm
Slab Area Supported	=	21.00	m²
P, Load Distance (a)	=	0.00	m
P, Load Distance (b)	=	6.00	m

Beam Loading:

Dead Load:				
Self Weight of Slab	=	3.24	(KN/m²)	68.04 (KN)
Self weight of Beam	=	1.84	(KN/m)	11.02 (KN)
Finishes	=	1.30	(KN/m²)	27.30 (KN)
Ceiling and Sevices	=	0.25	(KN/m²)	5.25 (KN)
Weight of wall	=	6.00	(KN/m)	36.00 (KN)
Total Dead Load, Gk	=			147.61 (KN)
Live Load:				
Live Load:				
Total Live Load, Qk	=	1.50	(KN/m²)	31.5 (KN)
Point load	=	**0.00**	(KN)	
Ult,Design Load,(1.4Gk+1.6Qk)	=	42.84	(KN/m)	

Doubly Reinforced Beam

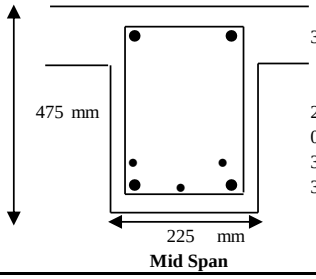
Beam Desining:

Main compresion steel As': **191** KNm — Cl:3.4.4.4

Effective, d = 396.5
k = 0.2160 — 0.156 **> K' , Section is Doubly Reinforced !**
z = 307.29 mm
x = (d-z)/0.45 = 198.25 mm
d'/x = 0.23 **OK, < 0.37**

Steel layers	2	area
(B1)	**3**	**T20**	942.5
(B2)	**3**	**T16**	603.2
(B3)	**0**	**T**	0.0

As' Prov, = 1545.7 mm²
As' Requ, = 383.9 mm²



Mid Span

As (required) 384mm2

As (provided) 1546mm2 OK!

Main tention steel As: **191** KNm — Cl:3.4.4.4

Steel layers	2	area
(T1)	**3**	**T20**	942.5
(T2)	**3**	**T16**	603.2
(T3)	**0**	**T**	0.0

As Prov, = 1545.7 mm²
As Requ, = 1522.6 mm²

As (required) 1523mm2

As (provided) 1546mm2 OK!

Beam Shear Stress

Maximum shear Force: V*= **155.00** KN — Cl:3.4.5.3

v = 1.737 N/mm² — (100xAs)/(b$_v$d) = 1.733 **< 3 OK!** — Table:3.7

Ult shear stress,(v$_c$) = 0.759 N/mm² — 400/d = **1.000** **> 1 OK!** — Table:3.8

(v - vc)bv = 220.13 N/mm — 0.5 vc = 0.380 N/mm²

vc + 0.4 = 1.159 N/mm² — **v < v Max, Beam Dimensions are Adequate!** — **Adopt!**

0.8√fcu or 5 N/mm2 = 4.00 N/mm² — **v > (v + 0.4) Links Required!** — **2 Rings**

Asv = 113.10 N/mm² — Rings Ø = **R6** mm — **6 mm Ø**

Sv = 122.02 mm — legs = **4** nos — **@120 mm c/c OK!**

Beam Deflection — Table:3.9

M/(bd²) = 5.40 — Allow (Span/d) ratio = 28.34

Service stress, fs = 68.7127 — Actual (Span/d) ratio = 15.13 — **Deflection OK !**

Modification factor, T= 1.09 **< 2 OK!** — Basic (Span/d) ratio = **26.00**

Modification factor, C= 0.58 **< 1.5 OK!**

Project:	Gas power plant	**Designed By:**	Hassan Nihad(Tel:7907270)	**Date:**	15-Oct-21
Beam No:	**B3**	**Licence No:**	DPR2019028LE	Emai;hassan.nihad@gmail.com	

Material Properties:

Concrete Strength (fcu):	25	(N/mm²)
Maint Reinforcement (fy):	415	(N/mm²)
Shear Reinforcement (fyv):	250	(N/mm²)
Unit weight of Concrete (γ):	24	(kN/m³)

Beam Properties:

Depth	=	450	mm
Width	=	200	mm
Cover	=	35	mm
Effective depth (d)	=	382.50	mm
Span (L)	=	3.50	m
Wall Length	=	3.50	m
Slab Thickness	=	135	mm
Slab Area Supported	=	9.00	m²
P, Load Distance (a)	=	0.00	m
P, Load Distance (b)	=	3.50	m

Beam Loading:

Dead Load:					
Self Weight of Slab	=	3.24	(KN/m²)	29.16	(KN)
Self weight of Beam	=	1.51	(KN/m)	5.29	(KN)
Finishes	=	1.30	(KN/m²)	11.70	(KN)
Ceiling and Sevices	=	0.25	(KN/m²)	2.25	(KN)
Weight of wall	=	6.00	(KN/m)	21.00	(KN)
Total Dead Load, Gk	=			69.40	(KN)
Live Load:					
Total Live Load, Qk	=	1.50	(KN/m²)	13.5	(KN)
Point load	=	**0.00**	(KN)		
Ult,Design Load,(1.4Gk+1.6Qk)	=	33.93	(KN/m)		

Beam Desining:

Max. Positive Moment @ Mid-Span M+ = **80** KNm — Cl:3.4.4.4

Effective, d = 382.5

k = 0.109 — 0.156 **< K' , Section is Singly Reinforced !**

z = 328.36 mm

0.95d = 363.38 mm

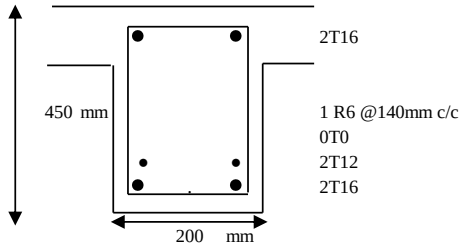
take = 328.36 mm (lsser from z & 0.95d)

Steel layers	2	area
(B1)	2	T16	402.1
(B2)	2	T12	226.2
(B3)	0	T	0.0

As Prov, = 628.3 mm²

As Requ, = 618.0 mm²

As Min, = 117



Mid Span

As (required) 618mm2

As (provided) 628mm2

OK!

Max. Negative Moment @ Support, M - = **80** KNm — Cl:3.4.4.4

Effective, d = 382.5

k = 0.109 — 0.156 **< K' , Section is Singly Reinforced !**

z = 328.36 mm

0.95d = 363.38 mm

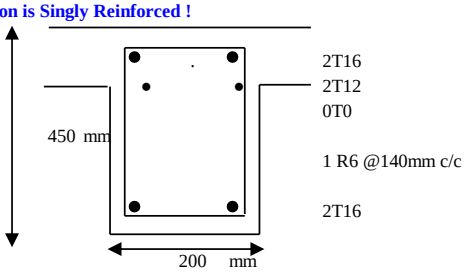
take = 328.36 mm (lsser from z & 0.95d)

Steel layers	2	area
(T1)	2	T16	402.1
(T2)	2	T12	226.2
(T3)	0	T	0.0

As Prov, = 628.3 mm²

As Requ, = 618.0 mm²

As Min, = 117



Support

As (required) 618mm2

As (provided) 628mm2

OK!

Beam Shear Stress

Maximum shear Force: V*= **80.00** KN — Cl:3.4.5.3

Table:3.7

v =	1.046	N/mm²	(100xAs)/(bvd) = 0.821	**< 3 OK!**
Ult shear stress,(vc) =	0.592	N/mm²	400/d = **1.000**	**> 1 OK!**
(v - vc)bv =	90.78	N/mm	0.5 vc = 0.296	N/mm²
vc + 0.4 =	0.992	N/mm²	**v < v Max, Beam Dimensions are Adequate!**	
0.8√fcu or 5 N/mm2 =	4.00	N/mm²	**v > (v + 0.4) Links Required!**	
Asv =	56.55	N/mm²	Rings Ø = **R6** mm	
Sv =	147.95	mm	legs = **2** nos	

Table:3.8

Adopt!

1 Ring

6 mm Ø

@140 mm c/c

Beam Deflection — Table:3.9

M/(bd²) =	2.73	Allow (Span/d) ratio =	26.52
Service stress, fs =	272.111	Actual (Span/d) ratio =	9.15
Modification factor, T=	1.02 **< 2 OK!**	Basic (Span/d) ratio =	**26.00**
Modification factor, C=	0.48 **< 1.5 OK!**		

Deflection OK !

Project:	Gas power plant	**Designed By:**	Hassan Nihad	**Date:**	10-Oct-21
Beam No:	**B2**	**Licence No:**	DPR2019028LE		

Material Properties:

Concrete Strength (fcu):	25	(N/mm²)
Maint Reinforcement (fy):	415	(N/mm²)
Shear Reinforcement (fyv):	250	(N/mm²)
Unit weight of Concrete (γ):	24	(kN/m³)

Beam Properties:

Depth	=	475	mm
Width	=	225	mm
Cover	=	40	mm
Effective depth (d)	=	396.50	mm
(d')	=	46.00	mm
Span (L)	=	6.00	m
Wall Length	=	6.00	m
Slab Thickness	=	135	mm
Slab Area Supported	=	21.00	m²
P, Load Distance (a)	=	0.00	m
P, Load Distance (b)	=	6.00	m

Beam Loading:

Dead Load:				
Self Weight of Slab	=	3.24	(KN/m²)	68.04 (KN)
Self weight of Beam	=	1.84	(KN/m)	11.02 (KN)
Finishes	=	1.30	(KN/m²)	27.30 (KN)
Ceiling and Sevices	=	0.25	(KN/m²)	5.25 (KN)
Weight of wall	=	6.00	(KN/m)	36.00 (KN)
Total Dead Load, Gk	=			147.61 (KN)
Live Load:				
Live Load:				
Total Live Load, Qk	=	1.50	(KN/m²)	31.5 (KN)
Point load	=	**0.00**	(KN)	
Ult,Design Load,(1.4Gk+1.6Qk)	=	42.84	(KN/m)	

Doubly Reinforced Beam

Beam Desining:

Main compresion steel As': **130** KNm — Cl:3.4.4.4

Effective, d = 396.5

k = 0.1470 — 0.156 **< K' , Section is Singly Reinforced !**

z = 307.29 mm

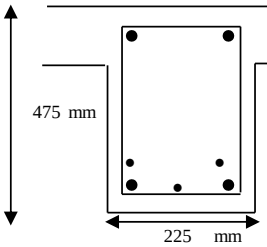
x = (d-z)/0.45 = 198.25 mm

d'/x = 0.23 **OK, < 0.37**

Steel layers	2	area
(B1)	**3**	**T16**	603.2
(B2)	**3**	**T16**	603.2
(B3)	**0**	**T**	0.0

As' Prov, = 1206.4 mm²

As' Requ, = -57.6 mm²



Mid Span

As (required) -58mm2

As (provided) 1206mm2 OK!

Main tention steel As: **130** KNm — Cl:3.4.4.4

Steel layers	2	area
(T1)	**3**	**T16**	603.2
(T2)	**3**	**T16**	603.2
(T3)	**0**	**T**	0.0

As Prov, = 1206.4 mm²

As Requ, = 1081.2 mm²

As (required) 1081mm2

As (provided) 1206mm2 OK!

Beam Shear Stress

Maximum shear Force: V*= **120.00** KN — Cl:3.4.5.3

Table:3.7

v = 1.345 N/mm² — (100xAs)/(b_v d) = 1.352 **< 3 OK!** — Table:3.8

Ult shear stress,(v_c) = 0.699 N/mm²

400/d = **1.000** **> 1 OK!**

(v - vc)bv = 145.40 N/mm — 0.5 vc = 0.349 N/mm²

vc + 0.4 = 1.099 N/mm² — **v < v Max, Beam Dimensions are Adequate!** — **Adopt!**

0.8√fcu or 5 N/mm2 = 4.00 N/mm² — **v > (v + 0.4) Links Required!** — **2 Rings**

Asv = 113.10 N/mm² — Rings Ø = **R6** mm — **6 mm Ø**

Sv = 184.74 mm — legs = **4** nos — **@120 mm c/c**

OK!

Beam Deflection — Table:3.9

M/(bd²) = 3.68 — Allow (Span/d) ratio = 37.51

Service stress, fs = -13.2004 — Actual (Span/d) ratio = 15.13 — **Deflection**

Modification factor, T= 1.44 **< 2 OK!** — Basic (Span/d) ratio = **26.00** — **OK !**

Modification factor, C= 0.54 **< 1.5 OK!**

TECHNICAL SPECIFICATION

PROJECT: HYDRO TEST ROOM AND GENERATOR ROOM

TABLE OF CONTENTS

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 leave 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 Megaflow 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 Megaflow SP4 of equivalent
For ready mix concrete use	Conmix Mega Flow SP4

Note : All underground concrete and masonary works shall be applied with Conmix MoyaSheild 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 (%)
7Coarse 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 [1]Mix 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/mm^2

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 leads 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 defection, 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 loosing of Nuts

5.4.2.1 Nuts shall be protected against loosing 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 shell be corrected by attaching deposited metal.

5.5.11.5 Injurious deformation left on welding material shall be correct 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.

6. MASONRY

6.1 Materials

6.1.1 Material used for masonry and plastering work, shall conform to Section 3 - CONCRETE WORKS.

6.1.2 Masonry work shall be done with cement bricks or blocks of approved quality unless specified otherwise.

6.1.3 The blocks shall be free from excessive amounts of salt or other impurities and shall be inspected and approved by the Consultant.

6.2 General

6.2.1 Execution Drawing

Work shall be complied with this specification unless otherwise stated on particular Specification or Drawings. Any work not specified shall be discussed and directed by the Consultant. Execution drawing of block or brick alignment (inclusive of indication for hanging bolt, wood plug and conduit pipe), detail reinforcement, window opening, and other requirement shall be prepared and submitted for the Consultant.

6.2.2 Stake-Board

Stake-board shall be provided at each 5m in length and shall be inspected by the Consultant for the accuracy, firmness and secureness. However, suitable ruler, plumb-bob and leveler shall be provided for minor performance of cement block and bricks.

6.2.3 Transportation and storing

Care shall be taken for damage during transportation of materials and any defect of natural finished concrete blocks or bricks shall be rejected. Different size of material shall be stored separately and projected from dirt and other impurities.

6.2.4 Curing

Any shock or load shall not be applied until concrete mortar or other fills hardened. Corner, projection and top of cement block or brick work shall be protected from rain, dryness, cold, damage and stain by covering. Void between blocks or bricks shall not be intruded by rain water.

6.3 Cement Blocks / Bricks

6.3.1 Material

Cement block shall be of acceptable quality low permeability blocks with no defects and sample shall be submitted for approval of the Consultant.

6.3.2 Horizontal reinforcement for concrete block wall ;

6.3.2.1 Horizontal reinforcement shall be provided at end of wall adjoining to concrete column. Reinforcing bar shall be anchored into end block and column.

6.3.2.2 Horizontal reinforcing bar for block wall shall be 6 dia. @ 600 mm and reinforcing bar for opening shall be 2 - 9 dia. with stirrup of 6 dia. @200 mm unless otherwise specified.

6.3.3 Placing Blocks & Bricks

6.3.3.1 Cement blocks shall be saturated with water and joint shall be cleaned.

6.3.3.2 Bonding mortar shall be used immediately after mix, and mixed mortar left for more than one hour shall be rejected.

6.3.3.3 Vertical and horizontal joint of blocks shall be filled completely and suitable with mortar on line shall not be moved or rearranged. Joint and surface of block of exposed finished block wall shall be cleaned immediately after joint is filled.

6.3.3.4 In case concrete block wall is attached to structural concrete, block wall shall be placed before concreting structure.

6.3.3.5 Mortar for joint shall be touched with steel trowel before hardened and exposed joint shall be finished with uniform width and planned without roughness or cavity.

6.3.3.6 Height for placing block per day shall be maximum 1.2 m unless otherwise specified.

6.3.3.7 Blocks shall be placed with cavity side under.

6.3.4 Joints

6.3.4.1 The thickness of joints shall not exceed 10 mm and the joints shall be rated (13 mm dup.) when the mortar is still floor, so as to provide for proper bond for the plaster. Any mortar which falls on the floor from this joints or removed due to raking of joints shall not be reused.

6.3.5 Lintel

6.3.5.1 7.3.5.1 Lintel shall be reinforced concrete as approved or directed by the Consultant.

6.3.5.2 Main reinforcing bar shall be anchored more than 40D (40 x diameter of the bar) at both end.

6.3.5.3 In case lintel is prefabricated, shop drawing shall be submitted for approval of the Consultant.

6.3.6 Frame of Opening

6.3.6.1 In case frame is temporarily installed before placing of blocks, frame shall be firmly placed and joiner shall be bonded with mortar as placing each block at side and top of frame.

6.3.6.2 In case frame is installed after placing of blocks, joiner shall be bonded with additional mortar at space or every two blocks or more.

6.3.6.3 Back of frame shall be filled and compacted with mortar by providing shuttering board.

6.3.6.4 Wood plug and anchor bolt shall be covered with mortar or concrete.

6.3.7 Piping

6.3.7.1 Principally, piping shall not be placed in block wall unless piping block is in use.

6.3.7.2 In case electric conduit pipe is placed in cavity of concrete blocks, care shall be taken not to obstruct reinforcing bar, and cavity shall be completely filled.

6.3.7.3 In case chipping and piping on face of blocks is unavoidable, performance shall be conform to instruction of the Consultant.

6.3.7.4 Joiner and supporter for exposed piping shall be buried at joint which back is filled or otherwise approved by the Consultant.

6.4 Concrete Bricks

6.4.1 Material and joint

6.4.1.1 Brick shall be without cracks, deformation, and any other defects, and sample shall be submitted for approval of the Consultant.

6.4.1.2 Mixture of mortar and width of joint of brickwork and blockwork shall conform to the following table unless otherwise specified.

Table 3.1 Mixture of Mortar (volume ratio) and width of joint.

Use	Cement	Slaked Lime	Sand	Joint Width
Ordinary Brick and Blocks	1	0.2	2.8	10
Exposed Bricks and Blocks	1		2	
Exposed Cavitied Blocks	1		1	
Furnace and smoke stack	1	0.5	3	

6.4.2 Placing

6.4.2.1 Brick shall be cleaned and suitably saturated in water before use.

6.4.2.2 Binding mortar shall be placed sufficiently compacted.

6.4.2.3 Bricks shall be placed in such away as to form alternate courses of headers and stretchers. Maximum height of placement shall not exceed 1.2 m per day.

6.4.2.4 All perpends shall be kept strictly true and square.

6.4.3 Lintel

6.4.3.1 Lintel shall be reinforced concrete or precast concrete as shown on the Drawing, unless otherwise specified, or approved or directed by the Consultant.

6.4.3.2 Main reinforcing bar shall be anchored more than 40D (40 x diameter of the bar) at both end.

6.4.3.3 In case lintel is prefabricated, shop drawing shall be submitted for approval of the Consultant.

6.4.4 Frame of Opening

6.4.4.1 In case frame is temporarily installed before placing of bricks, frame shall be firmly placed and joiner shall be bonded with mortar as placing each brick at side and top of frame.

6.4.4.2 In case frame is installed after placing of bricks, joiner shall be bounded with additional mortar at space of every two blocks or more.

6.4.4.3 Back of frame shall be filled and compacted with mortar by providing shuttering board.

6.4.4.4 Wood plug and anchor bolt shall be covered with mortar or concrete.

7. PLASTERING

7.1 General

7.1.1 All masonry walls shall have smooth finished cement plaster on both sides with a surface setting coat of neat cement applied within an hour of the completion of rendering.

7.1.2 Cement rendering to floor shall be same as above.

7.2 Materials and Storage

7.2.1 Plaster materials which are affected by moisture such as plaster and cement shall be stored properly.

7.2.2 Materials used for plastering shall conform to those of Section 3 - Concrete Works. Grading of sand, however, shall be as in table below;

Grading of sand	Mortar plastering	Plastering
5mm sifting thorough 100% 0.15mm sifting less than 10%	for first coat for finish coat	for first coat and dubbing out
2.5mm sifting through 100% 0.15mm sifting less than 10%	for finish coat	for second coat

7.2.3 White cement or filler or similar shall confirm to the requirements of Portland cement, BS.12.

7.2.4 The use of mixtures shall be approved by the Consultant's representative. The amount of admixture shall be such that it affects mortar strength very little.

7.2.5 Conmix MegaFlow MP or equivalent additive of approved brand shall be used with the cement plaster on the all exposed exterior and interior surfaces.

7.2.6 The additive used in plaster works shall be used as per manufacturer's recommendation or must confirm to consultant's instructions.

7.3 Mixing ratio

7.3.1 Mixing volume ratio of mortar shall be as in table below:

Base	Area of application	first coat cement:sand	Dabbing out cement:sand	Finish coat cement:sand
Masonry blocks	Floor	-	-	1:2
	Interior wall	1:2	1:3	1:3
	Exterior wall	1:2	1:3	1:3

7.4 Thickness of Coating

Standard thickness of coating (mm)

Base	Area of application	First coat	Dubbing out	Second coat	Finish coat	Total
Masonry block	Floor	-	-	-	25	25
	Interior wall	10	-	10	5	25
	Exterior wall	10	-	10	5	25

7.4.1 Thickness of coating shall be standard thickness of coating unless otherwise indicated on the Drawings.

7.5 Finish

7.5.1 Type of finish and work schedule

Type	Work Schedule	Notes
1.Trowel finish	1. Shall be applied flat by metal trowel 2. Shall be finished by pressing with th trowel.	Before applying second coat, corner and edge shall be screed well.
2. Wood trowel finish	1. Shall be applied and finished flat with wood trowel	
3. Brush finish	1. Shall be applied flat by wood trowel. 2. Shall be blushed	Care shall be taken not to wet brushes.
4.Spray finish	1. Cracks in base shall be fixed. 2. Shall be sprayed more than twice.	Mixing for spraying on exterior wall cement: (Plaster & pigment ≤1) spray shall be applied perpendicular to the surface.
5. Cement wash	1. Opening and projections in base shall be fixed 2. Cement water solution shall be applied with brush	
6. Coloured mortar finish	Shall be applied and finished with mortar of specified colour on base	Mixing colour mortar shall comply with that of spray finish
7. Scratch Surface finish	1. Mortar with rough finish materials shall be applied 2. Shall be scratched by metal comb after checking dryness.	Mixing shall be cement ≥ (plaster + pigment)
8. Floor plastering	1. Cement paste shall be smoothed. 2. Hard mortar shall be applied with trowel.	Dry mortar shall be hammered and screeded after checking dryness.
9. Floor concrete polish finish	1. Concrete shall be plate hammered smoothed by vibrator. 2. Shall be polish-finished by wood trowel or steel trowel	Agent of hardening and colouring shall be applied according to schedule and direction of the Consultant.

7.6 Preparation of setting bed

7.6.1 Deformation, unevenness on the wall or floor of concrete or concrete block shall be corrected.

7.6.2 Concrete surface which is too smooth to plaster shall be roughened with chisel, etc.

7.6.3 Dry backing of concrete or block or dry base coat of cement mortar or plaster shall be properly wetted. Backing and base coat shall be cleaned before plaster.

7.6.4 Looseness on backing or plastering face shall be immediately corrected.

7.6.5 Joints and corners where cracks are likely to occur must be properly dealt with and approved by the Consultant.

8. CARPENTRY AND JOINERY

8.1 Materials

8.1.1 Timber shall be in accordance with the requirements of BS 1186 'Quantity of Timber and Workmanship in Joinery', Part 1, 'Quality of Timber'.

8.1.2 Timber and timber products shall be subject to the inspection and approval of the Consultant.

8.1.3 Timber shall be seasoned to stable moisture content compatible with the finished use, straight and true and free from wind, warp and distortion and in lengths suitable for the members required.

8.1.4 All timber shall be in long lengths and laps, scars or splices shall be over a bearing surface. Where obtainable, finishing timber exposed to view shall be in single lengths.

8.2 Preservation of Timber

8.2.1 Where preservative treatment is specified, the timber is to be of the correct moisture content and free from surface moisture content and dirt.

8.2.2 All rafters, purlins, framing scribe pieces, wall plates, trusses etc. shall be treated with approved timber preservative oil. No extra payment shall be made for such coating and will be considered inclusive in the rate of the respective item in the BOQ.

8.2.3 Treatment shall be carried out after all cutting and shaping is completed.

8.3 Hardware

8.3.1 Hardware shall be standard quality and samples shall be submitted to the Consultant for approval.

8.3.2 All hinges shall be stainless steel or brass and shall be approved by the Consultant.

8.3.3 The dimensions and quality of hardware shall meet the requirements and shall not be rested, deformed or defective.

8.4 Dimensions and Finish

8.4.1 All dimensions of timber given are finished dimensions.

8.4.2 All elements and others of structural nature which are exposed must be machine planed to a smooth finish.

8.4.3 All unexposed timber shall be machine planed to a rough finish.

8.4.4 All joinery work shall be dressed on all four sides and hand dressed where necessary and sanded to all exposed surfaces. All arises in any way accessible shall be sanded and smoothed off.

8.5 Workmanship

8.5.1 All connections whether nailed, screwed, glued, moticed or dove-tailed shall be accurately made and properly executed to provide sound, satisfactory connections for the class of work required.

8.5.2 Timbers containing defects or distortions shall not be used.

8.5.3 All joinery shall be manufactured by skilled tradesman with accurate tolerances and set out and with tools, jigs, machines and equipment appropriate for the work.

8.5.4 Assembly of the joinery units and joinery frames, etc. shall be by means of glued connections appropriate to the work - motice and tennon, housing and doweling, etc. where practicable including the use of glued blocks wherever required. Nailing, screwing shall only be used with prior approval of the Consultant; corrugated fasteners shall not be used for effecting connections.

9. ACOUSTIC CEILING

9.1 General Requirements

9.1.1 Contractor shall examine all other sections of the specifications for requirements which affects work of this section whether or not such work is specifically mentioned in this section.

9.1.2 Contractor shall coordinate work with that of all other trades affecting, or affected by work of this section. Contractor shall check electrical , air conditioning drawings to ensure proper integration and fitting of light fittings, ceiling difference and other openings in the ceilings for access panels of Heating & Air Conditioning system.

9.2 Scope

9.2.1 Contractor shall provide all labour, equipment, services and transportation required to complete all acoustical ceiling work as shown on drawing, as specified herein, or both and see Drawings and schedules for details location.

9.3 Specifications and Standards

9.3.1 The ceiling system shall conform to British Standard Specifications -476: Part 5, Part 6 and Part 7.

9.4 Samples

9.4.1 Representative samples of ceilings tiles sheets shall be submitted for consultants approval before materials are purchased. Submit samples of suspension system parts showing materials, finish and methods of connection along with tiles. Materials delivered to the job site shall conform to the approved samples.

9.5 Manufactures

9.5.1 Suspension system shall be the products of reputable manufacturer and the suspension system shall fit to the specified acoustic tiles.

9.6 Workmanship

9.6.1 Acoustical units shall be delivered in manufacturer's original, labeled, unopened cartons, suitably stored within the building and protected from damage until ready for installation.

9.6.2 Installation of acoustical ceiling shall be done by approved or experience ceiling tile Contractor.

9.6.3 Before commencing acoustical ceiling work, inspect all surfaces and structural element to receive work of this section to assure that conditions are suitable for installation of the work.

9.6.4 The building shall be glazed and have a relative humidity not exceeding 70% before units are delivered to the site of work is begun.

9.6.5 Acoustical ceiling work shall be coordinated with that of related trades. Acoustical ceilings shall be suspended from structural elements only, completely independent of all mechanical and electrical system and their suspension.

9.6.6 Suspension system shall be manufactured by or approved by ceiling materials manufacturer. Manufacturer's standard recommended clips shall be used for attachment to structural

framings. Power driven eye pins will be permitted in concrete , but each pin shall be tested after installation for 150 pounds load (weight of one workman).

10. ALUMINIUM DOORS AND WINDOWS

10.1 Aluminium Doors and Windows

10.1.1 Aluminium Doors and Windows shall generally conform to relevant British Standard Specifications.

10.1.2 The sashes and frames shall be assembled from extruded ofiles made of aluminium alloy conforming to British Standard and distinguished for their out-standing anti-corrosive features and durability.

10.1.3 The auxiliary components in sashes as locks, pivots, sliding gear etc. shall comprise of stainless steel or resisting materials.

10.1.4 The tolerance are to be as follows:

a) Inside width of frame	3mm Maximum
b) Inside height of frame	3mm Maximum
c) Depth of frame	2mm Maximum
d) Opposite side, Inside distance	2mm Maximum

10.1.5 The performance - associated requirements are

1) Strength (resistance to wind pressure and other forces applied in use)
2) Air tightness or ability to cut out drafts.
3) Water - tightness against rain or dew.
4) Sound arresting effect to (shut off noise from outside as well as inside).

10.1.6 All surfaces shall have an anodized protective surface layer of minimum 25 Micron thickness.

10.1.7 Glazing shall be done as specified by the Consultant. Glass shall be tinted, clear or wired as specified in the drawings. Thickness shall be according to the size of panels as given hereunder.

Not exceeding 1 sq. ft.	2mm
Exceeding 1 sq. ft. but not exceeding 2 sq. ft.	3mm
Exceeding 2 sq. ft. but not exceeding 4 sq. ft	4mm
Exceeding 4 sq. ft. but not exceeding 6 sq. ft	5mm
Exceeding 6 sq. ft.	6mm

10.1.8 Prior to import and / or purchase of the Aluminum Doors and Windows, the relevant specification of the manufacturer's perfectly along with samples to be submitted to the Consultant for approval. This clause shall not be contravened on any account.

10.1.9 The fitting shall be done with utmost care not to spoil the finishes given by the manufactures, and any cleaning done shall be done with cleaners etc. as specified by the Manufactures.

10.1.10 The Contractor shall provide all items, articles, materials, operations, mentioned, or scheduled on the drawings, including all the labour materials, including fixing devices, equipment and incidentals necessary as required for their completion.

10.1.11 The Contractor shall submit shop drawings and/or samples of each type of doors, windows, railings and other items of metal work to the Consultant for approval. The shop drawings shall

show full size sections of doors and windows etc. thickness of metal, details of construction hardware as well as connection of windows, doors and other metal work to adjacent work.

10.1.12 Samples of all typical metal work shall be submitted to the Consultant from approval.

10.1.13 Aluminum doors and shutters shall be manufactured by an approved manufacturer and shall be of sections, sizes combination and details shown on the drawings. The frame member shall be one piece, corners shall be electrically welded, ground smooth and true and glazing bare shall be threaded or interlocked as approved by the Consultant.

10.1.14 Glazing for doors and windows shall be of specified thickness and of approved quality and shall conform to specification of glazing. Fixing for glazing shall be done with aluminum Snap-On beading as per detail drawing and instructions. Necessary continuous rubber gaskets of approved make shall be provided.

10.1.15 Colour for doors and windows shall be approved by the Consultant.

10.2 Aluminum louvers

10.2.1 Samples shall be submitted for approval.

10.2.2 All metal louvres shall be installed according to manufacturer's instructions.

10.2.3 All units shall be installed plum, well fitted and securely attached to supporting frames.

11. ROOFING

11.1 Roofing Material

11.1.1 Steel roofing shall be "BHP lysaght trimdeck Roofing sheet" or equivalent roofing sheets, of standard thickness fixed to supports with approved fasteners as per manufacturers recommendations or as shown on the Drawings. Sheets shall have approved side laps with the top sheet laps facing away from the prevailing weather.

11.1.2 Roofing sheets, gutters, flashing and fixings shall be approved by the Consultant.

11.1.3 Roof sheeting shall project a minimum of 50mm into gutters with the maximum projection into gutters leaving access for cleaning. Flashing are to be manufactured from like or compatible materials and shall cover the sheets a minimum of 100mm. Attachments and joints are to be made with mechanical fasteners and sealant approved by the sheet manufacturer.

11.1.4 Packs of sheets shall be kept dry in transit and on site to prevent water and/or condensation being trapped between adjacent surfaces. Packs of sheets standing on site shall be stored clear of the ground. Sheets shall be handled using clean dry gloves.

11.1.5 The roof and gutters shall be swept clean of all debris using a soft broom at least at the end of each day's work and particularly on the completion of fixing.

11.1.6 The job shall be left clean and in a weather tight condition.

11.1.7 All sheeting shall be fixed in a workmanlike manner and in accordance with the manufacturer's recommendations.

11.1.8 Contractor must submit a sample of roofing sheet for approval or supply manufacturers warranty to verify the quality if the product.

11.1.9 Color of the roofing sheets has to be approved by the consultant.

12. FINISHES

12.1 General

12.1.1 Ceramic Tile shall comply with British Standard specification No. 1281 and shall be approved sizes as shown on Drawings and the product of a reputable manufacturers approved by the Consultant.

12.2 Ceramic and Vitreous Tile Materials

12.2.1 Ceramic and Vitreous clay Wall Tiles:

12.2.1.1 All tiles for wall installation shall have cushion edge, impervious porcelain and highly glazed surface. Colours shall be as selected by the Consultant and shall include trimmers, corner pieces, bullnose and all other special shapes indicated or required. All this shall be free from flaws, cracks and crazing.

12.2.2 The contractor shall submit samples of the selected type of tile or when at the request of the consultant.

12.2.3 Color and design of the tile will be approved by the consultant

12.2.4 Floor Ceramic and Vitreous Tiles

12.2.4.1 Non-slip ceramic tile for shall be used on all floor locations. Floor tiles shall be specially prepared for floor use but shall have all the qualities of ceramic tiles listed above for wall use.

12.3 Mortar Materials

12.3.1 Standard brand of light gray or white Portland Cement as specified in drawings, conforming to current British Standard specifications shall be used.

12.3.2 Sand: shall be clean, sharp, river sand, conforming to British Standard Specifications and graded fine to coarse within the following limits: 100% passing 8 sieve, 90% to 100% passing 16 sieve, 60% to 90% passing 30 sieve, 25% to 55% passing 50 sieve and 0% to 15% passing 100 sieve.

12.4 Cement Colour

12.4.1 Dry cement colour, chemically inert, non fading, alkali fast, mineral pigment, as approved shall be used wherever refinished.

12.5 Waterproofing

12.5.1 Floors and walls of toilet areas, corridors and planter boxes shall be treated with Conmix Moyaproof WS2 water proofing or equivalent coating. The waterproofing material / compound shall be approved by the consultant prior to application

12.6 Installation Requirements

12.6.1 As far as possible, tile lay out work should be in such a way that no tile less than half size occurs. Align joints in wall tile vertically and horizontally except where other patterns are shown or specified, Align joints in floor tiles at right angles to each other straight with walls to

conform to the patterns selected. Verify locations of accessories before installing tiles. Work shall be coordinated with plumbing and other trades before starting of tile work.

12.6.2 Installation of ceramic and vitreous tile shall be in accordance with manufacturer's instructions.

12.7 Floor Tile Installation

12.7.1 All ceramic and vitreous clay tile floors shall be laid by using Conmix C-800 Tile Adhesive or equivalent. Concrete surfaces shall be cleaned and surface of concrete shall be wetted prior to placing of setting mortar.

12.7.2 When mixed with water, the mortar mix shall be of such consistency and workability as to produce maximum density. Determine consistency by stroking the mortar surface with a trowel. Whereof correct consistency, the trowlled surface readily assumes a smoothed, slickened appearance.

12.7.3 Spread setting bed mortar and screed to provide smooth, dense beds with true planes pitched to drains. The thickness of bed shall be such that the floor tile will finish flush with adjacent finished flooring, but bedding shall have average thickness of 38mm.

12.7.4 After bed has set sufficiently to be worked over, trowel or brush a thin layer, 3mm in thickness, of neat Portland cement paste over the surface of the back of tile. Do not prepare larger setting bed than can be covered with tile before the mortar sets.

12.7.5 Press tile firmly into the bed tapping with wood blocks to obtain firm bedding of total tile area and a smooth top surface. All tile shall be properly aligned with straight joints in even widths. Joints width shall be determined by spacers on ceramic tiles. Tamping shall be completed within one (1) hour after placintile. Adjust work out of line within this period.

12.7.6 Tiles shall be fitted closely around pipes running through walls and floors. Pitch floors to drains.

12.8 Wall Tile Installation

12.8.1 All wall tiles shall be laid by using an approved Conmix C-800 adhesive or equivalent compound. Concrete surfaces shall be cleaned and surface of concrete shall be wetted prior to placing of setting mortar.

12.8.2 Setting bed of tiles shall be done with cement slurry. The thickness of slurry bed shall be 3mm thick minimum for setting tiles and walls.

12.8.3 Installation of tiles shall be in accordance with standards and applicable requirements previously specified for floor tile.

12.8.4 Tiles shall be installed in perfect vertical plumb and as per the pattern and joints as shown on drawings.

12.9 Grouting

12.9.1 Grouting shall not commence for at least 24 hours after placing of tiles.

12.9.2 Grout for floor and wall ceramic and vitreous tiles shall be waterproof, tile grout approved and added as directed by the Consultant.

12.9.3 Grout mixed to a creamy consistency in accordance with manufacturer's directions shall be used for joint filling. Maximum width of joints shall be 3mm.

12.9.4 Force maximum grout into the joints with trowel. Before grout sets, strike or tool joints to base of cushion and fill all skips and gaps. Do not permit setting bed materials to show through grouted joints. Cure grout joints by maintaining damp condition for three (3) days by sponging down, or other methods approved by the Consultant. Allow floors to set 48 hours before permitting ordinary foot traffic.

12.10 Tiles on Staircases_

12.10.1 Special tiles manufactured for steps and risers shall be used on staircases as shown on drawings. These tiles for treads shall have grooved / raised patterns of straight lines for foot hold. The finish of tiles shall be matt and non-skid. The tiles should be installed on a base coat of mortar (1:2) cement to river sand mix with 3mm thick slurry coat of cement. All joints shall be filled with matching gray or white cement.

12.11 Terrazzo Tile

12.11.1 Terrazzo tiles 300mm X 300mm X 6mm thick made to the best local standard with best quality marble chips '0' to maximum of 4 No. size with white and gray cement and pattern as approved by the Consultant shall be used for all floors.

12.11.2 Tiles shall be laid on a bed of cement to river sand mortar of 1:2 ratio and the mortar shall be covered with neat cement slurry and the joints of the tiles shall be kept perfectly tight and grouted with the same colour as that of the matrix of the terrazzo tiles. Tiles shall be laid evenly and to the perfect level and shall be set between the walls of the rooms so as to cause minimum cutting of full size tiles and where the tiles do not "come-out-even" the excess space shall be divided equally on all sides of the space area. Joints pattern shall be continued throughout the floor.

12.11.3 The terrazzo matrix shall not be less than 15mm thick in 300mm X 300mm tiles and cement mortar base for tiles shall be (1:4). Tiles shall be cured for a minimum of seven days after casting of tiles.

12.11.4 Terrazzo tiles shall be made of white and gray cement to match sample of tiles approved by the Consultant. The joints shall be rendered invisible as far as possible in colour with cement to match the tile colours. The joints shall be perfectly straight and shall meet perfectly with the lines of adjoining rooms.

12.11.5 All terrazzo tiles shall be a product of reputable tile manufacturers and shall be cast and pressed hydraulically in machines especially made for the manufacture of terrazzo tiles. Tiles with terrazzo matrix less than the thickness stated above shall be rejected and the Contractor has to replace the tiles at his own cost and risk.

12.11.6 Contractor shall, before bringing the tiles, ensure conformity of tiles to the specifications with regard to their colour and size of marble chips. All rejected tiles shall be immediately removed from the site by the Contractor.

12.11.7 All terrazzo tiles shall be ground smooth and wax polished before acceptance by Consultant. No marble powder shall be allowed in the matrix of terrazzo topping.

12.12 Polishing and Finishing

12.12.1 Complete curing, initial grinding or cutting with No. 80 Carborundum Stone and finishing of the tiles by means of N0. 140 Carborundum Stone shall be done prior to delivery on the site. All terrazzo floor tiles shall remain in place after setting for not less than one (1) week unless otherwise approved, final grinding, cleaning and polishing shall be done to the best standard and up to the satisfaction of the Consultant.

12.13 Curing

12.13.1 All terrazzo floors and finishes shall be cured for a minimum of 14 days after laying by means of wet bags, sand or other approved methods.

12.14 Defects in Tiles and Tile Laying

12.14.1 The surface of all tiled floors shall be perfectly in level and shall be executed by experienced workers in the field of tile laying. A sample panel of laid tiles of each type shall be approved by the Consultant before commencement of tile laying. Chipped or damaged tiles installed by the Contractor shall be rejected and shall have to be replaced by the Contractor at his own cost and risk.

12.15 Guarantees

12.15.1 Manufacturer shall be provide his standard guarantees for work under this section. However, such guarantees shall be in addition to not in lieu of all other liabilities which manufacturers and Contractor may have by other provisions of the Contract Documents.

13. PLUMBING

13.1 General

13.1.1 The materials used and workmanship shall be of highest quality and grade unless otherwise specified shall conform to the latest specifications of British Standards and Codes of Practice " Water Supply "Sanitary. Pipe Work "Building Drainage " Surface Water and Sub- Soil Drainage" and applicable to details and work indicated on the Drawing and Bill of Quantities. In case of any discrepancy / ambiguity the decision of the Consultants shall be final, and the contractor will act and perform accordingly.

13.1.2 The work shall be executed strictly in accordance with the rules and regulations set by the relevant local authority of the Maldives.

13.1.3 The Contractor shall be responsible for obtaining the necessary approvals and test certificates from the concerned departments of Maldives.

13.1.4 Plumbing work shall be carried out by licensed plumbers and shall produce the copy of the license along with the tenders, or approved by the Consultant

13.1.5 Any damage done by the Contractor to any existing work during the course of execution of his work, shall be made good by him at his own cost. Failing which it shall be get done by the Consultants at Contractor's risk and cost.

13.1.6 The Contractor shall be responsible to connect the drainage and water supply to the mains and to obtain the necessary approvals and certificates from the relevant authorities of the Maldives.

13.1.7 All connections to mains and meter installation shall be arranged by the Contractor and payment of fees thereof, if any, shall also be made by him.

13.1.8 The Contractor shall be responsible for the watch and ward of all fittings until the Works is fully completed and handed over to the owner.

13.1.9 The levels, measurements and other information concerning the existing site as shown on the drawings or as described as are supposed to be correct. The Contractor shall, however, verify them by himself and no extra claim whatsoever shall be entertained on account of the errors or omissions in such matters or on account of the descriptions turning out to be different from what was excepted.

13.1.10 The Consultant shall instruct the Contractor to purchase and use such materials of particular make or from particular source as may in his opinion be necessary for proper and reasonable compliance with the specification and execution of the Works.

13.1.11 After all plumbing fixtures and equipment have been set ready for use, and before the Contractor leaves the job, he shall thoroughly clean all fixtures installed by him, removing all plaster, stickers, rust stains and other foreign matter of discolouration on fixtures, leaving every part in acceptable condition and ready for use to the satisfaction of the Consultants.

13.2 Drawings and Information Required

13.2.1 The Contractor shall submit shop drawing for the entire installation including installation details for all items required or asked for approval of the Consultant.

13.2.2 Approved by the Consultant of shop drawing for any material, apparatus, devices and layout, shall not relieve the Contractor from the responsibility of furnishing same of proper dimension, size, quantity and all performance characteristic to efficiently perform the requirements and intent of the Contract Documents. Such approval shall not relieve the Contractor from responsibility for errors of any sort in the shop drawing.

13.2.3 If the shop drawings deviate from the contract Documents the Contractor shall advise the Consultants of the deviations in writing accompanying the shop drawings including the reasons for the deviations. At the start of the Project the Contractor shall periodically and thereafter submit to the Consultants list of all shop drawings which will be submitted in the course of the project. The list shall show the disposition of each item including date of submission approval etc. The list shall be kept upto date through the entire course of construction.

13.3 Record Drawing

13.3.1 During Construction the Contractor shall keep an accurate record of all deviations between the work as shown on the Contract Drawings and that which is actually installed.

13.3.2 The Contractor shall secure from the Consultants after approval of his Shop Drawing a complete set of drawing and note changes thereon in ink.

13.3.3 The Contractor shall make a complete record of all changes and revisions in the original design which exist in the completed work.

The cost of furnishing above prints and preparing these for record " shall be deemed to be include in the tendered cost and its effects spread over other items of work, and as such item shall not be a subject to payment". When all revisions showing the work as finally installed the corrected Original Transparencies shall be submitted to the Consultants before final payment for the completed work will be made.

13.4 Operating and Maintenance Instructions

13.4.1 Three sets of operating and maintenance instruction covering completely the operation and maintenance of all plumbing equipment, controls, heaters, pumps and the like shall be furnished to the Owner, by the Contractor.

13.5 Tests

13.5.1 The entire system of drains, waste and vent piping inside and outside the building shall be tested by the Contractor under a water test, which shall include the entire system from the lowest point to the highest pipes above the roof.

13.5.2 The water test shall be made in accordance with all local requirement. Every portion of the system shall be tested to a hydrostatic pressure equilent to latest 15 feet head of water. After filling, the Contractor shall shut off water supply and shall allow it to stand 2 hours under test during which time there shall be no loss or leakage.

13.5.3 The Contractor shall furnish and pay for device, material supplies, labour and power require for all tests. All tests shall be made in the presence and to the satisfaction of Consultant.

13.5.4 Defects disclosed by the test shall be repaired or if required by the Consultant defective work shall be replaced with new work without any extra charge to the Owner. Test shall be operated as directed until the work is proved satisfactory.

13.5.5 Fixture shall be tested for soundness, stability of support and satisfactory operation.

13.5.6 The Contractor shall notify the Consultant at least one week in advance of making the required test, so that arrangements may be made for their presence to witness the test.

13.5.7 Equipment shall be tested in service and the Contractor shall demonstrate that the equipment performs the work intended for it and that it complies with the requirement of these specification for such equipment, to the satisfaction of Consultants.

13.5.8 The rates shall include for all costs associated with tests.

13.5.9 Timely notice shall be given by the Contractor to the Consultant of the hour of tests

13.6 Work in Common Piping

13.6.1 Material

13.6.1.1 Piping and fitting material shall be P.V.C, Hard Impact P.V.C. or High Temperature P.V.C. and approved by the Consultant.

13.6.1.2 Piping material shall comply with requirements of water supply and sewerage and other relevant authorities.

13.6.1.3 Materials for the piping and service requirements shall basically conform to the service pressures encountered.

13.6.2 Providing Drawings and Manuals

13.6.2.1 The Contractor shall submit one set of originals and further two copies of layout drawings to the Consultant after completion of the Works. These drawings must give the following information:

(a) Run of all piping and diameter on all floors and the vertical stacks.
(b) Location and sizes of all control valves, access panels and other equipment.
(c) IL of all manholes including IL at our files.

13.6.2.2 No completion certificate will be issued until the drawings are submitted.

13.6.2.3 The Contractor shall submit to the Consultant for approval, samples, shop drawings, manufacturer's drawings, equipment characteristics and capacity data etc. of all equipment, accessories devices etc. that he proposes to use in the installation.

13.6.3 Samples

13.6.3.1 The Contractor shall provide samples of all sanitary fittings, pipes and specials, man-hole cover and frames, gratings and water supply pipes and fittings etc., and shall be deposited with the Consultant (which will be returned to the Contractor at the completion of the Works) and shall obtain approval from the Consultant before using in the Works. Any material rejected by the Consultant shall be removed from the site within 24 hours of rejection.

13.6.4 Drawings

13.6.4.1 The works shall be done in conformity with the plans and within the requirements of the general architectural, electrical and structural plans. This work shall be properly coordinated with the work of the other trades. Hangers and sleeves shall be furnished in time for their installation as other work proceeds.

13.6.4.2 The plumbing drawings are diagrammatic, but shall be followed as closely as actual construction and work will permit. All deviations from drawings required to conform to the building construction shall be made by the Contractor at his own expense.

13.6.4.3 The architectural drawings shall take precedence over the plumbing drawings as to all dimensions.

13.6.4.4 Large size details shall take precedence over small size drawings. The special dimensions in the specifications or schedule of quantities or instructions of the Consultant shall supersede the drawings. The Contractor shall verify all dimensions at site.

13.6.4.5 The recommend position of the fittings, fixtures, control valves, tanks etc. as shown on the drawings will be adhered to as far as practicable.

13.6.4.6 Should there be any discrepancy due to incomplete description ambiguity or omission in the drawings and other documents, whether original or supplementary, forming the contract, either found on completion or during the currency of the installations work, the Contractor shall immediately, on discovering the same, draw the attention of the Consultants and the Consultants decision in final and binding on the Contractor.

13.6.5 Existing pipes

13.6.5.1 The site shall be examined for field drains and those, when found, shall be either entirely removed or diverted, trenches filled with dry earth in 200mm to 300mm layers and consolidated as directed by the Consultant.

13.6.6 Spare Parts

13.6.6.1 Necessary spare parts of the plumbing equipment for the one (1) year operation shall be supplied by the Contractor.

13.6.7 Excavation

13.6.7.1 All excavations shall be timbered to the satisfaction of the Consultant and the type of timber shall be suitable to the kind of earth encountered. Fixing of timber and removal after completion of work shall be done as directed by the Consultant.

13.6.7.2 Should any water accumulated in the trenches, headings or other excavation, the Contractor shall do such work as may be necessary to drain away the accumulated water and

shall install pumps as may be required to keep the excavation and trenches dry. The Contractor shall ensure that the flow water in trenches or excavation does not injure or remove cement or aggregate of any concrete that has not set. No subsoil water shall be discharged into open drains or sewer at the site.

13.6.7.3 In refilling trenches after excavation this should be done in layers of 150mm after consolidating each layer. Special care shall be to see that the earth is packed uniformly and no injury to the pipe.

13.6.7.4 Rates for excavation should include for backfilling in consolidated layers where necessary and as directed by the Consultant.

13.6.8 Piping

13.6.8.1 The Contractor shall, as soon as possible after the award of the contract, prepare and submit to the Consultant for approval, working drawings showing exact locations and pipe runs for all pipework, the layout and setting up of equipment and the connection of piping to the equipment. Such drawings shall include details and methods of supports, anchors and sleeves etc.

13.6.8.2 Pipe runs shown in the drawings are approximate and intended to indicate the general run and locations only. The exact locations of all pipework shall be determined on Site.

13.6.8.3 All pipes, fittings etc. shall be kept closed against moisture and foreign matters when stored at site and during installation.

13.6.8.4 All pipes shall be fixed clear of one another and be so arranged as to provide easy access for maintenance and repair.

13.6.8.5 All plumbing work shall be carried out by suitably qualified plumbers in accordance with the British Code of Practice and Regulations and requirements of related Authorities.

13.6.8.6 Materials for the piping and service requirements shall basically conform to the service pressures encountered.

13.6.8.7 Each part of the installation of the plumbing work shall be completed in all details as shown in the drawings or as specified and provided with all necessary control valves, etc. that will be necessary for their satisfactory operation.

13.6.8.8 All piping shall be run plumb, and straight and parallel to walls, except drain line which shall pitch 6mm per 300mm in the direction of flow.

13.6.8.9 Pockets, unnecessary traps, turns and off-sets shall be avoided. When traps or pockets are unavoidable they shall be valved drains.

13.6.8.10 Piping installed on the concrete slab shall be firmly fixed or anchored to the floor with packing to prevent damage to pipes. Pipes shall not be bent with bender where cross with other pipe or change to upward.

13.6.8.11 Where pipes are to be laid directly in the ground, bed shall be sufficiently compacted, necessary protection for piping shall be taken.

13.6.8.12 Backfill shall be done after the approval of the Consultant in such a manner not to damage the pipe line and shall be restored to the original stage.

13.6.8.13 Where pipes penetrate through waterproof part or fire partition or fire wall, pipe sleeves shall be provided and clearance between pipe sleeve and pipe shall be filled with caulking material approved by the Consultant.

13.6.8.14 Pipes, fittings, valves and accessories shall be thoroughly cleaned, both internally and externally before installation and shall be cleaned before putting into service.

13.6.8.15 Plumbing work shall be completed in accordance with the details shown on the Drawings or as specified and provided with all necessary control valves, etc. that will be necessary for their satisfactory operation.

13.6.8.16 All pipes shall be cut square and true to the pipe axis by means of suitable tools without reducing pipe diameter and cut ends shall be finished smooth. Before making connections, chips, dirt and other foreign matter shall be removed from inside interior of each pipe. Fixing of hangars and embedding of pipe sleeves shall be carried out without delay along with the progress of the work where required.

13.6.8.17 Pipe connections for the water supply system shall be by union type for pipes of 50mm diameter and less and for pipework above 50mm diameter, connections shall be made by means of appropriate socket fitting etc. Jointing shall be generally by means of solvent cement according to manufacturer's instructions

13.6.8.18 Vertical pipe shall be braced at more than 2 point in every story.

13.7 Water Supply Work

13.7.1 Materials

13.7.1.1 Pipes, joints and fittings for water supply work shall be high pressure P.V.C.

13.7.1.2 Materials and workmanship shall comply with the local water supply authority requirements.

13.7.2 Water pump

13.7.3 Spacing of supports

13.7.3.1 Support spacing for P.V.C pipes shall be as follows

Nominal Dia.	upto 40	more than 50
Space (m)	1.2	1.5

13.8 Drainage Work

13.8.1 General

13.8.1.1 High Pressure P.V.C pipe and fittings shall be used for all drainage work including vent pipes.

13.8.1.2 Joints shall be made by the cold-jointing method, and the pipe interior shall have not offset at the joint interfering with the flow. Joint adhesive shall be good quality and shall not be affected by heat and shock.

13.8.1.3 Where horizontal drain branch joints the main, such branch shall be connected to the main in a substantially horizontal position and at an acute angle of not more than 45 degree to the main in all cases.

13.8.2 Vent stack pipes

13.8.2.1 Vent pipe shall be vertically branched out upward from a horizontal drain branch pipe or other appropriate point. Horizontal branching of the vent pipe shall be done on approval of the Consultant.

13.8.2.2 Where vent pipes on each floor are to be connected to the vent stack, all connections shall be made at least 150mm above the respective overflow edges of fixture on that floor.

13.8.2.3 The provision of the preceding item shall also apply to the connection of vent stack vent pipe.

13.8.2.4 Vent stack shall be connected to the waste stack or soil stack at the lowest part to stack pipe.

13.8.2.5 Where vent pipe is to be connected to the horizontal drain pipe, such angle shall be more than 45 degree to upward.

13.8.2.6 Vent stack shall be extended 600 mm from the top of the roof or lead to the wall and top of pipe shall be covered with vent cap.

13.8.3 Spacing of Support

13.8.3.1 Spacing for support shall conform to the section of Water Supply Work item of spacing.

13.9 Laying of Pipes

13.9.1 The pipes shall be laid to proper lines and levels as shown in the plans and directed by the Consultant, as the main is laid, the front pipes in the trench shall always be closed with a plug either of iron or wood and security fastened. The plug shall not be removed except when pipe laying is resumed or for purposes of testing.

13.10 Laying of sewer water Mains

13.10.1 All mains shall be laid on a good solid, bottom to prevent subsidence and consequent fracture.

13.10.2 Mains running under buildings, if unavoidable, shall be completely surrounded by 150mm of concrete.

13.10.3 In case of mains passing through a well, the weight of the latter shall be carried by a lintel or a suitable relieving arches.

13.10.4 All rising mains shall be properly plugged to all wall brackets at regular intervals as given in the drawings.

13.10.5 All mains shall be concealed inside wall as far as possible except for vertical sewer mains, cleaning doors shall be provided in the walls whenever necessary and as directed by the Consultant.

13.11 Sewers

13.11.1 After the cement has had time to set, the pipes shall be tested in length between manholes in the following manner:-

13.11.1.1 In the lowest manhole/intercepting trap as the case may be, a plug shall be inserted in the pipe. The disc in the pipe at the upper manhole shall be fitted with a filling pipe with a right angle bend and an air cook. The pipe line shall then be filled with water by means of the pipe connection on the upper disc. The air cock on the upper disc shall be kept open white the pipe line is being filled to permit the escape of air. When the pipes are filled with water and air excluded, the air cock shall be shut and the water shall be poured into conical filler, attached to the filling pipe until the water remains in the filter. The filling pipe shall then be raised and fastened so that the height of surface of the water in the filler above the invert of the pipe is 1828 mm which will be usual test pressure for S.W pipes. If the water level does not fall more than 16mm (12mm) in a length of 91.4 metre the test may be considered satisfactory. The Contractor shall good all defective work at his own expense.

13.12 P.V.C Pipes

13.12.1 Manufacturer's instruction should be followed, Pipes to be used for water mains shall where specified have integral rubber ring joints when solvent cement joints are specified, a sufficient number of expansion/contraction joints shall be incorporated in the length of mains to allow for variation of temperature to the recommendation of the pipe manufacturers.

13.12.2 These pipes shall be effectively protected from the direct rays of sun immediately after they are laid and until permission is given for the trenches to be refilled by the Consultant. Subject to such permission being obtained, trenches shall be refilled without delay. Final connection at a fixed point shall be deemed unto the majority of the length of the pipe line has been covered by backfill in order to reduce the effect of expansion and contraction caused by temperature variations.

13.13 Bends and other Specials

13.13.1 In fixing bends care shall be taken to see that the axis of the bend is truly vertical or horizontal as the case may be and the spigot of the bend is well in the socket of the pipe with which a joint has to be formed. The Contractor shall be called on to replace any faulty work at his own expense.

13.14 Flanged Joints

13.14.1 All flanged joints shall be made by painting the faces of the flanged with red lead freely and bolting the flanges evenly on all sides. A thin fiber of lead wool may be used in making the joints water tight when facing of the flanges is not true. Rubber insertions may be used with approval. Sewage resistant rubber insertion to be used for sewer lines.

13.15 Support for P.V.C Pipes

13.15.1 When P.V.C pipe lines incorporate metal valves or other heavy fittings, it is essential to support the valves directly rather than allowing their weight to be carried by the P.V.C pipe and support shall be placed on either side of the fittings mentioned above. Moulded plastic fitting also should be supported.

13.15.2 Maximum allowable horizontal support distance for P.V.C are given below.

Nominal before	12 mm (1/2")	18 mm (3/8")	25 mm (1")	32 mm (1¼")	38 mm (1½")	50 mm (2")
Support distance	533 mm (1'9")	616 mm (2'0")	686 mm (2'3")	764mm (2'6")	840 mm (2'9")	915 mm (3'0")
Nominal bore	75 mm (3")	100 mm (4")				
Support distance	1220 mm (4'0")	1290 mm (4'6")				

13.15.3 For vertical installation supports, distances shall be doubled.

13.16 Sewer Pipe Specials

All 'P', 'S', 'I' junctions bends etc. required shall be furnished and set without extra charge and shall confirm to the pipe specifications as to quality.

13.17 Air Valves

These valves to be fitted as per drawings and Bill of Quantities shall be tested and accompanied by a certifying their efficiency. The floating ball in the valve shall be suitable metal or vulcanite or rubber specially manufactured for tropical conditions.

13.18 Scour Washout Valve

These shall be provided at portions shown in place and shall contain in one unit a flanged scour valve with short connection pieces, cast iron bend and T pieces for connection to main pipe. The rate shall also provide for short length of straight pipe to a convenient as per details complete with covers and surface boxes.

13.19 Reflux Valve

The Reflux valves shall be of approved manufacture and the body and door shall be of cast iron and the facing shall be gun metal.

13.20 Foot valves and Strainers

Foot valve and strainers should be of reputable manufacture approved by the Consultant and shall be fitted with flushing lever attachment where specified.

13.21 Pressure Reducers

Pressure reducing valves shall be of the equilibrium type of approved manufacture and capable of reducing the pressure to the valve required as per plan and Bill of Quantities.

13.22 Water Meter

This shall be provided if required by local authority as per their specification and approval.

13.23 Equilibrium Ball Valves

These should be of reputable manufacture approved by the Consultant and be of the angle pattern with gun metal valve seats guide bush, copper float with wrought iron lever and links with bronze pins.

13.24 Fittings

13.24.1 All sanitary pipes, gullies, water closets/bidets, squatting basins, sinks bath tubs etc. to be of approved design and to be obtained from approved Manufacture and to be of the best stoneware glazed inside and outside, with burnt hard and sound, free from flaws, blisters, cracks and other imperfections and best quality commonly called 'Firsts'. Rates should include for all bends, junctions, traps, specials, cleaning, painting, fixing clear of wall etc. complete as specified as per Bill of Quantities.

13.24.2 All pipes, fittings, flushing cisterns, valves, stop cocks, taps, tanks, surface boxes etc. to be of the best of their kinds and in addition to complying with previous clauses to be from approved Manufacturers and all taps, cocks, valves etc. to be screwed down pipe. Taps to be of brass/nickel coated and valves to be of gun metal as specified in Bill of Quantities. All tanks to be made fly-proof and to the complete satisfaction of the Consultant. All lavatory basins, sinks etc. must be fixed at least 12mm, the latter method of fixing is preferable. Rates should include for all cutting and waste, bends, taps junctures, cleaning eyes, tees.

12.24.3 Contractor shall submit pipes, fittings, flushing cisterns, valves, stop cocks, taps, tanks, surface boxes etc. to be approved by the consultant.

13.25 Manholes and Manhole covers and Frames

13.25.1 Concrete cover slabs or top rings of manholes shall provide a suitable seating for a rectangular cover and frame having a clear opening 0.61m x 0.457m or alternatively a circular or double triangular cover and frame having a clear opening of 550m dia depending on the type of C.I manhole cover to be used, and the rate for manholes shall allow for such provision.

13.25.2 Where the supply of C.I manhole cover and frames is payable separately the cost of setting, surrounding, painting and materials for same shall be allowed for in the rate for manholes.

13.25.3 Suitable lifting rings, hooks or brackets shall be provided in the precast manhole sections. Box holes shall be separately grouted with 1:2 cement mortar.

13.25.4 The Contractor shall supply two manhole keys for each pattern of cover without additional charge over the rate for covers (or manholes).

13.25.5 Heavy duty (grade A) cast iron manhole cover and frames shall be of the double triangular type to B.S and having a clear opening of 550mm dia.

13.25.6 Medium duty (grade B) cast iron manhole covers and frames shall be of the circular type having a clear opening of 550m dia or the rectangular type having a clear opening of 0.457m x 0.61m and confirm to BS. They shall be of the single seal type, the weight of cover frame being approximately 127.00 kgs.

13.25.7 Light duty (grade C) cast iron manhole cover and frames shall be of the doubles seal flat type having a clear opening of 0.457m x 0.61m conforming to B.S.S. weight of cover and frame approximately 50.75kgs.

13.25.8 All manhole covers and frames shall be supplied, coated with a black bituminous composition and be given two coats of bituminous paint after bedding.

13.25.9 No extra rate is payable for drop and/or junction manholes but piping in and surrounds of drop lines are payable at that relevant rates for S.W piping and manholes.

13.25.10 In drop manholes where the difference in level between the incoming drains and the sewer does not exceed 0.610m in 75mm and there is sufficient room in the manhole, the connecting pipe may be brought directly through the manhole wall, and the fall accommodated by constructing a ramp in the benching of the manhole. The ramp shall be of concrete and finished equal to that of the benches. No extra rate is payable.

13.26 Interceptor Manhole

13.26.1 All SWG gravity sewer lines should be, connected through an intercepting manhole before connecting to the main sewer line, and the dimensions of the manhole and trap to be in conformity with the drawings given.

13.26.2 Step iron shall be of galvanized malleable cast overall length per step 0.61m protected with 4 coats of anti-corrosive paint.

13.27 Fixtures and Accessories

13.27.1 Sanitary fixtures

13.27.2 Maker, class and colour shall conform to the Drawings and particular specifications or the instructions of the Consultant.

13.27.3 Sanitary fixtures shall be as follows:

Fixture	Type/model/catalogue No.	Color/Remarks
Water Closet	American standard or equivalent	White
Basin	American standard or equivalent	White
Muslim shower	Water Tec	White
Mirror Unit	Wooden type with higher quality finish	
Kitchen Sink	Not required	

13.27.4 Flush Valves

Flush valve for water closet shall be made of chrome-plated bronze and able to flush 15 litre of water within 10 seconds under 1.0kg/cm² supply pressure.

13.27.5 Faucet and Tap

Faucet and tap shall be made of chrome-plated bronze. Flush valve and faucet shall pass the_œ pressure test of 17.5 kg/cm².

13.27.6 Traps

All traps shall be made of Vitrified of P.V.C.

Fixture	Dia. (mm)	Seal depth
Water Closet (W.C.)	100	50 or more
Wash Basin	32	50 or more
Kitchen Sink	38	50 or more

13.27.7 Miscellaneous

13.27.7.1 Metal accessories which is exposed-to-view shall be chrome-plated.

13.27.7.2 Screw used to fix the fixture or accessories shall be brass made and shall be made chrome-plated where exposed-t-view.

Anchor bolts or expansion bolts shall be used where the fixtures are to be installed on the concrete, block or brick wall and wooden block, if used, shall be treated with preservative and firmly embedded in the wall.

13.27.7.3 In case wood block is used for anchor purpose, such wood shall be treated with anti-corrosive paint.

13.27.7.4 Where fixture is anchored to the slab, necessary anchor hole and pipe sleeve shall be provided at the construction of such slab.

13.27.7.5 Clearance between the fixture and wall shall be filled with white cement or sealing compound.

13.27.7.6 Position of faucet or tap shall be determined with due consideration given to convenience according to the surrounding situation, and securely installed.

13.5.8 Height of Fixture Installation

Height of fixture shall be as follows unless otherwise specified on the Drawings

Fixture		**Height (mm)**
Wash Basin	Floor finish to front top edge - Male	700
	Floor finish to top of mirror - Male	1675
	- Female	1660
Lavatory	Floor finish to front top edge	760
Shelf	Floor finish to top of shelf - Male	1005
	- Female	990
	F	
Drinking fountain	Floor to front top edge	765
Flush valve, WC	Floor to center of valve	600
Paper holder	Floor to center of holder - Japanese type	400
	- Western type	750
Faucets		
Sink	Sink floor to top of faucet	300
Lavatory	Lav. Top to top of faucet	150
Bath	Bath tub top to top of faucet	150
Bath room	Floor finish to top faucet	300

14. PAINTING

14.1 Material

14.1.1 Use KCC paint or equivalent for all the interior and exterior paint works. All paints shall be approved by the Consultant for colour, quality and type. All painting work shall be carried out in accordance with the paint manufacturer's specifications unless otherwise directed by the Consultant.

14.1.2 Paint shall be ready mixed and all paints, varnishes, enamels, lacquer stains, paste fillers and similar materials shall be delivered to the site in the original containers with the seals unbroken and labels intact. Each container shall give the manufacturer's name, type of paint, colour of paint and instructions for reducing. Thinning shall be done only in accordance with the manufacturer's directions.

14.1.3 Use of product by the same manufacturer shall be a general rule in each stage of work in this Specification.

14.1.4 Colour, luster, colour scheme, finish shall be decided by the Consultant after checking sample paint test.

14.1.5 The painting shall be performed by experienced and competent painter.

14.1.6 Where walls are specified to be painted, all columns arises, groove, rough surfaces, reveals, soffits and returns, etc. shall be included and no extra shall be payable.

14.2 Definition of Terminology

Surface Sealing

Surface to be painted shall be sealed to have uniform suction and prevent lye from oozing out.

Spot Puttying

All cracks and depressions shall be filled flush with putty.

Spot painting

Spot puttied area shall be touched up by paint

Touch-up

Any damaged area after the prime coat has been applied shall be touched up

Drying hour

The drying time of double coated paint shall be measured at the temperature of 20°C and humidity of 70%.

Amount of paint

The amount shall be standard amount of paint itself not including thinner. It shall increase or decrease depending on shape and surface condition in the process of painting.

14.3 Paint Finish Symbols

OP	Synthetic resin mix paint finish
VP	Solvent-polyvinyl chloride resin paint finish
EP	Polyvinyl acetate resin emulsion paint finish
AEP	Synthetic resin emulsion paint finish
CL	Clear lacquer finish
EXP	Epoxy resin paint finish

Stipple (OP)	Stippled finish (oil mix paint finish)
Stipple (EP)	Stippled finish (polyvinyl acetate resin emulsion paint finish

14.4 Painting in General

14.4.1 Preparation of Paint

(a) **Mixing:** Paint content with pigment shall be thoroughly stirred to make a uniform consistency.

(b) **Thinning:** Portable water shall be used for thinning of emulsion paint and water-soluble paint. Proper thinner, product of the same manufacturer as paint, as a rule, shall be used for other types of painting. Percentage of thinning and viscosity shall be conducted with direction of manufacturer or catalogue as they vary with the method of paint, temperature, type of material to be painted.

(c) **Allowable period of Use:** Paint mixed with more than 2 types shall be used with direction of a manufacturer or catalogue as allowable period of use, mixing ratio and mixing method vary. The paint which has passed allowable period of use shall not be used.

14.4.2 Conditions of Painting

(a) Work shall not be executed in the following situations
  (1) When humidity is above 85%
  (2) When raining or it is forecast
  (3) When dusts are present
  (4) When temperature of surface is high under hot weather and bubbles are likely to develop on the painted surface.

(b) Conditions of Surface to be painted: Work shall not be executed or proper means shall be taken in the following situations.
  (1) When surface is damp and wet
  (2) When condensation is likely to develop on the surface.
  (3) All nail holes on veneer, board. etc., shall be covered with proper rust-proof paint before the subsequent painting is applied in accordance with this specification.

14.4.3 Performance

Paint shall be evenly and uniformed applied on the surface. Areas of difficult application such as pointed part, internal angle, welded part, etc. shall be thoroughly painted and double coated as necessary to deep uniform coating thickness. Painting shall be properly done by carefully selecting the painting method by the shape of surface and types of paint.

14.4.4 Protection

Dangerous material such as paint, thinner, etc., excluding emulsion paint and water-soluble paint shall be kept in accordance with regulations concerned.

14.5 Procedure of Painting

14.5.1 Exterior - Surface of Mortar, Plaster, Concrete and Slate

AEP- Synthetic resin emulsion paint.

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface preparation		Dry, clean and free from impurities		
2. Surface sealing	1	Sealer for emulsion paint	longer than 4 hours	
3. Puttying		Putty for emulsion paint		
4. Grinding		Grind with proper grinding tool		
5. Spot painting		Synthetic resin emulsion paint		
6. Second coating	1	Synthetic resin emulsion paint	longer than 4 hours	0.10-0.13
7. Finish coating	2	Synthetic resin emulsion paint	longer than 4 hours	0.10-0.13

Notes:

(a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5
(b) Puttying and sanding process shall allowed to omit depending on the conditions of the surface.
(c) Drying time of putty shall be long enough for sanding to proceed.
(d) Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

14.5.2 Exterior - Iron Products in General

OP - Synthetic resin mix paint

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface preparation		Completely remove rust, moisture, oil and other impurities by sander, cleaner and surface.		
2. First Coating 24 hours	1	Rust proof oil paint	longer than 24 hours	0.13-0.15
3. Touch-up		Touch-up rustproof oil paint		
4. First Coating	1	Rustproof oil paint	longer than 24 hrs	0.13-0.15
5. Second coating	1	Synthetic resin mix paint	longer than 15 hrs	0.11-0.15
6. Finish coating	1	Synthetic resin mix paint	longer than 15 hrs	0.11-0.15

Note:

Paint for touch-up painting shall be the same as used for first coat in process No. 2

14.5.3 Exterior - Wood

OP - Synthetic resin mix paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface preparation		Clean and sand to plane surface		
2. Knot treatment	1-2	Lacquer varnish	longer than 24 hours	
3. First coating	1	First coat paint of oil mix paint	longer than 24 hrs	0.13-0.15
4. Second Coating	1	Oil mix paint	longer than 24 hrs	0.11-0.13
5. Finish coating	1	Oil mix paint	longer than 24 hrs	0.11-0.13

Note:

Puttying and sanding shall be done after process No.2 when there are cracks, etc. on the surface putty shall be oil-putty, but drying time shall vary depending on conditions.

14.5.4 Interior - Mortar, board, etc.

Stipple (EP) - Polyvinyl acetate resin emulsion paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface preparation		Dry, clean and free from impurities		
2. Surface sealing	1	Sealer for emulsion paint	longer than 4 hours	
3. Puttying		Putty for emulsion paint		
4. Grinding		Grind with proper grinding tool		
5. Spot painting		Second coating paint of polyvinyl acetate resin emulsion paint		
6. Second Coating	2	Polyvinyl acetate resin emulsion paint	longer than 4 hrs	1.11-0.13
7. Finish Coating	1	Polyvinyl acetate resin emulsion paint for stipple-finish	longer than 4 hrs	0.25-0.35

Notes:

(a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5
(b) Puttying and sanding process shall allowed to omit depending on the conditions of the surface.
(c) Drying time of putty shall be long enough for sanding to proceed.
(d) Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions

14.5.5 Interior - Mortar, plaster, concrete, etc.

VP Solvent - Polyvinyl chloride resin paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m²)
1. Surface preparation		Dry, clean and free from impurities		
2. Surface sealing	1	Sealer for emulsion paint	longer than 2 hours	
3. Puttying		Putty for polyvinyl chloride resin paint		
4. Grinding		Grind with proper grinding tool		
5. Spot painting		Solvent-polyvinyl chloride resin enamel emulsion paint		
6. Second Coating	1	Solvent-polyvinyl chloride resin enamel emulsion paint	longer than 4 hrs	0.11-0.14
7. Finish Coating	2	Solvent-polyvinyl chloride resin enamel emulsion paint	longer than 4 hrs	0.11-0.14

Notes:

(a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5
(b) Puttying and sanding process shall allowed to omit depending on the conditions of the surface.
(c) Drying time of putty shall be long enough for sanding to proceed.
(d) Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

14.5.6 Interior - Mortar, plaster, concrete, etc.

EP Polyvinyl acetate resin emulsion paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m²)
1. Surface preparation		Dry, clean and free from impurities		
2. Surface sealing	1	Sealer for emulsion paint	longer than 4 hrs	
3. Puttying		Putty for emulsion paint		
4. Grinding		Grind with proper grinding tool		
5. Spot painting		Polyvinyl acetate resin emulsion paint		
6. Second Coating	1	Polyvinyl acetate resin emulsion paint	longer than 4 hrs	0.11-0.13
7. Finish Coating	1	Polyvinyl acetate resin emulsion paint	longer than 4 hrs	0.11-0.13

Notes:

(a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5
(b) Puttying and sanding process shall allowed to omit depending on the conditions of the surface.
(c) Drying time of putty shall be long enough for sanding to proceed.

(d) Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

14.5.7 Interior - Iron products, steel.

OP - Synthetic resin mix paint

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface preparation		Completely remove rust, moisture, oil and other impurities by sander, cleaner and surface		
2. First Coating	1	Synthetic resin rust-proof. Red lead-type, lead compound-type	longer than 24 hrs	0.18-0.22 0.13-0.15
3. Touch-up		Touch-up rust proof paint		
4. First Coating	1	Synthetic resin rust-proof paint. Red lead-type, Lead compound-type	Longer than 24 hrs	0.18-0.22 0.13-0.15
5. Second Coating	1	Synthetic resin mix paint	longer than 15 hrs	0.11-0.13
6. Finish Coating	1	Synthetic resin mix paint	longer than 15 hrs	0.11-0.13

Notes:

(a) Paint for touch-up painting shall be the same as used for first coat in process No.2
(b) When oil rust-proof paint is used instead of synthetic resin rust proof, its specification shall conform to No. 5 and No.6.

14.5.8 Interior - Wood Products in Clear Finish.

Cl - Clear Lacquer Finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m²)
1. Surface preparation		Clean and sand to plane surface		
2. Colouring	1-2	N.G.R Stain	longer than 2 hrs	
3. Colouring sealer	1	Wood-sealer	longer than 2 hrs	0.08-0.10
4. Grain treatment	1-2	Oil sealer	Longer than 12 hrs	
5. Second Coating	2	Sanding sealer	longer than 4 hrs	0.10-0.13
6. Grinding		Grinding with proper grinding tool		
7. Finish Coating	2	Clear lacquer		0.06-0.08
8. Grinding		Sanding with water		
9. Finish Coating	1	Clear lacquer	Longer than 24 hrs	0.06-0.08
10. Polishing		Polish with polishing compound		

Notes:

(a) Grain treating process shall be allowed to omit for certain trees approved by the Consultant.
(b) Process (2) through (4) shall be allowed to omit by the use of colouring and grain treating agents.
(c) Number of coats for processed 5 and 6 and processes 7 and 8 shall indicate the repetition of process.

14.5.9 Interior - Wood Products

OP - Synthetic resin mix paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m²)
1. Surface treatment		Clean and sand to plane surface		
2. Knot treatment	1-2	Lacquer varnish	longer than 2 hrs	
3. First coating	1	First coating paint for synthetic resin mix paint	Longer than 2 hrs	0.13-0.15
4. Grinding		Grind with proper grinding tool		
5. Finish Coating	2	Synthetic resin mix paint	longer than 15 hrs	0.11-0.13

Notes:

(a) Puttying and sanding shall be done after process No.2 when there are Cracks, etc. on the surface. Putty shall be oil putty, But drying time shall vary depending on conditions.

14.5.10 Interior - Wood Products

AEP, EP - Synthetic resin emulsion paint or vinyl acetate resin emulsion paint finish.

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m²)
1. Surface treatment		Clean and sand to plane surface		
2. Knot treatment	1-2	Lacquer varnish	longer than 2 hrs	
3. First coating	1	First coating paint for synthetic resin emulsion, first coat paint for vinyl acetate resin emulsion	Longer than 24 hrs	0.10-0.13
4. Finish Coating	2	Synthetic resin emulsion paint Vinyl acetate resin emulsion paint	longer than 24 hrs	0.10-0.12 0.11-0.13

Notes:

(a) Puttying and sanding shall be done after process No.2 when there are Cracks, etc. on the surface. Putty shall be oil putty, but drying time shall vary depending on conditions.

14.5.11 Steel Sash

OP - Synthetic resin mix paint finish.

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m²)
1. Surface treatment		Phospheric acid chemical coat treatment by metal surface treating agent		
2. Priming	1	Wash-primer	between 2 - 8 hrs	0.06-0.08
3. First coating	1	Primer for sash	Longer than 10 hrs	0.10-0.16
4. Touch-up		Touch-up primer		
5. First coating	1	Primer for sash	Longer than 10 hrs	0.13-0.16
6. Second Coating	1	Synthetic resin mix paint	Longer than 15 hrs	0.11-0.13
7. Finish Coating	2	Synthetic resin mix paint	longer than 15 hrs	0.11-0.13

Notes:

(a) Wash primer shall be omitted when surface is treated by phospheric acid in process No.1.
(b) Paint for processes up to No.4 and No.5 shall be similar paint used for first coat in process No.3 or that recommended by a manufacturer.

14.5.12 Steel Sash, Machinery and Tools, Plates

OP - Synthetic resin mix paint finish.

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface treatment		Completely remove rust, moisture, oil and other impurities by sander, cleaner and scraper		
2. First coating	2	Rust-proof synthetic resin	Longer than 15 hrs	0.12-0.15
3. Second Coating	1	Synthetic resin mix paint	Longer than 15 hrs	0.11-0.13
4. Finish Coating	1	Synthetic resin mix paint	Longer than 15 hrs	0.11-0.13

Notes:

(a) Wash primer shall be omitted when surface is treated by phospheric acid in process No.1.
(b) Paint for processes up to No.4 and No.5 shall be similar paint used for first coat in process No.3 or that recommended by a manufacturer.

14.5.13 Inside of Steel, Inside of Water Tank

EXP - Epoxy resin paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface treatment		Remove rust by sand burst or shot burst and clean by volatilizer		
2. First coating	2	Rust-proof epoxy resin	Longer than 24 hrs	0.15-0.20
3. Second Coating	1	Second coating paint for epoxy resin paint	Longer than 24 hrs	0.12-0.15
4. Finish Coating	1	Finish coating paint for epoxy resin paint	Longer than 24 hrs	0.12-0.15

Notes:

(a) First coat shall be applied once within 5 hrs after surface preparation.
(b) Paint for inside of potable water tank shall be that recommended by a manufacturer.
(c) After finish paint is applied inside of water tank shall be kept out of water for 7 days.

14.5.14 Floor - Concrete and Mortar

EXP - Epoxy resin paint finish

Coating Process	No. of Coats	Type of Paint	Drying hour	Amount (kg/m^2)
1. Surface treatment		Dry, clean and free from impurities		
2. First coating	1	First coating paint for epoxy	Longer than 24 hrs	
3. Finish Coating	2	Epoxy resin paint	Longer than 24 hrs	

Notes:

(a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5.
(b) Amount of paint and number of paint shall be as directed by the Consultant as they vary with the conditions of surface and required thickness of coating.
(c) Painted surface shall be kept out of use for more than 7 days after application of final coat.

14.5.15 Painting aluminium primer on timber panels

Apply two coats aluminium primer on concealed side of plywood panels

15. ELECTRICAL INSTALLATIONS

15.1 General

15.1.1 The work shall be carried out strictly in accordance with the standard specifications and shall also conform to the requirements of Electricity Rules in force in Male', Republic of Maldives.

15.1.2 All materials to be used in the Works shall be of standard make and shall bear the certification marks of local authorities. All materials shall be approved by the Consultant before use in the Works.

15.1.3 Earthing shall invariably be done in the presence of the Consultant or his representative.

15.1.4 All the conduits shall be continuously earthed. Check nuts shall be provided at the point where the conduct enter the I.C. box and junction box.

15.1.5 The Contractor shall arrange for the inspection of all Medium Pressure Installation by the Electrical inspector of the local electric supply authority from where the electricity connections has to be obtained, and see that they are passed by him.

15.1.6 The Contractor shall be responsible for all necessary permits, approvals, fees, deposits etc., required to complete the Electrical works in accordance with the Contract.

15.1.7 Scope of work

15.1.7.1 The work consist of furnishing all tools, plants, labour, materials and equipment and performing the internal electrical Works comprising of:

(a) Light and power wiring
(b) Fans and fixtures
(c) Wires and Cables
(d) Fire Alarm System
(e) Telephone System
(f) Sub- Station Equipments:
(g) Distribution Fusegear
(h) Earthing System
(i) Lightening Protection System
(j) Air Conditioning System

15.1.8 Prequalification

15.1.8.1 The Electrification Work shall be carried out only by a licensed contractor authorized to under take such work under the Maldives Electricity Board.

15.1.8.2 Qualification

15.1.8.3 A licensed Electrical Contractors should have the following qualifications:

(a) Must have in his employment a competent Electrical Engineer registered with Maldives Electricity Board.
(b) Must have in its employment an Electrical Consultant having certificate of competency who will exclusively supervise this work.
(c) Must have necessary tools, plant and instruments.
(d) Must have adequate experience of similar works.
(e) If a contractor does not posses the above qualifications he shall be allowed to sublet the Work to a competent Sub-Contractor provided an application for his prequalification is made to the engineer for his approval. Decision of the Engineer in this case shall be binding on the Contractor.

15.1.9 Rules and Regulations

15.1.9.1 The installation in general shall be carried out in conformity with the Electricity Rules, 1937 (UK), and the latest edition of the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers, London (I.E.). However, in case of conflict between these Specifications and the I.E. Regulations, these Specifications shall be followed.

15.1.10 Standards

15.1.10.1 The latest relevant British Specifications, and I.E. recommendations shall be applicable and be followed for the equipment specified herein.

15.1.11 Climatic Conditions

15.1.11.1 All equipment supplied shall withstand, without developing any detect, the following climatic conditions:-

Maximum Ambient Temperature	=	113° F or 45° C
Minimum Ambient Temperature	=	28° F or - 2.2° C
Maximum Humidity	=	90%

15.1.12 Specifications

15.1.12.1 The Contractor shall furnish all material and equipment at site, confirming fully to the specifications given herein and to the accepted standards, the Institution of Electrical Engineers, London, and the Maldives Electricity Board. It is not the intent of these Specifications to include all details of design and construction of various material and equipment to be supplied under this contract. The Contractor shall supply and install all material and equipment specified herein and also all installation and small material such as nuts, bolts, washers, shims angles, leveling material, insulation, tape, solder , etc. and all such required for complete installation as intended by the Specifications.

15.1.12.2 The contractor shall provide for all the required technical and non - technical personnel, skilled and non - skilled labour, construction equipment, transportation etc., as required for the completion of Work in strict accordance the Technical Specifications laid herein-after. All material and equipment supplied by the Contractor shall be new and in all respects conforming to the high standard of engineering design and workmanship. All material and equipment which have to be supplied and installed by the Contractor shall be passed/approved by the Consultant; even if the same is exactly in accordance with the Bill of Quantities and Drawings.

15.1.13 Submittal

15.1.13.1 The Contractor, after the award of work, shall submit for approval of the Consultant all drawings and cuts of equipment, appliances, fixtures and accessories. Cuts, catalogues and drawings shall be clearly marked to indicate, the items furnished.

15.1.14 Approval of Drawings and Data

15.1.14.1 The Contractor shall provide detailed electrical drawings, wire diagrams, etc. for all electrical switchgear, fusegear and all other systems etc. for the Consultant to review and approval. Three sets of equipment drawings shall be provided for obtaining approval.

15.1.15 Drawings & Data

15.1.15.1 Three sets of drawings and data for each equipment shall be furnished by the Contractor for the Consultant approval before commencement of work. The drawings to be supplied by the Contractor shall be as follows:-

Electrical Drawings showing:-

(a) One-Line diagram
(b) Detailed wiring diagram
(c) All interconnections
(d) Relays, their locations, and internal wiring diagrams
(e) Other electrical devices including meters instruments and their wiring diagram

15.1.16 Shop Drawings

15.1.16.1 The design drawings do not show conduit routes and depict only the position of various fixtures and outlets. All the planning for the conduit routes shall be carries out, well in advance of the actual execution of work, by the Contractor to the satisfaction of the Consultant. For this purpose the Contractor shall prepare shop drawings and obtain prior approval of the Consultant. There prints of each shop drawings shall be submitted for obtaining approval. work.

15.1.16.2 No piece of work shall be allowed to be executed at site without the availability of these approved shops drawings. These shop drawings shall clearly depict the load balancing chart of each Distribution Board. Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.

15.1.17 Spare Parts list

15.1.17.1 A list of spare parts required for the one year's operation of each equipment where deemed necessary together with unit price of each part, shall be supplied by the contractor.

15.1.18 Guarantee

15.1.18.1 The Contractor shall furnish written guarantee in triplicate of the manufacturer for successful performance of each equipment. Such guarantee shall be for replacement which may be found defective in material or workmanship. The guarantee shall cover a minimum period of 12 months effective from the date of completion certificate.

15.1.19 As-Built Drawings

15.1.19.1 The Contractor shall, during the progress of work keep a careful record of all changes and where the actual installation differs from that shown on shop drawings. These changes and revisions where the actual installation differs from that shown on shop drawings. These changes and revisions shall be accurately carried out on the shop drawings and submitted to the Consultant for approval. After approval these drawings shall become the property of the Owner. These updated and approved shop drawings depicting clearly all changes and revisions made on site shall be called As-Built Drawings. Reproducible tracings of all these As-Built Drawings shall be handed over to the Consultant. Final payment will be withheld until the receipt of the approved As-Built Drawings.

15.1.20 Test Reports

15.1.20.1 The Contractor shall be responsible for the submitting the test reports/certificates and get the installation inspected passed by the Maldives Electricity Board.

15.1.21 Electricity Board Requirement

15.1.21.1 The Contractor shall assist the Owner in sponsoring application for Electrical connection, lies with Electricity Board and carry out necessary formalities. Any special requirement of the Contractor.

15.2 Conduit And Conduit Accessories

15.2.1 Conduit Pipe

15.2.1.1 The conduit for the wiring of lights, socket outlets and other systems shall be made of PVC confirming to BSS 3505/1968 Class-D.

The conduit shall have following wall thickness and standard weights:

Pipe Size	Wt/100Rft.	Wall thickness
20mm dia	3.4 Kg	0.04 to 0.05
25mm dia	4.5 Kg	0.045 to 0.055

15.2.1.2 Steel conduit shall conform to BSS 31/latest. The conduit shall be enameled with good quality non- cracking and non-flaking black paint.

15.2.2 Conduit Accessories

15.2.2.1 The use of factory made round PVC junction boxes shall be used and should have nipples to receive PVC pipe with force fit, shall be used for ceiling outlets. The wall type junction box shall also be PVC. Each junction box shall be provided with one piece cover which shall be fitted on the box with screws.

15.2.2.2 Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of PVC having dust tight covers. All boxes shall have required number of conduit entry holes. All the rectangular or square shaped boxes shall have nipples to receive PVC conduit force fit.

15.2.2.3 Manufactured smooth bends shall be used where conduit changes direction. Bending of Conduit by heating or otherwise shall be allowed only at special situations with the permission of the Consultant. Use of sharp 90 degree bends and tees is prohibited. Bends shall have enlarged ends to receive the conduit without any reduction in the internal diameter of the PVC pipe.

15.2.2.4 All accessories e.g. boxes, coupling, bends, solid plugs, bushes, reducers, checknuts etc. shall be equal in quality to the specified conduit.

15.2.2.5 The drawings do not show conduit routes and all the planning for arranging conduit routes shall be carried out by the Contractor to the satisfaction of the Consultant.

15.2.2.6 The entire conduit system shall be essentially completed before the wiring pulling is taken in hand. Each conduit run shall be tested for continuity and obstructions. All obstructions shall be cleared in an approved manner. Water and moisture that has entered any section of the conduit installation must be dried with suitable swabs to the satisfaction of the Consultant.

15.2.2.7 Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in the concrete slab of the buildings.

15.2.2.8 All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.

15.3 Wires, Cables And Cords

15.3.1 Wires & Cords

15.3.1.1 The wires & cords for the conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to B.S. 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on Drawings and Bills of Quantities.

(a) For light or fan point wiring with 1.5 mm square or as specified in the BOQ.
(b) For light circuit wiring with 2.5 mm square or as specified in the BOQ.
(c) For power plug 15A wiring with 4mm square or as specified in the BOQ.

15.3.2 Installation Instructions

15.3.2.1 All wiring shall be continuous between terminations and use of connectors or joints is not be allowed. Spurr and tee connections are strictly prohibited.

15.3.2.2 Manufacturers recommended lubricant shall be allowed to facilitate pulling of wires. Use of any kind of oil and soap is prohibited.

15.4 Wiring Accessories

15.4.1 Switches

15.4.1.1 Indoor switches controlling lights and fans shall be single pole, 5A, one or two way, suitable for 250V,50 Hz. The body of the switches shall be made of moulded plastic, one, two, three or four gang with integral built in moulded plastic face plate.

15.4.1.2 Weatherproof switches shall conform to B.S. standard.

15.4.2 Switch Socket Outlet Units

15.4.2.1 Switch & socket units shall be single, pole, 3 pin rated 5A. 15A or 20A, 250V, 50 Hz. These shall be moulded plastic type with white integral built-in face plate. Each socket shall have its control switch by the side of it on a common face plate. Thus the complete unit specified in BOQ shall be as switch and a socket outlet unit.

15.4.3 Fans

15.4.3.1 All fans shall be capacitor type Deluxe models and suitable for operation on 200/220 volts, 50 Hz, A.C Supply. All ceilings fans shall have five speed dimmers. The air displacement shall be 10,000 c.f.m for 48" (1219 mm) Sweep and 12,000 c.f.m. for 56" (1423 mm) Sweep at maximum speed. The fan motor shall be capacitor type and bearings shall be groove type to give noiseless and quiet operation. The noise level relative to a frequency of range 1000 Hz should be within the limits of +3 dB.

15.4.4 Dimmer

15.4.4.1 The dimmer shall be recessed type as required and shall be approved by the Consultant.

15.4.5 Fan Hook

15.4.5.1 The fan hook shall be made of 12 dia mild 5/5 steel rod bent to shape of approved design. It should be in the form of a loop about 3-1/4" (87.5 mm) long and about 2" (50 mm) wide. The rod shall be bend to have at least 8" (200 mm) extension on both sides for tieing to the reinforcement steel of the slab. All ceiling fan shall be of one make only.

15.4.5.2 The fan hook shall be installed in the RCC slab of the ceiling at the time of pouring concrete.

15.5 Light Fixtures

15.5.1 General

15.5.1.1 The description of light fixtures is given in the Bills of Quantities, and stated on the Drawings, and all relevant material are described in this Section. The determination of quality is based on certified photometric data covering the coefficient of utilization, light distribution curves, construction material, shape, finish, operation, etc.

15.5.1.2 The Contractor shall submit samples of each and every lighting fixture specified for approval of the Consultant.

15.5.1.3 The type of fixtures with manufacturer catalogue reference are given in Bill of Quantities. The lighting fixtures shall be manufactured by M/s. Philips, M/s.RZB Lighting as approved by Consultant.

15.5.2 Incandescent Light Fixture

15.5.2.1 The glass globes/ shades/ diffusers of the incandescent light fixtures shall be first class quality glass free from any air bubbles or voids. The glass shall generally be of opal white colour unless otherwise specified. The shape of the glass may be spherical, hemispherical, flattened bottom or tablet shaped as required.

15.5.2.2 Surface mounted fixture shall have stove enamelled sheet steel body. It may also be satin brass or aluminium anodised finish as required. The fixing holes shall match the outlet box. Wall bracket light fixtures shall have back plates with matching holes of the outlet box and decorative finish as required.

15.5.2.3 All the lighting fixtures shall be suitable for local climatic conditions.

15.5.3 Fluorescent Light Fixture

15.5.3.1 All the light fixtures shall have lamps and electronic ballasts of the wattage specified. The fluorescent lamp shall be either 2 ft - 18 watts or 4 - 35 watts and the colour shall generally be day light, cool day light in the order of preference or as mentioned specifically. The fluorescent lamps shall be Philips to BSS 1853 but having a minimum useful life of 5000 hours. The new generation of 26mm dia 18 watts and 36 watts energy efficient lamps shall be preferred.

15.5.3.2 The ballast shall be totally enclosed electronic type suitable for operation on 220 V, 50 Hz, single phase supply, a wiring diagram, wattage, voltage and current ratings shall be printed on the body of the ballasts. The power loss shall not more than 10 watts for 36 watts ballast. The ballast shall be noiseless in operation without any whistling sound. The manufacture shall be called upon to guarantee a trouble free life of 3 years, effective from the date of completion certificate.

15.5.3.3 The starters shall have radio-interference suppressers.

15.5.3.4 The internal wiring of the light fixtures shall be carried out at manufacturers factory with heat resistance wires of size not less than 1.5 mm square.

15.5.3.5 The louvers of light fixtures shall be made of anodized aluminium and/or moulded plastic. The diffusers shall be made of acrylic perspex.

15.5.3.6 All the lighting fixtures shall be suitable for local climatic conditions.

15.5.4 Installation Instructions

15.5.4.1 The light fitting shall be installed according to manufacturers recommendations or as approved by the Consultant.

15.5.4.2 Flexible connecting wires from outlet box to the fixture shall be provided by the contractor; connector made of porcelain or thermoplastic material shall be provided and installed in the outlet boxes for connecting flexible wires to the point wires.

15.5.4.3 Outlet boxes or any openings in the ceilings and walls shall be covered with appropriately fabricated accessories to provide an architectural entity to conceal them.

15.5.5 Main L.T. Switchboard

15.5.5.1 The L.T. switchboard shall be indoor type, free standing, free supporting, floor mounted, totally enclosed, sheet cald, dust and suitable for operation on 3 phase 4 wire system, 415 v , 50 Hz, AC supply . The board shall be suitable for installation back to the wall and capable of front attendance. The switch board shall be designed to suit service conditions and ensure security and safety during operation , inspection , operation , cleaning and maintenance. The switch board shall be designed and tested to IEC recommendations. Each panel shall withstand strain of 2000 volts insulation level for one minute power frequency test.

15.5.5.2 The L.T. switch board shall consist of the following:

(a) Maldives electricity board incoming panel.
(a) Stand by generator incoming panel with A.M.F.

15.5.6 Distribution Feeder Panel

15.5.6.1 Single diagram of the L.T. switch board shall be approved by the consultant before placing order for the switch board.

15.5.7 Earthing

15.5.7.1 The switchboard shall be effectively earth by means of a copper strip of 25mm x 3mm (1" x 1/8") cross -section bolted to connections near the bottom of the switchboard.

15.5.8 Accessories

15.5.8.1 Designations labels, lifting lugs , foundation bolts, interconnecting nuts blots, and washers, thimbles, lugs, levelling shims cable glands and/or cable end box for all the sizes of incoming and outgoing cable shall be supplied with the switchboard.

15.6 Testing

15.6.1 The following tests shall be conducted on each completed switchboard

15.6.1.1 Type Tests

(a) Temperature rise test
(b) Mechanical endurance test
(c) Making/Breaking Capacity test

15.6.1.2 Routing Test

(a) High Voltage test

The Switchboard shall be tested to British/Electricity Council Standard 41-5. Preference shall however, be given to Switchboards fabricated from all components manufactured by only one manufacturer.

15.6.2 Installation Instruction

15.6.2.1 All labour, equipments, tools and plants required to complete the installation shall be provided by the contractor. The Switchboard shall be fixed firmly on the floor in perfect line, plumb and level position. All incoming and outgoing cable connections shall be made from the bottom including Earth connections.

15.7 Distribution Board

15.7.1 The distribution boards shall be either free standing, cubical type or wall mounting type suitable for recessed mounting. Each distribution board (d.b.) shall be tropical in design, fully dust and vermin proof and liquid repellent.

15.8 Package Substation

Package substation consisting of

(a) 1 No : Transformer, 1000 KVA, 3 phase, 50 Hz, Dyn 11, 11000/433V +_ 2.5% to +_5% tapping.
(a) 1 No : Type T4GF3 (GEC Alshthom) ring main unit comprising of two ring main oil switches and a TEE-OFF oil fuse switch, 630A, 11KV, rated breaking capacity 46.9 KA.
(b) 1 No : 6way, LV feeder pillar with main disconnector.

15.9 Fire Alarm System

15.9.1 General

15.9.1.1 The contractor shall be under obligation to plan, supply, install, test, commission and maintain for the period specified elsewhere, a fire alarm system for this building. The proposed

system shall be micro-processor controlled, simple to install yet easy to operate and offer reliable protection against fire hazards.

15.9.2 Specifications

The system shall conform to B.S. 5839 Part -1 and B.S. 3116 Part -4 and shall facilitate the detection of fires occurring in any part of the building by subsequent audible and visual indications. The system shall generally comprise of the following :-

15.9.3 Main Control Panel

15.9.3.1 The system shall be controlled by a multi-zone micro-processor programmable fire alarm panel to be located at the ground floor reception room.

15.9.3.2 The control panel will be perspex fronted panel and will display all screened labelling and indications by block LEDs mounted behind the front hinged cover. The control panel shall be mounted in pressed steel housing and provide the following functions and indications.

15.9.3.3 Fully monitored two wire circuit for each sensor zone (24V D.C.) as required.

15.9.3.4 Fully monitored two wire sounded circuit (24V D.C.) as required.

15.9.3.5 Change over relay contacts each rated 5 amps 240V A.C. (Resistive load).

15.9.3.6 Full test and isolate functions via a key-board located on the facia of the main termination housing to provide the following:-

15.9.3.7 Ability to isolate sensor zones.

15.9.3.8 Ability to isolate sounder zones.

15.9.3.9 Ability to test automatically zones with an auto reset facility to enable a single person to carry out testing.

15.9.3.10 Full LED display of all functions comprising of:-

15.9.3.11 System on, system fault, processor fault, alarm, zone supply fault, system supply fault, battery fault, charger/mains fault, sounder fault and sensor fault together with a test mode display which provides zone clears , zone open circuit and zone short circuit indication for individual sensor and sounder lines.

15.9.3.12 Sequence of sounder operation- All sounder and relay out-put sequences shall be completely programmable to enable future changes to be carried out with only soft ware changes.

15.9.3.13 The control panel shall provide the following functions and indications:-

a) Twin LED display for system on , system fault ,sounder fault, alarm, mains/ charger fault, main processor fault, sensor fault, alarm silenced , battery fault, supply fault and earth fault.
b) Also five dedicated control functions on illuminated push buttons which are key - isolated. These shall provide Evacuate, Buzzer Mute, Alarm silence, Lamp test and Reset controls.

15.9.4 Battery charger - the battery charger shall be an integral part of the main fire alarm control panel cabinet and shall be capable of fully recharging the stand - by batteries after a main's failure within 12 hours. The capacity of the batteries shall be sufficient to supply the standing load for the least 24 hours and the maximum alarm load for one hour. The system shall be suitable for operation on 220V single phase or 415V , 3- phase 50 Hz supply.

15.9.5 Sensors and Sounders

15.9.5.1 The main control panel as described in the foregoing shall be capable of working with the following devices having common specification as under :-

(a) Operating voltage	10-30 volts d.c (two wire system)
(b) Ambient temperature	10 C to +80 C.
(c) Humidity range	20 to 90 RH
(d) Altitude range	Sea level to 6000 meters
(e) Alarm mode	Self latching producing a resistance of 680 ohms across the supply line.

15.9.6 Photocell (optical) Smoke Detectors- The units shall operate on light scattering principle. An internal infra-red light source shall be pulsed , with the light beam ranged so as to by-pass a receiving unit. The presence of smoke shall scatter the light beam, causing it to be reflected on to the receiving photocell. An evaluation circuit shall measure the amount of light and shall compare it to a reference. The detector shall trigger in to an alarm state when the amount of smoke exceeds a pre-set level. To ensure against false alarms several pulse readings shall be taken and compared before the detector shall be triggered into alarm. The detectors shall conform to B.S.S. 5446 Part -1 and shall have the following specifications:-

(a) Quiescent Current	Less than 100 microamps at 20 volts.
(b) Alarm Current	Maximum 60 mA
(c) Maximum Coverage	300 cubic meters
(d) Weight	250 grams approx.
(e) Diameter x Height	92 mm x 80 mm

15.9.7 Fixed Temperature Heat Finder - The unit shall operate at a fixed temperature setting of 58 degree centigrade (135 degree Fahrenheit) by means of a bimetal switch connected through a circuit on an external indicator lamp. The high temperature version shall operate at 88 degree centigrade.

(a) Quiescent Current	80 microamps at 20 volts.
(b) Alarm Current	60 mA maximum
(c) Maximum Coverage	150 cubic meters
(d) Weight	150 grams approx.
(e) Diameter x Height	92 mm x 80 mm

15.9.8 Manual stations - This unit also named call point shall be break glass type that do not require a hammer. The frangible glass is pressed hand to break the glass which shall activate the alarm. The call point shall conform to B.S. 5839 Part-2

15.9.9 Alarm Bells - The alarm bells shall be centrifugal type and the gong shall be 100 mm diameter or as specified. The unit shall be suitable for an input of 24 V d.c. and shall provide a normal output of 94 db at 1 meter.

15.9.10 Electronic Sounders - The unit shall be primarily designed to operated on 24V.d.c. and arranged easily to generate a variety of sound signals: intermittent, continuos or warble tones.

15.9.11 Manufacturer

15.9.11.1 The equipment described as above shall be manufactured by M/s. GENT U.K, M/s. Honeywell, USA or M/s. Simplex, equivalent manufacturer.

15.9.12 Wiring

15.9.12.1 The wiring for the fire alarm system shall be carried out in PVC conduit in accordance with instructions contained herein relevant section. 2x2.5 mm square or 4x2.5 mm square PVC insulated single core cable 300/500 volts grade shall be pulled in 1" dia PVC

conduit laid for the purpose. Any spurs and tee joints in the wiring are strictly prohibited. Instructions contained in section -E.2.2 and 2.3 shall be followed.

15.9.13 Installation

15.9.13.1 The installation as a whole shall be tested and commissioned, in accordance with manufacturers instructions, to the entire satisfaction of the Consultant.

15.9.14 Shop Drawings

15.9.14.1 Shop drawing of the fire alarm system layout shall be submitted to the Consultant for approval.

15.10 Cable Ladder System

15.10.1 General

15.10.1.1 The cable ladder system shall generally be installed in vertical riser ducts provided for the purpose for parallel runs of cables of various services.

15.10.1.2 The Contractor shall be under obligation to supply all labour, material and accessories for the completion of cable ladder installation strictly in accordance with the specification laid as under and as illustrated on drawing to the entire satisfaction of the Consultant.

15.10.2 Design

15.10.2.1 The cable ladder system shall be fabricated from 16SWG (2.5 mm) thick sheet steel strip and then hot dip galvanized. All fixing accessories e.g. rawl bolts, cable clamps, nuts and bolts used for the cable ladder system shall be hot dip galvanised. All cable ladder shall have standard length of 4000 mm and a width of 500 mm. The ladder and accessories shall be subject to the prior approval of the Project Manager before mass production is taken in hand.

15.10.3 Installation

15.10.3.1 The cable ladders shall be installed in perfect line and plumb on the surface of walls in riser ducts by means of galvanized rawl bolts 1/2” dia x 3” long. Alternate ladder step in each length of ladder shall be clamped to the ladder in a neat and orderly manner by means of cable clamps. Depending upon the number of multiple cable runs two or three parallel ladders may be installed, side by side, in the same riser ducts in case one ladder is unable to accommodate all the cable runs. Each cable ladder (or an assembly of two or three parallel cable ladders laid side by side) shall be solidly earthed with 1” x 1/8” copper tapes on both sides.

15.11 Lightning Protection System

15.11.1 General

15.11.1.1 The Contractor shall be under obligation to supply all labour material, services and skilled supervision necessary. Shop drawing for the lighting system shall be submitted to the Consultant at least 4 weeks before commencing the work.

15.11.2 Workmanship

15.11.2.1 The installation shall be carried out by skilled and competent workmen so as to achieve top class workmanship.

15.11.3 Specifications of Preventor Mast

15.11.3.1 There shall be at least two down conductors of soft drawn copper size 8mm dia which shall follow the most direct parth between preventor and the earth point through the down conductor.

15.11.3.2 Care must be given to ensure that when the conductor is fixed there shall be no sharp bend and absolutely no upturns. Joints should be made with CS605 square clamps. These joints must be kept to minimum number. Test clamps should be provided for each down conductor at about 600mm above plinth level. No joint in conductor should be made below the test clamp, except at the earth terminal. The earth resistance for the entire system, in no case, should exceed 5 ohms.

15.11.3.3 All reinforcement steel of columns and slabs, where possible, shall be connected with the protective system. Metal pipes running parallel to the structures, within 1800mm of down conductor should be bounded at the top and bottom, and also at intermediate positions if directed at site.

15.11.3.4 The Mast should be mounted at the highest level and close to the centers marked as possible. The conductor shall be fixed to the roof/wall with PVC saddles.

15.11.3.5 All the instructions and the safety measures should be adhered to at site. The Consultant should be consulted at site if any changes due to site conditions are required to be made.

15.11.4 Manufacturer

15.11.4.1 Inquiries regarding the components and materials should be made to W.J Furse & Co. Ltd, Wilford Road, Nottingham NG2 IEB, UK. Fax 0602860538 or equivalent manufacture.

15.12 Telephone System

15.12.1 General

15.12.1.1 For telephone system the Contractor is required to provide and install telephone conduit, outlet boxes, equipment and apparatus will be supplied by the client.

15.12.2 Conduit & Conduit Accessories

15.12.2.1 The specifications for conduit and accessories shall be the same as given in Section 01.1 of these Specifications. The telephone outlet boxes shall be 3” x 3” x 2” deep. These shall be made of 16 SWG sheet steel and provided with earth terminals. A 5mm thick white plastic coverplate shall be on the box for fixing flush type rosettes on it.

15.12.3 Internet

15.12.3.1 15.12.3.1 The specification and accessories shall be the same given in section 01.01 of these specifications. However the contractor has the option of submitting equivalent accessories to the consultant for approval. The internet outlet shall be 3” x 3” x 2” deep with A 5mm thick white plastic coverplate shall be on the box for fixing flush type rosettes on it.

Design Of Member No. 2 As Per BS 5950-1:2000
Design Of Member No. 2 As Per BS 5950-1:2000

Input Parameters

Member Section	PIP602.5
Section Type	STAAD.Pro database
Cross Sectional Area A_x	0.000 m ^{2}
Net section factor	1.000
Net Effective Sectional Area A_{net}	0.000 m ^{2}
Shear Area Along Major Axis A_z	0.000 m ^{2}
Shear Area Along Minor Axis A_y	0.000 m ^{2}
r_z	0.020 m
r_y	0.020 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m ^{3}
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m ^{3}
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m ^{3}
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m ^{3}
Moment of Inertia About Major Axis - I_{zz}	0.000 m ^{3}
Moment of Inertia About Minor Axis - I_{yy}	0.000 m ^{3}
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m ^{3}
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m ^{3}
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	2.287 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	2.287 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Input Parameters
Input Parameters

Member Section	PIP602.5
Section Type	STAAD.Pro database

Cross Sectional Area A_x	0.000 m^2
Net section factor	1.000
Net Effective Sectional Area A_{net}	0.000 m^2
Shear Area Along Major Axis A_z	0.000 m^2
Shear Area Along Minor Axis A_y	0.000 m^2
r_z	0.020 m
r_y	0.020 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m^3
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m^3
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m^3
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m^3
Moment of Inertia About Major Axis - I_{zz}	0.000 m^3
Moment of Inertia About Minor Axis - I_{yy}	0.000 m^3
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	2.287 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	2.287 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Details Of Calculation

Slenderness Check

No slenderness checking has been performed.

Classification Of Section Class (BS-3.5.2)

Section Belongs To Class	3 (SEMI-PLASTIC)

Checking Minimum Web Thickness For Serviceability (BS-4.4.3.2)

Root Radius r	0.000 mm
Depth Of Web $d = d_{ww} - 2t_f - r$	0.000 mm

(d_{ww} = Overall Depth, t_f = Flange Thickness)

Allowable Ratio	1.0
Web Check for Serviceability	**SAFE**

Checking Minimum Web Thickness To Avoid Compression Flange Buckling (BS-4.4.3.3)

Root Radius r	0.000 mm
Depth Of Web d = d_{ww} - $2t_f$ - r	0.000 mm
(d_{ww} = Overall Depth, t_f = Flange Thickness)	
Design Strength Of Compression Flange p_{yf}	0.000 MPa
Allowable Ratio	1.0
Compression Flange Buckling Check	**SAFE**

Check Against Shear (BS-4.2.3)

Shear Along Major Axis	
Critical Loadcase No.	3
Critical Section	1.190 m
Beam No.	2
Shear Force Along Major Axis F_z	0.026 kN
Shear Capacity Along Major Axis $F_{z\_allowable}$ =$0.6p_yA_v$	44.946 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Major Axis) =F_z / $F_{z\_allowable}$	0.001
Major Axis Shear Check	**SAFE**

Shear Along Minor Axis	
Critical Loadcase No.	3
Critical Section	1.190 m
Beam No.	29
Shear Force Along Minor Axis F_y	0.394 kN
Shear Capacity Along Minor Axis $F_{y\_allowable}$ =$0.6p_yA_v$	44.946 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Minor Axis) =F_y / $F_{y\_allowable}$	0.009
Minor Axis Shear Check	**SAFE**

Checking Resistance To Lateral Torsional Buckling (BS-4.3.6)

Check Against Cross-Section Capacity (BS-4.8.3.2)

Design Forces

Combined Axial Force & Bi-axial moment	
Axial Load F_x	26.545 kN
Major Axis Moment M_z	0.008 kN m
Minor Axis Moment M_y	0.000 kN m
Critical Loadcase No.	3
Beam No.	30
Effective Cross-Sectional Area A_{eff} (As Per BS-3.6)	0.000 m^2
Major Axis Moment Capacity Of The Cross-Section M_{cz} (As Per BS-4.2.5)	2.299 kN m
Minor Axis Moment Capacity Of The Cross-Section M_{cy} (As Per BS-4.2.5)	2.299 kN m
Cross-Section Capacity	**SAFE**

Check Against Axial Compression (BS-4.7)

Calculation Of Allowable Compressive Stress (Annex C)

Strut Curve (Table 23)	a (Y-Y Axis of Buckling)
Strut Curve (Table 23)	a (Z-Z Axis of Buckling)
E	205000.781 MPa
Slender Reduction (λ in each direction is reduced by this factor)	1.000
$p_{Ey} = \pi^2 E / \lambda_y^2$	597.622 MPa
$p_{Ez} = \pi^2 E / \lambda_z^2$	597.622 MPa
Perry Factor $\eta_y = (\lambda y - \lambda_0) / 1000$	0.08206
where $\lambda_0 = 0.2 (\pi^2 E / p_y)^{0.5}$	17.155
Perry Factor $\eta_z = (\lambda z - \lambda_0) / 1000$	0.08206
where $\lambda_0 = 0.2 (\pi^2 E / p_y)^{0.5}$	17.155
$\phi_y = p_y + (\eta_y + 1) p_{Ey}$	460.832 MPa
$\phi_z = p_y + (\eta_z + 1) p_{Ez}$	460.832 MPa
Allowable Compressive Stress About Minor Axis p_{cy} $= p_{Ey} p_y / (\phi_y + (\phi_y^2 - p_{Ey} p_y)^{0.5})$	241.697 MPa
Allowable Compressive Stress About Major Axis p_{cz} $= p_{Ez} p_y / (\phi_z + (\phi_z^2 - p_{Ez} p_y)^{0.5})$	241.697 MPa
Effective Cross-Sectional Area A_{eff} (As Per BS-3.6)	0.000 m^2
Compressive Strength p_c = Min (p_{cy}, p_{cz}) * A_{eff}	109.731 kN

Design Forces

Critical Loadcase No.	3
Beam No.	30
Axial Load F_x	26.565 kN
Interaction Ratio = Actual Load / Allowable Load	0.242
Axial Compression Check (BS-4.7)	**SAFE**

Compression Members With Moments (BS-4.8.3)

Member Buckling Resistance Check (BS-4.8.3.3)

Simplified Method (BS-4.8.3.3.1)

Design Forces

Critical Loadcase No.	3
Beam No.	29
Axial Load F_x	21.535 kN
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Maximum Major Axis Moment In The Segment M_z	0.273 kN m
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Maximum Minor Axis Moment In The Segment M_y	0.002 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Maximum Minor Axis Moment In The Segment M_{LT}	0.273 kN m
Buckling Resistance Moment M_b (As Per BS-4.3.6.4)	2.299 kN m

Interaction Ratio (BS-4.8.3.3.1)

$= \text{Max} (F_x / p_c + m_z M_z / p_y S_{zz} + m_y M_y / p_y S_{yy} ,$

$F_x / p_{cy} + m_{LT} M_{LT} / M_b + m_y M_y / p_y S_{yy})$ 0.317

Simplified Method Check (BS-4.8.3.3.1) **SAFE**

Exact Method (BS-4.8.3.3.3)

Design Forces

Critical Loadcase No.	3
Beam No.	29
Axial Load F_x	21.544 kN
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Maximum Major Axis Moment In The Segment M_z	0.273 kN m
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000

Maximum Minor Axis Moment In The Segment M_y	0.002 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Maximum Minor Axis Moment In The Segment M_{LT}	0.273 kN m
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Major Axis Moment Capacity Of The Cross-Section M_{cz} (As Per BS-4.2.5)	2.299 kN m
Minor Axis Moment Capacity Of The Cross-Section M_{cy} (As Per BS-4.2.5)	2.299 kN m
Buckling Resistance Moment M_b (As Per BS-4.3.6.4)	2.299 kN m
Interaction Ratio For Major Axis Buckling $= F_x / p_{cz} + m_z M_z / M_{cz} (1 + 0.5F_x / p_{cz}) + 0.5m_{yz}M_y / M_{cy}$	0.370
Interaction Ratio For Lateral Torsional Buckling $= F_x / p_{cy} + 0.5m_{LT}M_{LT} / M_b + m_y M_y / M_{cy} (1 + 0.5F_x / p_{cy})$	0.257
Ratio For Interactive Buckling $= m_z M_z / M_{cz} (1 + 0.5F_x / p_{cz}) / (1 - F_x / p_{cz}) +$ $m_y M_y / M_{cy} (1 + 0.5F_x / p_{cy}) / (1 - F_x / p_{cy})$	0.217
Interaction Ratio (Maximum of the above three - BS-4.8.3.3.3)	0.370
Exact Method Check (BS-4.8.3.3.3)	**SAFE**

Interaction Check (Annex I)

Design Forces

Critical Loadcase No.	3
Beam No.	29
Axial Load F_x	21.555 kN
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	2.287 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	2.287 kN m
$M_{yz} = 2*M_{cz} (1 - F_x / p_{cy})$	3.695 kN m
k_y	0.500
$M_{oy} = M_{cy} (1 - F_x / p_{cy}) / (1 + k_y F_x / p_{cy})$	1.682 kN m
$M_{oz} = M_{cz} (1 - F_x / p_{cz}) / (1 + 0.5F_x / p_{cy})$	1.682 kN m
$M_{ay} = M_{oy} + (85.8\varepsilon - \lambda_y) / 68.65\varepsilon (M_{ry} - M_{oy})$	1.896 kN m
$M_{az} = M_{oz} + (85.8\varepsilon - \lambda_z) / 68.65\varepsilon (M_{rz} - M_{oz})$	1.896 kN m
$r_c = F_x / p_{cy}$	0.196
$r_b = m_{LT}M_{LT} / M_b$	0.119
λ_{LT}	0.000
$\lambda_r = (r_b\lambda_{LT} + r_c\lambda_y) / (r_b + r_c)$	36.246
$\lambda_{r0} = 17.15\varepsilon (2r_b + r_c) / (r_b + r_c)$	23.617

$M_{ob} = M_b (1 - F_x / p_{cy})$	1.847 kN m
$M_{ab} = M_{ob} + (85.8\varepsilon - \lambda_r) / (85.8\varepsilon - \lambda_{r0}) * (M_{rz} - M_{ob})$	2.140 kN m
Interaction Ratio For Major Axis Buckling	
$= m_z M_z / M_{cz} / M_{az} + 0.5 m_{yz} M_y / M_{cy} / (1 - F_x / p_{cy})$	0.145
Interaction Ratio For Lateral Torsional Buckling	
$= m_{LT} M_{LT} / M_{ab} + m_y M_y / M_{ay}$	0.129
Ratio For Interactive Buckling	
$= m_z M_z / M_{az} + m_y M_y / M_{ay}$	0.145
Interaction Ratio (Maximum of the above three - Annex I.1)	0.145
Interaction Check (Annex-I)	**SAFE**

Check Against Axial Tension (BS-4.6)

Design Forces

Critical Loadcase No.	3
Beam No.	28
Axial Load F_x	7.970 kN
Tension Capacity $P_t = p_y A_{net}$	124.850 kN
Interaction Ratio = Actual Load / Allowable Load	0.064
Axial Tension Check (BS-4.6)	**SAFE**

Check Against Axial Tension And Bi-Axial Bending (BS-4.8.2)

Combined Axial Force & Bi-axial moment

Design Forces

Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	28
Axial Load F_x	7.970 kN
Major Axis Moment M_z	0.178 kN m
Minor Axis Moment M_y	0.000 kN m

Interaction Check - Simplified method (BS-4.8.2.2)

Tension Capacity $P_t = p_y A_{net}$	124.850 kN
Major Axis Moment Capacity Of The Cross-Section	
M_{cz} (As Per BS-4.2.5)	2.299 kN m
Minor Axis Moment Capacity Of The Cross-Section	
M_{cy} (As Per BS-4.2.5)	2.299 kN m

Interaction Ratio (BS-4.8.2.2)	
= F_x / P_t + M_z / M_{cz} + M_y / M_{cy}	0.141
Simplified Method Check (BS-4.8.2.2)	**SAFE**

Design Forces

Major Axis Moment M_z	0.178 kN m
Minor Axis Moment M_y	0.000 kN m
Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	28

Interaction Check - More exact method (BS-4.8.2.3)

Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	2.287 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	2.287 kN m
Constant z_1	2.000
Constant z_2	2.000
Interaction Ratio (BS-4.8.2.3)	
= $(M_z / M_{rz})^{z}_{1} + (M_y / M_{ry})^{z}_{2}$	0.006
Exact Method Check (BS-4.8.2.3)	**SAFE**

Deflection Checking Ignored

DESIGN SUMMARY : ALL UNITS ARE - KN METE

Member : 29 Result : PASS Critical Cond : BS-4.8.3.3.1 Ratio : 0.317
Loading : 3 Fx : 21.54 My : 0.00 Mz : 0.27 Location : 0.50

Design Of Member No. 4 As Per BS 5950-1:2000
Design Of Member No. 4 As Per BS 5950-1:2000

Input Parameters

Member Section	PIP422.6
Section Type	STAAD.Pro database
Cross Sectional Area A_x	0.000 m^2
Net section factor	1.000
Net Effective Sectional Area A_{net}	0.000 m^2
Shear Area Along Major Axis A_z	0.000 m^2
Shear Area Along Minor Axis A_y	0.000 m^2
r_z	0.014 m
r_y	0.014 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m^3
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m^3
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m^3
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m^3
Moment of Inertia About Major Axis - I_{zz}	0.000 m^3
Moment of Inertia About Minor Axis - I_{yy}	0.000 m^3
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	1.114 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	1.114 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Input Parameters
Input Parameters

Member Section	PIP422.6
Section Type	STAAD.Pro database

Cross Sectional Area A_x	0.000 m^2
Net section factor	1.000
Net Effective Sectional Area A_{net}	0.000 m^2
Shear Area Along Major Axis A_z	0.000 m^2
Shear Area Along Minor Axis A_y	0.000 m^2
r_z	0.014 m
r_y	0.014 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m^3
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m^3
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m^3
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m^3
Moment of Inertia About Major Axis - I_{zz}	0.000 m^3
Moment of Inertia About Minor Axis - I_{yy}	0.000 m^3
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	1.114 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	1.114 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Details Of Calculation

Slenderness Check

No slenderness checking has been performed.

Classification Of Section Class (BS-3.5.2)

Section Belongs To Class	1 (PLASTIC)

Checking Minimum Web Thickness For Serviceability (BS-4.4.3.2)

Root Radius r	0.000 mm
Depth Of Web $d = d_{ww} - 2t_f - r$	0.000 mm

(d_{ww} = Overall Depth, t_f = Flange Thickness)

Allowable Ratio	1.0
Web Check for Serviceability	**SAFE**

Checking Minimum Web Thickness To Avoid Compression Flange Buckling (BS-4.4.3.3)

Root Radius r	0.000 mm
Depth Of Web d = d_{ww} - $2t_f$ - r	0.000 mm
(d_{ww} = Overall Depth, t_f = Flange Thickness)	
Design Strength Of Compression Flange p_{yf}	0.000 MPa
Allowable Ratio	1.0
Compression Flange Buckling Check	**SAFE**

Check Against Shear (BS-4.2.3)

Shear Along Major Axis	
Critical Loadcase No.	3
Critical Section	0.190 m
Beam No.	4
Shear Force Along Major Axis F_z	0.010 kN
Shear Capacity Along Major Axis $F_{z\_allowable}$	
$=0.6p_yA_v$	32.175 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Major Axis)	
$=F_z / F_{z\_allowable}$	0.000
Major Axis Shear Check	**SAFE**

Shear Along Minor Axis	
Critical Loadcase No.	3
Critical Section	0.190 m
Beam No.	4
Shear Force Along Minor Axis F_y	0.000 kN
Shear Capacity Along Minor Axis $F_{y\_allowable}$	
$=0.6p_yA_v$	32.175 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Minor Axis)	
$=F_y / F_{y\_allowable}$	0.000
Minor Axis Shear Check	**SAFE**

Checking Resistance To Lateral Torsional Buckling (BS-4.3.6)

Check Against Axial Tension (BS-4.6)

Design Forces

Critical Loadcase No.	3
Beam No.	4
Axial Load F_x	10.421 kN
Tension Capacity $P_t = p_y A_{net}$	89.375 kN
Interaction Ratio = Actual Load / Allowable Load	0.117
Axial Tension Check (BS-4.6)	**SAFE**

Check Against Axial Tension And Bi-Axial Bending (BS-4.8.2)

Combined Axial Force & Bi-axial moment

Design Forces

Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	4
Axial Load F_x	10.421 kN
Major Axis Moment M_z	0.013 kN m
Minor Axis Moment M_y	0.000 kN m

Interaction Check - Simplified method (BS-4.8.2.2)

Tension Capacity $P_t = p_y A_{net}$	89.375 kN
Major Axis Moment Capacity Of The Cross-Section M_{cz} (As Per BS-4.2.5)	1.133 kN m
Minor Axis Moment Capacity Of The Cross-Section M_{cy} (As Per BS-4.2.5)	1.133 kN m
Interaction Ratio (BS-4.8.2.2) $= F_x / P_t + M_z / M_{cz} + M_y / M_{cy}$	0.128
Simplified Method Check (BS-4.8.2.2)	**SAFE**

Design Forces

Major Axis Moment M_z	0.013 kN m
Minor Axis Moment M_y	0.000 kN m
Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	4

Interaction Check - More exact method (BS-4.8.2.3)

Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	1.114 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	1.114 kN m
Constant z_1	2.000
Constant z_2	2.000
Interaction Ratio (BS-4.8.2.3)	
$= (M_z / M_{rz})^{z}_{1} + (M_y / M_{ry})^{z}_{2}$	0.000
Exact Method Check (BS-4.8.2.3)	**SAFE**

Deflection Checking Ignored

DESIGN SUMMARY : ALL UNITS ARE - KN METE

Member : 4 Result : PASS Critical Cond : BS-4.8.2.2 Ratio : 0.128
Loading : 3 Fx : -10.42 My : 0.00 Mz : 0.01 Location : 0.00

Design Of Member No. 9 As Per BS 5950-1:2000

Input Parameters

Member Section	PIP422.6
Section Type	STAAD.Pro database
Cross Sectional Area A_x	0.000 m ^{2}
Shear Area Along Major Axis A_z	0.000 m ^{2}
Shear Area Along Minor Axis A_y	0.000 m ^{2}
r_z	0.014 m
r_y	0.014 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m ^{3}
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m ^{3}
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m ^{3}
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m ^{3}
Moment of Inertia About Major Axis - I_{zz}	0.000 m ^{3}
Moment of Inertia About Minor Axis - I_{yy}	0.000 m ^{3}
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m ^{3}
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m ^{3}
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	1.127 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	1.127 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Details Of Calculation

Slenderness Check

No slenderness checking has been performed.

Classification Of Section Class (BS-3.5.2)

Section Belongs To Class	3 (SEMI-PLASTIC)

Checking Minimum Web Thickness For Serviceability (BS-4.4.3.2)

Root Radius r	0.000 mm
Depth Of Web d = d_{ww} - 2t_f - r	0.000 mm
(d_{ww} = Overall Depth, t_f = Flange Thickness)	
Allowable Ratio	1.0
Web Check for Serviceability	**SAFE**

Checking Minimum Web Thickness To Avoid Compression Flange Buckling (BS-4.4.3.3)

Root Radius r	0.000 mm
Depth Of Web d = d_{ww} - 2t_f - r	0.000 mm
(d_{ww} = Overall Depth, t_f = Flange Thickness)	
Design Strength Of Compression Flange p_{yf}	0.000 MPa
Allowable Ratio	1.0
Compression Flange Buckling Check	**SAFE**

Check Against Shear (BS-4.2.3)

Shear Along Major Axis	
Critical Loadcase No.	3
Critical Section	0.182 m
Beam No.	9
Shear Force Along Major Axis F_z	0.009 kN
Shear Capacity Along Major Axis $F_{z\_allowable}$	
=0.6$p_y A_v$	32.175 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Major Axis)	
=F_z / $F_{z\_allowable}$	0.000
Major Axis Shear Check	**SAFE**

Shear Along Minor Axis	
Critical Loadcase No.	3
Critical Section	2.190 m
Beam No.	9
Shear Force Along Minor Axis F_y	0.027 kN
Shear Capacity Along Minor Axis $F_{y\_allowable}$	
=0.6$p_y A_v$	32.175 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Minor Axis)	
=F_y / $F_{y\_allowable}$	0.001
Minor Axis Shear Check	**SAFE**

Checking Resistance To Lateral Torsional Buckling (BS-4.3.6)

Check Against Cross-Section Capacity (BS-4.8.3.2)

Design Forces

Combined Axial Force & Bi-axial moment	
Axial Load F_x	5.854 kN
Major Axis Moment M_z	0.009 kN m
Minor Axis Moment M_y	0.000 kN m
Critical Loadcase No.	3
Beam No.	9
Effective Cross-Sectional Area A_{eff} (As Per BS-3.6)	0.000 m^2
Major Axis Moment Capacity Of The Cross-Section	
M_{cz} (As Per BS-4.2.5)	0.838 kN m
Minor Axis Moment Capacity Of The Cross-Section	
M_{cy} (As Per BS-4.2.5)	0.838 kN m
Cross-Section Capacity	**SAFE**

Check Against Axial Compression (BS-4.7)

Calculation Of Allowable Compressive Stress (Annex C)

Strut Curve (Table 23)	a (Y-Y Axis of Buckling)
Strut Curve (Table 23)	a (Z-Z Axis of Buckling)
E	205000.781 MPa
Slender Reduction (λ in each direction is reduced by this factor)	1.000
$p_{Ey} = \pi^2 E / \lambda_y^2$	83.853 MPa
$p_{Ez} = \pi^2 E / \lambda_z^2$	83.853 MPa
Perry Factor $\eta_y = (\lambda y - \lambda_0) / 1000$	0.27636
where $\lambda_0 = 0.2 (\pi^2 E / p_y)^{0.5}$	17.155
Perry Factor $\eta_z = (\lambda z - \lambda_0) / 1000$	0.27636
where $\lambda_0 = 0.2 (\pi^2 E / p_y)^{0.5}$	17.155
$\phi_y = p_y + (\eta_y + 1) p_{Ey}$	191.013 MPa
$\phi_z = p_y + (\eta_z + 1) p_{Ez}$	191.013 MPa
Allowable Compressive Stress About Minor Axis p_{cy}	
$= p_{Ey} p_y / (\phi_y + (\phi_y^2 - p_{Ey} p_y)^{0.5})$	75.141 MPa
Allowable Compressive Stress About Major Axis p_{cz}	
$= p_{Ez} p_y / (\phi_z + (\phi_z^2 - p_{Ez} p_y)^{0.5})$	75.141 MPa

Effective Cross-Sectional Area A_{eff} (As Per BS-3.6)	0.000 m^2
Compressive Strength p_c = Min (p_{cy}, p_{cz}) * A_{eff}	24.421 kN

Design Forces

Critical Loadcase No.	3
Beam No.	9
Axial Load F_x	5.904 kN
Interaction Ratio = Actual Load / Allowable Load	0.242
Axial Compression Check (BS-4.7)	**SAFE**

Compression Members With Moments (BS-4.8.3)

Member Buckling Resistance Check (BS-4.8.3.3)

Simplified Method (BS-4.8.3.3.1)

Design Forces

Critical Loadcase No.	3
Beam No.	9
Axial Load F_x	5.904 kN
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Maximum Major Axis Moment In The Segment M_z	0.017 kN m
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Maximum Minor Axis Moment In The Segment M_y	0.013 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Maximum Minor Axis Moment In The Segment M_{LT}	0.017 kN m
Buckling Resistance Moment M_b (As Per BS-4.3.6.4)	0.838 kN m

Interaction Ratio (BS-4.8.3.3.1)

= Max ($F_x / p_c + m_z M_z / p_y S_{zz} + m_y M_y / p_y S_{yy}$, $F_x / p_{cy} + m_{LT} M_{LT} / M_b + m_y M_y / p_y S_{yy}$)	0.277
Simplified Method Check (BS-4.8.3.3.1)	**SAFE**

Exact Method (BS-4.8.3.3.3)

Design Forces

Critical Loadcase No.	3
Beam No.	9

Axial Load F_x	5.904 kN
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Maximum Major Axis Moment In The Segment M_z	0.017 kN m
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Maximum Minor Axis Moment In The Segment M_y	0.013 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Maximum Minor Axis Moment In The Segment M_{LT}	0.017 kN m
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Major Axis Moment Capacity Of The Cross-Section M_{cz} (As Per BS-4.2.5)	0.838 kN m
Minor Axis Moment Capacity Of The Cross-Section M_{cy} (As Per BS-4.2.5)	0.838 kN m
Buckling Resistance Moment M_b (As Per BS-4.3.6.4)	0.838 kN m
Interaction Ratio For Major Axis Buckling $= F_x / p_{cz} + m_z M_z / M_{cz} (1 + 0.5F_x / p_{cz}) + 0.5m_{yz}M_y / M_{cy}$	0.272
Interaction Ratio For Lateral Torsional Buckling $= F_x / p_{cy} + 0.5m_{LT}M_{LT} / M_b + m_y M_y / M_{cy} (1 + 0.5F_x / p_{cy})$	0.269
Ratio For Interactive Buckling $= m_z M_z / M_{cz} (1 + 0.5F_x / p_{cz}) / (1 - F_x / p_{cz}) +$ $m_y M_y / M_{cy} (1 + 0.5F_x / p_{cy}) / (1 - F_x / p_{cy})$	0.052
Interaction Ratio (Maximum of the above three - BS-4.8.3.3.3)	0.272
Exact Method Check (BS-4.8.3.3.3)	**SAFE**

Interaction Check (Annex I)

Design Forces

Critical Loadcase No.	3
Beam No.	9
Axial Load F_x	5.849 kN
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	1.127 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	1.127 kN m
$M_{yz} = 2*M_{cz} (1 - F_x / p_{cy})$	1.718 kN m
k_y	0.500
$M_{oy} = M_{cy} (1 - F_x / p_{cy}) / (1 + k_y F_x / p_{cy})$	0.766 kN m
$M_{oz} = M_{cz} (1 - F_x / p_{cz}) / (1 + 0.5F_x / p_{cy})$	0.766 kN m
$M_{ay} = M_{oy} + (85.8\varepsilon - \lambda_y) / 68.65\varepsilon (M_{ry} - M_{oy})$	0.766 kN m

$M_{az} = M_{oz} + (85.8\varepsilon - \lambda_z) / 68.65\varepsilon (M_{rz} - M_{oz})$	0.766 kN m
$r_c = F_x / p_{cy}$	0.242
$r_b = m_{LT}M_{LT} / M_b$	0.020
λ_{LT}	0.000
$\lambda_r = (r_b\lambda_{LT} + r_c\lambda_y) / (r_b + r_c)$	143.487
$\lambda_{r0} = 17.15\varepsilon (2r_b + r_c) / (r_b + r_c)$	18.458
$M_{ob} = M_b (1 - F_x / p_{cy})$	0.635 kN m
$M_{ab} = M_{ob} + (85.8\varepsilon - \lambda_r) / (85.8\varepsilon - \lambda_{r0})*(M_{rz} - M_{ob})$	0.635 kN m
Interaction Ratio For Major Axis Buckling	
$= m_zM_z / M_{cz} / M_{az} + 0.5m_{yz}M_y / M_{cy} / (1 - F_x / p_{cy})$	0.029
Interaction Ratio For Lateral Torsional Buckling	
$= m_{LT}M_{LT} / M_{ab} + m_yM_y / M_{ay}$	0.043
Ratio For Interactive Buckling	
$= m_zM_z / M_{az} + m_yM_y / M_{ay}$	0.038
Interaction Ratio (Maximum of the above three - Annex I.1)	0.043
Interaction Check (Annex-I)	**SAFE**

Deflection Checking Ignored

DESIGN SUMMARY : ALL UNITS ARE - KN METE

Member : 9 Result : PASS Critical Cond : BS-4.8.3.3.3 Ratio : 0.272
Loading : 3 Fx : 5.90 My : 0.01 Mz : 0.02 Location : 0.00

Design Of Member No. 63 As Per BS 5950-1:2000
Design Of Member No. 63 As Per BS 5950-1:2000

Input Parameters

Member Section	PIP332.6
Section Type	STAAD.Pro database
Cross Sectional Area A_x	0.000 m ^{2}
Net section factor	1.000
Net Effective Sectional Area A_{net}	0.000 m ^{2}
Shear Area Along Major Axis A_z	0.000 m ^{2}
Shear Area Along Minor Axis A_y	0.000 m ^{2}
r_z	0.011 m
r_y	0.011 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m ^{3}
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m ^{3}
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m ^{3}
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m ^{3}
Moment of Inertia About Major Axis - I_{zz}	0.000 m ^{3}
Moment of Inertia About Minor Axis - I_{yy}	0.000 m ^{3}
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m ^{3}
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m ^{3}
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	0.693 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	0.693 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Input Parameters
Input Parameters

Member Section	PIP332.6
Section Type	STAAD.Pro database

Cross Sectional Area A_x	0.000 m^2
Net section factor	1.000
Net Effective Sectional Area A_{net}	0.000 m^2
Shear Area Along Major Axis A_z	0.000 m^2
Shear Area Along Minor Axis A_y	0.000 m^2
r_z	0.011 m
r_y	0.011 m
Elastic Section Modulus About Major Axis - Z_{zz}	0.000 m^3
Elastic Section Modulus About Minor Axis - Z_{yy}	0.000 m^3
Plastic Section Modulus About Major Axis - S_{zz}	0.000 m^3
Plastic Section Modulus About Minor Axis - S_{yy}	0.000 m^3
Moment of Inertia About Major Axis - I_{zz}	0.000 m^3
Moment of Inertia About Minor Axis - I_{yy}	0.000 m^3
Steel Grade	S275
Design Strength p_y	275.000 MPa
Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	0.693 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	0.693 kN m
Equivalent Uniform Moment Factor For LTB m_{LT}	1.000
Equivalent Uniform Moment Factor For Lateral Flexural Buckling m_{yz}	1.000
Equivalent Uniform Moment Factor For Major Axis Flexural Buckling m_z	1.000
Equivalent Uniform Moment Factor For Minor Axis Flexural Buckling m_y	1.000
Allowable Ratio For Interaction Check	1.000

Details Of Calculation

Slenderness Check

No slenderness checking has been performed.

Classification Of Section Class (BS-3.5.2)

Section Belongs To Class	1 (PLASTIC)

Checking Minimum Web Thickness For Serviceability (BS-4.4.3.2)

Root Radius r	0.000 mm
Depth Of Web $d = d_{ww} - 2t_f - r$	0.000 mm

(d_{ww} = Overall Depth, t_f = Flange Thickness)

Allowable Ratio	1.0
Web Check for Serviceability	**SAFE**

Checking Minimum Web Thickness To Avoid Compression Flange Buckling (BS-4.4.3.3)

Root Radius r	0.000 mm
Depth Of Web d = d_{ww} - $2t_f$ - r	0.000 mm
(d_{ww} = Overall Depth, t_f = Flange Thickness)	
Design Strength Of Compression Flange p_{yf}	0.000 MPa
Allowable Ratio	1.0
Compression Flange Buckling Check	**SAFE**

Check Against Shear (BS-4.2.3)

Shear Along Major Axis	
Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	105
Shear Force Along Major Axis F_z	0.000 kN
Shear Capacity Along Major Axis $F_{z\_allowable}$	
$=0.6p_yA_v$	25.146 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Major Axis)	
$=F_z / F_{z\_allowable}$	0.000
Major Axis Shear Check	**SAFE**

Shear Along Minor Axis	
Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	105
Shear Force Along Minor Axis F_y	0.049 kN
Shear Capacity Along Minor Axis $F_{y\_allowable}$	
$=0.6p_yA_v$	25.146 kN
(A_V = Shear Area As Per BS-4.2.3)	
Interaction Ratio (Along Minor Axis)	
$=F_y / F_{y\_allowable}$	0.002
Minor Axis Shear Check	**SAFE**

Checking Resistance To Lateral Torsional Buckling (BS-4.3.6)

Check Against Axial Tension (BS-4.6)

Design Forces

Critical Loadcase No.	3
Beam No.	105
Axial Load F_x	0.073 kN
Tension Capacity $P_t = p_y A_{net}$	69.850 kN
Interaction Ratio = Actual Load / Allowable Load	0.001
Axial Tension Check (BS-4.6)	**SAFE**

Check Against Axial Tension And Bi-Axial Bending (BS-4.8.2)

Combined Axial Force & Bi-axial moment

Design Forces

Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	105
Axial Load F_x	0.073 kN
Major Axis Moment M_z	0.029 kN m
Minor Axis Moment M_y	0.000 kN m

Interaction Check - Simplified method (BS-4.8.2.2)

Tension Capacity $P_t = p_y A_{net}$	69.850 kN
Major Axis Moment Capacity Of The Cross-Section M_{cz} (As Per BS-4.2.5)	0.693 kN m
Minor Axis Moment Capacity Of The Cross-Section M_{cy} (As Per BS-4.2.5)	0.693 kN m
Interaction Ratio (BS-4.8.2.2) $= F_x / P_t + M_z / M_{cz} + M_y / M_{cy}$	0.043
Simplified Method Check (BS-4.8.2.2)	**SAFE**

Design Forces

Major Axis Moment M_z	0.029 kN m
Minor Axis Moment M_y	0.000 kN m
Critical Loadcase No.	3
Critical Section	0.000 m
Beam No.	105

Interaction Check - More exact method (BS-4.8.2.3)

Reduced Plastic Modulus About Major Axis S_{rz} (Annex I.2)	0.000 m^3
Reduced Plastic Modulus About Minor Axis S_{ry} (Annex I.2)	0.000 m^3
Reduced Plastic Moment Capacity About Major Axis $M_{rz} = p_y S_{rz}$	0.693 kN m
Reduced Plastic Moment Capacity About Minor Axis $M_{ry} = p_y S_{ry}$	0.693 kN m
Constant z_1	2.000
Constant z_2	2.000
Interaction Ratio (BS-4.8.2.3)	
$= (M_z / M_{rz})^{z}_{1} + (M_y / M_{ry})^{z}_{2}$	0.002
Exact Method Check (BS-4.8.2.3)	**SAFE**

Deflection Checking Ignored

DESIGN SUMMARY : ALL UNITS ARE - KN METE

Member : 105 Result : PASS Critical Cond : BS-4.8.2.2 Ratio : 0.043
Loading : 3 Fx : -0.07 My : 0.00 Mz : 0.03 Location : 0.00

Project	Gas power plant	The Concrete Centre		
Client		Made by: AM	Date: 14-Oct-21	Page:
Location	C1	Checked:	Revision: -	Job No:

SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO BS 8110:2005

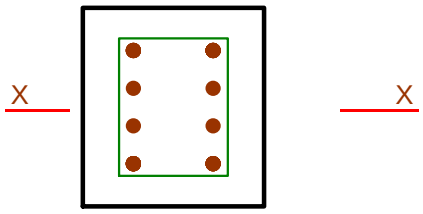
Originated from RCC53.xls v3.2 on CD © 2006 TCC

MATERIALS

fcu	25	N/mm²	γm, steel	1.15	Cover to link	40	mm
fy	415	N/mm²	γm, conc	1.5	h agg	20	mm
steel class	A						

SECTION

h	325	mm
b	250	mm
with	2	bars per 250 face
and	4	bars per 325 face



RESTRAINTS

	Lo (mm)	Top Condition	Btm Condition	Braced ?	ß	Le (mm)	Slenderness	Status
X-AXIS	3000	1	1	N	1.2	3600	Lex/h = 11.08	Column is
Y-AXIS	3000	1	1	N	1.2	3600	Ley/b = 14.40	SLENDER

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) M ix	TOP MOMENTS (kNm) M iy	BTM MOMENTS (kNm) M ix	BTM MOMENTS (kNm) M iy
D+L	340	43.0	10.0	43.0	10.0
dead+wind my max				0.0	0.0
dead+wind mx max				0.0	0.0
D+L+W				0.0	0.0
				0.0	0.0
				0.0	0.0

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 250 Face	BAR CENTRES (mm) 325 Face	Nuz (kN)	Checks
R 40	12.37	10	110	62	0	Asc > 6 % (3.12.6.2)
R 32	7.92	8	122	66	0	Asc > 6 % (3.12.6.2)
R 25	4.83	8	129	68	2281	ok
R 20	3.09	6	138	71	1786	ok
R 16	1.98	6	142	72	1470	ok
R 12	1.11	6	146	74	1224	ok

DESIGN MOMENTS (kN

	X AXIS K	X AXIS M add	X AXIS Mx	Y AXIS M add	Y AXIS My	COMBINED Axis	COMBINED M '	REBAR	max V *
D+L	1.000	6.8	49.8	8.8	18.8	X	70.7	8 R16	38.0
+wind my max									#DIV/0!
+wind mx max									#DIV/0!
D+L+W									#DIV/0!
0									#DIV/0!
0									#DIV/0!

SEE CHARTS ON NEXT SHEET

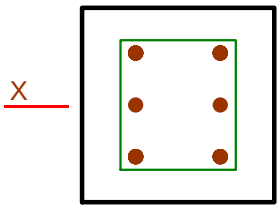
Project	Gas power plant		The **Concrete** Centre		
Client			Made by	Date	Page
Location	C2		AM	14-Oct-21	
	SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO BS 8110:2005		Checked	Revision	Job No
	Originated from **RCC53.xls** v3.2 on CD	© 2006 TCC		-	

MATERIALS

fcu	25	N/mm²	γm, steel	1.15	Cover to link	40	mm
fy	415	N/mm²	γm, conc	1.5	h agg	20	mm
steel class	A						

SECTION

h	300	mm
b	250	mm
with	2	bars per 250 face
and	3	bars per 300 face



RESTRAINTS

	Lo (mm)	Top Condition	Btm Condition	Braced ?	ß	Le (mm)	Slenderness	Status
X-AXIS	3000	1	1	N	1.2	3600	Lex/h = 12.00	Column is
Y-AXIS	3000	1	1	N	1.2	3600	Ley/b = 14.40	SLENDER

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) M ix	TOP MOMENTS (kNm) M iy	BTM MOMENTS (kNm) M ix	BTM MOMENTS (kNm) M iy
D+L	250	30.0	10.0	30.0	10.0
dead+wind my max				0.0	0.0
dead+wind mx max				0.0	0.0
D+L+W				0.0	0.0
				0.0	0.0
				0.0	0.0

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 250 Face	BAR CENTRES (mm) 300 Face	Nuz (kN)	Checks
R 40	10.05	10	110	80	0	Asc > 6 % (3.12.6.2)
R 32	6.43	8	122	86	0	Asc > 6 % (3.12.6.2)
R 25	3.93	8	129	90	1867	ok
R 20	2.51	6	138	94	1497	ok
R 16	1.61	6	142	96	1259	ok
R 12	0.90	6	146	98	1075	ok

DESIGN MOMENTS (kN

	X AXIS K	X AXIS M add	X AXIS Mx	Y AXIS M add	Y AXIS My	COMBINED Axis	COMBINED M '	REBAR	max V *
D+L	1.000	5.4	35.4	6.5	16.5	X	52.9	6 R16	36.4
+wind my max									#DIV/0!
+wind mx max									#DIV/0!
D+L+W									#DIV/0!
0									#DIV/0!
0									#DIV/0!

SEE CHARTS ON NEXT SHEET