Republic of the Union of Myanmar
Myanma Port Authority

THE PREPARATORY SURVEY FOR THE PROJECT FOR EXPANSION OF YANGON PORT IN THILAWA AREA

FINAL REPORT 2

June 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

The Overseas Coastal Area Development Institute of Japan
NIPPON KOEI CO., LTD

ABBREVIATION

A	ADB	Asian Development Bank
	AFTA	ASEAN Free Trade Area
	AIS	Automatic Identification System
	APEC	Asia-Pacific Economic Cooperation
	ASEAN	Association of Southeast Asian Nations
	AWPM	Asia World Port Management Co., Ltd
	AWPT	Asia World Port Terminal
B	BA	British Admiralty
	BOD	Biochemical Oxygen Demand
	BOT	Build Operate Transfer
	BS	British Standard
C	CBD	Central Business District
	CCTV	Closed Circuit Television
	CD	Chart Datum
	CDL	Chart Datum Level
	CFS	Container Freight Station
	CPI	Consumer Price Index
	CSI	Container Security Initiative
	CY	Container Yard
D	DA	Designated Authority
	DD	Detailed Design
	DDT	Dichloro-diphenyl-trichloroethane
	DFR	Draft Final Report
	DL	Datum Level
	DMA	Department of Marine Administration
	DMH	Department of Meteorology and Hydrology
	DO	Dissolved Oxygen
	DWT	Dead Weight Ton
E	EIA	Environmental Impact Assessment
	EIRR	Economic Internal Rate of Return
	ENC	Electronic Navigational Chart
	ETA	Estimated Time of Arrival
	ETD	Estimated Time of Departure
	EU	European Union
F	FC	Foreign Cost
	FCL	Full Container Load
	FDI	Foreign Direct Investment
	FIRR	Financial Internal Rate of Return

	FR	Final Report
	F/S	Feasibility Study
	FT	Freight Ton
	FZ	Free Zone
G	G8	Group of Eight
	GC	Gantry Crane
	GDP	Gross Domestic Product
	GIS	Geographic Information System
	GMS	Greater Mekong Subregiomal
	GRT	Gross Registered Tonnage
	GT	Gross Tonnage
	GTAP	Global Trade Analysis Project
H	HP	Horse Power
	HSHD	Department of Human Settlement and Housing Development, MOC
	HHWL	Highest High Water Level
	HWL	Hight Water Level
I	IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
	IAPH	International Association of Ports and Harbors
	ICR	Inception Report
	IMO	International Maritime Organization
	ISPS	International Ship and Port Facility Security Code
	ITR	Interim Report
	IWD	Inland Waterway Department
	IWT	Inland Water Transport
J	JETRO	Japan External Trade Organization
	JICA	Japan International Cooperation Agency
	JPY	Japanese Yen
L	LC	Local Cost
	LCL	Less than Container Load
	LED	Light Emitting Diode
	LOA	Length Overall
	LWL	Low Water Level
M	METI	Ministry of Economy, Trade and Industry (Japan)
	M&E	Mechanical and Electrical
	MIPL	Myanmar Integrated Port Ltd.
	MIP	Myanmar Industrial Port
	MITT	Myanmar International Terminal Thilawa
	MLIT	Ministry of Land, Infrastructure, Transport and Tourism
	MNPED	Ministry of National Planning and Economic Development
	MOC	Ministry of Construction

	MOECF	Ministry of Environmental Conservation and Forestry
	MOT	Ministry of Transport
	M/P	Master Plan
	MPA	Myanma Port Authority
	MSL	Mean Sea Level
	MWL	Mean Water Level
N	NCEA	National Cmmission of Environmental Affairs
	NK	Nippon Koei Co., Ltd.
	NM	Nautical Mile
	NSDS	National Sustainable Development Strategy
O	OCDI	Overseas Coastal Area Development Institute of Japan
	ODA	Official Development Assistance
P	PAPRD	Project Appraisal and Progress Reporting
	PCB	Polychlorinated biphenyl
	PCCD	Pollution Control and Cleansing Department
	PFSA	Port Facility Security Assessment
	PFSP	Port Facilities Security Plan
	PFSO	Port Facility Security Officer
	PHAJ	The Ports and Harbors Association of Japan
	PHC	Prestressed High-strength Concrete
	PIANC	World Association for Waterborne Transport Infrastructure
	PVD	Prefabricated Vertical Drain
	PZ	Promotion Zone
R	RC	Reinforced Concrete
	ReCCAP	Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia
	RSO	Recognized Security Organization
	RTG	Rubber Tired Gantry Crane
S	SAFE	Security and Facilitation in a Global Environment
	SEZ	Special Economic Zone
	SFA	State Fund Account
	SOLAS	Safety of Life at Sea
	SS	Suspended Solids
	STS	Ship-to-Shore
T	TBT	Tributyltin
	TEU	Twenty-feet Equivalent Unit
	T-N	Total Nitrogen
	T-P	Total Phosphorus

	TSHD	Trailing Suction Hopper Dredger
U	US	United States
	USA	United States of America
	USCG	United States Coast Guard
V	VAT	Value Added Tax
	VHF	Very High Frequency
	VTMS	Vessel Traffic Management System
	VTS	Vessel Traffic Service
W	WCO	World Customs Organization
Y	YCDC	Yangon City Development Committee

Exchange Rate

January, 2013

	USA (US$)	Japan (JPY)	Myanmar (Kyat)
US$	1.00	83.64	858
JPY	0.0120	1.00	0.00117

Contents

Table

Figure

1. Outline of the Study

Myanmar has a population of about 60 million and spreads across an area of 680,000 km2, making it one of the relatively larger countries in ASEAN, however, its economic development has been delayed due to economic sanctions imposed by foreign countries. Myanmar offers cheaper labor costs than surrounding countries, and also, is geographically located next to India, the People's Republic of China and ASEAN countries which have large industrial power and strong consumption demand, which gives Myanmar great development potential. Therefore, the recent lifting of sanctions is most likely to trigger a rapid economic development in Myanmar.

Moreover, there is a general election planned in 2015 which many believe will bring more democracy to Myanmar, and also planned in 2015 is the reduction and abolition of custom tax within the ASEAN region, hence it is envisaged that Myanmar with such a high potential would attract significant foreign investment and thus there needs to be speedy infrastructure development in order to prepare a good environment for such investment.

1.1. Background of the Study

To support the future economic development of Myanmar, key roles will be played by Yangon Port in Yangon City (Yangon Main Port) and Yangon Port in Thilawa Area (Thilawa Area Port) which have Yangon, the largest city in Myanmar, as the hinterland. The two ports have limitations in channel depth, however, considering the proximity to the largest city as well as the development of SEZ (Special Economic Zone) in the hinterland, they are expected for the time being to function as the gateway ports supporting the economic development of Myanmar, coping with the rapid increase of cargo handling volume.

1.2. Objectives of the Study

In this context, the project for expansion of Yangon port in Thilawa area (The Project) is to clarify the division of roles between Yangon Main Port and Thilawa Area Port, and develop and expand the port in order to satisfy the cargo demand of the hinterland SEZ as well as the whole of Myanmar, for the economic development of Myanmar. In this additional study, the objective is to conduct a further detail study on technical matters regarding the '**Thilawa Area Port Urgent Development Plan**', which is formulated as the first implementation package due to its highly urgent nature.

1.3. The Study Team and the Schedule

1.3.1. Study Team

The Study Team is comprised of the experts listed in Table 1.3-1;

Table 1.3-1 The member list of the Study Team

Name	Position	Company
Tadahiko YAGYU (Dr.)	Team Leader/Port Planning	OCDI
Kuniomi HIRANO (Mr.)	Hinterland Development Planning	NK
Takeshi SUZUKI (Mr.)	Economic and Financial Analysis	OCDI
Mitsuhiko OKADA (Mr.)	Port Management and Operation Systems 1 (including Public Private Partnership)	OCDI
Kazuhisa IWAMI (Mr.)	Co-Team Leader /Channel Planning	NK
Lars FRYDKAER (Mr.)	Port Facility Design 2	NK
Kentaro KIMURA (Mr.)	Port Civil Design I	NK
Nobuhiro OCHI (Mr.)	Port Civil Design II	NK
Takashi OKA (Mr.)	Port Civil Design III	NK
Satoshi ANDOU (Mr.)	Port Civil Design IV	NK
Hajime SUZUKI (Mr.)	Pavement / Drainage Design	NK
Yuzo SHIMIZU (Mr.)	Cargo Handling Equipment Design	NK
Thi Ha (Dr.)	Soil Improvement Design	NK
Hideaki KANAYAMA (Mr.)	Building Plan	NK
Satomi MAKINO (Mr.)	Building Design	NK
Masami YONEZAWA (Mr.)	Work Plan / Cost Estimate (Building 1)	NK
Takeyoshi HANADA (Mr.)	Work Plan / Cost Estimate (Building 2)	NK
Kenichi HAYASHIDA (Mr.)	Building Facility / Water Supply Design	NK
Heikichi OKI (Mr.)	Electricity Design	NK
Katsumi YANAGIHARA (Mr.)	Work Plan / Cost Estimate (Civil 2)	NK
Tetsuo KAWAI (Mr.)	Work Plan / Cost Estimate (Civil 3)	NK
Toshihiro KATO (Mr.)	P.Q and Bidding Documents Preparation	NK
Satoshi SASAKURA (Mr.)	Environmental and Social Consideration	OCDI
Kyoko MISHIMA (Ms.)	HIV/AIDS Prevention	OCDI
Koichi TAKAMIYA (Mr.)	Natural Condition Survey (additional survey)	NK
Hiroshi OTANI (Mr.)	Construction Safety Plan	NK
Shojiro KOGA (Mr.)	Design Review	NK
Kazuyuki YAMAGUCHI (Mr.)	Port Planning 3	OCDI
Naoyuki SHIRAYAMA (Mr.)	Coordinator/Assistant of Port Operation	OCDI
Masao ICHINOSE (Mr.)	Port Operation	OCDI

1.3.2. Study Schedule

The work schedule is as shown below;

Table 1.3-2 Work Schedule of the Study

No.	Contents	2013							2014					
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Compilation of Inception Report 2													
2.1	Detailed soil survey													
2.2	Offshore sediment survey													
3.1	Follow up of Environmental Impact Assessment													
3.2	Follow up of Resettlement Plan													
3.3	Responding to the comments of Social Environmental Advisory Committee													
3.4	Information Gathering on Thilawa SEZ													
3.5	Necessary support to the responses to the JICA Social Environmental Consideration Guideline													
3.6	Support to the Follow up Survey on the Number of Affected Households, and to the Additional Survey on Appropriateness of Compensation Amount													
4.1	Confirmation of the Planning and Design Conditions, and Design Standards													
4.2	Detail Study on Terminal Operation													
4.3	Terminal Design													
4.4	Design of Utilities													
4.5	Design of Pavement, Drainage and Fence													
4.6	Design of Cargo Handling Equipments													
4.7	Building Design													
4.8	Planning and Scheduling of Construction Works													
4.9	Consideration on Procurement Packages													
4.10	Cost Estimation													
4.11	Study on Project Effect													
4.12	Study on Construction Safety and Proposal of Countermeasures													
4.13	Compilation of Draft Bidding Documents													
5	Review and Additional Revision of the Environmental Management and Monitoring Plan													
6	Compilation of the HIV/AIDS Prevention Program													
7	Compilation of Draft Final Report 2													
8	Compilation of Final Report													
	Reporting Schedule	▲	IC/R2			▲PQ				▲TD	▲	DF/R2	▲	F/R

2. Natural Condition Survey

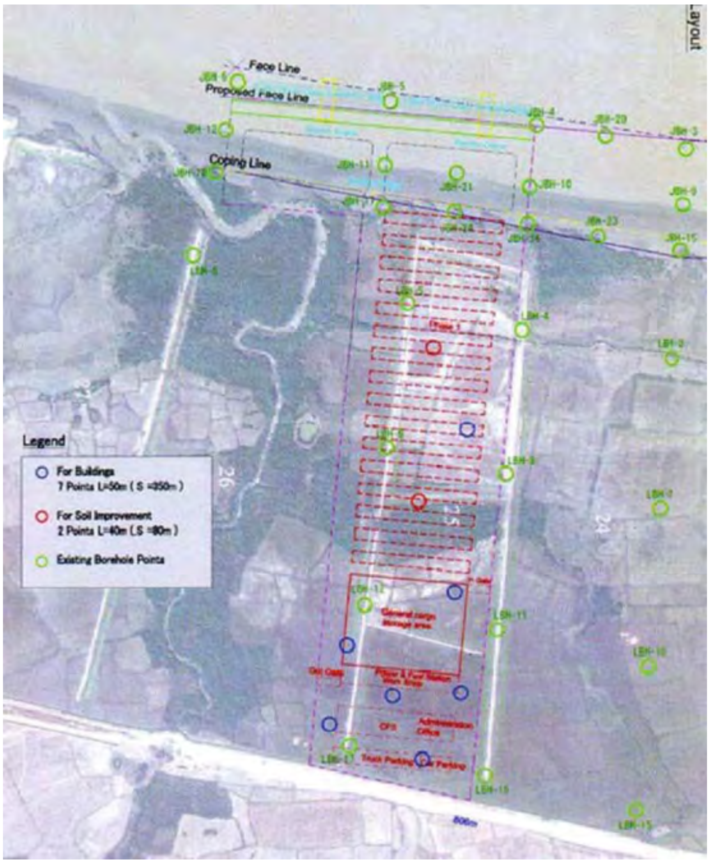
2.1. Soil Investigation

2.1.1. Objective

Soil Investigation is carried out to obtain the necessary data and information used for the detailed design of port facility (Jetty and Yard) for the project. However, since it became impossible to obtain the entrance permission in this study period, the soil investigation could not be carried out. Therefore, in this study, ground condition model and soil property required for the design of the terminal is set by analyzing the existing data carried out in 2012 FY. In this Section, the summary is described.

2.1.2. Survey Location

The location of the soil investigation carried out in 2012 FY is plotted by green mark and the location of the planed soil investigation on additional survey in 2013 FY is plotted by red and blue mark as shown in Figure2.1-1. The existing survey location for Jetty and Yard area carried out in 2012 FY is shown in Figure2.1-2 and Figure2.1-3 respectively.

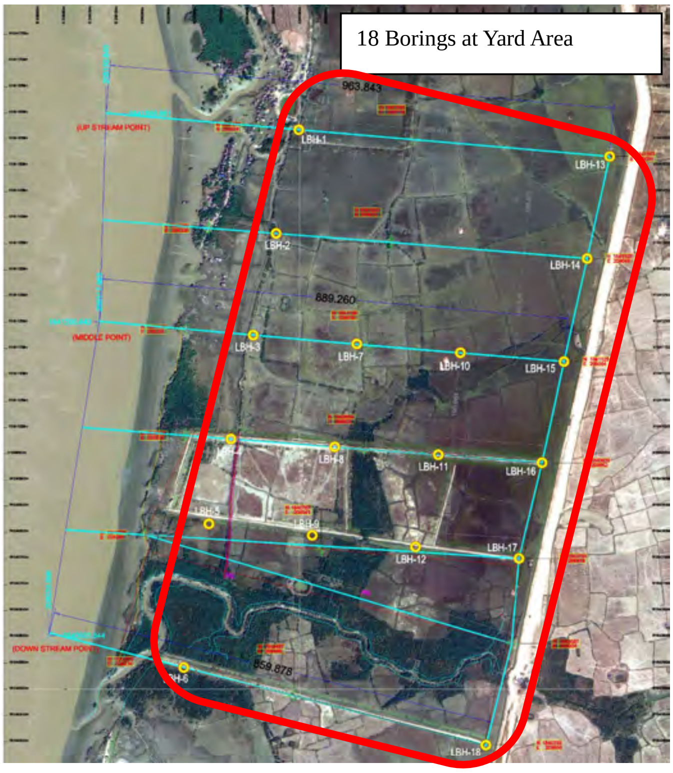


Source: JICA Study Team

Figure 2.1-1 Location Map of Jetty Area

Source: JICA Study Team

Figure 2.1-2 Location Map of Jetty Area



Source: JICA Study Team

Figure 2.1-3 Location Map of Yard Area

2.1.3. Item and Quantity of Soil Investigation

The item and quantity of initial plan and existing survey for Jetty and Yard is shown in Table2.1-1.

Table 2.1-1 Item and Quantity

NO	DESCRIPTION	UNIT	Quantity			REMARKS
			Initial Plan	Jetty Area	Yard Area	
A	**Boring and field investigation**					SEP (Self Elevated Platform) is used for offsore boring work
1	Rig set up	Point	9	24	18	
2	Boring 0 to 10m	meter	90	240	180	
3	Boring 10 to 20 m	meter	90	240	180	
4	Boring 20 to 30m	meter	90	240	180	
5	Boring 30 to 40m	meter	-	-	-	If required
6	Boring 40 to 50m	meter	-	-	-	If required
7	Standard Penetration Testing	Nos.	243	648	486	
8	Undisturbed sample taking in soft soil	Nos.	27	72	54	
9	Water level measuring and sample taking	Nos.	9	-	18	
B	**Laboratory Testing for Soil**					
1	Natural Moisture Content	Nos.	54	144	108	
3	Specific Gravity	Nos.	54	144	108	
4	Plastic Limit	Nos.	54	144	108	
5	Liquid Limit	Nos.	54	144	108	
6	Seive analysis	Nos.	81	216	152	
7	Hydrometer	Nos.	54	144	108	
8	Unit weight	Nos.	27	72	54	
9	Unconfined compressive strength	Nos.	27	72	54	
10	One-dimensional consolidation	Nos.	27	36	54	
11	Direct shear test (UU)	Nos.	27	24	18	
12	Water quality analysis	sample	9	-	6	

Source: JICA Study Team

2.1.4. Results of Soil Investigation

At the beginning of the work on additional survey in 2013 FY, soil investigation shown in Figure 2.1-1 and Table 2.1-1 is planned to be carried out at fist. However, since entrance and work permission for the survey area could not be obtained from the counterpart (MPA) within the work period, the planned soil investigation could not be carried out. For the site entrance permission, arrangement and negotiation with local people had been carried out through MPA. The negotiation is very difficult so that we had to give up starting soil investigation on additional survey in 2013 FY.

In this Section, based on the existing data carried out in 2012 FY, the detailed study result of such as soil profile and soil characteristics for each facility area, Jetty, Revetment and Yard area is described in each Section for each facility design.

3. Environmental and Social Considerations

3.1. Environmental and Social Survey

3.1.1. Sediment Survey

(1) Objective of Survey

Examination of sediment of Yangon River at off Thilawa and at the mouth, as well as the soil at the construction point was conducted, since dredged sediment from those locations will be used for the land filling material for the yard construction. A water quality survey was also conducted to investigate turbidity around dredging sites. The survey was conducted by a local sub-contractor.

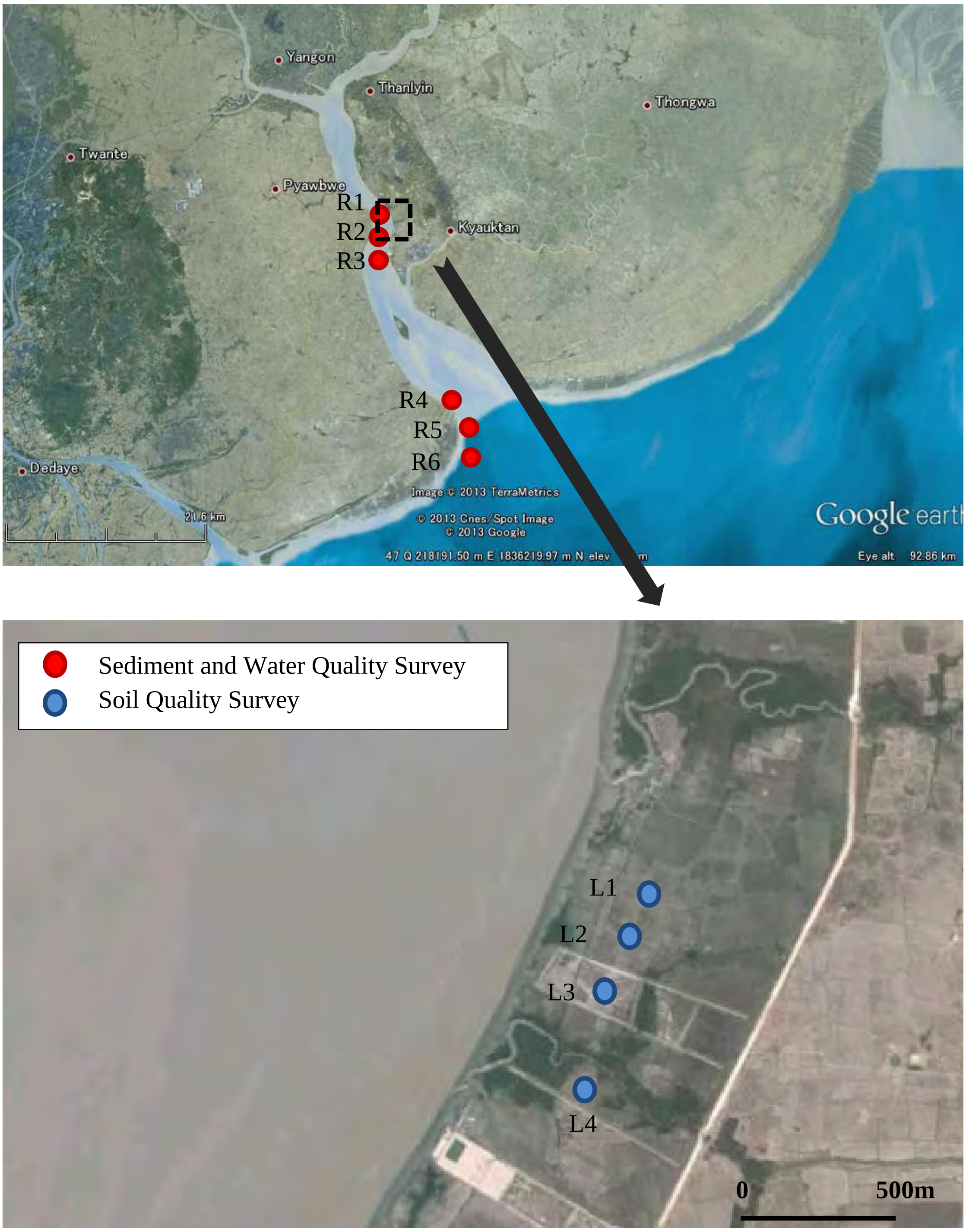
(2) Survey Location and Date

The survey location is shown in Figure 3.1-1 and Table 3.1-1 which includes the survey date and depth.

Table 3.1-1 Survey location, date and depth

Sta.	Lat.	Long.	Date	Time	Depth
R1	16º 38’ 28.75”N	96º 15’ 12.44”E	9-7-2013	10:30	3.5m
R2	16º 37’ 57.68”N	96º 15’ 13.05”E	9-7-2013	11:10	2.8m
R3	16º 37’ 34.06”N	96º 15’ 7.28”E	9-7-2013	12:30	4.9m
R4	16º 26’ 17.26”N	96º 20’ 27.62”E	8-7-2013	10:15	1.7m
R5	16º 25’ 46.98”N	96º 20’ 42.65”E	8-7-2013	09:55	8.4m
R6	16º 24’ 57.99”N	96º 20’ 12.83”E	7-7-2013	09:45	6.2m
L1	16º 38’ 8.29”N	96º 16’ 5.95”E	12-7-2013	11:39	-
L2	16º 38’ 2.56”N	96º 16’ 4.98”E	12-7-2013	13:00	-
L3	16º 37’ 56.95”N	96º 16’ 3.98”E	11-7-2013	10:00	-
L4	16º 37’ 47.31”N	96º 16’ 2.09”E	12-7-2013	13:40	-

(Prepared by the Study Team)



Source: Google Earth, the Study Team

Figure 3.1-1 Survey location

(3) Contents of Survey

Contents of the surveys are shown in Table 3.1-2.

Table 3.1-2 Contents of the Surveys

Category	Analyzing Items	Quantity
Sediment and Soil	Grain Size Distribution, Specific gravity, Moisture content, All organic carbon, Arsenic, Cadmium, Chrome, Copper, Lead, Nickel, Zinc, Cyanogen	6 sites for sediment, 4 sites for soil
Water quality	Suspended Solid (SS), Biochemical Oxygen Demand (BOD)	6 sites and 2 layers (Surface, Bottom)

(Prepared by the Study Team)

(4) Survey Results

1) Sediment and Soil

As there are no sediment quality standards in Myanmar, the results were compared with the Soil Contamination Countermeasures Act in Japan and the Agricultural Land Soil Pollution Prevention Law in Japan. Concentration above the screening level would mean that toxic effects on organisms could be expected. The result is shown in Table 3.1-3 and the result of the grain size distribution is shown in Table 3.1-4.

Pollutant substances above the criteria of the Soil Contamination Countermeasures Act in Japan and the Agricultural Land Soil Pollution Prevention law in Japan were not found in the proposed land filling materials or the project site.

Table 3.1-3 Results of Sediment and Soil Survey

Item		Criteria[1)]	Criteria[2)]	Project site (land)				Off Thilawa			Yangon Riv. Mouth		
				L1	L2	L3	L4	R1	R2	R3	R4	R5	R6
Specific gravity	-	-	-	2.68	2.69	2.71	2.69	2.65	2.68	2.66	2.67	2.63	2.65
Water content	%	-	-	32.74	38.69	26.46	28.1	27.57	30.68	29.99	30.71	33.27	34.74
TOC	mg/g	-	-	7.23	8.11	6.84	8.25	1.18	0.78	0.39	0.39	1.19	0.79
Arsenic	mg/kg	150	15	ND[4)]	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	150	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	250[3)]	-	98.7	80.6	105.3	107.3	83	36	38	70.5	75.3	80
Copper	mg/kg	-	125	21.95	22.45	23.8	22.15	7.05	6.4	5.5	6.9	8.325	9.55
Lead	mg/kg	150	-	14.1	15.15	15.6	11.95	ND	ND	ND	ND	ND	ND
Nickel	mg/kg	-	-	61.4	69.85	65.35	74.50	38.9	37.55	20.3	35.15	36.55	43.85
Zinc	mg/kg	-	-	94.95	90.00	97.5	88.05	52.3	32.25	34.35	29.85	47.63	44.25
Cyanide	mg/kg	50	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

1) Soil Contamination Countermeasures Act
2) Agricultural Land Soil Pollution Prevention Law
3) Criteria for a chromium hexavalent
4) ND:Not Detectable

(Prepared by the Study Team)

Table 3.1-4 Results of Sediment and Soil Survey (Grain Size Distribution)

Size	Project site (land)				Off Thilawa			Yangon Riv. Mouth		
(%)	L1	L2	L3	L4	R1	R2	R3	R4	R5	R6
Gravel	0	0	0	0	0	1	1	0	0	0
Sand	2	1	0	1	84	95	97	98	94	95
Silt	49	46	63	51	16	4	2	2	6	5
Clay	49	53	37	48						

(Prepared by the Study Team)

2) Water Quality

Result of the water quality survey is summarized in Table 3.1-4. BOD shows relatively high values, surface; 32 ~ 92 mg/L, bottom; 35~88 mg/L, which indicates organic pollution. SS also shows high values ,surface; 328~888 mg/L, bottom; 442~986 mg/L. SS at bottom layer tends to be higher than those at surface as soil at bottom might be resuspended due to the fast current of the river.

Table 3.1-5 Results of Water Quality Survey

Item		Layer	Off Thilawa			Yangon Riv. Mouth		
			R1	R2	R3	R4	R5	R6
BOD	mg/L	Surface	52	36	32	72	78	92
		Bottom	58	40	35	68	82	88
SS	mg/L	Surface	480	328	380	514	640	888
		Bottom	610	460	442	568	882	986

(Prepared by the Study Team)

3.1.2. Fishery Activity Survey

(1) Objective of Survey

The objective of the survey was to gain basic information on the impact of the construction work and operation of the project on fishing activities. The survey was conducted by a local sub-contractor.

(2) Contents of Survey

1) Interview Survey

An interview survey was conducted to obtain information on fishing activity in the Yangon River, especially around the project site. Fishermen and fish sellers were interviewed in Aouk Taw area and Chaung Wa area in September 2013.

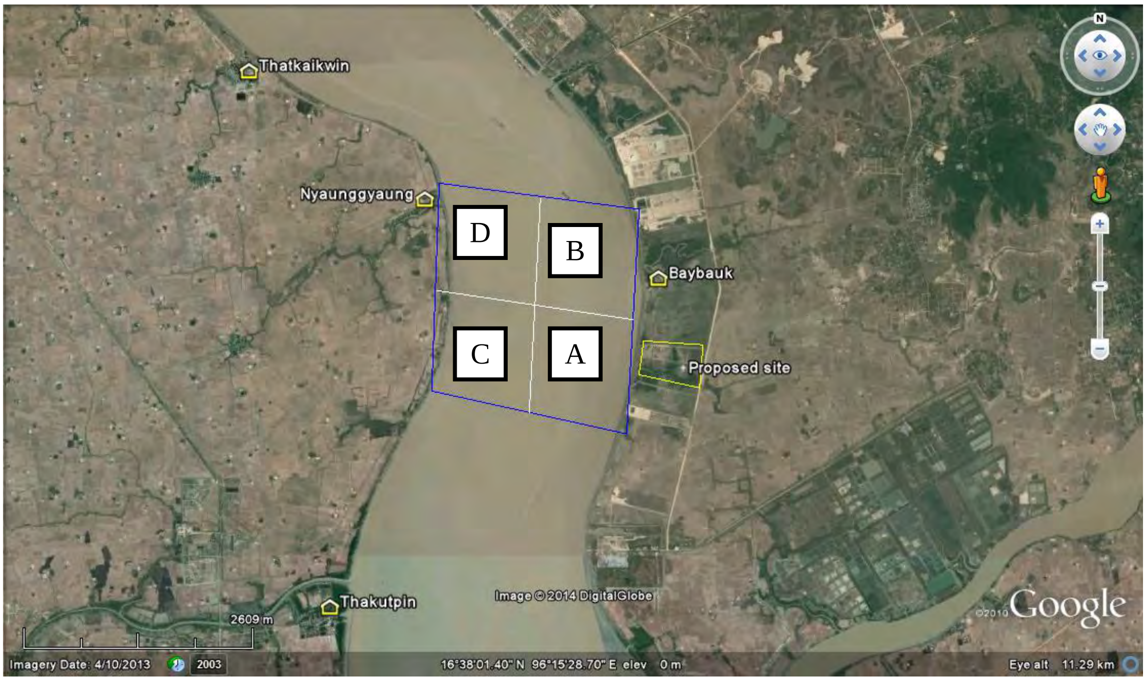
2) Monitoring Survey

A monitoring survey of fishing activities around the project site was conducted for 15 consecutive days from 21st December 2013 to 4th January 2014 including spring tide and neap tide condition from 6 AM to 6 PM. The tide table during the survey is shown in Table 3.1-6. Fishing activities were monitored visually on a boat and was recorded by a GPS and a camera. The survey site was divided into 4 areas (A to D) and daily activities were recorded in each area (Figure 3.1-2). An informal interview survey was also carried out with the fishermen on their residents, fishing methods and fish species.

Table 3.1-6 Tide Table during the Monitoring Survey

No.	Date	Time	Height (m)	Time	Height (m)	Time	Height (m)	Time	Height (m)
1	21-12-2013	05:26	5.7	12:07	1.1	17:58	5.3	-	-
2	22-12-2013	00:17	1.7	06:00	5.5	12:40	1.4	18:34	5.2
3	23-12-2013	00:54	1.8	06:34	5.3	13:16	1.4	19:12	5.0
4	24-12-2013	01:34	2.0	07:13	5.0	13:55	1.7	19:58	4.9
5	25-12-2013	02:21	2.1	08:03	4.7	14:41	1.9	20:57	4.8
6	26-12-2013	03:18	2.3	09:12	4.5	15:36	2.1	22:08	4.8
7	27-12-2013	04:28	2.3	10:36	4.4	16:45	2.2	23:18	5.0
8	28-12-2013	05:50	2.2	11:51	4.5	18:04	2.1	-	-
9	29-12-2013	00:19	5.2	07:05	1.8	12:54	4.8	19:16	1.8
10	30-12-2013	01:14	5.6	08:05	1.3	13:38	5.1	20:16	1.5
11	31-12-2013	02:03	5.9	08:57	0.9	14:38	5.5	21:09	1.1
12	1-1-2014	02:50	6.2	09:44	0.4	15:25	5.8	21:58	0.8
13	2-1-2014	03:36	6.5	10:30	0.2	16:10	6.0	22:45	0.7
14	3-1-2014	04:21	6.5	11:14	0.1	16:55	6.1	23:30	0.6
15	4-1-2014	05:06	6.5	11:58	0.2	17:41	6.0	-	-

(Prepared by the Study Team)



Source: Google Earth, the Study Team

Figure 3.1-2 Monitoring Area and Fishing Village

(3) Survey Results

1) Interview Survey

The major fishing area is shown in Figure 3.1-3. The volume of fish caught, fish species and prices are summarized in Table 3.1-7 based on the results of interviews.

The major fishing method is a gill net and the major fishing ground is around the Aouk Taw area for Aouk Taw fishermen, and river mouth of the Hmaw Wunn Chaung creek and the area from Chaung Wa to Outer-Bar in the Yangon River for the Chaung Wa fishermen. Fish catches are higher from the rainy season (June to October) to the winter season (November to February) , 1 to 15 viss/day (2 to 23 kg/day), and lower in the summer season (March to May). The major fish species are hilsa, soldier croaker and cat fish with the prices of 5,000 to 40,000 kyat/viss (3,000～26,000 kyat/kg), 2,000 to 25,000 kyat/viss (1,000～16,000 kyat/kg) and 2,000 to 3,000 kyat/viss (1,000～2,000 kyat/kg) respectively. （1 viss = 1.56 kg）

Source: Google Earth, the Study Team

Figure 3.1-3 Fishing Grounds of Aouk Taw Area and Chaung Wa Area

Table 3.1-7 Interview Results on Fishing Activities

No.	Place	Occupatin	Method	Catch/Day (Viss)			Major Fish Species			Price(kyat)	
				Summer	Rain	Winter	Summer	Rain	Winter	Species	Price/ viss
1	Aouk Taw	Seller, Farmer (17 Acre)	Gill net		1 to 2	10	No	Mango Fish, Soldier croaker	Mango Fish, Soldier croaker, Striped cat fish	Hilsa Soldier croaker Mango Fish Striped cat fish	8000 6000 4500 2500
2	Aouk Taw	Seller, Fisheman	Gill net	1	1 to 2	5	No	Striped cat fish	Commerson's anchovy, Mrigal Fish	Striped cat fish Commerson's anchovy Mrigal Fish	2000 3000 15000
3	Aouk Taw	Seller, Fisheman	Gill net	1	1 to 2	5 to 7	No	Striped cat fish	Hilsa	Striped cat fish Hilsa	2000 9000
4	Aouk Taw	Fisheman	Gill net		1	8	No	Hilsa	Striped cat fish, Soldier croaker	Hilsa Soldier croaker Striped cat fish	10000 4000 2500
5	Aouk Taw	Fisherman	Gill net		1	7	No	Soldier croaker	Hilsa	Hilsa Soldier croaker	10000 3500
6	Aouk Taw	Fisherman	Gill net		5 to 10	10	No	Soldier croaker	Hilsa, Striped cat fish	Hilsa Soldier croaker Striped cat fish	30,000 3000 3500
7	Aouk Taw	Fisherman	Gill net		5 to 10	7	No	Soldier croaker, Striped cat fish	Hilsa	Hilsa Soldier croaker Striped cat fish	10000 2000 3000
8	Aouk Taw	Fisherman	Gill net		10	10	No	Hilsa	Striped cat fish, Soldier croaker	Hilsa Soldier croaker Striped cat fish	15000 3000 3000
9	Aouk Taw	Fisherman	Gill net		15	10	No	Hilsa, Striped cat fish	Hilsa, Striped cat fish	Hilsa Striped cat fish	30000 3000
10	Aouk Taw	Fisherman	Gill net		3	3	No	Hilsa, Striped cat fish	Hilsa, Striped cat fish	Hilsa Striped cat fish	30000 3000
11	Aouk Taw	Fisherman	Gill net		6	8		Striped cat fish	Striped cat fish	Striped cat fish	3000
12	Aouk Taw	Seller, Fisherman	Gill net		3	5	Various kind of fish	false trevally	false trevally and other small fishes	False Trevally	3000
13	Chaung Wa	Fisherman	Gill net	2	10	5	Soldier croaker	Hilsa	Soldier Croaker	Hilsa Soldier croaker	10000 2000
14	Chaung Wa	Fisherman	Gill net	2	8	7	Sea Cat Fish	Climbing Perch	Sea Cat Fish	Sea Cat Fish Climbing Perch	15000 9000
15	Chaung Wa	Fisherman	Gill net	0.5	1	2	Soldier croaker	Hilsa	Soldier Croaker	Hilsa Soldier croaker	5000 2000
16	Chaung Wa	Fisherman	Gill net	5	10	10	Climbing Perch	Sea Cat Fish	Sea Cat Fish	Sea Cat Fish Climbing Perch	10000 8000
17	Chaung Wa	Fisherman	Gill net	2	5	5	Soldier croaker	Hilsa	Hilsa	Hilsa Soldier croaker	10000 5000
18	Chaung Wa	Fisherman	Gill net	2	2	2	Soldier croaker	Hilsa	Hilsa	Hilsa Soldier croaker	5000 2000
19	Chaung Wa	Fisherman	Gill net	5	7	10	Soldier croaker	Striped cat fish	Hilsa	Hilsa Striped cat fish Soldier croaker	40000 2500 25000
20	Chaung Wa	Seller		(50)	(200) (Sell)	(200)	Soldier croaker	Hilsa	Soldier Croaker	Hilsa Soldier croaker Mango Fish Striped cat fish	8000 7000 5000 2500

(Prepared by the Study Team)

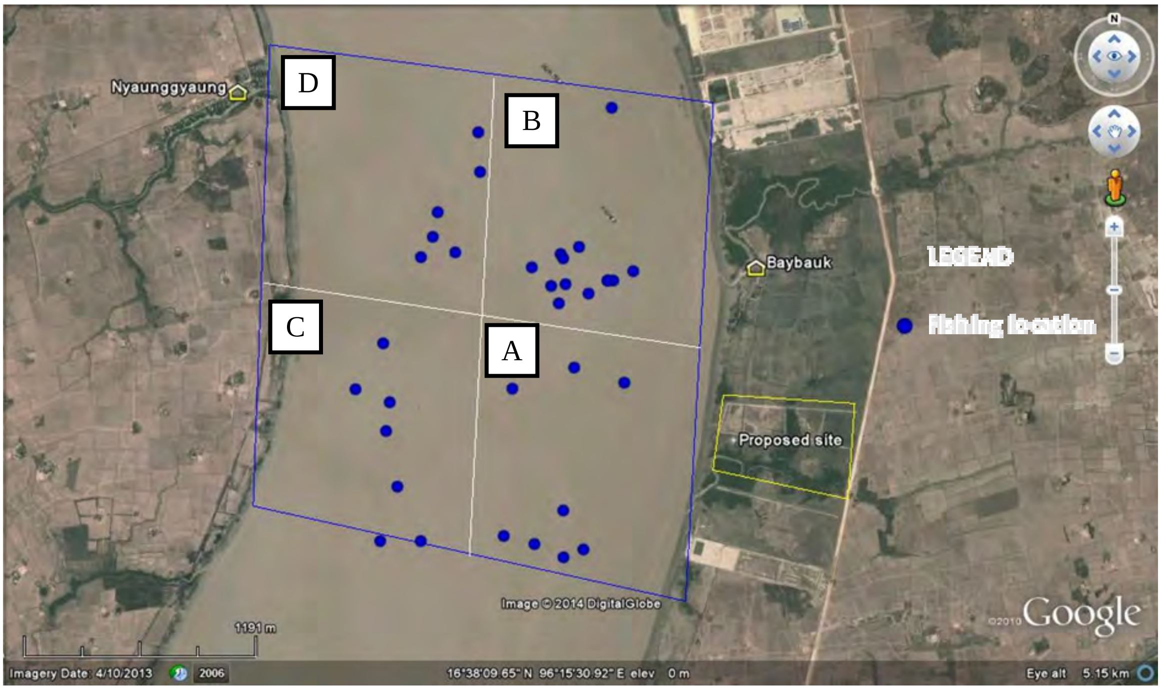
2) Monitoring Survey

The locations of the fishing boats identified at the survey site are shown in Figure 3.1-4 and the survey results are summarized in Table 3.1-8.

Fishing is usually conducted twice a day from high tide through low tide. The major fishing method is a gill net. Fishermen normally use floating type in spring tide and fixed type in neap tide. The size of the net is 50m in length and 3m in height. The floating type is set from surface and middle layer and the fixed type is set from middle layer to bottom layer. The fish species are hilsa, soldier croaker and cat fishes.

The fishing is conducted all over areas A, B, C and D with the average number of boats per day being 20, 45, 11 and 24 at each area respectively. The fishing ground is at least 400 m from the project site and no fishing activity is found at the river bank of the project site such as beach seine net or set net. Fishermen from Bay Pauk, Nyaung gyaung Thakutpin and Thatkaikwin were found in the survey period (Figure 3.1-3).

Large vessels usually are able to pass over the fishing nets.



Source: Google Earth, the Study Team

Figure 3.1-4 Locations of Fishing Boats in the Survey Area

Table 3.1-8 Result of Monitoring Survey for Fishing Condition

No	Date	Time	Area	Method	Residence of fishermen	No. of boat
1	21-12-2013	7:00 - 8:00 AM	A	Floating Net	1, 3, 4	~20
2	21-12-2013	7:00 - 7:45 AM	B	Floating Net	1, 2, 3	~25
3	21-12-2013	7:00 - 7:45 AM	C	Floating Net	1, 3, 4	~10
4	21-12-2013	2:00 - 2:45 PM	A	Floating Net	1, 3, 4	~20
5	21-12-2013	2:00 - 2:45 PM	B	Floating Net	1, 2, 3	~20
6	21-12-2013	2:00 - 2:30 PM	C	Floating Net	1, 3, 4	~15
7	22-12-2013	8:00 - 9:15 AM	A	Floating Net	1, 3, 4	~15
8	22-12-2013	8:00 - 9:15 AM	B	Floating Net	1, 2, 3	~20
9	22-12-2013	8:00 - 9:00 AM	C	Floating Net	1, 3, 4	~15
10	22-12-2013	8:00 - 8:45 AM	D	Floating Net	1, 3	~25
11	22-12-2013	2:00 - 3:00 PM	A	Floating Net	1, 3, 4	~20
12	22-12-2013	2:00 - 3:00 PM	B	Floating Net	1, 2, 3	~30
13	22-12-2013	2:00 - 3:00 PM	C	Floating Net	1, 3, 4	~ 5
14	22-12-2013	2:00 - 2:45 PM	D	Floating Net	1, 3	~20
15	23-12-2013	8:30 - 9:30 AM	A	Fixed Net	1, 3	~10
16	23-12-2013	8:30 - 9:45 AM	B	Fixed Net	1, 2, 3	~20
17	23-12-2013	3:00 - 3:45 PM	A	Fixed Net	1, 3	~15
18	23-12-2013	3:00 - 3:45 PM	B	Fixed Net	1, 2, 3	~30

19	24-12-2013	9:00 - 9:30 AM	B	Fixed Net	1, 3	~25
20	24-12-2013	9:00 - 9:30 AM	C	Fixed Net	3, 4	~15
21	25-12-2013	10:00 - 10:45 AM	A	Fixed Net	1, 3	~20
22	25-12-2013	10:00 - 11:00 AM	B	Fixed Net	1, 2, 3	~20
23	25-12-2013	10:00 - 11:00 AM	C	Fixed Net	2, 3, 4	~10
24	25-12-2013	1:30 - 2 :15 PM	A	Fixed Net	1, 3	~25
25	25-12-2013	1:30 - 2 :15 PM	B	Fixed Net	1, 2, 3	~20
26	25-12-2013	1:30 - 2 :15 PM	C	Fixed Net	2, 3, 4	~15
27	26-12-2013	2:00 - 2:30 AM	A	Fixed Net	1, 3	~20
28	26-12-2013	2:00 - 2:45 AM	B	Fixed Net	1, 2, 3	~25
29	26-12-2013	10:00 - 10:45 AM	A	Fixed Net	1, 3	~15
30	26-12-2013	10:00 - 10:45 AM	B	Fixed Net	1, 2, 3	~30
31	27-12-2013	2:30 - 3:15 AM	A	Fixed Net	1, 3	~15
32	27-12-2013	2:30 - 3:15 AM	C	Fixed Net	3, 4	~15
33	27-12-2013	10:00 - 11:15 AM	A	Fixed Net	1, 3, 4	~20
34	27-12-2013	10:00 - 11:00 AM	C	Fixed Net	3, 4	~10
35	28-12-2013	3:00 - 3:45 AM	A	Fixed Net	1, 3	~20
36	28-12-2013	3:00 - 3:45 AM	C	Fixed Net	3, 4	~15
37	28-12-2013	11:00 - 12:00 AM	A	Fixed Net	1, 3, 4	~25
38	28-12-2013	11:00 - 11:45 AM	C	Fixed Net	3, 4	~10
39	29-12-3012	6:00 - 7:00 AM	B	Floating Net	1, 3	~30
40	29-12-3012	1:30 - 2:15 PM	B	Floating Net	1, 3	~35
41	30-12-2013	7:00 - 8:00 AM	B	Floating Net	1, 3	~30
42	30-12-2013	7:00 - 8:00 AM	D	Floating Net	1, 3	~30
43	30-12-2013	2:00 - 3:00 PM	B	Floating Net	1, 3	~30
44	30-12-2013	2:00 - 3:00 PM	D	Floating Net	1, 3	~30
45	31-12-2013	8:00 - 9:00 AM	B	Floating Net	1, 3	~35
46	31-12-2013	8:00 - 9:00 AM	D	Floating Net	1, 3	~35
47	31-12-2013	2:30 - 3:45 PM	B	Floating Net	1, 3	~30
48	31-12-2013	2:30 - 3:45 PM	D	Floating Net	1, 3	~30
49	1-1-2014	8:30 - 9:30 AM	B	Floating Net	1, 3	~30
50	1-1-2014	8:30 - 9:30 AM	D	Floating Net	1, 3	~35
51	1-1-2014	3:00 - 3:30 PM	B	Floating Net	1, 3	~35
52	1-1-2014	3:00 - 3:30 PM	D	Floating Net	1, 3	~30
53	2-1-2014	9:00 - 10:00 AM	B	Floating Net	1, 3	~30
54	2-1-2014	9:00 - 10:00 AM	D	Floating Net	1, 3	~35
55	2-1-2014	3:30 - 4:15 PM	B	Floating Net	1, 3	~35
56	2-1-2014	3:30 - 4:15 PM	D	Floating Net	1, 3	~30
57	3-1-2014	9:30 - 10:30 AM	B	Floating Net	1, 3	~30
58	3-1-2014	9:30 - 10:30 AM	D	Floating Net	1, 3	~35
59	3-1-2014	4:00 - 4:45 PM	B	Floating Net	1, 3	~25
60	3-1-2014	4:00 - 4:45 PM	D	Floating Net	1, 3	~20
61	4-1-2014	5:00 - 5:45 AM	A	Fixed Net	1, 4	~25
62	4-1-2014	5:00 - 5:45 AM	B	Fixed Net	1, 3	~20
63	4-1-2014	5:00 - 5:45 AM	C	Fixed Net	3, 4	~25
64	4-1-2014	1:30 - 2:15 PM	A	Fixed Net	1, 4	~15
65	4-1-2014	1:30 - 2:15 PM	B	Fixed Net	1, 3	~20
66	4-1-2014	1:30 - 2:15 PM	C	Fixed Net	3, 4	~25

1 - Baypauk; 2 - Thatkaikwin; 3 - Nyaunggyaung; 4 – Thakutpin

(Prepared by the Study Team)

3.1.3. Farmland Use Survey

MPA conducted farmland use survey of farmers who use the project site as farmlands on Plot 25 to 26 in October 2013. JICA Study Team has requested their survey results from MPA but MPA has not released them because the negotiation with the farmers is still continuing (as of February 2014). The number of farmers using the farmland on Plot 25 to 26 is allegedly seven based on the survey result by MPA.

3.2. Progress of Resettlement Plan

3.2.1. Implementation Situation on Phase 1 Area

As mentioned above, seven farmers are using the project site as their farmlands on Plot 25 to 26 in the Phase 1 project site. Even though MPA already paid compensation of the land to them in 1996, farmers are requesting additional compensation due to insufficiency of the compensation and income restoration. MPA is currently negotiating with the farmers on the issue. Results on the resettlement and the draft additional assistance measures are shown in Annex Resettlement Action Plan Study Report in DFR1.

3.2.2. Implementation Situation on Plot 3

A project site on Plot 3 used by three farmers as their farmlands may serve as a useful reference since the historical background is the same as in this project. MPA paid cash assistance of 1.1million kyat/acre in December 2013 after several negotiations with the farmers.

3.3. Environment and Social Considerations of SEZ Project

3.3.1. Present Situation

Compensation and assistance were given to the residents and land users for the Class A area of the Thilawa SEZ project . The class A area is the urgent development area with 400 ha in the entire SEZ project (total area is 2400ha).

3.3.2. Comparison between Thilawa Area Port Project and SEZ Project

The draft of the additional assistance menu on the Thilawa area port project and the actual compensation and assistance menu on the SEZ project are summarized in Table 3.3-1.

Cash assistance equivalent to six times the yield amount for a rice cropping was paid in the SEZ project. If cash assistance of 1.1million kyat/acre, the same amount of cash assistance paid to the farmers on Plot 3 in the Thilawa area port, is given to the farmers in the current project, the amount is equivalent to 6.3 times the annual yield amount of 174,000 kyat/acre (refer to Annex Resettlement Action Plan in DFR1 in detail). Cash assistance of 1.1million kyat/acre would be sufficient in this case because there are only paddy fields and no residential area or vulnerable people on the project site.

Table 3.3-1 Comparison on the Resettlement Issue on the Thilawa Area Port and the SEZ

Category	Thilawa Area Port	SEZ
Project Owner	MPA	Myanmar Japan Thilawa Development Ltd. (Myanmar and Japan Consortium for Thilawa Special Economic Zone Project)
Historical Action	Myanmar government made compensation (20,000 kyat/acre) and prepared relocation sites for the residents and farmers on project site for Thilawa port project in 1996. After the compensation, some residents and farmers have continued to use the land as a paddy field because the project has not been implemented. The land was transferred to MPA in 1997 and 2000.	Myanmar government made compensations (with crop; 20,000 kyat/acre, without crop; 10,000 kyat/acre) and prepared relocation sites for the residents and farmers on project site for the Thanlyin-Kyauktan Industrial Zone Development in 1997. After the compensation, some residents and farmers have continued to use the land because the project has not been implemented. The land was transferred to DHSHD, MOC in 1998-1999 and to the SEZ Management Committee in March 2013.
Project Affected Parsons	Residents: No Farmland Users: 7 parsons (rice cropping)	Residents: 65 households Farmland Users: 16 households
Assistance Menus	Cash assistance: Under negotiation. Three times the annual yield is proposed in RAP (1,100,000 kyat/acre on Plot 3) Income restoration: provision of job training and opportunity is proposed. Compensations for housing, cattle or crops except rice will not be made because there are no residents and farmers other than rice cropping. Also there are no	Housing: provision of a relocation site with housing and infrastructure. Other Structures: To be calculated based on the floor area and materials of a structure Agricultural Machines: Cash assistance at the current market price. Paddy Farmer: Cash assistance of six times the yield amount in total at the current market price. Vegetable/Tree Farmer: Cash assistance of four (4) times of yield amount and/or number of trees in total at the current market price. Livestock Farmer: Cash assistance per

	vulnerable people in the project area.	animal. Cash assistance of three (3) times the income from a milking cow. Assistance for non-working days: 28,000 kyats/person Moving cost: One time cash assistance of 150,000 kyats/household Commuting Assistance (Worker): One time cash assistance of 72,000 kyats/worker Commuting Assistance (Student): One time cash assistance of 30,000 kyats/student Cooperation Allowance: 100,000 kyats/household Vulnerable groups: One time cash assistance of 25,000 kyats/person (equivalent to one big bag, about 50kg, of rice per person), Income Restoration Assistance: provision of job training and operation program

(Prepared by the Study Team)

3.4. Environmental Management and Monitoring Plan

The environmental impact assessment conducted in the feasibility study was reviewed based on the result of the detail planning study, and an environmental management and monitoring plan (counter measures and monitoring) was made. The environmental management and monitoring plan is shown in DFR1.

3.5. HIV/AIDS Prevention Program

3.5.1. Objectives

The construction works of the urgent development for Yangon Port in Thilawa Area are expected to take about 2.5 years during which time 250 local and international workers will be hired on average (400-500 workers may be employed during peak times). Large portion of the workers may migrate from regions inside/outside of the country. Since migrating workers generally live in an unfamiliar environment for a certain period of time, the risk of HIV/AIDS infection spreading increases as other Sexual Transmitted Infection (STI) due to unsafe sexual and other practices.

Accordingly, this HIV/AIDS prevention program is prepared aiming to reduce the risk of infection between the construction workers and the local people such as sex workers during the construction period of urgent development for Yangon Port in Thilawa Area, through activities for disseminating correct knowledge of infection risks and prevention of HIV/AIDS and other STI together with volunteer counseling and testing.

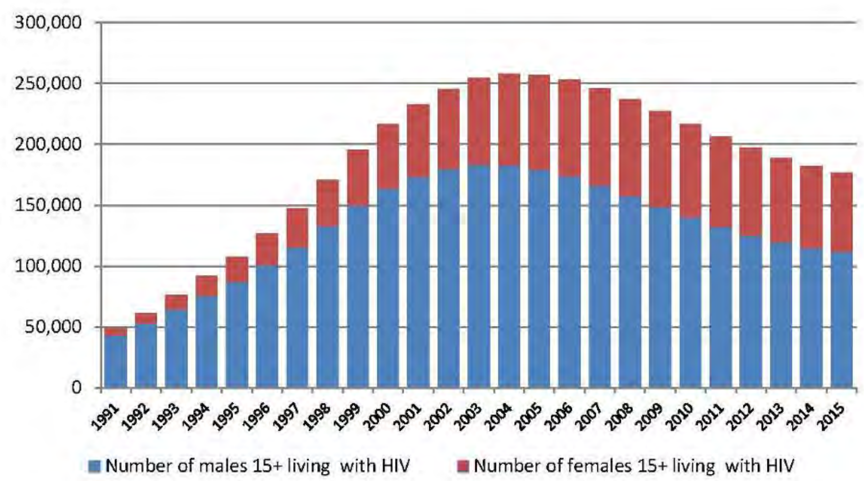
3.5.2. Present Situation and Measures of HIV/AIDS

(1) Situation in Myanmar

Population living with HIV in Myanmar increased rapidly in the 1990's but has tended to decrease after peaking in 2004 (Figure 3.5-1). However, it is estimated that around 216,000 people are living with HIV in Myanmar as of 2011 (of which 36% were female), 18,000 people died of AIDS‐related illness and 8,000 people were newly infected in 2011[1]. In addition, data of the Ministry of Health states that HIV was responsible for the largest number of deaths by diseases in 2011[2].

According to Global AIDS Response Progress Report (2012) issued by National AIDS Programme (NAP), the epidemic status in Myanmar is as follows.

The HIV epidemic in Myanmar is concentrated, with HIV transmission primarily occurring in high risk sexual contacts between sex workers and their clients, men who have sex with men and the sexual partners of these sub‐populations. In addition, there is a high level of HIV transmission among injecting drug users through use of contaminated injecting equipment, with transmission to sexual partners. It is estimated that the HIV prevalence in the adult population (aged 15 and more) is 0.53% in 2011. For key populations most‐at‐risk, surveillance data from 2011 showed HIV prevalence in the sentinel groups at 9.6% in female sex workers, 7.8% in men who have sex with men, and 21.9% in male injecting drug users.



Source：HIV Estimates and Projections Myanmar 2010-2015, National AIDS Programme

Figure 3.5-1 Number of People Living with HIV in Myanmar

[1] Global AIDS Response Progress Report Myanmar, National AIDS Programme, 2012.
[2] Health in Myanmar 2013, Ministry of Health.

(2) National Strategic Plan on HIV/AIDS

To cope with a potential HIV/AIDS epidemic, the Ministry of Health has developed National Strategic Plan (NSP) on HIV and AIDS. Currently, the 2nd NSP has been launched for 2011-2015 following the 1st NSP for 2006-2010. In the 2nd NSP, three strategic priorities are identified to address the most pressing needs of populations at higher risk of HIV infection3:

- Strategic priority I: Prevention of the transmission of HIV through unsafe behavior in sexual contacts and use of contaminated needles,
- Strategic priority II: Comprehensive continuum of care of people living with HIV, and
- Strategic priority III: Mitigation of the impact of HIV on people living with HIV and their families.

In regard to the strategic priority I, which is the most related strategy with this prevention program, 42 million condoms were distributed for free in 2010 according to NAP Progress Report in 2012. Number of people who received HIV test and post-test counseling in 2010 is 101,088 including 22,655 of most-at-risk populations.

(3) Framework for HIV/AIDS prevention

HIV/AIDS issues are addressed by the government, international/local NGO and private agencies such as clinics in Myanmar; those activities are coordinated by National AIDS Programme (NAP), the Ministry of Health. NAP has AIDS/STD teams in each region which consists of doctors, nurses and laboratory technicians to implement following ten activities4. In Yangon District, eight AIDS/STD teams have been allocated in Yangon City according to the regional AIDS/STD team out of the eleven5 in the district.

1) Advocacy (e.g. explanation to community leaders)
2) Awareness raising
3) Prevention of sexual transmission of HIV/STD (promotion of condom use and early treatment of STIs)
4) Prevention of HIV transmission through injecting drug use
5) Prevention of mother to child transmission of HIV
6) Provision of safe blood supply
7) Provision of care and support
8) Enhancing the multi-sectoral collaboration & cooperation

[3] Myanmar National Strategic Plan on HIV and AIDS, 2011-2015.
[4] Results of interview to National AIDS Programme (NAP).
[5] National Strategic Plan for HIV/AIDS in Myanmar, National AIDS Programme, Progress Report, 2011.

9) Special intervention programme

10) Supervision, monitoring and evaluation

In addition, NGOs are playing practical roles on HIV prevention. According to NAP Progress Report(2011), 27 international/local NGOs are currently working for HIV/AIDS in Myanmar. The activities are various: some NGOs are good at education/awareness program, while others are only working for screening and treatment. The activities of NGOs are supervised and governed by NAP.

(4) Situation around Thilawa Area

Table 3.5-1 presents population and number of health facilities in Kyauktan Township where the project site is located and Thanlyin Township at the north of the project site where the access route from Yangon City will pass through.

Thanlyin Township Hospital, which has 150 beds, is recognized as a larger hospital comparing with the other township hospitals. For HIV prevention, the hospital is working such as for prevention of mother to child transmission and condom distribution (about 10,000 pieces/month); the prevention activities also covers Kyauktan Township[6]. In addition, a section for Anti-Retroviral Therapy (ART) was established in December 2012, and it has provided treatment to 36 patients (18 males and 18 females) at no charge. According to the hospital, 14 patients who need ART are on a waiting list for getting the treatment.

In Thanlyin, an AIDS/STD team of National AIDS Programme has been allocated. However, it is hardly working as of July 2013 because it consists of only one doctor and he has already indicated that he will resign.

In addition to the government activities described above, NGOs are working for HIV prevention around Thilawa Area. For example, it has been identified that French-based NGO named Médecins du Monde (MDM) is providing prevention programs such as education/awareness programs and condom distribution as well as screening and treatment around Yangon City including Thanlyin and Kyauktan. Some private clinics also provide HIV testing and ART.

As there is no data on regional HIV/AIDS, number of infected people around Thilawa Area is unknown. According to Thanlyin Township Hospital, unsafe sexual contacts with sex workers are recognized as a major infection source the same as the national trend.

[6] Results of interview to Thanlyin Township Hospital.

Table 3.5-1 Population and number of health facilities in Kyauktan and Thanlyin Township in 2009

Township		Kyauktan	Thanlyin
Area		844.30 km^2	378.40 km^2
Population	Total	157,938	180,581
	Sex ratio (male/female x 100)	97	95
	0-14 year	41,681	52,928
	15-49 year	87,163	95,256
Number of health facilities	Township hospital	1 (25beded)	1 (150bedded)
	Station hospitals	2	1
	Rural health center	9	4
	Sub health center	36	17
	School health center	-	1
	Private clinics and maternity homes	20	45

Source: Township Health Profile 2009, Ministry of Health

3.5.3. Principles

This HIV/AIDS prevention program is implemented by an appropriate service provider under responsibility of the construction contractor based on sub-clause of health and safety of the construction contract. Principles of planning and implementing the program are listed below.

1) Linkage with National AIDS Programme(NAP)

Considering that NAP is working as the coordinator for HIV programs in Myanmar, necessary procedure and coordination with NAP shall be taken for this program to link with the national scheme.

2) Consideration on local sex workers in the education/awareness program

Sex workers, recognized as one of the major infection sources in local communities, are likely to contact with the construction workers. Therefore, local sex workers shall be considered to be covered by the education and awareness program besides the construction workers.

3) Screening, diagnosis and counseling as well as referral to a treatment provider

In order to raise awareness on infection risks and prevent further spread in case of infection, the program shall include screening, diagnosis and counseling of HIV and diagnosis of other Sexual Transmitted Diseases (STDs). If the person is identified to be treated, referral to an appropriate treatment provider shall be ensured. The HIV testing shall be voluntary and confidential for preventing discrimination and dismissal.

4) Qualification of the service provider considering the manpower and the technical level

National AIDS Programme(NAP) is a government agency which has responsibility on implementing prevention programs including education and awareness programs; however, NAP is not suitable as the service provider for this program because of the limitation of manpower. On the other hand, NGO is able to be recommended as it has enough human capacity in general.

Meanwhile, it should be considered that the technical level of NGO differs depending on the work fields of each organization. Especially for testing and counseling, the technical level needs to satisfy the national requirements suggested by the government. For HIV testing, National Health Laboratory of the Ministry of Health is periodically checking and assessing the testing adequacy of each laboratory through National External Quality Assessment Scheme (NEQAS). For counseling, the Ministry of Health has provided training and issued a guideline. In order to ensure the adequate technical level, NGO shall be selected considering these technical criteria suggested by the government.

3.5.4. Program Activities

(1) Components of the HIV/AIDS prevention program

This HIV/AIDS prevention program consists of following components complying with the items in the standard bidding documents under Japanese ODA loans. The program shall be implemented throughout the construction period (about 2.5 years).

1) Information, Education and Communication (IEC) campaigns concerning the risks, dangers and impact, and appropriate avoidance behavior with respect to, of STD/STI in general and HIV/AIDS in particular (at least every other month).

Target group: all site staff and labour (including truck drivers and crew making deliveries to the site for construction activities) and the immediate local communities (sex workers)

2) Condom distribution at no charge

Target group: all site staff and labour

3) STI and HIV/AIDS screening, diagnosis, counseling and referral to a treatment provider

Target group: all site staff and labour

(2) Details of the program activities

Considering current situation of HIV/AIDS infection and the prevention activities in Myanmar, program activities of each component are proposed as follows. According to the standard bidding documents under Japanese ODA loans, the program shall be conducted by the construction contractor via a service provider. The following activities shall be included in the construction contract and implemented under the contractor’s responsibility by an appropriate service provider hired by the construction contractor.

1) IEC campaign

IEC, which stands for Information, Education and Communication, means to inform and educate people about the infection and the prevention in an acceptable way to the target group and the communities. The representative ways in general are mass media, printed materials such as pamphlet and awareness events with quiz/game. For the program of this project, following activities are proposed targeting the construction workers and the local communities (sex workers).

a) Construction workers: Site staffs and labours (including truck drivers and crew making deliveries to the site for construction activities)

Since construction workers are under the responsibility of the construction contractor, participants are easily identified and can be gathered at the project site or the neighborhood. Therefore, periodical session for the workers shall be held to promote awareness on HIV/AIDS and STI. Time length of one session is about two hours, being facilitated by an experienced person with enough knowledge. To ensure two-way communication, the session shall be mainly composed of exchange of ideas and discussion within small groups of not more than twenty participants. Example of composition and subjects of the session is presented in Table 3.5-2.

As the construction workers are replaced in association with the construction progress, the session shall be held at least every other month. List of the target persons and the record of participation shall be managed so that all target persons can attend the session at least one time. Participation rate shall be reported to the construction contractor by the service provider.

In addition, pamphlet for raising awareness shall be prepared to distribute to the construction workers at the session or any other opportunities. Figure 3.5-2 shows an example of the pamphlet.

Table 3.5-2 Standard composition and subjects of the session (example)

Items	Outline
Composition	- Introduction of program and participants (10 min.) - Presentation, exchange of ideas and discussion (60 min.) - Question and answer (20 min.) - Mini test to check understanding of the participants (10 min.) - Recap (20 min)
Subjects	- Basic facts about HIV/AIDS and STI (transmission route, symptom, impacts and others) - How to prevent HIV/AIDS and STI (demonstration of condom use and others) - How to manage if you may be infected (testing, counseling and treatment) - Anti- stigma message

Source: Study Team

Source: Ministry of Health

Figure 3.5-2 Example of pamphlet for promoting awareness on HIV/AIDS infection and prevention

b) Local communities (sex worker)

Sex workers are identified as a major infection source in local communities and likely to contact with the construction workers. Therefore, small group sessions shall be held also for the sex workers in Thanlyin and Kyauktan Township.

Unlike in the case of construction workers, it is difficult to identify sex workers mainly due to the illegality. To solve the difficulties, it is recommended to cooperate and share the necessary information with NGO working in Thanlyin and Kyauktan Township for HIV prevention activities for sex workers.

Additionally, persuading the sex workers to attend the session may also be difficult because they are not controlled by any administrators. In this case, peer education approach (educational communication in daily life by peer educator) shall be considered to be taken. Some local sex workers shall be selected to be assigned as peer educators and they shall be trained at least every other month.

Record of the session or the peer educator training including number of participants shall be reported to the construction contractor by the service provider.

2) Condom distribution

To prevent infection caused by high-risk sexual behavior, condom shall be distributed to the construction workers at no charge. In addition to free distribution at the session of IEC, condoms shall be placed at designated places where construction workers can easily access, for example at site office, toilet and workers camp, so that the workers can get them anytime.

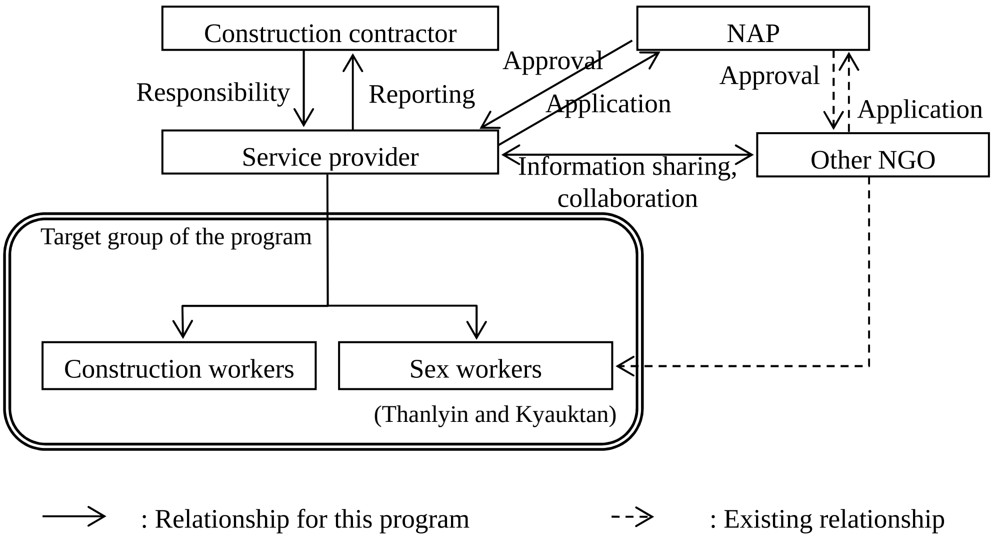
3) Screening, diagnosis, counseling and referral to a treatment provider

For those of the construction workers who are interested, screening, diagnosis and counseling for HIV shall be conducted as well as diagnosis of other STI. The venue shall be selected from two options: one is a medical center prepared at the construction site, the other is nearby hospital or clinic. In the case of the site medical center, a doctor or a counselor who was trained by the government training course shall be sent to the site periodically for taking blood samples, making diagnosis and counseling for those who are interested. If nearby hospital or clinic is selected as the venue, the service provider shall take responsibility for transportation of the workers. In both cases, frequency of the testing, diagnosis and counseling shall be at least every other month. The service provider shall inform the schedule to the construction workers in advance.

In case that treatment is judged to be required as the result of testing and diagnosis, the doctor and the counselor shall certainly refer the patient to suitable treatment provider. To prevent discrimination and dismissal, the results shall be reported only to the patient; even other staffs of the construction contractor will not be shown the results.

(3) Implementation framework

Figure 3.5-3 shows implementation framework of the HIV/AIDS prevention program. The program shall be implemented by a service provider (NGO) which satisfy requirements described in the following section under responsibility of the construction contractor. As HIV programs in Myanmar are coordinated by National AIDS Programme (NAP), the service provider shall apply to NAP for necessary permit. In addition, the service provider shall make positive efforts to coordinate with NGO working around the site to collect information especially about the local communities (sex workers) in order to proceed with the program effectively.



Source: Study Team

Figure 3.5-3 Implementation framework of the HIV/AIDS prevention program

(4) Monitoring and evaluation

For monitoring and evaluating the HIV/AIDS prevention activities, the service provider shall record the activities including items listed in Table 3.5-3. Progress and achievement of the activities shall be evaluated referring to the established goals. The results shall be reported to the construction contractor through monthly reports.

Table 3.5-3 Monitoring items of the HIV/AIDS prevention activities

Activities	Items to be recorded	Goals as a base of evaluation
(1) IEC campaign	- Date, time, venue and number of participants of each session*. - Proportion of the construction workers who have attended the sessions at least one time to entire number of the workers working for two months or more. - Number of distributed pamphlet. - Understanding of the participants (e.g. response during the session).	- To hold a series of sessions at least every other month for construction workers and local sex workers. - To let all construction workers working for two months or more attend the session at least one time during the period of employment. - To distribute planned number of pamphlets (supposed to be 200 prints on average in one month).
(2) Condom distribution	- Number of distributed condom (monthly and accumulated). - Place and method of distribution.	- To distribute planned number of condoms (supposed to be 1,000 pieces on average in one month).
(3) Screening, diagnosis, counseling	- Date, venue and number of construction workers who received the services of testing, diagnosis and counseling.	- To provide opportunities of testing, diagnosis and counseling at least every other month.

*: For local sex workers, peer educator training session can be replaced for the small group session.

Source: Study Team

(5) Qualification of service provider

Qualification of service provider for this program is listed below.

- NGO authorized by the government of Myanmar,
- To have experience of HIV/AIDS prevention activities including education and awareness programs,
- To be able to assign a person who was trained for HIV/AIDS counseling by the Ministry of Health of Myanmar, and
- To be able to conduct HIV testing evaluated by National External Quality Assessment Scheme (NEQAS) of the Ministry of Health of Myanmar.

For reference, Table 3.5-4 presents a list of NGOs recognized as potential service provider confirmed by the Study Team as of July 2013. Apart from the potential service provider, NGO working around the site for HIV/AIDS prevention for sex workers is presented in Table 3.5-5 to cooperate and share the necessary information.

Table 3.5-4 Example of NGO recognized as potential service provider

Local/ International	Name	Contact
Local NGO	Myanmar Business Coalition on AIDS (MBCA)	No.55, Aung Min Gaung 1st street, Windermere, Kamayut T/S, Yangon Office: 01-501568
	Pyi Gyi Khin (PGK)	Room 305/403, Yankin Garden Residence, Si Pin Lan Thit 1st Street, Yankin T/S, Yangon Office: 01-400261 / 09-8551510
	Ratana Metta	No.406, Lower Pazundaung St, Yangon Office: 01- 73024794 / 201480
International NGO	Premiere Urgence - Aide Medicale Internationale (PU-AMI)	No.73, Than Lwin Road, Kamayut T/S, Yangon Office: 01-525246 / 526487
	Population Services International (PSI)	No. 16, West Shwe Gone Dine 4th Street, Bahan T/S, Yangon Office: 01-375854-58

Source: Study Team

Table 3.5-5 NGO working around the site for HIV/AIDS prevention for sex workers

Local/ International	Name	Contact
International NGO	Médecins du Monde（MDM）	No.2, Aung Dhama Yeik Thar Street, Hlaing T/S, Yangon Office: 01-664352 / 660948

Source: Study Team

(6) Schedule

Table 3.5-6 shows implementation schedule of the HIV/AIDS prevention activities. The implementation period shall cover the entire construction period which is estimated to be 2.5 years. In case of extension of the construction working period at the site for any reasons, the period of HIV/AIDS prevention activities shall also be extended.

Table 3.5-6 Implementation schedule of the HIV/AIDS prevention activities

Year	1												2												3						Notes
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Construction	△Start of construction works																													Completion△	
HIV prevention activities																															
1) IEC session	●		●		●		●		●		●		●		●		●		●		●		●		●		●		●		at least every other month
2) Condom distribution																															any time
3) Screening, diagnosis and counseling	●		●		●		●		●		●		●		●		●		●		●		●		●		●		●		at least every other month
Reporting of the HIV prevention activities	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	monthly

Source: Study Team

(7) Cost estimation

Rough estimation of the HIV/AIDS prevention activities is tabulated in Table 3.5-7.

Table 3.5-7 Cost estimation for the HIV/AIDS prevention activities (2.5 years)

Items		Activities	Specification	Unit price (USD)	Quantity	Unit	Amount (USD)	Total (USD)	Notes
Preparation and cordination		Preparation works including cordination with the government	Team leader	1,000	2	man-month	2,000	3,500	
			Expert	750	2	man-month	1,500		
Implementation of the program	1) IEC campaign	Session（construction workers）	2 hours/session	150	90	session	13,500	16,350	6 sessions x 1 time/ 2 months
		Session (sex workers）	2 hours/session	150	15	session	2,250		1 session x 1 time/ 2 month
		Preparation and distribution of pamphlet	Designing and printing	0.10	6,000	print	600		200 prints/month
	2) Condom distribution	Condom distribution	Condom	0.03	30,000	piece	900	900	1,000 pieces/month
	3) Screening, diagnosis and counseling	Diagnosis and counseling	Doctor/counselor	1,500	2.5	man-month	3,750	3,975	5 days/ 2 months
		Testing	Blood testing	0.5	450	man-month	225		30 cases/ 2 months
Summarizing results and reporting			Expert	750	3	man-month	2,250	3,250	3 days/month
			Assistant	500	2	man-month	1,000		2 days/month
Transportation			Car rental	80	225	car-day	18,000	18,000	15 car-day/ 2 months
Overhead			20%	-	-	-	9,195	9,195	
Total								55,170	

Source: Study Team

4. Additional Detailed Study

4.1. Planning and Design Conditions

4.1.1. Planning Condition

(1) Container Cargo Handling Volume

Planned container cargo handling volume of the new terminal is shown below.

Year 2016 190,000 TEU/ year

(2) Wharf

Planned wharf length, number and target vessel size is shown below.

Length of wharf ： 200m x 2 ＝ 400m
Number of wharves ： 2
Vessel size ： 20,000 DWT
Length 177m.
Draft 9m
1,000 TEU
Berthing direction ： Starboard

(3) Container Yard

Planned container yard storage capacity, container loading style and trailer cruise direction in cruising lane are shown below.

Storage capacity ： 5,700 TEU
Container Loading ： RTG
Trailer cruise direction in East-west Cruising Lane ：Westward

(4) Bulk Yard

Bulk yard shall be prepared in the terminal to handle general cargo and bulk cargo.

(5) Buildings and Facilities

Necessary buildings and facilities for new terminal are shown below.

① Administration Building
② Truck Gate
③ Container Freight Station (CFS)
④ Maintenance Shop

⑤ Container Wash
⑥ Container Repair Shop
⑦ Marine Workers' Lounge
⑧ X-Ray Inspection
⑨ Water Supply Tower

4.1.2. Design Condition

Design condition at the civil work and the building work is shown.

(1) Design Condition for civil work

1) Natural Condition

a) Tide level

It makes the sea level which was calculated by the harmonic-analysis based on the one year (2009-2010) tide level observation archiving on Thilawa area a design tide level.

Highest Water Level	H.H.W.L	:D.L+7.10m
Mean Springs High Water Level	H.W.L	:D.L+6.24m
Mean Water Level	M.W.L	:D.L+3.28m
Mean Springs Low Water Level	L.W.L	:D.L+0.33m
Datum Level	D.L	:D.L±0.00m

b) Wind velocity

There is not at the site a wind observation record, it fixes a design wind-speed from the wind observation record in Yangon.

The wind observation record in Cyclone Nargis attack is as the following.

Maximum-wind-speed	:59.2m/s
Maximum instantaneous wind speed	:72m/s

It makes a design maximum-wind-speed 60 m/s from above and it makes a maximum instantaneous wind speed 72 m/s.

c) Tidal current

There is not an observation archiving of the tidal current at the site, it uses the design current velocity of Yangon port.

Maximum tidal current velocity : 6kt≒3.1m/s

Current direction : It is the direction of the river center in the direction of the downstream.

d) Wave

The width of a river of the plan spot is wide and the wind wave by the wind occurs.

It estimates a wind wave by the SMB method from the fetch and the continuation maximum-wind-speed.

It makes a maximum-wind-speed by the wave forecasting and hind casting 40 m/s and for the wave, it makes it a wind direction.

Wind wave estimation result is shown in Table 4.1-1.

Table 4.1-1 Wind Wave

Wave direction	Fetch (km)	Wave height $H_{1/3}$(m)	Period $T_{1/3}$(sec)
S	2.50	1.5	3.2
SW	3.33	1.7	3.5
W	2.87	1.6	3.4
NW	3.32	1.7	3.5

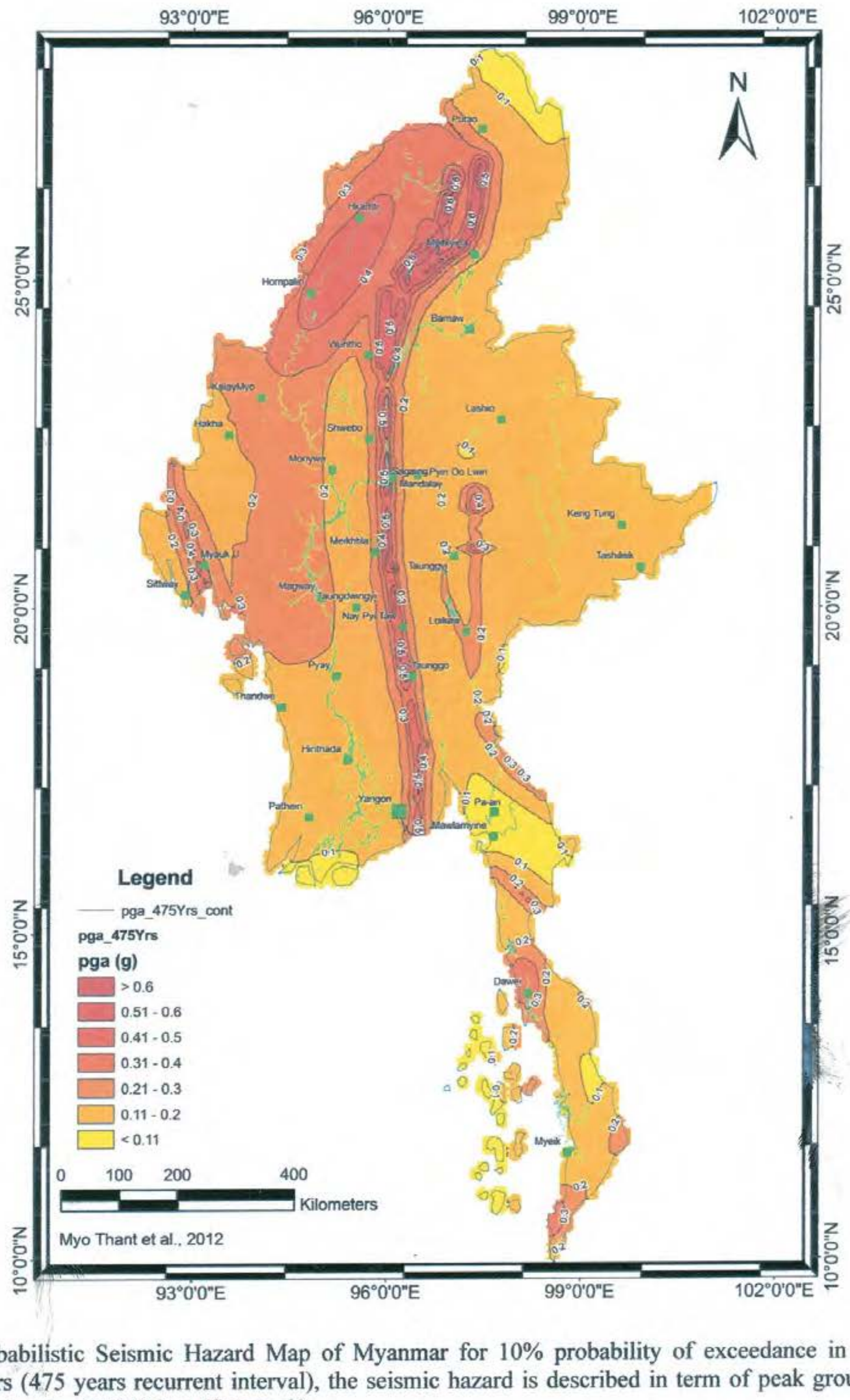
Source : Study Team

2) Seismic Coefficient

It calculates a seismic-coefficient by Thilawa from the seismic zoning map in Myanmar.

An earthquake seismic-coefficient zoning map is shown in Figure 4.1-1.

နောက်ဆက်တွဲ (စ)



Probabilistic Seismic Hazard Map of Myanmar for 10% probability of exceedance in 5
years (475 years recurrent interval), the seismic hazard is described in term of peak groun
acceleration (PGA) in g (firm rock).

Source :Myanmar Geosciences Society

Figure 4.1-1 Seismic Zoning Map

According to this seismic zoning map, Thilawa area is located in III of the area.

Earthquake area	: III
Regional Seismic Coefficient	: 0.20
Coefficient of Importance	: 1.25
Factor for Subsoil Condition	: 1.2
Abatement Coefficient by Structure	: 0.5

It calculates a horizontal design seismic coefficient (Kh) to the construct from these coefficients.

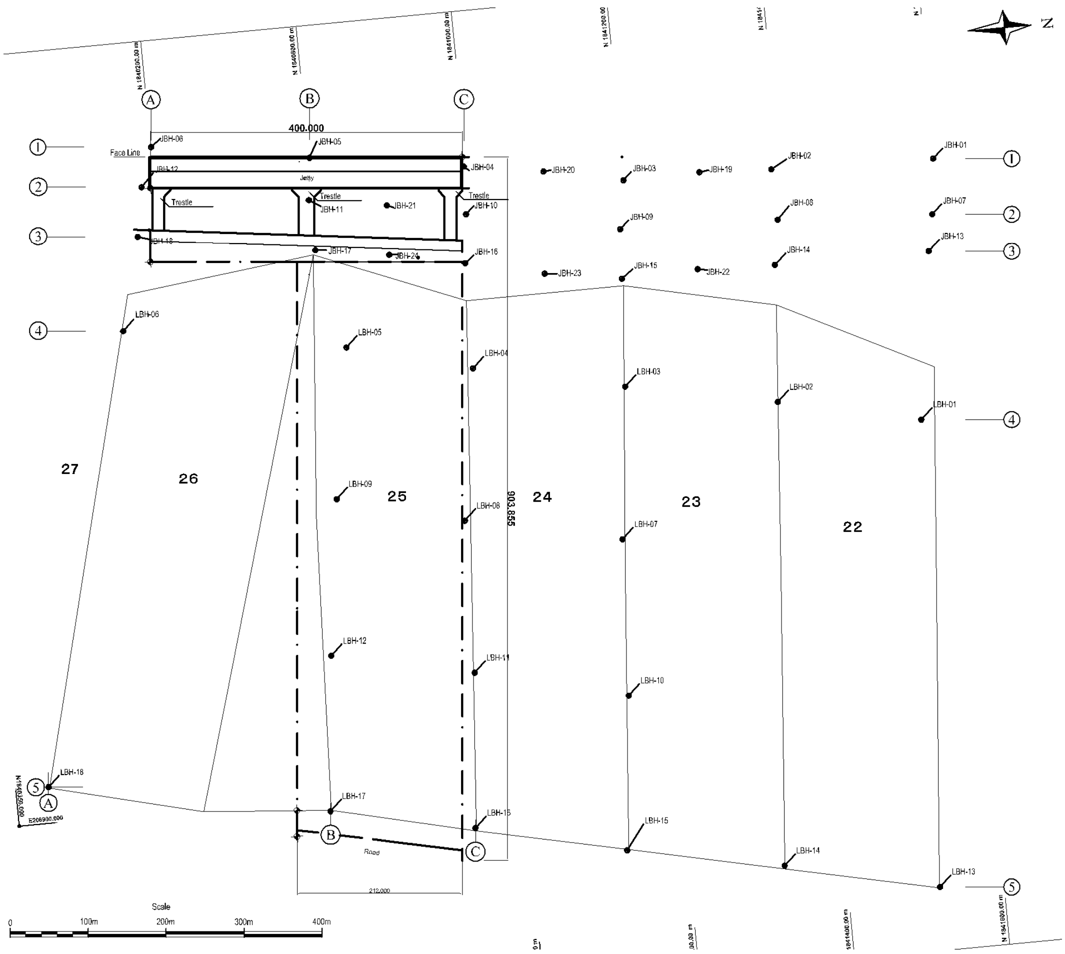
The horizontal design seismic coefficient becomes Kh=0.15.

In this design, it doesn't consider a vertical seismic coefficient. Therefore, it makes Kv=0.0.

3) Soil Condition

It set a soil condition from the soil investigation result in “REPORT ON SOIL INVESTIGATION FOR Part A DECEMBER 2012”.

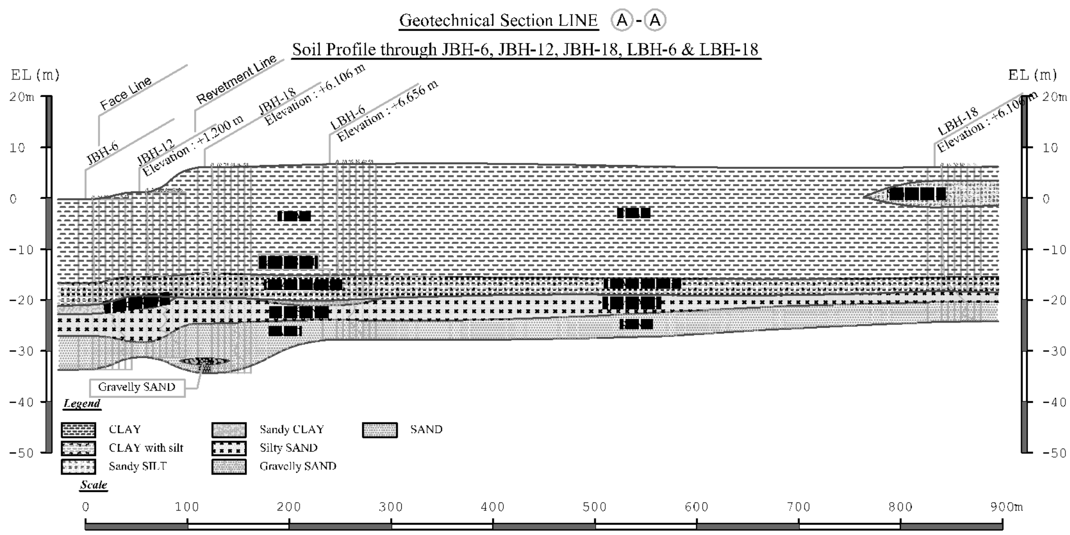
Soil investigation geometry chart is shown in Figure 4.1-2.



Source : Study Team

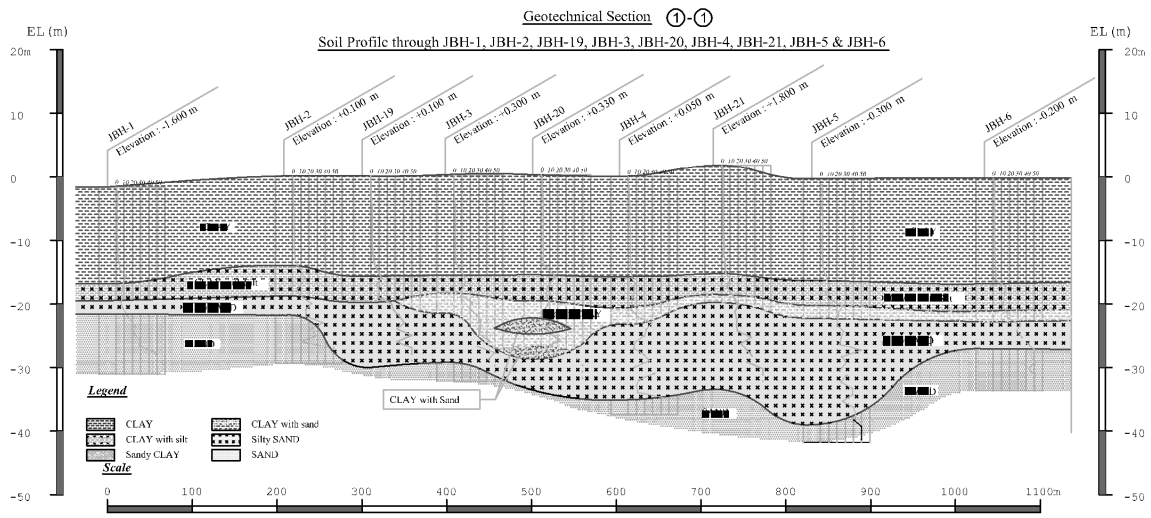
Figure 4.1-2 Soil Investigation Geometry Chart

Main soil stratum cross section is shown in Figure 4.1-5 from Figure 4.1-3.



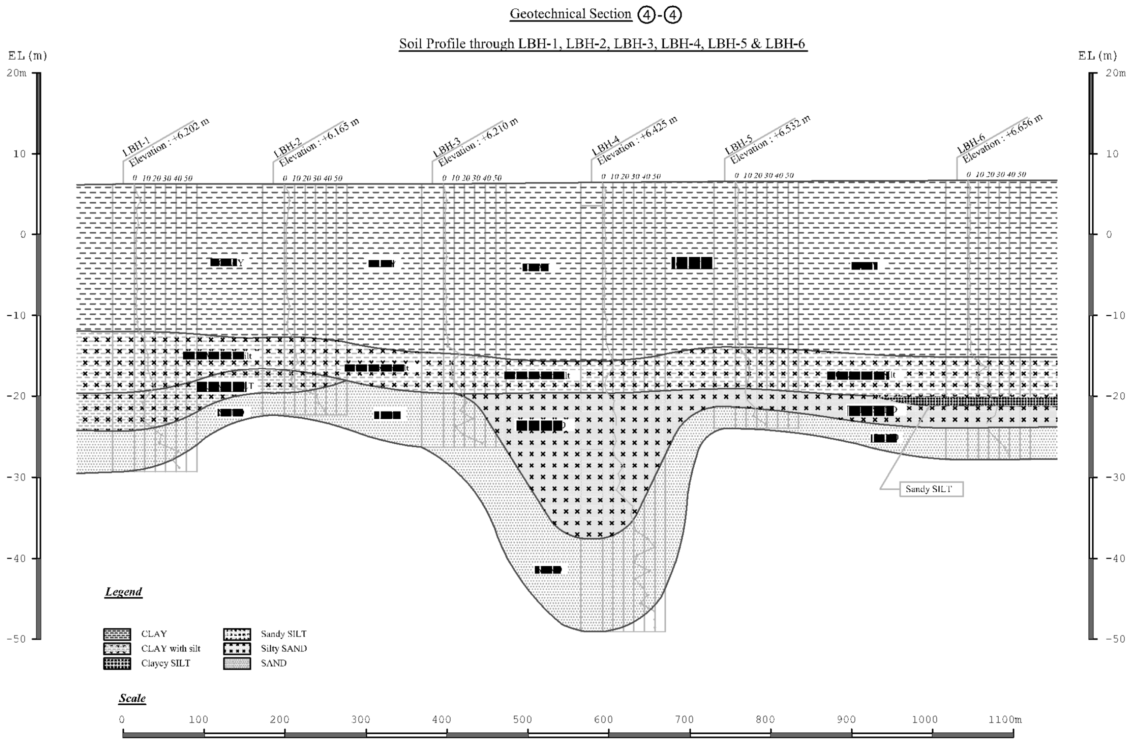
Source : Study Team

Figure 4.1-3 Soil Stratum Cross Section A-A (River side to Land side)



Source : Study Team

Figure 4.1-4 Soil Stratum Cross Section 1-1 (River side)



Source : Study Team

Figure 4.1-5 Soil Stratum Cross Section 4-4 (Land side)

It set as a soil character constant is shown in Table 4.1-2, dividing into the side of the river and the side of the land based on the soil investigation result.

It used a soil character constant on the side of the river for the design at the jetty, the trestle and in the revetment and it used a soil character constant on the side of the land for the design in the soil improvement and on the land facilities.

Table 4.1-2 Soil Character Constant

River Side

No	Soil Name	Elevation (m)	Mean N-Value	Cohesion C kN/m^2	Friction angle φ(°)	Unit Weight γ(KN/m^3)	Unit Weight γ'(kN/m^3)	Modulus of Elasticity E (kN/m^2)
1	CLAY	G.L -16.5	2	C=-1.79･Z+25.81 (Z=0 at ±0.00)	-	17	7	1300
2	CLAY with silt	-16.5 -18.0	10	C=-1.79･Z+25.81 (Z=0 at ±0.00)	-	19	9	6600
3	Silty CLAY	-18.0 -19.0	12	50	-	18	8	8000
4	Sandy SILT	-19.0 -19.5	25	50	-	18	8	16600
5	Sandy CLAY	-19.5 -20.0	16	50	-	19	9	10600
6	Sandy CLAY and CLAY with sand interbedded	-20.0 -22.0	17	50	-	19	9	11300
7	Silty SAND	-22.0 -39.0	30	-	32	19	10	21000
8	SAND	-39.0	40	-	34	20	10	28000

Land Side

No	Soil Name	Elevation (m)	Mean N-Value	Cohesion C kN/m^2	Friction angle φ(°)	Unit Weight γ(KN/m^3)	Unit Weight γ'(kN/m^3)	Modulus of Elasticity E (kN/m^2)
1	CLAY	G.L -14.5	2	C=-1.46･Z+30.89 (Z=0 at ±0.00)	-	17	7	1300
2	CLAY with silt	-14.5 -16.0	11	C=-1.79･Z+25.81 (Z=0 at ±0.00)	-	19	9	7300
3	Sandy SILT	-16.0 -16.5	9	50	-	18	8	6000
4	Sandy CLAY	-16.5 -17.0	9	50	-	19	9	6000
5	Clayey SILT	-17.0 -17.5	10	50	-	18	8	6600
6	Silty CLAY	-17.5 -19.0	11	50	-	19	9	7300
7	Silty SAND	-19.0 -23.0	22	-	30	19	10	15400
8	SAND	-23.0	31	-	32	20	10	21700

Source : Study Team

a) Loading Condition

i) Unit Weight

Unit weights of each material of construction is shown in Table 4.1-3

Table 4.1-3 Unit Weights of Materials

Materials	Unit Weight (kN/m^3)
Steel	77.0
Reinforced concrete	24.0
Plain concrete	22.6
Timber	7.8
Asphalt concrete	22.6
Stone(Granite)	26.0
Stone(Sandstone)	25.0
Sand, Gravel, Rubble (Dry condition)	16.0
Sand, Gravel, Rubble (Wet condition)	18.0
Sand, Gravel, Rubble(Saturated condition)	20.0

Source : Technical Standards for Port and Harbour Facilities in Japan

ii) Live Load

It considers the load on wheel of the cargo-handling-equipment according to each use as the live loads. Place to be used of the cargo-handling-equipment and the load is shown in Table 4.1-4.

Table 4.1-4 Cargo-handling-equipment and Service place

Cargo handling equipment	Service place of Load
Gantry crane	Jetty
Tractor Trailer	Jetty, Trestle, Container yard
Reach Stacker	Jetty, Trestle, Container yard
RTG	Container yard
Forklift	Container yard
Truck	Jetty, Trestle, Container yard
Mobile crane	Jetty, Trestle

Source : Study Team

b) Material of Construction Installation Specifications

Installation specifications of the material of construction is based on the Japan Industrial Standards (JIS).

Incidentally, in Myanmar, as for the available bulk material, it uses the installation specifications of Myanmar.

c) Design basis and Design reference book

Technical standard does a design about the design basis which isn't created in Myanmar based on the design basis in Japan.

Besides, it make British Standard (BS), PIANC, EURO-CODE and so on, too, a reference as occasion demands.

Main criteria for use and a reference book are shown in the following.

- Standard Specification for Concrete Structures Japan Society of Civil Engineers MAR, 2008
- Technical Standards for Port and Harbour Facilities in Japan, Japan Port and Harbour Assoc., SEP, 2007
- Technical Standards for Coastal protection Facilities, National Association of Sea Cost, JUN, 2004
- Dynamics design method of the building a breakwater, Japan Institute of Country-ology and Engineering, NOV, 2007
- Commentary and use of the road structure law, Japan Road Assoc., FEB, 2004
- Soft ground measures mechanic guidance, Japan Road Assoc., JUL, 2012
- Specifications for Highway Bridges, Japan Road Assoc., MAR, 2012
- Pile foundation design manual, Japan Road Assoc., JAN, 2007
- Pavement design manual, Japan Road Assoc., FEB, 2006

(2) Design condition for building work

1) Codes and Standards

Applicable codes, regulations and standards for architectural works are as follows;

- Myanmar National Building Code 2012 (Draft) : MNBC 2012
- Building Code of Japan
- Japanese Industrial Standards (JIS)

2) Design Concepts

About design concepts of building, the following have been taken into consideration for building design.

a) Simple plan of the buildings

All the building plans have been studied taking into consideration to be functional and operational in a simple manner. The plan of buildings reflects the required function, number of workers to utilize, adequate and appropriate space, and so on. The plan of each building is referred to in the drawings attached.

b) Simple shape of the buildings

All the buildings have a simple shape of modern design. Derived from simple plan of the buildings, elevation and section of the buildings show the simple shape of the buildings, and it results in cost efficiency of initial cost and running cost.

c) Simple structure of the buildings

All the buildings have a simple structure system. Since almost all buildings require long span framing and wide range of opening, steel superstructure system which is suitable for such requirement is adopted. Derived from the simple shape of the buildings, a strong and safe structure has been designed on each building.

d) To shorten the construction period

About the Administration Building which has 5 storey high, steel superstructure system is adopted instead of reinforced concrete superstructure in order to shorten the construction period.

Since the construction period for building works is limited to a year and a few months, it is necessary to study the construction method to fit to such short period, and prefabricated steel structure system and curtain wall cladding system have been adopted to lessen on-site works and to shorten the construction period.

e) Maintenance free and corrosion proof

From the view points of maintenance free and corrosion proofing against brine damage, the usage of fluoride resin paint coating which has strong capability for weather proofing is proposed on the surface of steel materials, such as roofing metal sheet, wall cladding metal sheet, steel structure exposed directly to outside, and so on. The building site is located close to the sea and the buildings are likely to have brine damage. Therefore, maintenance free and corrosion proofing materials are recommended as much as possible for long term use of the buildings.

f) Intake of natural day-light and natural ventilation for energy saving

It is proposed for almost all buildings to utilize natural day-light intake through sky light on the roof and natural ventilation through ventilation monitor on roof top to save energy. Even for the Administration Building, natural day-light is taken into the Atrium (court yard) of the building, which has 4 storey high, from the sky lights of the roof.

4.2. Terminal Planning

4.2.1. Terminal Operation

Basic operational conditions for terminal facility planning in the Expansion Project of Yangon Port Thilawa Area are addressed in this section as follows; 1) Targeted container handling volume and its breakdown, 2) Berthing side of the calling vessels, 3) Cargo handling system in the terminal, 4) Cargo handling capacity (Berth capacity, Yard capacity), 5) Terminal layout plan, and 6) Container and truck flow in the terminal.

(1) Targeted Container Handling Volume and its Breakdown

① Targeted container handling volume :200,000 TEUs per year

② Breakdown of each type of containers :See Table 4.2-1

Table 4.2-1 Targeted Proportions of each type of Containers

Type of Container		Targeted Proportions		Present Proportions	
		Proportion(%)	Container Volume (TEU/Year)	Proportion (%)	Container Volume (TEU/Year)
Import	Full Container	45%	90,000	45%	90,000
	Empty Container	5%	10,000	5%	10,000
Export	Full Container	45%	90,000	35%	70,000
	Empty Container	5%	10,000	15%	30,000
Amount		100%	200,000	100%	200,000

Source : Study Team

(2) Berthing Side of the Calling Vessels

Berthing side of the calling vessel is mainly starboard side for the following reasons.

Generally, berthing side depends on tidal stream. Considering the existing tugboat power of Yangon Port, calling vessels come alongside the pier against the tidal stream. As almost all container vessels calling this port have a deeper draft than general cargo vessels, they come into the port on the flood tide. Accordingly, they come alongside the pier of Thilawa Terminal on starboard-side in response to the change of current direction. If the current is still flowing in the same direction, they turn round and berth at the pier along the port-side of vessels. Therefore, from the viewpoint of water side, calling vessels will berth both at starboard-side as well as port-side.

From the viewpoint of land transportation, vehicles are obliged to run on the right side of the road while trailers from the hinterland mainly come from the north of the terminal; therefore, the safest and most efficient traffic flow (less intersecting in the terminal traffic road) is for trailers to 1) come into the terminal from the north side, 2) go through the traffic road in the terminal anti-clockwise, 3) enter into the stacking yard from the north side of stacking blocks, and 4) exit from the south side of the terminal. In other words, trailers for vessel operation go round between quayside and stacking yard in a clock-wise direction.

To enhance the safety and efficiency of the vessel operation, introduction of more powerful tugboats are planned in Phase-II of the Thilawa Area Port expansion project. Accordingly, influence of tidal stream on deciding berthing side will be less in the near future, Considering the situation above, land transportation rule and traffic safety in the terminal are given preference over water side requirement, and berthing side of the calling vessel is designed at starboard side.

In the case that a calling vessel is moored on portside, trailers in seaside operation can easily turn round by using trailer traffic road constructed between the stacking yard and revetment alongside the river.

(3) Cargo Handling System in the Terminal

1) Cargo handling system at quay-side

QGC (Quay Gantry Crane) system is applied for quay-side handling system based on the findings of the foregoing feasibility study. Since the terminal operator will introduce 200-Ton MHCs (Mobile Harbor Cranes) in the early stage of the terminal operation to handle heavy weight cargoes such as construction materials and equipment for Thilawa SEZ infrastructure development, structure of quay-side apron is designed to have sufficient bearing force for 200-Ton MHCs in this project.

2) Cargo handling system in the yard

RTG (Rubber Tired Gantry Crane) system is applied for container handling in the yard (full container stacking yard) based on the findings of the foregoing feasibility study. Due to Myanmar's customs clearance regulations, container terminals are obliged to organize import and export container cargo inspection facilities in the terminal premise. Because of the limited yard space, especially in Phase-1 stage of the project, maximum stacking height of RTG is planned at five tiers (one-over-five) (See Section4.2.2(1) "Container Yard") to obtain required yard capacity.

The new Thilawa terminal has a high possibility of being operated as a multi-purpose terminal for handling general cargoes (imported vehicles, steel products, construction materials, machinery and equipment, etc.) rather than a container-dedicated terminal in early stage of its operation or for a long period depending on the situation. Therefore, the new terminal should be planned flexibly so that it can serve as a multipurpose terminal, even though it will be able to accommodate 200,000 TEUs of containers at the final stage. Considering this requirement, the pavement structure of half the RTG yard is designed to accommodate general cargoes while it will also be possible to store empty containers using reach stackers or forklifts.

(4) Cargo Handling Capacity

1) Berth Capacity

With the construction of two (2) berths and installation of two (2) QGCs which were recommended in the foregoing feasibility study, required berth capacity at 200,000 TEUs per year will be achieved in this project. Berth handling capacity and main operational preconditions are addressed in the following paragraphs (See Table 4.2.1-2). As the construction of an additional berth is not planned in the Phase-2 project, some operational conditions are to be improved for achieving the expected terminal capacity of Phase-2 project (400,000 TEUs per year). The operational issues for this purpose are addressed in this section.

① Cargo Handling Lot : Average container handling volume per vessel call (cargo handling lot) is 1,200 TEUs at present in AWPT which handled 300,000TEUs in 2012. Cargo handling lot of the new Thilawa terminal is assumed at the same level even though it might handle 200,000 TEUs in the future. Ratio of 20ft to 40ft containers is 2 :1. Therefore TEU factor is 1.333 at present. However, TEU factor might be increased if 40ft container volume increases in the future; this factor is assumed as the same level in this project (See Table 4.2-2).

Table 4.2-2 Berth Capacity of Thilawa New Terminal (Phase I)

No.	Item	Code	Unit				
handling Lot							
1.	Parcel Size	(a)	TEU/Call	1,200			
		(b)	Box/Call	900			
2.	TEU Factor	(c)		1.3333333			
Number of Cranes, Handling Productivity, Berthing Time							
3.	Number of Cranes	(d)	Set	2			
4.	Handling Productivity	(e)	Box/Hr/Set	25			
5.	Crane Utilization Ratio	(f)		0.9			
6.	Crane Operation Hours per Day	(g)	Hr/day	21			
7.	Operation Hours rate in a Day	(h)	(g) / 24 Hr	0.875			
8.	Crane Operation Hours per Call	(i)	Hr/ Call	22.9			
9.	Average Tide Waiting Time for Sail	(j)	Hr/ Call	12.0			
	(Including Preparation Time for Sail)						
10.	Berthing Time of Calling Vessel	(k)	Hr/ Call	34.9			
Available Berthing Time							
11.	Colander Days per Year	(l)	Day/Year	365			
12.	Berth Occupancy Ratio (BOR)	(m)	%	0.5	0.6	0.7	0.8
13.	Total Available Berthing Hour per Year	(n)=	(l)*(m)*24	4,380	5,256	6,132	7,008
Number of Vessels to be called per Year (Call/Year)		(o)=	(n) / (k)	126	151	176	201
Berth Capacity for Container Handling							
15.	Berth Capacity (TEU/Year/Berth)	(p)=	(a)*(o)	150,787	**180,944**	211,102	241,259

Source : Study Team

② Container Handling Productivity :In the foregoing feasibility study of Phase 1, container handling productivity of QGC is assumed at 25 Box/hour/crane. This productivity can be attainable on the condition that a private company operates the new terminal. At

Yangon river port, pilotage services are not available at night. Therefore, average tidal waiting time for de-berthing after completion of container handling operation is assumed at 12 hours. Considering this situation, average time at berth of container vessels is estimated at 35 hours/call, where average container handling time is 23 hours/call and tidal waiting time is 12 hours/call. As a result, vessel productivity per berthing hours is considered to be 25.7 Boxes/berthing hours (See Table 4.2-2).

③ Available Berthing Hours and Number of Vessels : Total available berthing hours depends on BOR (berth occupancy ratio). To avoid extreme berth congestion and long berth waiting time of calling vessels, it usually assumed at about sixty percent (60%). Then, total available berthing hours per year is assumed as 5,256 hours, and eventually number of calling container vessels per year is considered to be at about 151 vessels (See Table 4.2-2).

Based on the operational preconditions described from ① to ② above, handling capacity of a berth equipped with QGC is estimated at 180,000 TEUs per year. On the other hand, most existing terminals in Yangon Port do not have quay gantry cranes, and half of the calling vessels to the port use ship’s gear for loading and unloading operations. Therefore, 20,000 TEUs of annual capacity (to make up the required capacity) can be secured by the ship gear operation at berths without QGC operation, which means the total required berth capacity in Phase-1 project (200,000 TEUs) can be attained with two (2) berths with two (2) QGCs.

However, even though two (2) QGCs are added in Phase-2 stage, two (2) berths with four (4) QGSs will be insufficient to reach the required capacity of 400,000 TEUs if berth capacity remains at 180,000 TEUs. Therefore, by the time that full capacity of Phase-2 is required, external conditions operational performance should be improved as follows;

i) Increase of 40ft container ratio
ii) Increase of parcel size
iii) Decrease of average tidal waiting time by expanding pilotage service time range
iv) Increase of BOR by improving berth management
v) Installation of additional quay-cranes (MHCs or QGCs), etc.

2) Yard capacity

Main operational preconditions which is the basis of yard capacity at 200,000 TEUs in Phase-1 project are addressed in Section 4.2.2 (1)”Container Yard”.

(5) Terminal Layout Plan

Container terminal facilities of Yangon Port (Thilawa Area) are planned to be constructed on the premises of Plot 25 of the Area which extends 212m in the north-south direction and 793m in the east-west direction. On the west side of the premises, open-type detached pier and trestles bridges are to be constructed. Facility layout plan (Phase-1) of the terminal is drawn in Fig.4.2-1.

1) Facility Allocation in the North-South Direction

Allocation of yard facilities in the south-north direction is summarized in Table 4.2-3. From the south edge of the premises to the south , 1) Border area between Plots 25 and 26, 2) South-side trailer traffic road, 3) South-side RTG crossing lane, 4) Container Stacking Blocks, 5) North-side RTG crossing lane, 6) North-side trailer traffic road, and 7) Border area between Plots 24 and 25 are allocated.

In this plan, width of trailer road is unified at 3.5 m per lane. A pitch of bay (dry container) in the stacking blocks is designed at 6.5m per TEU in the north-south direction, and a pitch of row is designed at 2.5 m per lane in the east-west direction. As a result, length of stacking block becomes 142.5 m (22 TEUs). In the border area between Plots 24 and 25, a culvert, pipe line space, electric power cable space is allocated. Technical basis of dimensions of south and north side RTG crossing lanes are addressed in Section 4.2.2 (1) “Container Yard”.

Table 4.2-3 Facility allocation (from South to North)

	Name of Facility	Intended Use	Dimension (m)	Proportion
1	Border area between Plot 25 and 26	Green belt	5.0	2%
2	South-side trailer traffic road	Traffic road for trailers (4 Lanes x 3.5m = 14.0m)	14.0	7%
3	RTG Crossing Lane (South-side)	RTG crossing lane, Space distance for safety RTG operation	16.0	8%
4	Container Stacking Block	Container Stacking Area (22 Bays x 6.5m/TEU－Container Clearance(0.5m) = 142.5m)	142.5	67%
5	RTG Crossing Lane (North-side)	RTG crossing lane, Space distance for safety RTG operation	14.5	7%
6	North-side trailer traffic road	Traffic road for trailers (3 Lanes x 3.5m = 10.5m)	10.5	5%
7	Border area between Plot 24 and 25	Culvert, Pipe line space, Electric power cable space, etc.	9.5	4%
	Total		212.0	100%

Source : Study Team

2) Facility allocation in the East-West direction

Allocation of yard facilities in the east-west direction is summarized in Table 4.2-4. From the west (public road side) to the east (river side) edge of the premises, 1) Detached pier and trestles, 2) Revetment, traffic road and container stacking yard, 3) Customs inspection area and traffic road, 4) CFS, gate, administration building and utility facilities, and 5) Border area beside public road are allocated.

Basic operational conditions to be considered for facility allocation planning in the east-west directions are summarized in the following paragraphs.

a) To utilize empty space between revetment alongside the river and stacking yard

Development of four (4) berths with total length at 800m from Plot23 to Plot26 is the basic requirement for Thilawa area port expansion project. At the same time, as quay-wall face line of each berth is located not alongside river bank but along a straight line, the distance between quay-wall face and river bank differs depending on the Plot. From the viewpoint of terminal planning, quay-wall face line and RTG yard block are usually located in parallel.

According to the result of berth allocation plan of the project, the distance between revetment of river bank and western edge line of the RTG block is 28m at the northern end of Plot 25 and 42m at the southern end of Plot 25. In the Phase-1 project the vacant lot between revetment and RTG stacking yard is utilized for trailer traffic (north-south direction) and special container storage yard. This road will be important as it can be used by seaside trailers to turn around when container vessels are berthed along her portside, and it connects the berth in Plot 26 and RTG yard in Plot 25.

Table 4.2-4 Facility allocation (from West to East)

	Name of Facility	Intended Use	Dimension* (m)		Proportion	
	Detached pier and Trestle					
1	Berth and Apron	Sea-side container handling operation	40.0	106.6	4%	12%
2	Trestle Bridge	Connecting bridge	66.6		7%	
	Container stacking yard, Traffic road, Revetment					
3	Traffic road	Traffic road, Revetment, Storage of DG containers	28.8	459.2	3%	51%
4	**Container Yard**	**Container storage (Full / Reefer)**	**272.0**		**30%**	
5	Passing way beside maintenance area	Passing way for trailers	4.5		1%	
6	Equipment maintenance area	Equipment maintenance, Container repairing, Storage for heavy cargoes	60.0		7%	
7	Passing way beside MT Yard	Passing way for trailers and equipment	8.0		1%	
8	**Empty container yard (MT)**	**Empty container yard, Second gate**	**74.4**		**8%**	
9	South-North main traffic road (2)	Traffic road for trailers (3 Lanes)	11.5		1%	
	Customs inspection area, Traffic road					
10	**Customs inspection yard**	**Installation area for X-ray inspection machines, Trailer parking space related to the customs inspection**	**96.5**	111.5	11%	12%
11	South-North main traffic road (1)	Traffic road for trailers (4 Lanes)	15.0		2%	
	CFS, Gate, Administration building and Utility facilities					
12	Space beside CFS	Parking area	8.5	175.5	1%	20%
13	**CFS and main gate**	**CFS and main gate**	**104.0**		12%	
14	Passing road beside CFS	Passing road for outside trucks to CFS	18.5		2%	
15	Administration building, Cooling tower, Water supply facilities, Power station, etc.		44.5		5%	
	Border area beside public road					
16	Border area, etc.	Green belt, Passage, others	46.6		5%	5%
	合計		899.4		100%	
Note:	* Figures represent the dimensions at the northern edge of Plot 25					

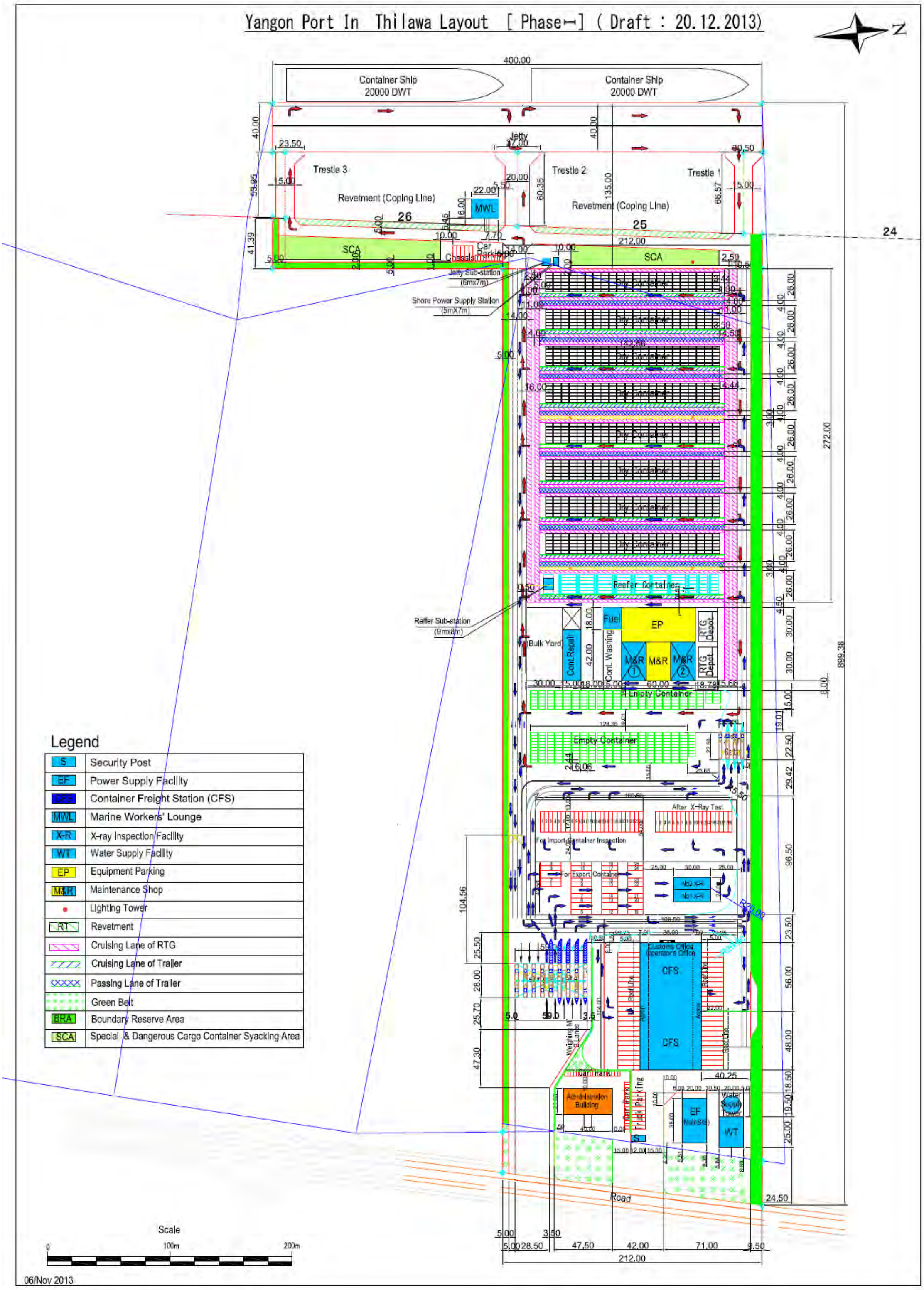
Source : Study Team

b) Location of Reefer Container Yard Adjacent to the Maintenance Yard

Operation and maintenance of reefer containers' electric power system is likely to be managed by the same technical department as that of equipment maintenance facilities. Therefore, it would be better for both facilities to be located adjacent to each other.

c) Location of Container Cargo Inspection Facilities in the Terminal

Under Myanmar customs regulations, all the import and export container cargoes are required to be inspected by a customs officer dispatched to the terminal. The related facilities such as X-ray inspection facilities and CFS for physical examination are required to be located in the terminal. Cargo inspection for import and export containers is performed between gate and stacking yard. Technical basis of the required customs inspection facilities and their locations are addressed in Section 4.2.2 (5).



Source : Study Team

Figure 4.2-1 Facility Layout Plan (Phase-1) of the Thilawa Area New Terminal

d) Installation of the Second Gate and Security Area responding to SOLAS Convention

Due to the container cargo inspection conducted between in-gate and stacking yard, instruction of yard location (destination) to the truck driver at the in-gate and operation order to the RTG operator on a real time basis, which is important for effective terminal operation, would be difficult. Therefore, at the time of completion of customs inspection or at the time of truck entering into the stacking yard, instructions to the driver will be necessary. For this purpose, installation of a second gate is planned at the entrance of the stacking yard.

Security Area responding to SOLAS Convention (the International Convention for the Safety of Life at Sea) is established on the extending line (in the south and west line) of the second gate.

(6) Container and Truck Flow in the Terminal

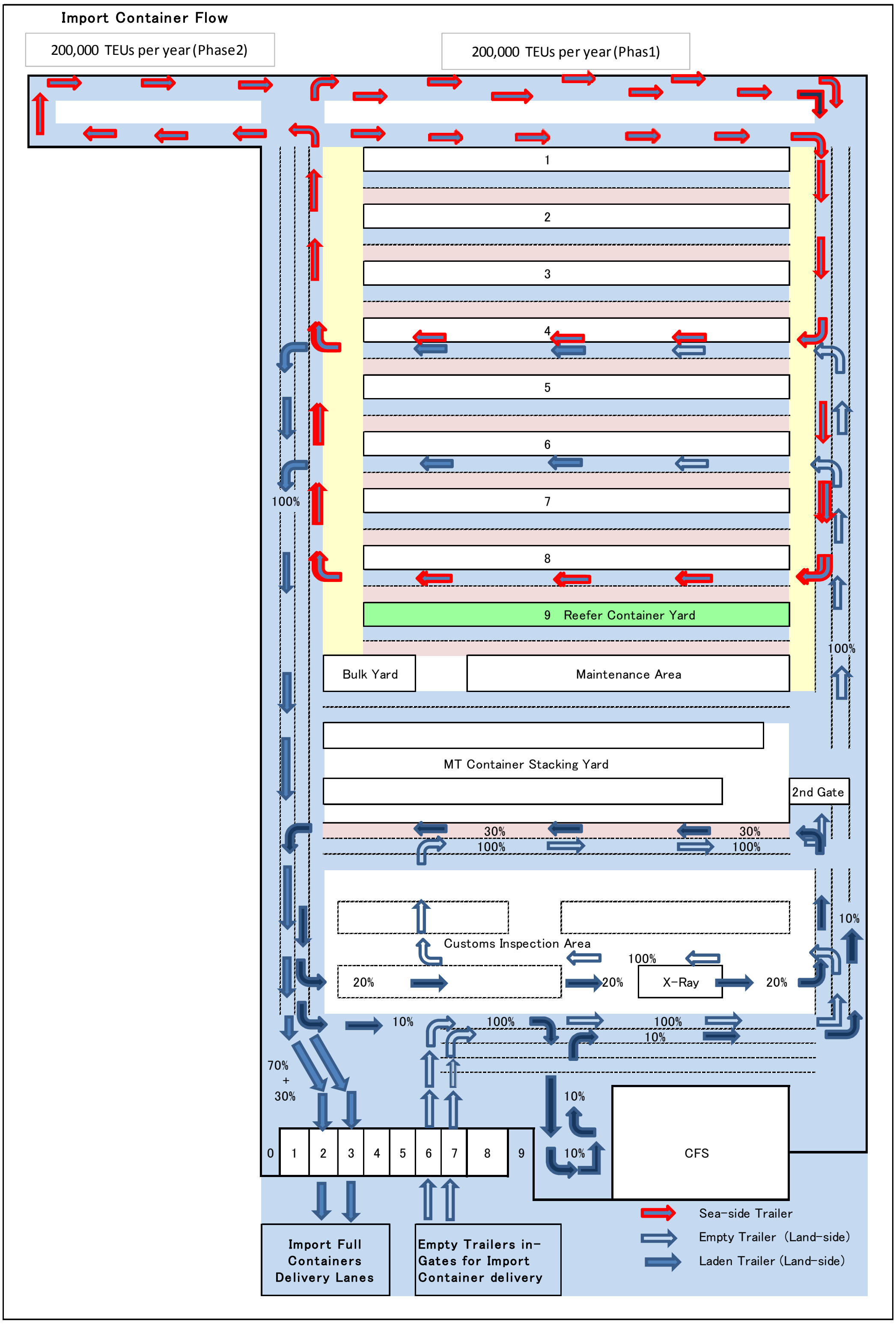
Basically, a standardized handling system is adopted at container terminals and the cargo flow is simple. However, due to the import and export cargo clearance rule that cargo must be inspected in the terminal, container cargo flow in the terminal is somewhat complicated. There are three categories of inspection, i.e., 1) Green Category where container cargo is cleared only by assessment of declared documents by CFS customs, 2) Yellow category where X-ray inspection is necessary in addition the to document assessment, and 3) Red category where physical examination is necessary in addition to the document assessment. Proportions of containers by inspection category adopted as the operational conditions for facility planning in the Phase-1 project are summarized in Table 4.2-5. In particular, although about fifty percent (50%) of import containers fall under the Red category at present. Myanmar Customs Office is aiming to reduce this figure to ten percent (10%) in the future to simplify cargo inspection procedure and to facilitate foreign trade process. Considering this situation, targeted proportions of containers by inspection category are shown in Table 4.2-5.

Table 4.2-5 Targeted Proportions of Containers by Inspection Category

Inspection Category	Inspection Procedures	Import Containers	Export Containers
(1) Green	Cargoes are cleared by document checking	70%	0%
(2) Yellow	X−Ray Inspection is required after document checking	20%	90%
(3) Red	Physical examination is required after document checking	10%	10%

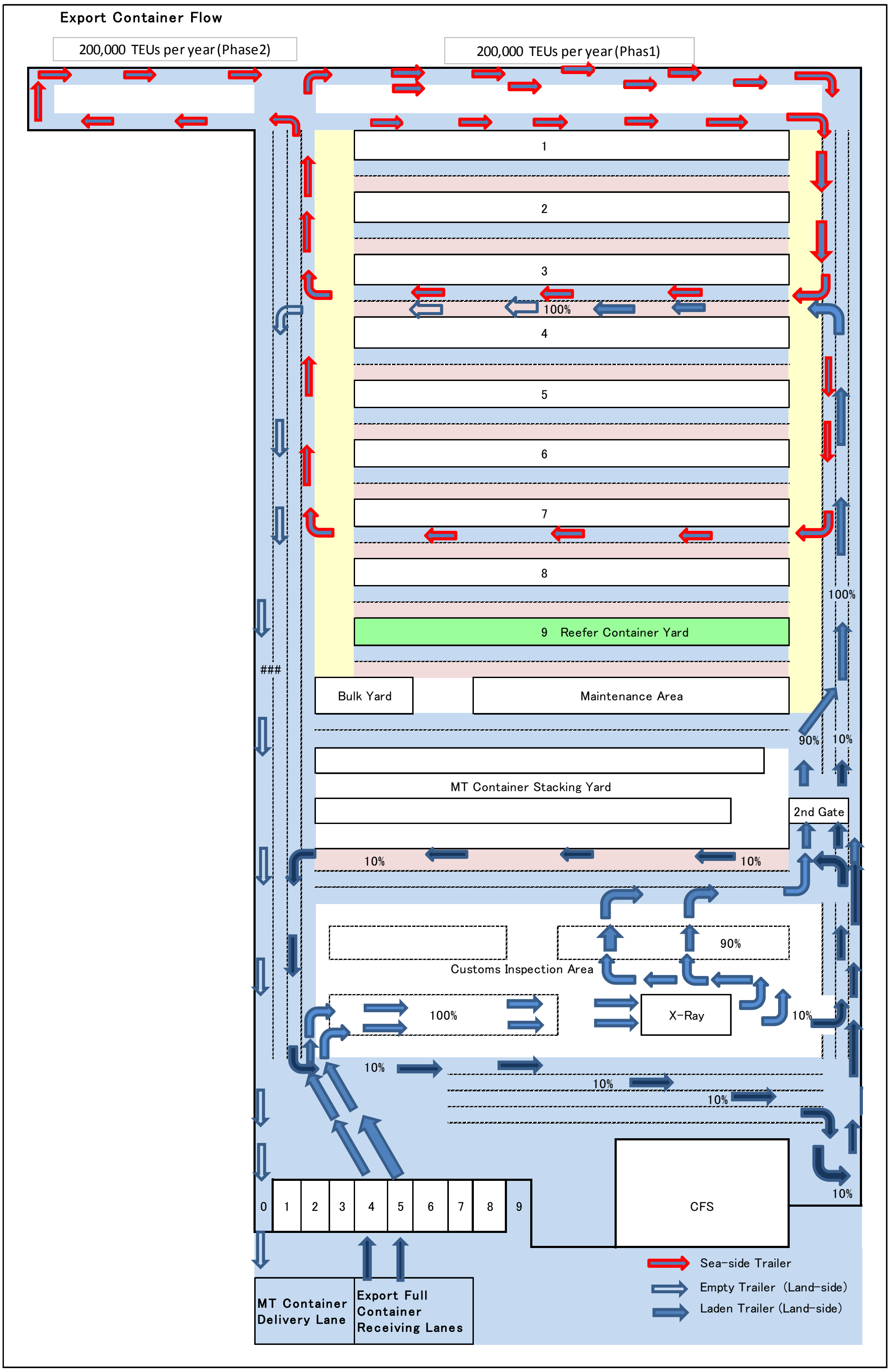
Source : Study Team

Based on the basic requirement of terminal traffic (See Section 4.2.1 (2) “Berthing Side of the Calling Vessels” and proportions of cargo falling under the respective inspection categories described above, import container flow and export container flow in the terminal are illustrated in Fig.4.2-2 (import) and Fig.4.2-3 (Export).



Source : Study Team

Figure 4.2-2 Import Container Flow in the Terminal (Phase-1)



Source : Study Team

Figure 4.2-3 Export Container Flow in the Terminal (Phase-1)

4.2.2. Size and Location of Fundamental Facilities

(1) Container Yard

1) Yard storage capacity

a) Preconditions for planning

① Annual container handling volume :200,000 TEU

② Breakdown of each kind of container :Refer to Table 4.2-6

Table 4.2-6 Targeted Proportions of each type of Containers

Type of Container		Targeted Proportions		Present Proportions	
		Proportion(%)	Container Volume (TEU/Year)	Proportion (%)	Container Volume (TEU/Year)
Import	Full Container	45%	90,000	45%	90,000
	Empty Container	5%	10,000	5%	10,000
Export	Full Container	45%	90,000	35%	70,000
	Empty Container	5%	10,000	15%	30,000
Amount		100%	200,000	100%	200,000

Source : Study Team

③ Container dwelling time in the yard :Refer to Table 4.2-7

Table 4.2-7 Container Dwelling Time

Type of Container		Average Dwelling Time (Day)	
		Targeted Dwelling Time	Present Dwelling Time
Import	Full Container	7	7～12
	Empty Container	14	14～15
Export	Full Container	7	7～10
	Empty Container	14	14～15
Reefer Container		4	4～7

Source : Study Team

④ Yard Utilization Ratio :

a) Import and export full containers : 65%

b) Empty containers : 70%

⑤ Yard block size :22Bays×6 Raw×5Tiers (1-over-5)

b) Yard capacity and required yard blocks

i) Capacity of full containers and required yard blocks

Based on the above preconditions, annual yard capacity per block for import full containers is estimated to range from 13,000 TEUS to 22,000 TEUs with average dwelling times from 7 days to 12 days, and that for export full containers is estimated to range from 16,000 TEUs to 22,000 TEUs with average dwelling times from 7 days to 10 days. Assuming that average dwelling time is 7 days, required yard blocks for import and export full containers are estimated at 9 blocks (See Table 4.2-8). However, accounting for the yard capacity of reefer container block (estimated at about 15,000 TEUs/ year), 8 blocks for full containers will be sufficient (See Table 4.2-9). This estimation is based on the assumption that the average dwelling time at the new terminal should be in line with the international standard of 7 days.

Table 4.2-8 Container Yard Capacity and Required Yard Blocks

Type of Container	Import Full Container (Dry)	Export Full Container (Dry)	Reefer Container
Proportion (%)	45%	45%	
Container Volume (TEU/Year) (a)	**90,000**	**90,000**	
Container Dwelling Time (Day)	7 ～ 12	7 ～ 10	4 ～ 7
Turnover Rate (Times/Year) (b)	52.14 ～ 30.42	52.14 ～ 36.50	91.25 ～ 52.14
Stacking Capacity per Block			
Number of Bays (TEU)	22	22	17
Rows in a Block (Row)	6	6	6
Number of Ground Slot (TEU)	132	132	102
Maximum Stacking Height (Tier)	5	5	3
Stacking Capacity per Block (TEU) (c)	660	660	306
Yard Utilization Ratio (%) (d)	65%	65%	65%
Yard Capacity per Block (TEU/Year/Block) (e) (e) = (b) * (c) * (d)	22,000 ～ 13,000	22,000 ～ 16,000	18,000 ～ 10,000
Required Number of Blocks (f)			
Breakdown (f) = (a) / (e)	4.09 ～ 6.92	4.09 ～ 5.63	
Required Blocks (Calculated figures)	**Full Container:**	**8.18 ～ 12.55**	**Reefer Container:**
Required Blocks (Round up figures)	**Full Container:**	**9 ～ 13**	**1**

Source : Study Team

Table 4.2-9 Required Yard Blocks for Import and Export Full Containers

Type of Container		Import Full Container (Dry)	Export Full Container (Dry)	Reefer Container
Total Volume of Full Container (TEU/Year)	Full Container (Total)	180,000		
	Breakdown into Dry / Reefer Container (a)	165,000		15,000
Container Dwelling Time (Day)		7		4
Turnover Rate (Times/Year) (b)		52.14		91.25
Stacking Capacity per Block (TEU) (c)		660		306
Yard Utilization Ratio (%) (d)		65%		65%
Yard Capacity per Block (TEU/Year/Block) (e) (e) = (b) * (c) * (d)		22,000		18,000
Required Number of Blocks (f)				
	Required Blocks (f) = (a) / (e)	Full Container:	7.50	Reefer Container:
	Required Blocks (Round up figures)	Full Container:	8	1

Source : Study Team

ii) Capacity of empty containers and required yard slots

Based on the above preconditions, number of ground slots for empty container is sufficient at 220 TEUs-GS to accommodate 20,000 TEUs/year, which is 10% of total annual container handling volume of the terminal (See Table 4.2-10).

However, in the case that proportion of empty container continues at the present level, number of ground slots for empty container would have to be increased. For example, 329 TEUs-GS is necessary to accommodate 30,000 TEU/year of empty container (15% of total volume) and 438 TEUs-GS is necessary to accommodate 30,000 TEU/year of empty container (20% of total volume). As proportion of full containers and that of empty containers is 100%, increasing of empty container proportion means decreasing of full container proportion. For planning of the empty container ground slot capacity, required blocks and ground slots corresponding to the variation of each proportion (full and empty containers) are shown in Table 4.2-10.

Table 4.2-10 Estimated Myanmar Population by Region

Total Container Volume (TEU/Year)	200,000							
Breakdown of Container Volume								
Proportion of each type of Containers (%)								
Full Container	90%	88%	86%	85%	84%	82%	80%	78%
Empty Container	10%	12%	14%	15%	16%	18%	20%	22%
Breakdown of Container Volume (TEU/Year)								
Total Volume of Full Containers	180,000	176,000	172,000	170,000	168,000	164,000	160,000	156,000
Import/ Export Full Containers (a1)	165,000	161,000	157,000	155,000	153,000	149,000	145,000	141,000
Reefer Container	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Empty Container (a2)	20,000	24,000	28,000	30,000	32,000	36,000	40,000	44,000
Required Full Container Blocks (Dry)								
Container Dwelling Time (Day)								
Full Container	7							
Empty Container	14							
Turnover Rate (Times/Year)								
Full Container (b)	52.1							
Empty Container	26.1							
Required Blocks of Full Containers (Dry)								
Yard Capacity of Import/ Export Full Containers per Block (TEU/Year/Block) (e) = (b) * (c) * (d)								
Stacking Capacity per Block (TEU) (c)	660							
Yard Utilization Ratio (%) (d)	65%							
Yard Capacity per Block (TEU/Year/Block) (e)	22,369							
Required Blocks of Full Containers (Dry)								
Number of Required Blocks (f) = (a) / (e)	7.38	7.20	7.02	6.93	6.84	6.66	6.48	6.30
Number of Required Blocks (Round up figures)	8	8	8	7	7	7	7	7
Required Reefer Container Blocks	1	1	1	1	1	1	1	1
Required Empty Container Ground Slots								
Preconditions								
Maximum Stacking Height (Tier) (g)	5							
Yard Utilization Ratio (%) (h)	70%							
Container Dwelling Time (Day) (i)	14							
Turnover Rate (Times/Year) (j)=365/(i)	26.1							
Required Ground Slots (TEU) (k)=(a2)/(j)/[(g)*(h)]	219	263	307	329	351	395	438	482

Source : Study Team

As shown in the table, when the proportion of empty container exceeds 15% of the total volume (that is to say when the proportion of full container becomes lower than 85% of the total volume), seven (7) yard blocks for full container (dry container) would be sufficient and the remaining one yard block could be used for empty container storage. As a result, number of required ground slots for empty container is settled at 330 TEUs-GS, which can accommodate 30,000 TEUs of empty containers (15% of total volume).

2) Allocation of yard facilities in the terminal

a) Allocation of yard facilities in the south-north direction

Allocation of yard facilities in the south-north direction is summarized in Table 4.2-11.

Table 4.2-11 Allocation of Yard Facilities (from North to South Direction)

	Name of Facility	Intended Use	Distance (m)	Proportion
1	Border area between Plot 25 and 26	Green belt	5.0	2%
2	South-side trailer traffic road	Traffic road for trailers（4 Lanes x 3.5m = 14.0m）	14.0	7%
3	RTG Crossing Lane (South-side)	RTG crossing lane, Space distance for safety RTG operation	16.0	8%
4	Container Stacking Block	Container Stacking Area （22 Bays x 6.5m/TEU－Container Clearance(0.5m) = 142.5m)	142.5	67%
5	RTG Crossing Lane (North-side)	RTG crossing lane, Space distance for safety RTG operation	14.5	7%
6	North-side trailer traffic road	Traffic road for trailers（3 Lanes x 3.5m = 10.5m）	10.5	5%
7	Border area between Plot 24 and 25	Culvert, Pipe line space, Electric power cable space, etc.	9.5	4%
	Total		212.0	100%

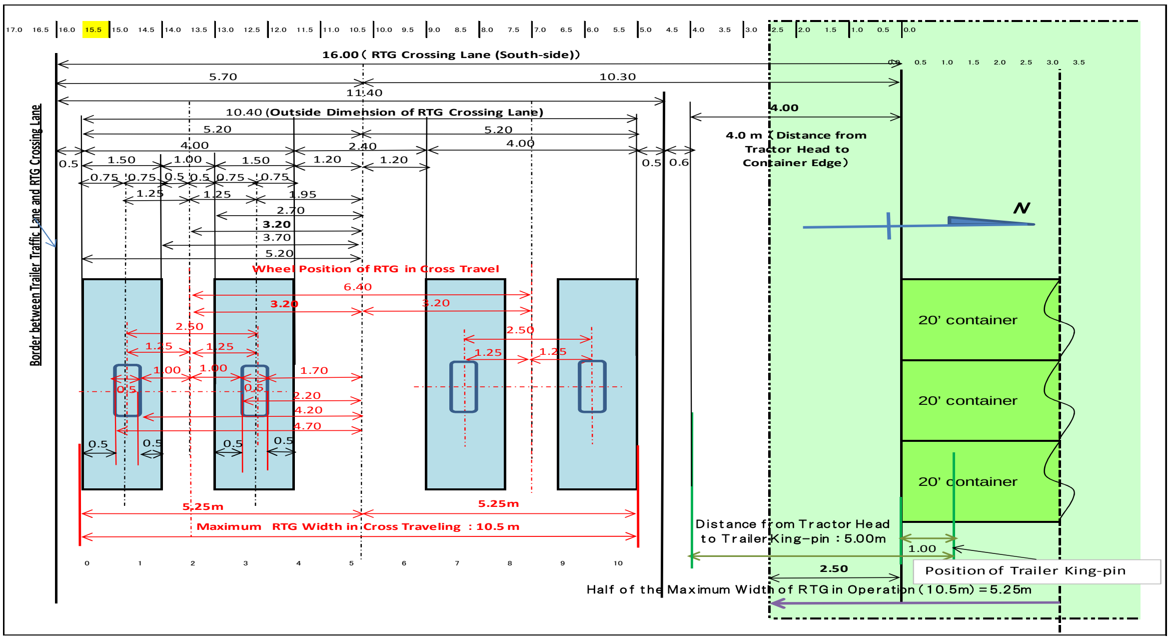
Source : Study Team

Detailed dimensions of the RTG Crossing Lanes are summarized in Table 4.2-12 (South-side of RTG Blocks) and Table 4.2.1-1-8 (North-side of RTG Blocks).

Table 4.2-12 Dimension of RTG Crossing Lane (South-side of RTG Blocks)

	Breakdown of Dimension of RTG Crossing Lane (South-side)	Distance (m)
1	Safety Clearance in RTG Cross Travelling	0.5
2	Outside Dimension of RTG Crossing Lane	10.4
3	Safety Clearance in RTG Cross Travelling	0.5
4	Margin between Cross Travelling RTG and Tractor Head	0.6
5	Distance from Tractor Head to the Southern Edge of Stacking Block	4.0
	Total	16.0

Source : Study Team



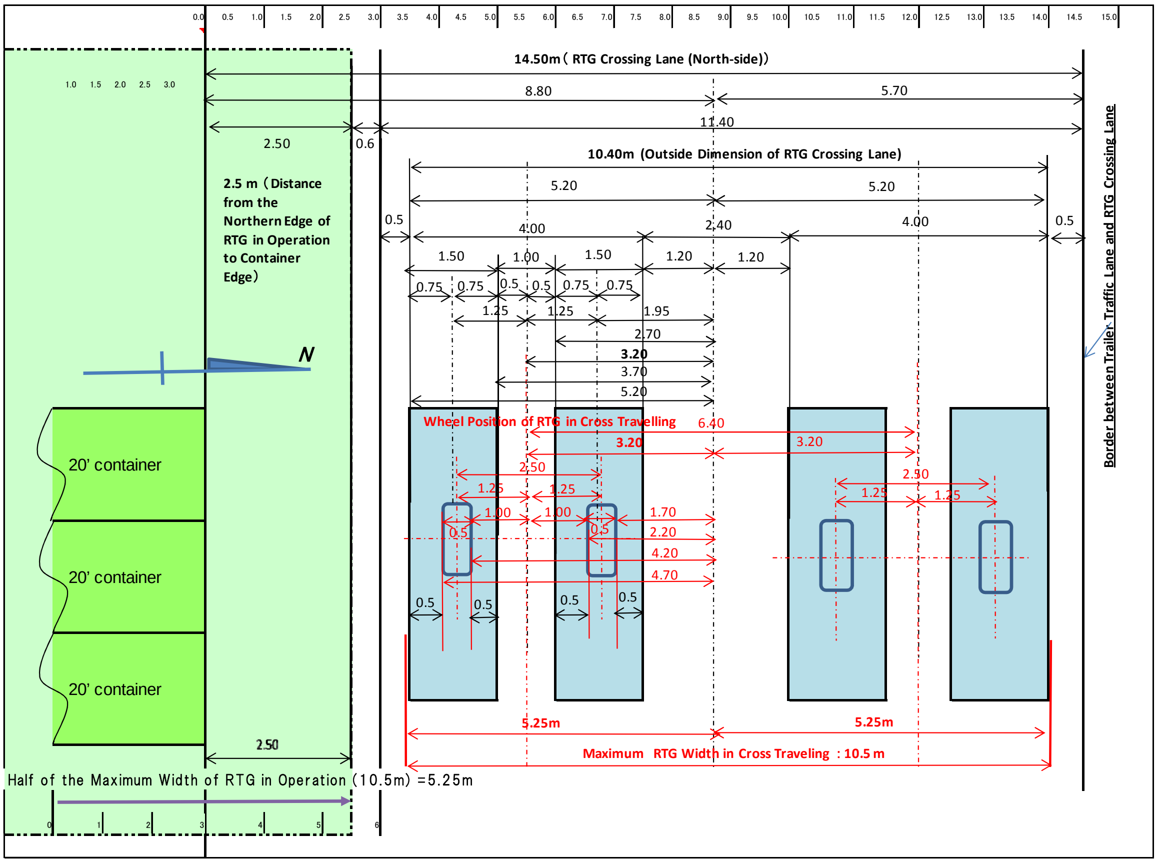
Source : Study Team

Figure 4.2-4 Position of RTG Crossing Lane (South-side of Yard Block)

Table 4.2-13 Dimension of RTG Crossing Lane (North-side of RTG Blocks)

	Breakdown of Dimension of RTG Crossing Lane (North-side)	Distance (m)
1	Safety Clearance in RTG Cross Travelling	0.5
2	Outside Dimension of RTG Crossing Lane	10.4
3	Safety Clearance in RTG Cross Travelling	0.5
4	Margin between Cross Travelling RTG and RTG in Container Handling	0.6
5	Distance from the Northern Edge of RTG in Operation to the Northern Edge of Stacking Block	2.5
	Total	14.5

Source : Study Team



Source : Study Team

Figure 4.2-5 Position of RTG Crossing Lane (North-side of Yard Block)

b) Allocation of yard facilities in the east-west direction

Allocation of yard facilities in the east-west direction is summarized in Table 4.2-14.

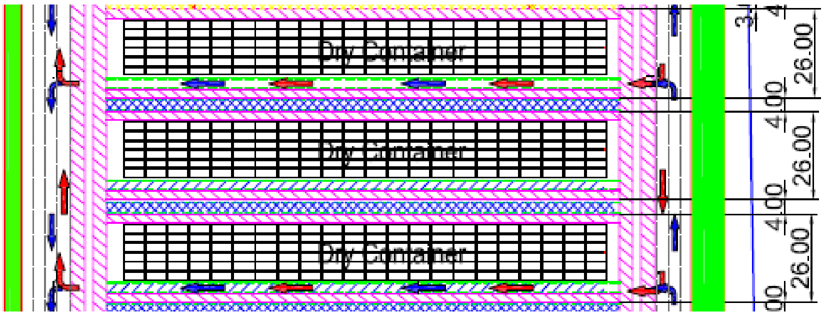
Table 4.2-14 Allocation of Yard Facilities from West to East Direction

	Name of Facility	Intended Use	Distance* (m)		Proportion	
	Detached Pier and Trestle					
1	Berth and Apron	Sea-side container handling operation	40.0	106.6	4%	12%
2	Trestle Bridge	Connecting bridge	66.6		7%	
	Container stacking yard, Traffic road, Revetment					
3	Traffic road	Traffic road, Revetment, Storage of DG containers	28.8	459.2	3%	51%
4	**Full Container Yard (RTG Yard)**	**Container storage (Full / Reefer)**	**272.0**		**30%**	
5	Passing way beside maintenance area	Passing way for trailers	4.5		1%	
6	Equipment maintenance area	Equipment maintenance, Container repairing, Storage for heavy cargoes	60.0		7%	
7	Passing way beside MT Yard	Passing way for trailers and equipment	8.0		1%	
8	**Empty container yard (MT)**	**Empty container yard, Second gate**	**74.4**		**8%**	
9	South-North main traffic road (2)	Traffic road for trailers（3 Lanes）	11.5		1%	
	Customs inspection area, Traffic road					
10	**Customs inspection yard**	**Installation area for X-ray inspection machines, Trailer parking space related to the customs inspection**	**96.5**	111.5	11%	12%
11	South-North main traffic road (1)	Traffic road for trailers（4 Lanes）	15.0		2%	
	CFS, Gate, Administration building and Utility facilities					
12	Space beside CFS	Parking area	8.5	175.5	1%	20%
13	**CFS and main gate**	**CFS and main gate**	**104.0**		**12%**	
14	Passing road beside CFS	Passing road for outside trucks to CFS	18.5		2%	
15	Administration building, Cooling tower, Water supply facilities, Power station, etc.		44.5		5%	
	Border area beside public road					
16	Border area, etc.	Green belt, Passage, others	46.6		5%	5%
	合計		899.4		100%	
Note:	* Figures represent the dimensions at the northern edge of Plot 25					

Source : Study Team

c) Allocation of full container yard blocks (RTG Blocks)

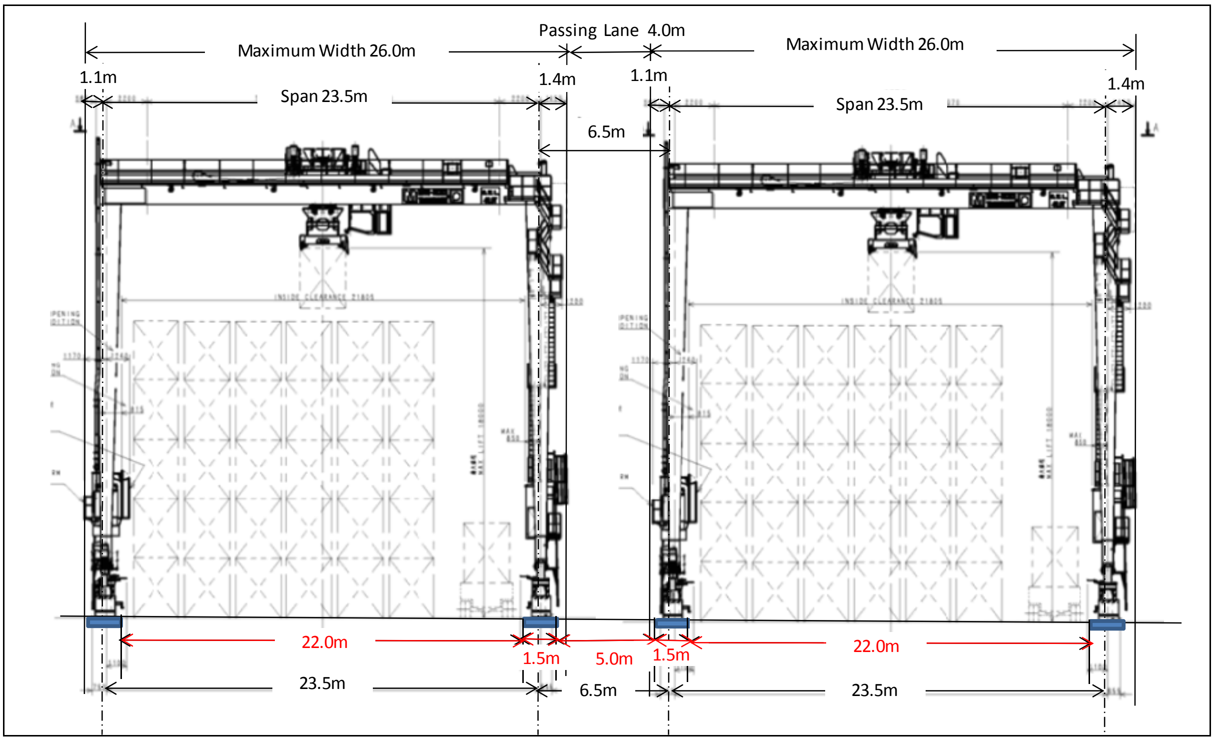
Full container yard (RTG yard) has eight (8) dry container stacking blocks and one (1) reefer container stacking block, each with a width of 26.0m (total 234.0m), eight passing lanes, each with a width of 4.0m (total 32.0m), which are allocated between one dry container block and another, and two (2) utility lanes, each with a width of 3.0m (total 6.0m). Therefore, total width of full container yard is 272.0m (See Table 4.2-14). Each dry or reefer container block and passing lane composes one module of which width is 30.0m (26.0m+4.0m=30.0m). Each module is allocated in the east-west direction (See Fig.4.2-6).



Source : Study Team

Figure 4.2-6　Allocation of RTG Blocks

Dimension and allocation of each module and RTG traffic lanes are illustrated in Fig. 4.2-7. Dimension of RTG traffic lane is designed to be 1.5m in width, where the following preconditions are assumed; 1) Number of wheels of REG : 8 wheels, 2) RTG standard span : 23.5m, 3) Width of RTG tire : 0.5m, 4) Safety allowance of RTG in travelling : 0.5m.

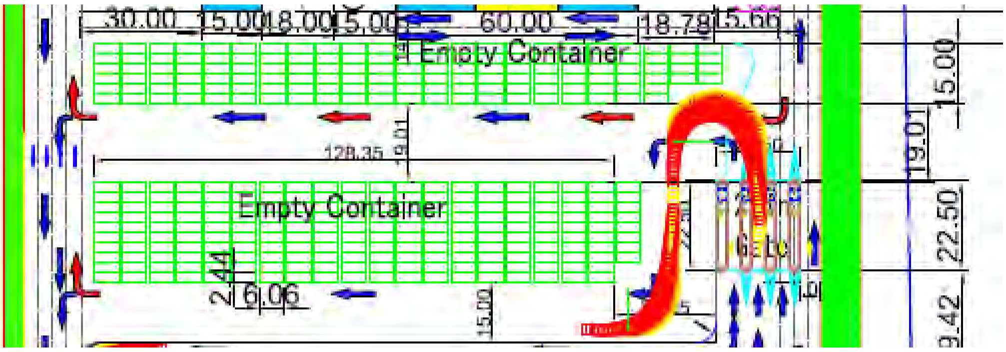


Source : Study Team

Figure 4.2-7　Dimension and Allocation of RTG traffic Lanes

d)　Ground slot allocation in empty container yard

Based on the study described above (1),b)②「Capacity of empty containers and required yard slots」) number of ground slots of empty container is planned at 330TEU-GS. Allocation of the ground slots is shown in Fig. 4.2-8.



Source : Study Team

Figure 4.2-8 Allocation of Empty Container Ground Slots

(2) Soil Improvement

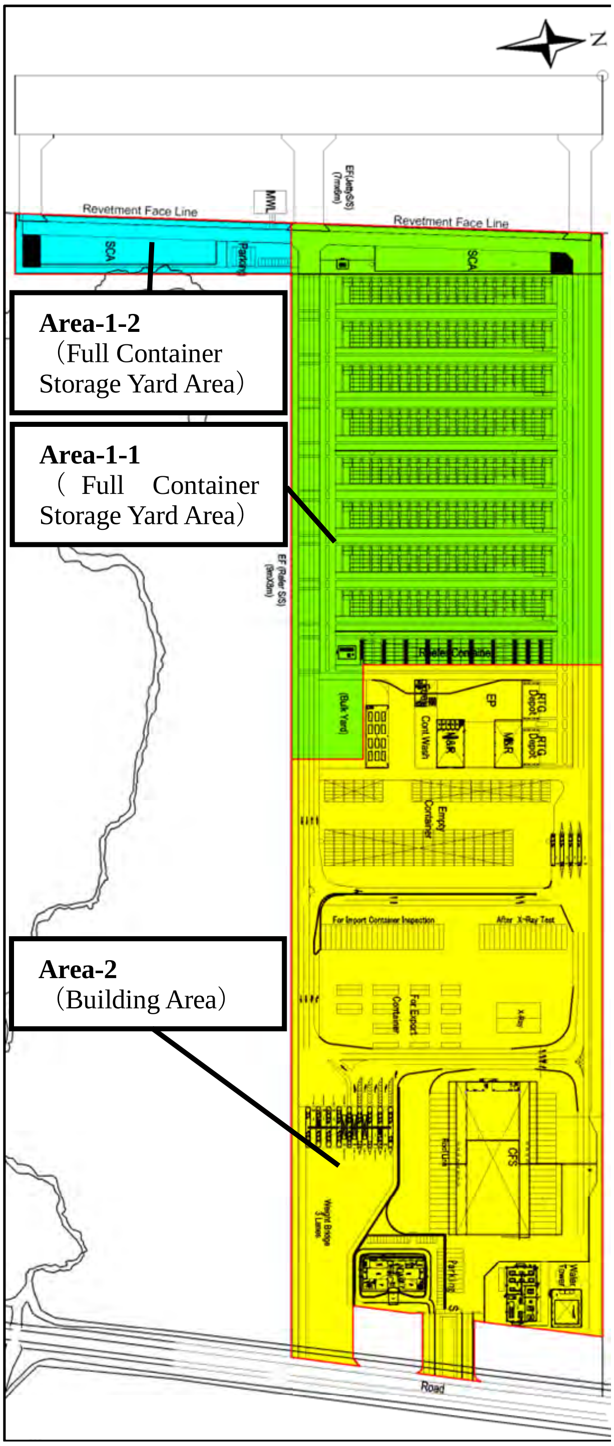
Soft clay layer deposits in the project area with a thickness of around 22m. It is predicted that significant settlement occurs over a long period of time after fill construction on the soft ground. To protect the settlement problem, some measures for soft ground improvement were studied in the basic design stage. As a result of comparing some methods, Prefabricated Vertical Drain (PVD) with preloading was selected as a most suitable method from a view of economy, social environment and workability.

Therefore, PVD with preload method is adopted for the project area.

1) Classification of Study Area

The Plot 25, project site is classified into three area from a viewpoint of land use as shown in Figure 4.2-9. Also in the ground improvement design, the analysis is carried out by the given loading condition to each area. For the study of consolidation settlement and stability, the loading condition after opening of port is set to be as followings. The load of construction machines during construction work is assumed to be 10kN/m^2.

- Area-1-1 :This area is to stock container outside (hereinafter referred to as “Full Container Storage Yard”). The load of the Container is set to be 50kN/m^2.
- Area-1-2 :This area is to stock container outside (hereinafter referred to as “Full Container Storage Yard”). The load of the Container is set to be 50kN/m^2.
- Area-2 :Building Area except Area-1-1 and Area-1-2. The load of Building is set to be 20kN/m^2(exclude pile foundation load).



Source : Study Team

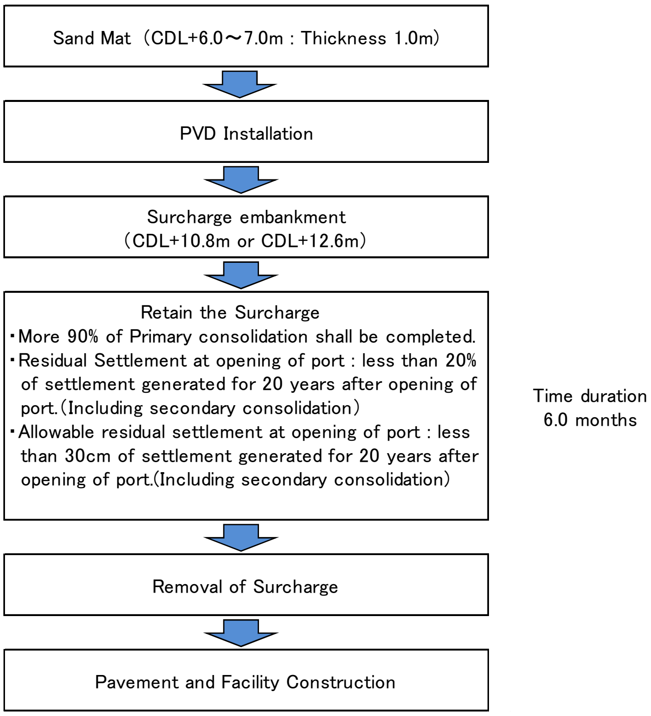
Figure 4.2-9 Area Classification

2) Outline of Soil Improvement

The method of soil improvement is to accelerate the consolidation for the original ground (clay layer). The main work is spreading of Sand mat after land fill up to CDL+6.0m, PVD installation and Preloading. The work flow and representative cross section is shown in Figure

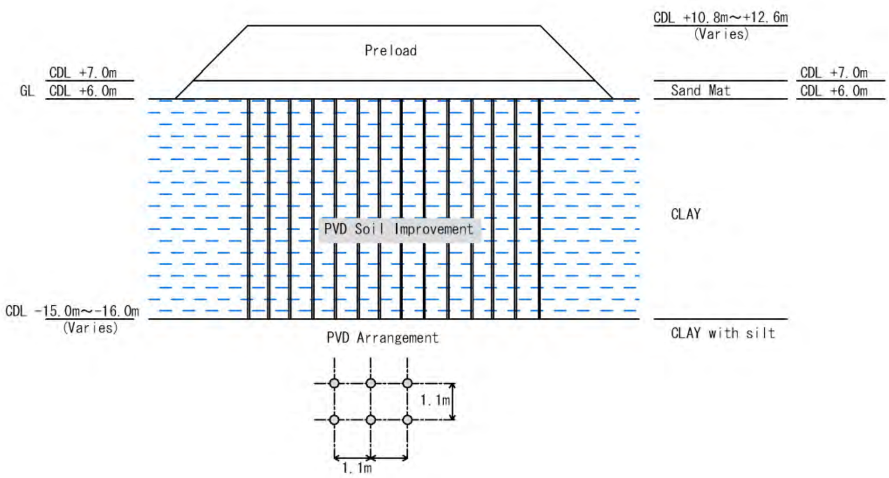
4.2-10 and Figure 4.2-11 respectively. The dimension of PVD installation is set to be square type (1.1m*1.1m). The installation depth is from surface of Sand mat (CDL+7.0m) to bottom of clay layer. After PVD installation, Preload is filled up to CDL+10.8 to CDL+12.6m and kept at least 6 months for consolidation settlement. After completion of consolidation period, the preload shall be removed up to the level of subgrade. The timing of removal of preload is decided by following procedure.

- More than 90% of primary consolidation degree
- Residual settlement at opening of port shall be less than 20% of settlement generated for 20 years after opening of port. (Including secondary consolidation)
- Allowable residual settlement at opening of port : less than 30cm of settlement generated for 20 years after opening of port. (Including secondary consolidation)



Source : Study Team

Figure 4.2-10 Work Flow of Soil Improvement

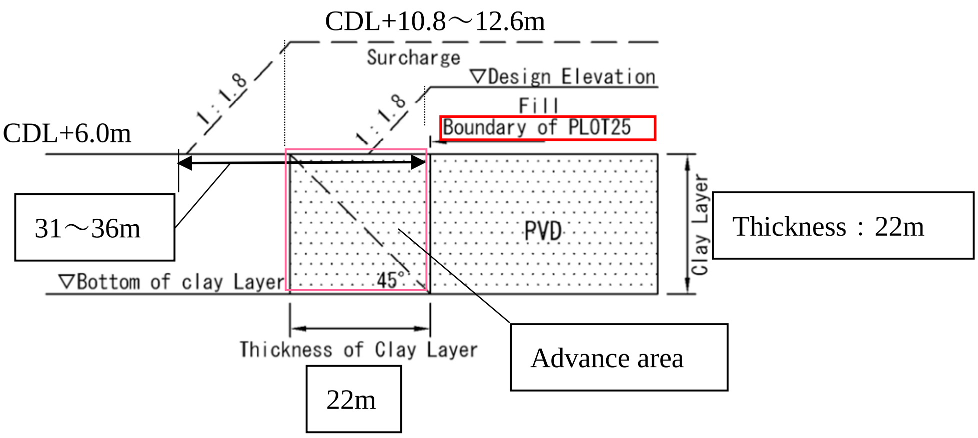


Source : Study Team

Figure 4.2-11　Representative Cross Section of Soil Improvement

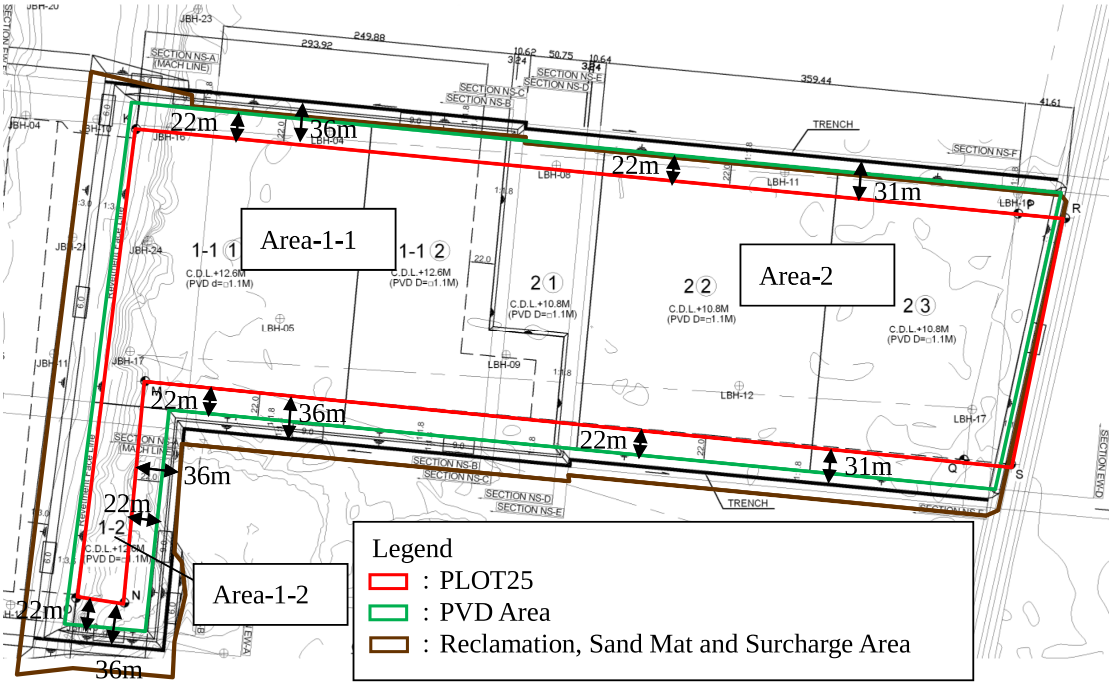
3)　Area of Soil Improvement

Area of soil improvement is shown in Figure 4.2-13. It is predicted that some settlement will occur at the area of Plot 25 due to a filling load for the area of Plot 24 and Plot 26 adjacent to Plot 25 in future expansion of the project and such settlement will cause a problem of settlement and crack of existing pavement. The affective area to Plot 25 is considered to be around 22m (from surface of ground CDL+6.0m to bottom of clay layer CDL-16m) from land boundary of the Plot as shown in Figure 4.2-13. In case of filling work in this area, it might cause a problem of settlement and crack at pavement portion. To protect such problem in future, this area is also set to be improved (advanced improvement) in this project.



Source : Study Team

Figure 4.2-12　Concept of Soil Improvement considering advanced improvement area



Source : Study Team

Figure 4.2-13 Area of Soil Improvement

(3) Cargo Handling Equipment

1) Planning of STS Gantry Crane

Due to superior efficiency of container loading and unloading operation at the quayside in container terminal, STS gantry crane is being widely used at the container terminals over the world. At the end of 2013, total seven STS gantry cranes are being placed on service in Myanmar, each two at MITT, MIP and Hteedan ports, and one at BAG port. As the port of Phase I is being planned to handle maximum 200,000 TEUs containers per year to/from the maximum size of 20,000 DWT Panamax type container ship, it is essential to install STS Gantry Crane with sufficient size and performance. The STS gantry crane shall be so designed as to enable loading and unloading operation for the Panamax Container Ship.

a) Design of Hoisting and Trolley traversing speed of STS Gantry Crane

In order to achieve the target of capacity, 200,000 TEUs per year at Phase I, it is required to install two Panama Ship size STS Gantry Cranes with theoretical handling capacity of average 40 boxes per hour per each. (refer to P370, 2) a) of THE PREPARATORY SURVEY FOR THE PROJECT DRAFT FINAL REPORT 1)

By theoretical simulation of the cycle time, following main hoisting and trolley traversing speed are proven to realize the theoretical handling capacity of 40 Boxes per hour.

Consequently, following speed shall be applied for the STS Gantry Crane.

Hoisting speed; with 40.6t load 60m/min
without load 135m/min
Trolley traversing speed; 180m/min
The average theoretical cycle times by the above speeds are ;
Cycle time for the containers on the deck 79.0 sec/cycle
Cycle time for the containers in the hold 89.4 sec/cycle
Cycle time for one bay of the ship 84.2 sec/cycle ((79.0＋89.4)/2=84.2)
The average theoretical container handling capacity;
3600sec/hr.÷84.2sec/box = 42.8 box/hr. > 40.0 box/hr.

The gantry traveling and boom hoisting shall be designed to the following popular speeds.

Gantry traveling speed; 45m/min
Boom hoisting (excl. latching/unlatching); 8min/cycle

b) Crane with Seismic Isolation System

Myanmar dose not suffer from the earthquake so often as Japan. However, geometrically as the India-Australia Plate which caused the Great Sumatra-Andaman earthquake in 2004 lays at the east side of the country and furthermore as the Sagaing Fault runs through the central zone of the country from north to south, the records show that the country has experienced so far several earthquakes with almost same strength level in Japan. Under the circumstance, not only the buildings but also general infrastructures in Myanmar should be designed and constructed by anticipating occurrence of strong earthquake (kh=0.20) in the not-so-far future. In Japan and some other countries, the advanced design technology to increase the strength against earthquake has been developed and actually being applied. The STS gantry cranes in this project shall be designed and constructed by using these advanced technology. The isolation system in this project shall be designed in consideration of kh=0.15 over.

i) Outline of Seismic quake Isolation System

The Seismic Isolation System works to lengthen the peculiar period and consequently to reduce the response acceleration of the crane under the earthquake with over intensity. The less response acceleration producing less horizontal force is effective in preventing Locking motion of a crane which caused fatal damage of cranes and quay constructions at the several strong earthquake in the past. The Seismic Isolation System is effective in minimizing damage of earthquake.

Locking motion of a crane; the motion that some of the legs of the crane with gantry traveling wheels are lifted apart from the gantry rails by exceeding horizontal force.

The Seismic Isolation System shall be equipped between the main equalizer beams of gantry traveling system and the lower ends of the gantry structure. The Seismic Isolation System shall be consisting of the upper component (connected to gantry structure) and the lower component (fixed to the equalizer beam). Potentially both components shall be mutually slide-able with each other. However, under normal circumstances, both components shall be kept to be rigidly connected by the mechanical devices and unable to slid each other. As soon as the earthquake over the design level attacks the area, the mechanical locking device shall automatically be released and the crane structure shall be mechanically isolated from the gantry equalizer beam which have same behavior with the earth. After the isolation, the crane shall present independent movement from that of earth and acquire longer peculiar period.

2) Planning of Rubber Tyred Gantry Crane (RTG)

As the yard operation system in a container terminal, the RTG + tractor & chassis system, the RMG (Rail Mounted Gantry Crane) + tractor & chassis system, the Reach stacker + tractor & chassis system and the Straddle Carrier system are popular in the world. In Japan and Asian countries, the RTG + tractor & chassis system is most popular due to it's effectiveness for the operation in standard size of a terminal. The said system is being utilized at MITT and BAG container terminal in Myanmar. At the AWPT terminal, the Reach Stacker system is in use. The Reach stacker system shall provide better cost performance at a smaller size of a terminal. However, increase of handling volume bring less efficiency of operation and less security on the terminal. As a result of study of both system, the RTG + tractor & chassis system is selected as useful system for this terminal.

From not only the theoretical analysis but also the long experience at many terminals, 3 RTGs per one STS gantry crane are considered to be most effective and economical. At Phase I of this project, two STS gantry cranes and 6 RTGs shall be installed.

3) Planning of Reach Stacker

Reach Stacker shall be used for handling of empty containers at the empty container yard, handling of hazardous cargos at the designated zone and handling of empty and loaded containers at CFS. At Phase I of the project, total 3 Reach Stackers, 2 for the empty container yard and 1 for other purpose, shall be provided.

4) Planning of Fork Lift

Two 3.5t Fork Lifts shall be provided for loading and unloading operation of LCL load to/from container at CFS.

5) Planning of Mobile Crane

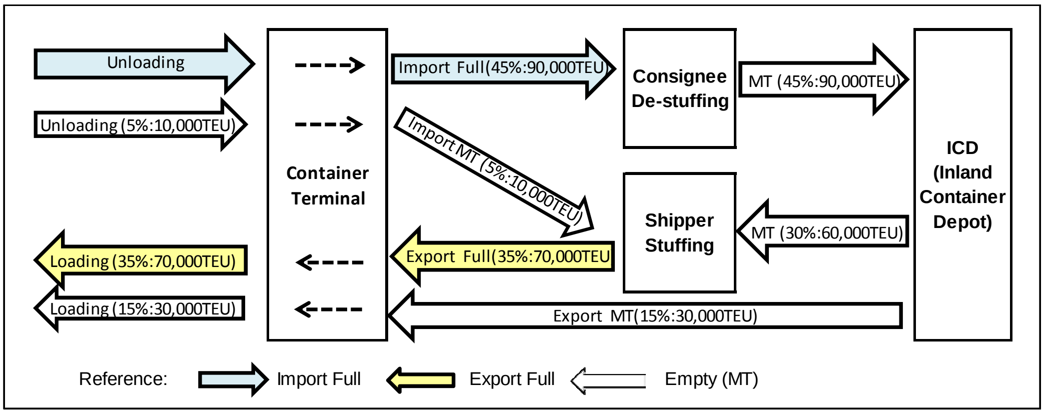
However the terminal will be planned as an exclusive container terminal in the future, it is planned as an multi-purpose terminal at the moment. Mobile crane will be needed to handle heavy cargos. Consequently, the plan of the terminal was renewed as a berth commonly used for container handling and mobile crane operation. The specification and capacity of a mobile crane will finally depend upon the business plan of a terminal operator and the cargo to be handled. However the business plan has not finalized yet. Accordingly, at this stage, the berth and it's facility shall be planned for 200ton mobile crane considering the heavy cargo for SEZ in the back yard.

(4) Gate

Main functions of the gates in Yangon Port Thilawa Area Terminal (the new terminal) are basically the same as those of standard terminals in the world. However, according to the cargo clearance procedures of Myanmar Customs, cargo inspection is required for all the import and export containers in the terminal. Therefore, work load during gate operation is less than other terminals.

1) Gate capacity and required gate lanes

As empty container storage capacity is limited in Phase 1 stage of the new terminal, main role of the empty container yard will be as a temporary storage of import empty containers discharged and export empty containers for loading, and will not include such functions as ICD (Inland Container Depot). Container flow among terminal, shippers, consignees and ICDs is illustrated in Fig.4.2-14. This flow represents present proportions of import, export and empty containers in Yangon Port.



Source : Study Team

Figure 4.2-14 Container Flow among Terminal, Shipper, Consignee and ICD

a) Preconditions of Gate Planning(See Table 4.2.1-4-2)

① Annual container terminal capacity :200,000 TEU
② TEU Factor :1.33
③ Gate operation days per year :287 days
④ Gate operation hours per day :12 hours
⑤ Peak Ratio :1.4
⑥ Gate productivity per hour :15 transactions/ hour

⑦ Gate productivity per day :180 transactions/day

b) Containers and trucks to be handled per year at the gate(See Table 4.2-15)

Number of containers and trucks to be handled per year at the gate is summarized in Table 4.2-15. As shown in the table, transactions at the gate are considered to become at least 1.5 times the total boxes to be handled at the berth.

Table 4.2-15 Containers and trucks to be handled per year at the gate

			Targeted Proportions	Present Proportions
Container Terminal Capacity (TEU/Year)			200,000	200,000
Containers to be handled (Box/Year)			150,000	150,000
Proportions of each type of containers		Import Full Containers	45%	45%
		Import Empty Containers	5%	5%
		Export Full Containers	45%	35%
		Export Empty Containers	5%	15%
Containers to be handled at the Gate (Box/Year)	**Total**		**225,000**	**225,000**
	Imported Containers (Discharged)	**Import related Gate Operations**	**150,000**	**150,000**
		Registration of Import Full Container Delivery (In-gate)	67,500	67,500
		Delivery of Import Full Containers (Out-gate)	67,500	67,500
		Registration of Empty Container pick-up (In-gate)	7,500	7,500
		Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	7,500	7,500
	Export Containers (Loading)	**Export related Gate Operations**	**75,000**	**75,000**
		Reception of Export Full Containers (In-gate)	67,500	52,500
		Leaving Empty Chassis after Releasing Export Full Containers (-)	–	–
		Reception of Empty Containers for Loading (In-gate)	7,500	22,500
		Leaving Empty Chassis after Releasing Empty Containers for Loading (-)	–	–

Source : Study Team

c) Required lanes

Required lanes at the gate of the new terminal, which is based on the containers and trucks to be handled per year and operational conditions described in the preconditions above, are estimated below.

① Regarding import full (laden) containers, four (4) lanes are required for registration of import full container delivery (two (2) lanes) and for delivery of import full containers (two (2) lanes).

② Regarding export full (laden) containers, two (2) lanes are required for reception of export full containers.

③ Regarding empty containers, three (3) lanes are required for registration of empty containers pick-up (one (1) lane), for delivery of empty container (one (1) lane) and for reception of empty containers for loading (one (1) lane).

Number of required lanes at the gate of the new terminal is summarized in Table 4.2-16. In total, nine (9) lanes are required.

However, there are some lanes which can be used in common and number of required lanes may be reduced by effective re-allocation of each gate functions to the lanes. The planned number of lanes and result of re-allocation of each gate function is summarized in Table 4.2-17.

Table 4.2-16 Required Lanes at the Gate

			Present Proportions		Targeted Proportions	
Preconditions						
	Container Terminal Capacity (TEU/Year)		**200,000**		**200,000**	
	Proportions of each type of containers	Import Full Containers	45%		45%	
		Import Empty Containers	5%		5%	
		Export Full Containers	35%		45%	
		Export Empty Containers	15%		5%	
	TEU Factor		**1.33**		**1.33**	
	Gate Operation Days per Year (Day) *1		287		287	
	Gate Operation Hours per Day (Hour)		12		12	
	Gate Operation Efficiency (Transaction/Hr/Lane)		15		15	
	Gate Productivity per Day (Transaction/Day/Lane)		180		180	
	Gate Productivity per Year (Transaction/Year/Lane) (a)		51,660		51,660	
	Peak Factor (b)		1.4		1.4	
Containers to be handled (Box/Year)			**150,000**		**150,000**	
Containers to be handled at the Gate (Box/Year)			**225,000**		**225,000**	
	Imported Containers (Discharged)	**Import related Gate Operations**	**150,000**		**150,000**	
		Registration of Import Full Container Delivery (In-gate)	67,500		67,500	
		Delivery of Import Full Containers (Out-gate)	67,500		67,500	
		Registration of Empty Container pick-up (In-gate)	7,500		7,500	
		Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	7,500		7,500	
	Export Containers (Loading)	**Export related Gate Operations**	**75,000**		**75,000**	
		Reception of Export Full Containers (In-gate)	52,500		67,500	
		Leaving Empty Chassis after Releasing Export Full Containers (-)	–		–	
		Reception of Empty Containers for Loading (In-gate)	22,500		7,500	
		Leaving Empty Chassis after Releasing Empty Containers for Loading (-)	–		–	
Containers to be handled by In/Out-gate (Box/Year or Hour) (c)			Box per Year	Box per Hour	Box per Year	Box per Hour
	Containers to be handled at the In-gate		**150,000**	**61**	**150,000**	**61**
	Empty Chassis	Registration of Import Full Container Delivery (In-gate)	67,500	27	67,500	27
	Empty Chassis	Registration of Empty Container pick-up (In-gate)	7,500	3	7,500	3
	Full Cont.	Reception of Export Full Containers (In-gate)	52,500	21	67,500	27
	Empty Cont.	Reception of Empty Containers for Loading (In-gate)	22,500	9	7,500	3
	Containers to be handled at the Out-gate		**75,000**	**30**	**75,000**	**30**
	Full Cont.	Delivery of Import Full Containers (Out-gate)	67,500	27	67,500	27
	Empty Cont.	Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	7,500	3	7,500	3
	Total Containers to be handled at the Gate		**225,000**	**91**	**225,000**	**91**
Required Number of Gate Lanes (Related to the Containers)			Required Lanes ((c)*(a)/(b))	Round-up	Required Lanes ((c)*(a)/(b))	Round-up
	Total (In-gate and Out-Gate)		6.10	**9**	6.10	**9**
	In-gate Total		4.07	**6**	4.07	**6**
	Empty Chassis	Registration of Import Full Container Delivery (In-gate)	1.83	**2**	1.83	**2**
	Empty Chassis	Registration of Empty Container pick-up (In-gate)	0.20	1	0.20	1
	Full Cont.	Reception of Export Full Containers (In-gate)	1.42	**2**	1.83	**2**
	Empty Cont.	Reception of Empty Containers for Loading (In-gate)	0.61	1	0.20	1
	Out-gate Total		2.03	**3**	2.03	**3**
	Full Cont.	Delivery of Import Full Containers (Out-gate)	1.83	**2**	1.83	**2**
	Empty Cont.	Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	0.20	1	0.20	1

Note＊1 Gate Operation Days per Year＝365Days－52Weeks x1．5(Sunday and Saturday)＝287Days

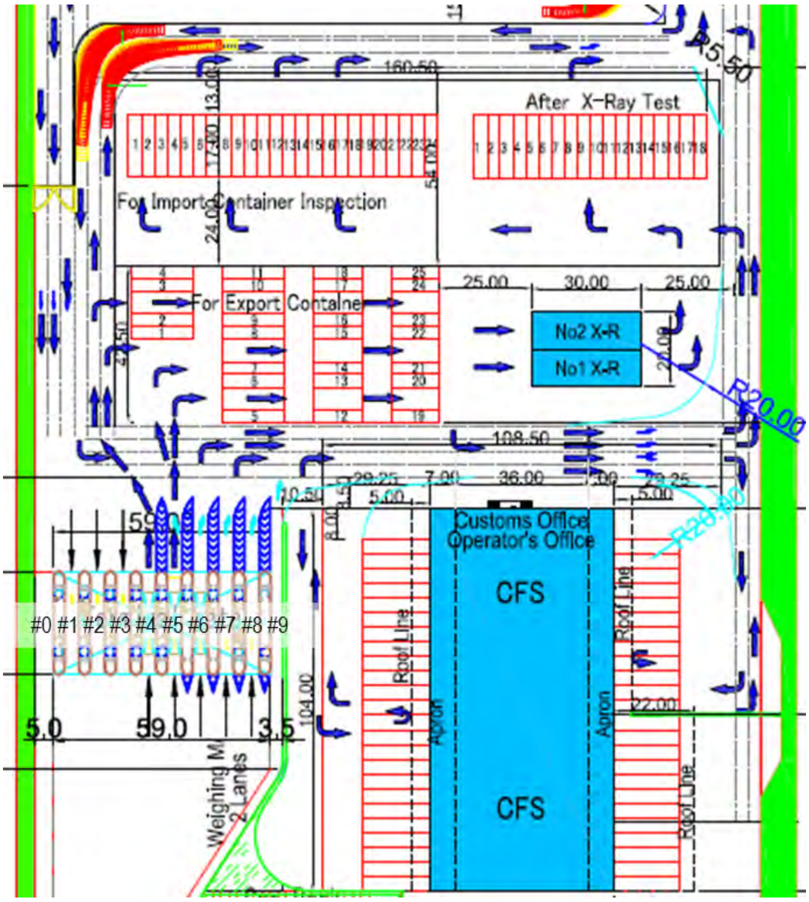
Source : Study Team

Table 4.2-17 Planned Number of Gate Lanes and Lane Allocation

Number of Planned Gates (for Containers)		Present Proportions: Number of Required Lanes – Planned	Present Proportions: Number of Required Lanes – Round-up Figures	Targeted Proportions: Number of Required Lanes – Planned	Targeted Proportions: Number of Required Lanes – Round-up Figures	Allocated Gate Number
Total (In-gate and Out-Gate)		6.10	8	6.10	8	
In-gate Total		4.07	5	4.07	5	
Empty Chassis	Registration of Import Full Container Delivery (In-gate)	1.83	2	1.83	2	6,7
Empty Chassis	Registration of Empty Container pick-up (In-gate)	0.20		0.20		
Full Cont.	Reception of Export Full Containers (In-gate)	1.42	2	1.83	2	4,5
Empty Container	Reception of Empty Containers for Loading (In-gate)	0.61	1	0.20	1	8
Out-gate Total		2.03	3	2.03	3	
Full Cont.	Delivery of Import Full Containers (Out-gate)	1.83	2	1.83	2	2,3
Empty Container	Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	0.20	1	0.20	1	1
Empty Chassis	Leaving Empty Chassis	–	–	–	–	0

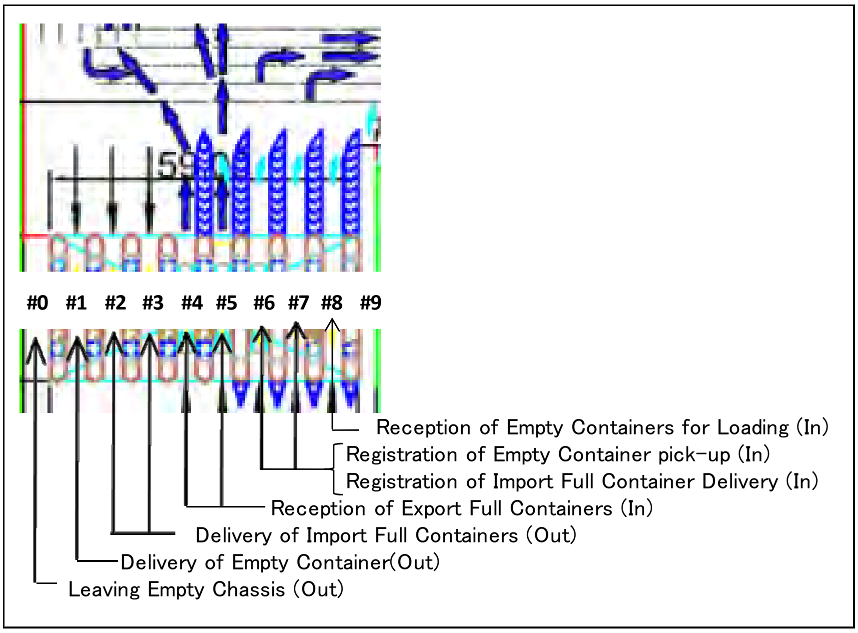
Source : Study Team

Based on the planned number of gate lanes and lane allocation summarized in the table above, gate layout and truck flow lines around the Gate lane allocation, as well as lane allocation at the gate is illustrated in the following figures, Fig. 4.2-15 and Fig. 4.2-16



Source : Study Team

Figure 4.2-15 Gate Layout and Truck Flow Line around the Gate



Source : Study Team

Figure 4.2-16 Lane Allocation at the Gate

(5) X-Ray Inspection and Customs Facilities

1) Cargo inspections in the Port

Before transporting export containers to the terminal or extracting import containers from the terminal, exporter or importer have to declare cargoes for clearance at the customs office (central office) in Yangon. After obtaining permission of the export or import at the customs head office, container cargoes must clear inspection by the customs officer at the terminal (CFS customs) for shipping or withdrawal of the cargo.

a) Customs procedures for export container cargoes

At the time of export container stacking in the yard, exporter (shipper) applies for container cargo inspection with the relevant documents, including permission of the customs head office, to the CFS customs at the terminal. After assessment of the documents, CFS customs instruct the exporter on the inspection procedures to be followed. There are three categories in the procedures;

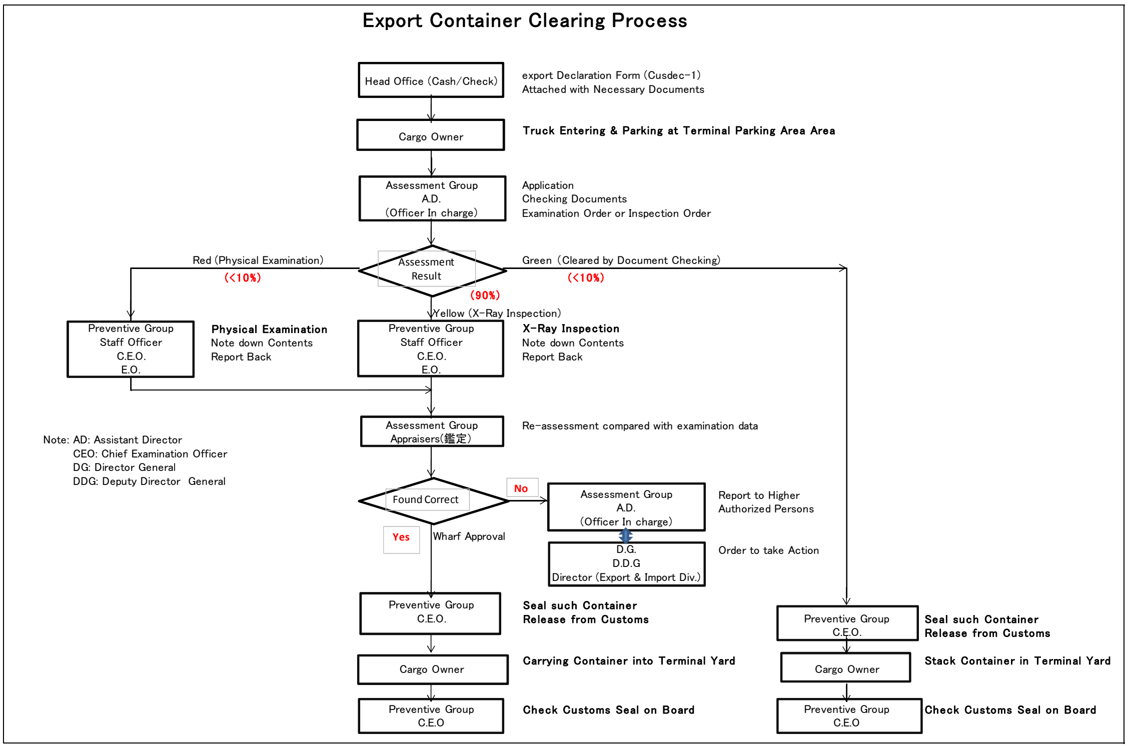
① Green Category : The container cargoes are cleared without any additional inspection or examination (cleared only by document assessment).

② Yellow Category : Container cargoes are obliged to undergo an X-ray inspection. (cleared by document assessment and X-ray inspection)

③ Red Category : Container cargos are obliged to undergo a physical examination at the CFS. (cleared by document assessment and physical examination)

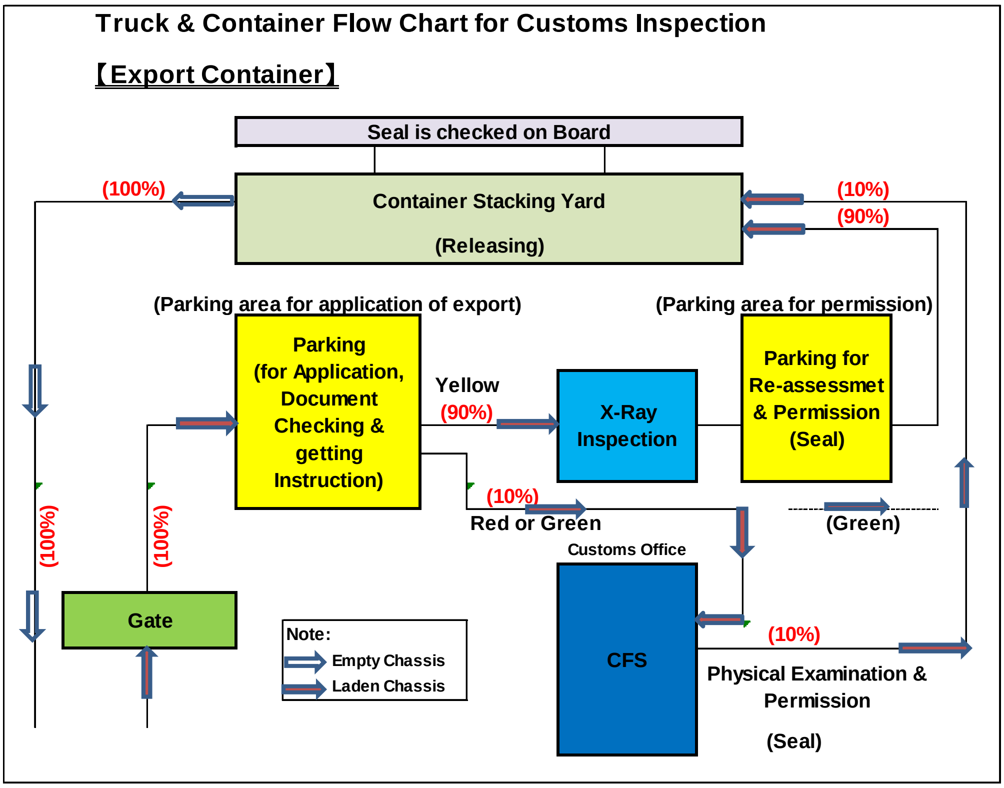
After completion of the procedures in each category, containers are sealed by the CFS customs and sent to the stacking yard. The customs seal is checked by customs at the time of loading. At present, about ninety percent (90%) of the export containers fall under the Yellow Category, while the remaining ten (10%) of the export containers either fall under the Red or Green Categories. The customs procedures of export container cargo inspection at the terminal are illustrated in Fig. 4.2-17.

Truck flows in the terminal for customs inspection, including terminal gate, X-ray inspection, and physical examination in CFS, as well as parking areas for the trucks arranged by the exporters, are shown in Fig. 4.2-18.



Source : Study Team

Figure 4.2-17 Procedures of Export Container Cargo Inspection



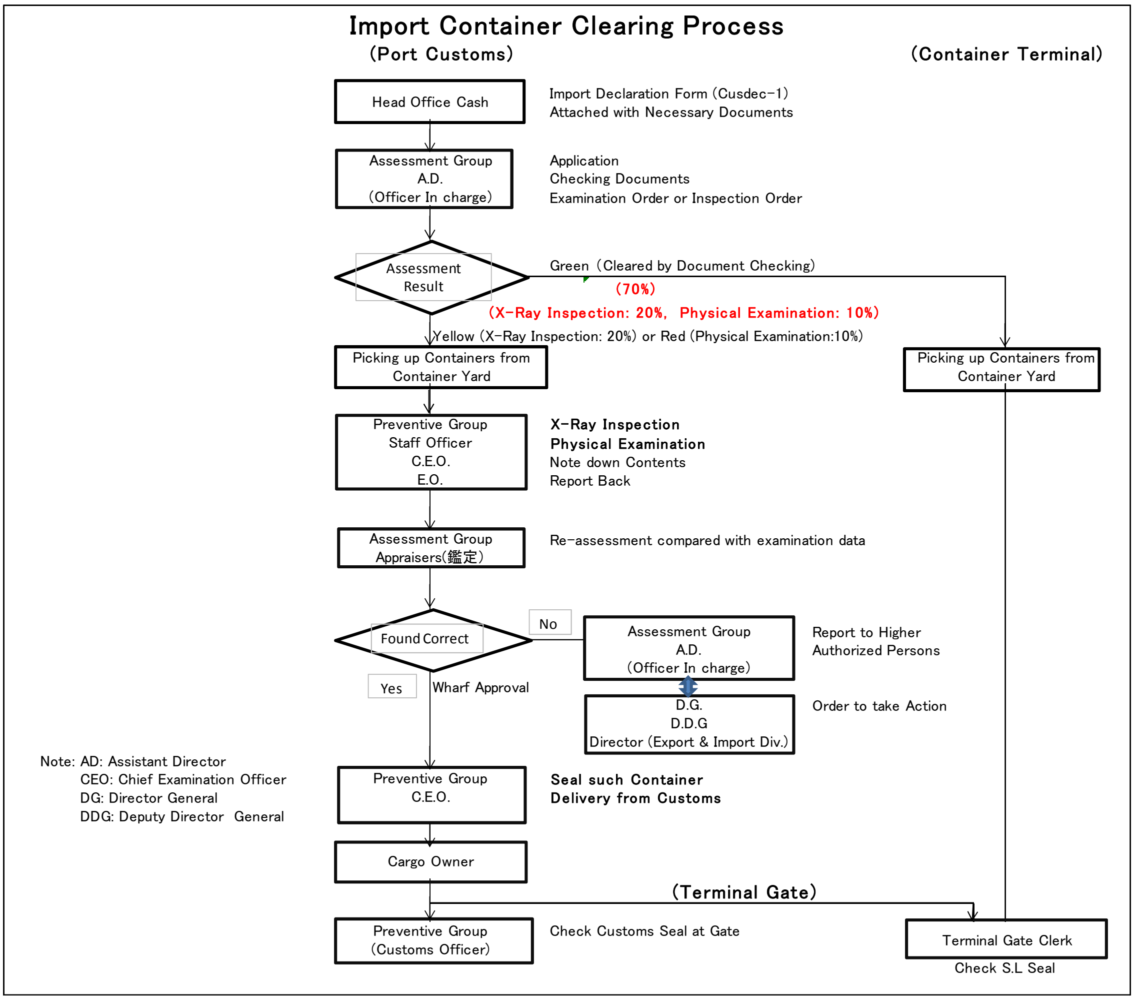
Source : Study Team

Figure 4.2-18 Container and Truck Flow for Customs Inspection(Export)

b) Customs procedures for import container cargoes

At the time of extracting export container from the terminal, importer (consignee) applies for container cargo inspection with the relevant documents, including permission of the customs head office, to the CFS customs at the terminal. After assessment of the documents, CFS customs instruct the exporter on the inspection procedures to be followed. There are three categories in the procedures which are the same as export procedures described above. After completion of the procedures in each category, importer can proceed to the next step.

The customs procedures of import container cargo inspection at the terminal are illustrated in Fig. 4.2-19. Truck flows in the terminal for customs inspection, including terminal gate, X-ray inspection, and physical examination in CFS, as well as parking areas for the trucks arranged by the importers, are shown in Fig. 4.2-20.



Source : Study Team

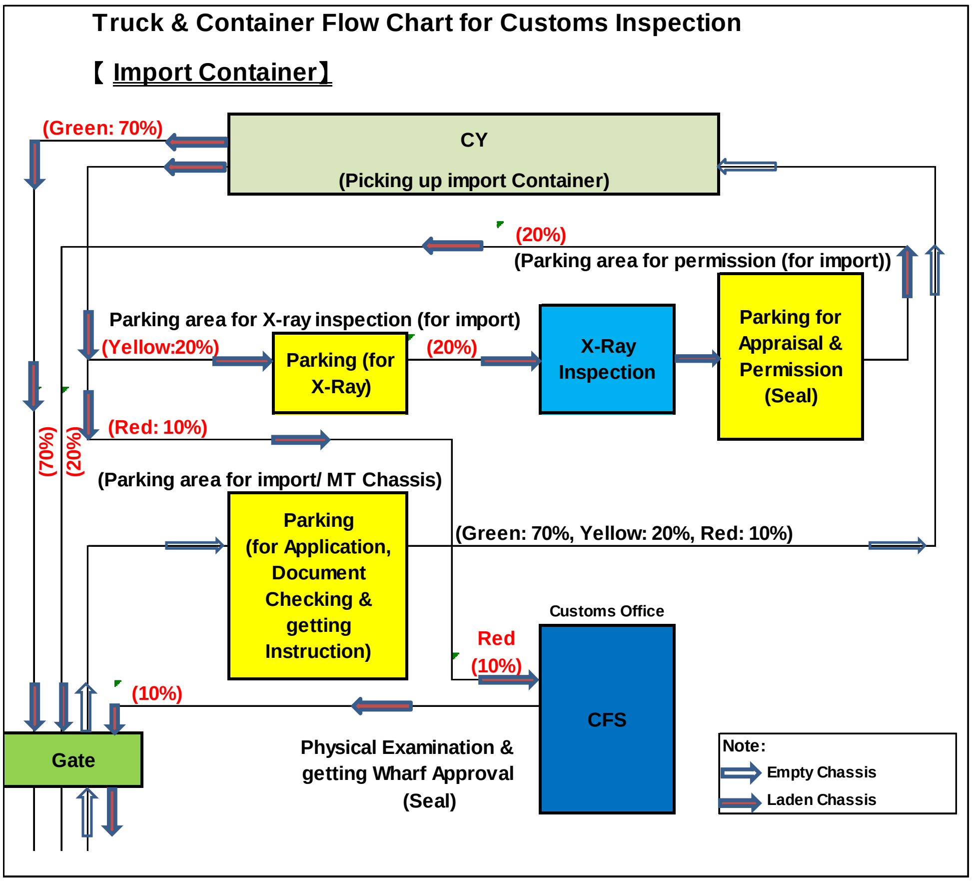
Figure 4.2-19 Procedures of Import Container Cargo Inspection

At present, more than fifty per cent (50%) of import containers fall under the Red Category. However, Myanmar customs are planning to reduce the proportion of this category to ten percent (10%) by introducing NACCS in 2016. The proportion of each category of import containers are expected to become as follows in the near future;

① Green Category : seventy percent (70%)

② Yellow Category : twenty percent (20%)

③ Red Category : ten percent (10%)



Source : Study Team

Figure 4.2-20　Container and Truck Flow for Customs Inspection(Import)

2)　Capacity and Required Facilities for Container Cargo Inspection

According to the customs inspection procedures described above, required facilities for container cargo inspection and their capacity are estimated in this section, which include X-ray inspection, physical inspection and parking slots for trailers arranged by the exporters and importers.

a)　Preconditions for facility planning

① Container Volume and daily container flow : 200,000 TEU/Year (refer to Table 4.2-18「Daily Container Flow」)
② Customs operation days per year : 287 days/year
③ Customs operation hours per day : Normal days :7.5 hours/day (9 :00-16 :30)、Peak days :10 hour/day(9 :00-19 :00)
④ TEU Factor :1.33
⑤ Peak Ratio :1.3
⑥ Daily container volume to be handled :Refer to Table4.2-18　「Daily Container Flow」
⑦ Inspection Rate by each category :Refer to Table 4.2-19「Inspection Rate by Category」

Table 4.2-18 Daily Container Flow

		Preconditions	TEU/Year	Box/Year	Box/Day (average)
1. Terminal Capacity			200,000	150,000	523
2. TEU Factor		1.33			
3. Customs Operation Day (Days/Year)	Full Time Bases	287			
4. Customs Operation Hour (Hours/Day)	Monday-Friday	7.5			
(9:00-16:30 (7.5Hour))	Saturday	Half of Mon-Fri			
5. Peak Ratio		1.3			
6. Proportion	Import Full	45%	90,000	67,500	235
	Import Empty	5%	10,000	7,500	26
	Export Full	45%	90,000	67,500	235
	Export Empty	5%	10,000	7,500	26
	Total	100%	200,000	150,000	523

Source : Study Team

Table 4.2-19 Inspection Rate by Category

	Import Container	Export Container
(1) Green : Document Check	70%	0%
(2) Yellow : X-Ray Inspection	20%	90%
(3) Red : Physical Examination	10%	10%

Source : Study Team

b) Required number of X-ray Machines :(Refer to Table 4.2-20 「Required number of X-ray machines」)

① Required number of containers to be inspected :Average :259 Boxes/day(336 Boxes/day at peak days)

② Operating hours of X-ray inspection :7.5 hours/day(10 hours/day at peak days)

③ X-ray inspection efficiency (per hour) :12 Boxes/hour

④ X-ray inspection efficiency (per day) : 90 Boxes/day(120 Boxes/day at peak days)

⑤ Required number of X-ray machines (Phase1) :3 Sets

Table 4.2-20 Required number of X-ray machines (Phase1)

	Average Inspection Capacity		Inspection Capacity at peak	
	Import	Export	Import	Export
(1) Inspection Ratio	20%	90%	20%	90%
(2) Number of Containers (Average: Box/Day)	47	212	47	212
(3) Number of Inspection Container at peak	47	212	61	275
(4) Peak Ratio	1.0	1.0	1.3	1.3
(5) Total Number of Containers to be Inspected	259		336	
(6) Operation Hour (Hours/Day) (9:00-16:30) (at peak: 9:00-19:00)	7.5		10.0	
(7) Hourly Inspection Capacity (Boxes/Hour)	12		12	
(8) Daily Inspection Capacity (Boxes/Day)	90		120	
(9) Required Inspection Machines	2.9		2.8	

Source : Study Team

c) Required physical examination facilities :(Refer to Table 4.2-21 「Capacity of Physical Examination Facilities」)

① Required number of containers to be inspected :Average :48 Boxes/day(61 Boxes/day at peak days)

② Operating hours of physical examination :Normal days :7.5hours/day, Peak days : 10 hours /day)

③ Average Examination hour :1hour/ Box/ (Examination group)

④ Capacity of physical examination per day :Average :7.5 Boxes/ day/(Examination group)(Peak days : 10 Boxes/ day/(Examination group)

⑤ Required number of examination groups : 7 Group

⑥ Bay occupation hours in physical examination :3～4 hours/Box(2 cycles/bay/day)

⑦ Required number of examination bays :30 Bays(15 Bays for import containers、15 Bays for export containers)

Physical examination bays are installed on the apron of CFS. Inspected cargoes are de-stuffed and some cargoes are stored in the bonded area in CFS.

Table 4.2-21 Required Capacity of Physical Examination Facilities

	Inspection Capacity at peak	
	Import	Export
(1) Inspection Ratio	10%	10%
(2) Number of Containers (Average: Box/Day)	24	24
(3) Number of Inspection Container at peak	31	31
(4) Peak Ratio	1.3	1.3
(5) Total Number of Containers to be Inspected	61	
(6) Operation Hour (Hours/Day) (9:00-16:30) (at peak: 9:00-19:00)	7.5	
(7) Cycle Time of Berth (Hours/ Cycle)	3	
(8) Bay Utilization (Cycles /Day)	2	
(8) Required CFS Inspection Bays (Slots)	30.6	

Source：Study Team

d) Required parking slots for customs inspection in the terminal :(Refer to Table 4.2-22 「Required Trailer Parking Capacity」)

As described in container and truck flow for customs inspection(Fig. 4.2-19 (for export) and Fig. 4.2-21 (for Import), three types of parking areas are required for trailers in the customs inspection area in the terminal as follows;

① Parking area for empty trailers (chassis) which are parked in the area waiting for application of cargo inspection (import), document assessment and receiving instructions by CFS customs. After receiving instructions pertaining to the inspection category, these trailers enter the yard to pick-up import containers and proceed to the next process according to the instruction.

② Parking area for trailers with export full containers which are waiting for application of cargo inspection (export), document assessment and receiving instructions by CFS customs (in most cases they will be instructed to move to the X-ray inspection area). After the X-ray inspection, these trailers go to the next parking area and wait for permission of export.

③ Parking area for trailers with full containers which have undergone the X-ray inspection and are waiting for final approval of yard stacking (in the case of export containers) and withdrawal from the terminal gate (in the case of import containers).

Traffic volume of trailers in each parking area, estimated average parking hours and required parking slots of each type of the parking area is summarized in Table 4.2-22.

Table 4.2-22 Required Trailer Parking Capacity

	Import Container			Export Container	
	(for picking up containers)	(for X-ray)	(after X-Ray)	(for X-Ray)	(after X-Ray)
(1) Parking Truck Ratio	100%	20%	20%	100%	90%
(2) Traffic Volume (Boxes/Day)	235	47	47	235	212
(3) Traffic Volume at peak (Boxes/Day)	306	61	61	306	275
(4) Peak Ratio	1.3	1.3	1.3	1.3	1.3
(5) Operation Hour (Hours/Day)	8.0	7.5	7.5	8.0	7.5
(first arrival 8:30-final arrival16:30)					
(6) Average Parking Hour (Hours/Truck)	0.5	0.5	0.4	0.5	0.4
(7) Rotation per day (1/Day)	16	15	18.75	16	18.75
(8) Required Parking Bays	19.1	4.1	3.3	19.1	14.7
(a) Empty Chassis for picking up Import Containers			19.1		
(b) Trucks with Export Containers for stacking and Import Containers for X-Ray			23.2		
(c) Trucks with Import & Export Containers after X-Ray			17.9		

Source : Study Team

3) Required space and layout plan of CFS

There are two main functions required for CFS in the new terminal. One is ordinary CFS functions such as stuffing or de-stuffing LCL cargoes into or from containers. The other is physical examination of import or export container cargoes by CFS customs. Therefore, CFS should have special structures (aprons) for the physical examination. The main features of CFS planned to be installed in the customs area of the new terminal are as follows.

a) Planning preconditions and main specifications of CFS

１. Cargoes to be handled in CFS :Import LCL cargoes

２. Cargo volume :4,500 TEU/year(5% of import full container)

３. Storage capacity :86.5 TEU(Dwelling time : 7 days、Warehouse operation (storage) days :365 days/year, Turnover rate 52 times/year)

４. Number of container de-stuffed per day :(De-stuffing operation days per year :287 days、TEU factor :1.333、Peak ratio :1.3)

(１) Average :11.8 Boxes/day(Gang operation hours : 8 hours/day)

(２) Peak days :15.3 Boxes/day(Gang operation hours : 12 hours/day)

(３) De-stuffing hours per box :2.0 hours/Box

(４) Number of required gangs :3 gangs(for de-stuffing)

(Note :Three (3) gangs are necessary for loading operation on consignees trucks.)

(５) Turnover rate of parking bays :4 times/day on average ～5 times/day at peak days

(６) Number of required parking bays :3～４Bays(Actually 10 bays are planned for safety)

５. Cargo volume per TEU :26.4 m^3/TEU(2.35m(W)x 5.90m(L)x 2.38m(H)x 80%)

６. Pallet dimension :

(１) EU VMF Pallet (2 Pallets/ Rack)

① Dimension :1,200(W)x 1,000(D)x 1,200(H)= 1.44 ㎥

② Pallets/TEU :18.33

③ Number of required pallets :1,586 Pallets

④ Number of required ground slots (４tier x 2 Pallet/module)＝198.25 GSs

(２) ISO International Container Pallet (2 Pallets/ Rack)

① Dimension :1,100(W)x 1,1000(D)x 1,200(H)= 1.45 ㎥

② Pallets/TEU :18.2

③ Number of required pallets :1,574 Pallets

④ Number of required ground slots (4 tiers x 2 Pallet/module)＝196.75Gs

(３) Japanese Standard Pallet (1 Pallet/Rack)

① Dimension :1,500(W)x 1,200(D)x 1,200(H)= 2.16 ㎥

② Pallets/TEU :12.2

③ Number of required pallets :1,056Pallets

④ Number of required ground slots (4 tiers x 1 Pallet/module)＝264Gs

７. Number of required ground slots in CFS :

(１) Assuming that 50% are EU Type Pallet and 50% are Japanese Standard Pallet

(２) Number of required ground slots :232 Ground Slots (264x 0.5 +198.25 x 0.5= 231.125)

８. Standard rack module and block size :

(１) Dimension of module :Width 2.5m x Depth 1.25m x Height 1.5m

(２) Number of module in each block(12 modules x 2 rows)＝24 GSs = 96 Modules

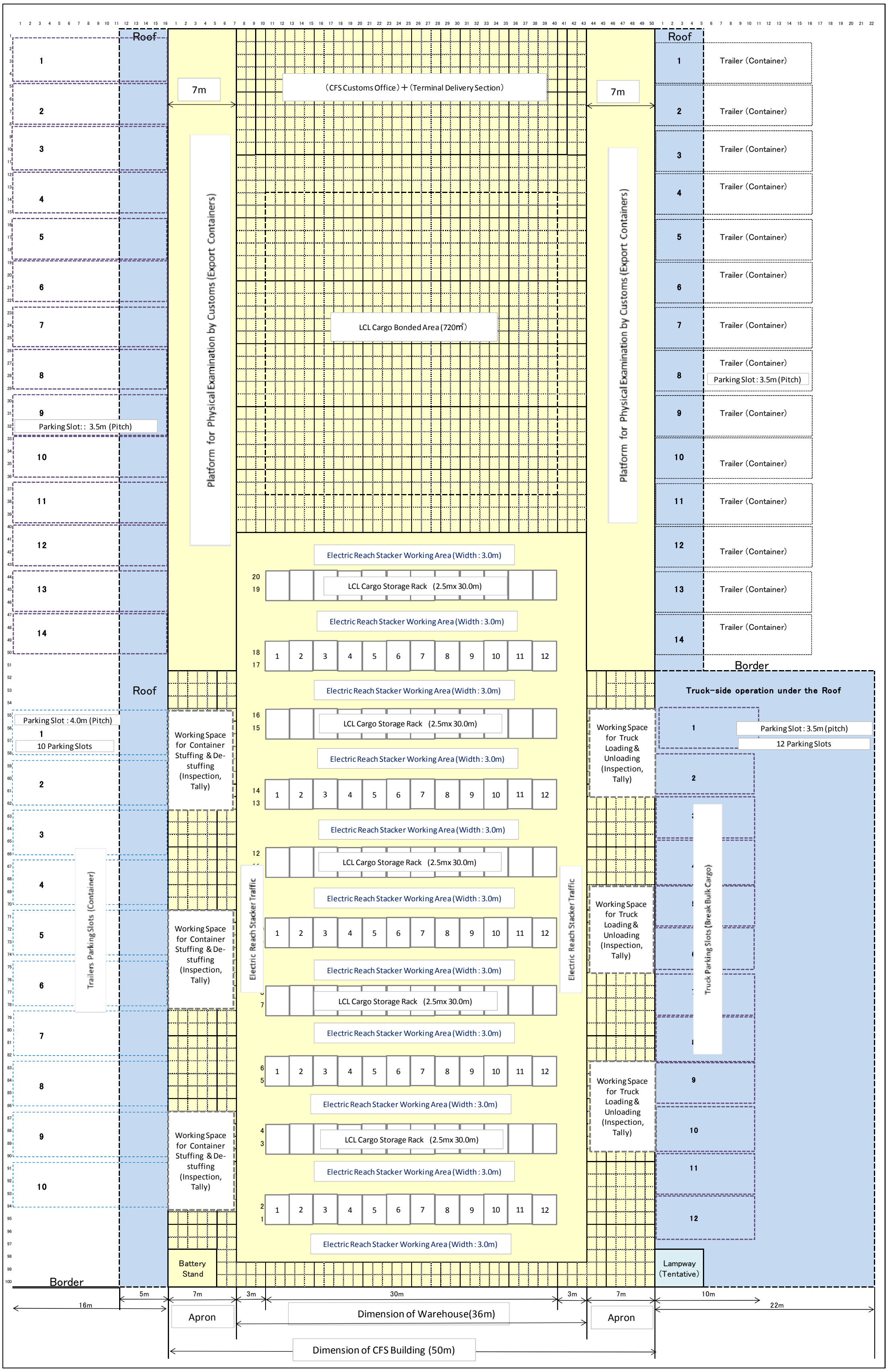
(３) Dimension of Block :30m (L) x 2.5m (D) x 6m (H)

９. Number of required blocks :9.66 Blocks(232/24=9.66)

(１) Number of planned blocks :10 Blocks

b) Layout plan of CFS

Layout plan of CFS is illustrated in Fig. 4.2-21.



Source : Study Team

Figure 4.2-21 Layout Plan of CFS

(6) Administration Building

The Administration Building is planned to be located near the entrance of the Terminal. Table 4.2-23 shows the planned number of personnel for the Administration Building.

Table 4.2-23 Estimated Myanmar Population by Region

	Number	remarks
Clerical employee	38	
Operational employee	55	
Shipping company and Agent	16	2 person × 8 companies
Customs officer	30	
Total	139	

Source : Study Team

Table 4.2-24 shows use of rooms, planned number of people for each room, rough area of each room and rough total area of the Administration Building.

Table 4.2-24 Use of Rooms, Planned Number of People, Area of Rooms of Administration Building

Use of room	number of people	number	Area (m2)	Total Area (m2)
President's office and drawing room	1	1	60	60
Office (General affairs, accounting and sales)	10	3	30	90
Computer room	2	1	30	30
Office (Control & planning)	12	1	120	120
Document odffice (Container cargto)	15	1	120	120
Document odffice (Warehouse, Bulk and RORO)	8	1	120	120
Resting room for operation stuff	55	1	180	180
Resting room for subcontractor	36	1	120	120
Large meeting room	36	1	120	120
Small meeting room	10	2	30	60
Customs office	30	1	300	300
Office (shipping company and agent)	2	8	30	240
Canteen	96	1	200	200
Shower room		1	30	30
Total Area（except for coridors and common areas)				1,790

Source : Study Team

(7) Maintenance Building

1) Cargo Handling Equipment Maintenance Shop

Maintenance and repair work for cargo handling equipment shall be done in two locations', maintenance of large cranes will be carried out on site while others will be done at the maintenance shop. Table 4.2-25 shows type and number of cargo handling equipment which is planned to be mobilized, maintenance area and frequency of regular maintenance. Maintenance shop is planned to consist of 2 buildings, one is indoor type and other is covered with roof only. Number of staff and workers for maintenance shop is twelve.

Table 4.2-25 Maintenance Area and Frequency by Type of Cargo Handling Equipment

Cargo Handling Equipment		Maintenance		
Type	Number	Area	Frequency	
			/month	Annual
Gantry Crane	2	on site	1	1
Mobile Crane	1	on site	1	1
Rubber Tire Gantry Crane	4	on site	1	1
Reach Stucker	2	under roof/ indoor	1	1
Fork Lift	2	under roof/ indoor	1	1
Engine Fork Lift (12ton)	1	under roof/ indoor	1	1
Engine Fork Lift (4ton)	2	under roof/ indoor	1	1
CFS Battery Fork Lift (3ton)	6	under roof/ indoor	1	1
CFS Battery Reach (3ton)	6	under roof/ indoor	1	1
Tracter Head	12	under roof/ indoor	1	-
Container Chassis	18	under roof/ indoor	1	-

Source : Study Team

2) Container Box Wash

Twenty-five of 20 ft. container boxes can be placed simultaneously in a single layer for washing. A forklift is used to place and shift Containers. The container box wash is equipped with a washing water tank and a purifier for used water.

3) Container Box Repair Shop

Twelve 20 ft. container boxes can be placed as single layer simultaneously. Container box will be placed as single layer and shifted by forklift. Repair shop needs roof and wall for welding work and painting work. Number of staff and workers for container box repair shop is ten.

(8) Marine Workers' Lounge

Marine Workers' Lounge is planned to be located near the cargo handling wharf. Function of Marine Workers' Lounge are work meeting space, changing-room, dining, shower –room and so-on. Fifty-one of stationed workers and sixty ship crew member in-charge of cargo loading from/to ship are expected to use the Lounge. Ship crew members will be to use only the lavatory and kiosk.

(9) Buildings

The following buildings are included in building works of the Terminal.

Table 4.2-26 List of Buildings in the Terminal

No	Building	Floor Area (m^2)	Number of Workers	Storey	Remarks
1	Administration Building	3,436	115 (139)	5	(*1)
2	Container Freight Station (CFS)	6,606	60	1+M	
3	Terminal gate	1,538.5	18 (x 2shift)	1	
4	2nd gate	476.5	4 (x 2shift)	1	
5	Maintenance Shop (1)	720	16	1+M	
	Maintenance Shop (2)	576		1	
6	Container Repair Shop	630	10	1	
7	Fuel Station	156.5	2	1	
8	Marine Workers' Lounge	450	35 (x 2shift)	2	
9	Security Post	69	4 (x 2shift)	2	
10	Power Supply Facility	720	-	1	
11	Water Supply Facility	500	-	1	
12	Water Supply Tower	20	-	-	
13	Reefer Sub-station	-	-	-	Equipment
14	Jetty Sub-station	-	-	-	Equipment
*	X-ray Inspection Facility		(10)		Future work (*2)
	Total	15,898.5	264 (349)	-	-

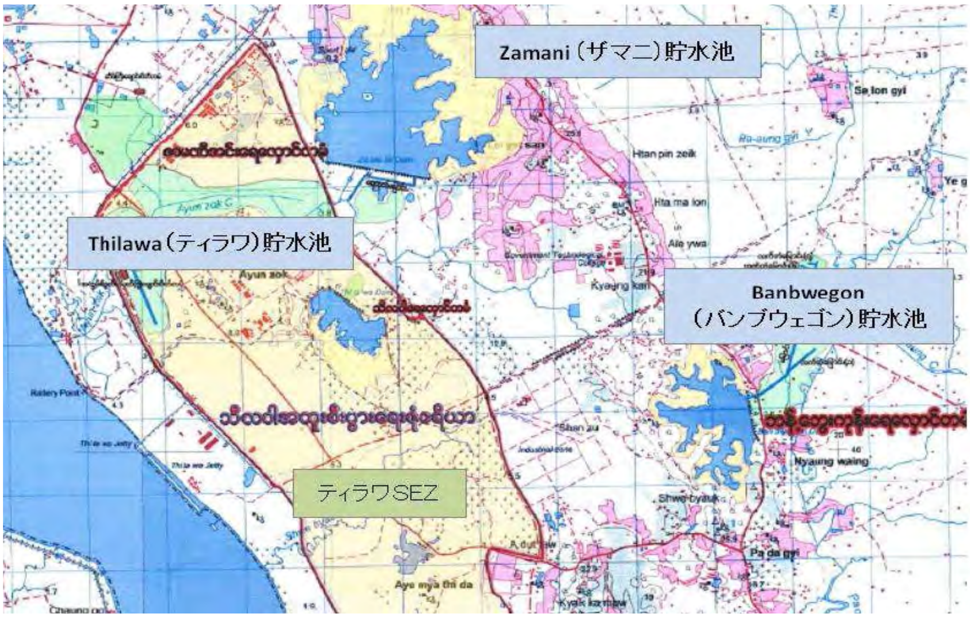
(Note) M : Mezzanine,
(*1) : Figure in brackets shows overall number of workers in a day taking into account 2 shifts a day working system.
(*2) : Figure in brackets shows expected number of workers in future.
Source : Study Team

(10) Water Supply System

1) Water Resources

There are three relatively large water reservoirs around the Thilawa area, these are Banbwegon, Zamani and Thilawa reservoirs which having a storage capacity of 1.89 million m^3, 6.63 million m^3 and 1.34 million m^3 respectively, and these water resource are mainly used for the irrigation, industry and domestic purposes. Two water treatment plants in Thilawa reservoir are currently operating by ministry of construction (MOC) and ministry of industry (MOI). The water treatment plant operated by the MOC is supplying water to the five business establishments including MITT and MIPA. However, it is unable to supply potable water to the all container terminal facilities due to lack of the storage capacity.

MPA recognizes this situation, and currently coordinating with MOC to seek the potential water resources to supply potable water to this project.



Source : Study Team

Figure 4.2-22 Water Reservoirs around Project Site

2) Outline of the Water Supply System

Incoming water from the public water network will be once stored in the above ground water storage tank. Thereafter the water storage tank, two (2) potable water distribution pipe networks; one for buildings use and one for ship water supply will be utilized due to its different operational requirements. Potable water for the building occupants and sanitary use will be distributed by a gravity piping system through an elevated water tank to the sanitary fixtures, pantries, kitchens, washing areas and etc., in the various building and areas as per the overall site layout and architectural plans. A dedicated water supply pipe for ship will separately be provided by pressure pipe system for supply potable water directly to ship from the water storage tank by dedicated water supply pumps.

3) Water Demand

Water demand for the terminal facilities to be used is categorized into the followings :

- Water Supply to Building Occupants and Sanitary Use
- Water Supply to Ships
- Water Supply to Container Washing

a) Water Supply to Buildings

Water consumption for the building occupants and sanitary use has been estimated on the basis of the project population based on the international guidelines for water consumption. The adoptive water consumption rate of 100 liter/capita/day is applied for occupancy staff. As for water demand for the future facilities in the plot 26, it is estimated that 50 percent of the water demand is considered as the future demand to minimize construction of the unnecessary facility and save the construction cost in future.

Table 4.2-27 Water Demand for Building

Name of Building	Occupants			Water Use Rate (L/person/day)	Water Consumption (m^3/day)
	No. of Occupant per Shift	No. of Shift or Night staff	Daily		
Administration Building	113	24 staff	137	100	13.7
Meal	113 meals		113	30	3.39
Container Freight Station	60	1 shift	60	100	6
Maintenance Shop	16	1 shift	16	100	1.6
Container Repair Shop	10	1 shift	8	100	1.0
Terminal Gate	12	2 shift	24	100	2.4
Second Gate	3	2 shift	6	100	0.6
Marine Worker Lounge	permanent	temporary	-	-	
	51	60	111	100	11.1
	51 meals x 2		102	30	3.06
Fuel Station	2	1 shift	2	100	0.2
Sub-Station	-	-	-	-	-
Water Pump House/Tank	-	-	-	-	-
X-ray Check Facility	10	1 shift	10	100	1.0
Security Post	4	2 shift	8	100	0.8
Subtotal					44.85
Future Water Demand (50% of the above)					23.0
Total					68

Source : Study Team

b) Water Supply to Ship

Water demand for ships has been estimated based on the recommendation of the “Technical Standards and Commentaries Port and Harbor Facilities in Japan” and the recommendation of the prospective terminal operator. In general, 20,000DWT class vessel requires approximately 200 m3 water supply during the berthing. Assuming that maximum 2 vessels is berthing simultaneously along the 400 meter length jetty and maximum daily water supply demand to the vessels is estimated as follows :

200 m3 x 2 vessels = 400 m3/day

200 m3 water supply to a vessel will be completed within 5 hours operation and no simultaneous operation will be considered for the ship water supply.

c) Water Supply for Container Wash

It is assumed that 50 TEU will be washed daily and approximately 60 L/TEU will be consumed using the high pressure washing apparatus. The daily water consumption for container wash will be calculated as follows :

50 EU/day x 60 liter/TEU = 3000 L/day= 3.0 m^3/day

d) Total Water Demand

Total water demand has been summarized based on the above estimation :

Table 4.2-28 Water Demand

Building Occupants and Sanitary Use	68 m^3/day
Ship Supply	400 m^3/day
Container Wash	3 m^3/day
Total	471 m^3/day
Rounded	480 m^3/day

Source : Study Team

It is concluded that 480 m3/day water consumption is a planned water demand for the container terminal.

4) Water Storage Tank

One common above ground water storage tank for building use and for firefighting requirement will be provided at the north-east corner of the site together with the associated pump house. Amount of the water storage will be 640 m3 based on requirements of one day domestic water consumption mentioned above and firefighting requirement which are 480 m3 and 160 m3 respectively.

The storage tank will be compartmented into two separate section in order to permit tank cleaning and the future maintenance without interruption to the water supply.

Water storage requirement for the firefighting has been determined based on the locally applicable fire code. The firefighting system will consist of the yard fire hydrant and hose reel system for buildings. Amount of the fire storage for firefighting are considered that two yard hydrants will operate simultaneously that 38 L/sec for first hydrant and 19 L/sec for second hydrant, 2.27 L/sec for hose reel system for the 45 minutes duration of water supply. It is, therefore, storage water requirement of firefighting has been calculated as follow :

(38 L/sec + 19 L/sec + 2.27 L/sec) x 60 sec x 45 min = 160,029 litters = 160 m3

5) Elevated Water Tank

Domestic water to the building and sanitary appliances including container wash will be supplied through the elevated water tank by gravity. To maximize the safety for water supply, the elevated water tank will have a capacity of 40 m^3 which is approximately equivalent to 60% of the daily water consumption for the building use and others except the ship water supply. The height of the elevated tank will be determined to maintain the minimum residual pressure of 70kPa at the highest and the remotest plumbing fixtures.

6) Water Supply Pumps

Two sets of the water supply pump; one set for water supply to the elevated tank and one set for ship water supply will be provided in the pump house. Each set of pump will consist of one duty pump and one standby pump. The capacity of the water supply pump for elevated water tank will be determined to supply water at peak hourly water demand as calculated below :

Table 4.2-29 Requirement of Water Supply Pump

Name of Building	Water Consumption m^3/day	Operation hours	Average Flow m^3/h	Max. Flow m^3/h	Peak Flow m^3/h
Administration Building	17.1	8	2.14	4.26	6.42
Container Freight Station	6.0	8	1.33	1.66	3.99
Maintenance Shop	1.6	8	0.2	0.4	0.6
Container Repair Shop	1.0	8	0.13	0.26	0.39
Terminal Gate	2.4	24	0.1	0.2	0.3
Second Gate	0.6	24	0.25	0.5	0.75
Marine Worker Lounge	14.16	24	0.59	1.18	1.77
Fuel Station	0.2	8	0.03	0.06	0.09
X-ray Check Facility	1.0	8	0.13	0.26	0.39
Security Post	0.4	24	0.02	0.04	0.06
Future Demand	23.0	24	0.96	1.92	2.88
Total (Rounded)	68.0		5.88	11.76	17.64
Water Supply Pump					300 l/min

Source : Study Team

Water supply pump to the ship will supply 200 m^3 water to the ship within 5 hours with the minimum residual pressure of 200kPa at the most remotest outlet and will have a following capacity.

$200m^3$ / 5 hrs. = 40 m^3/h =670 l/min

7) Water Distribution Mains

Two potable water distribution mains will be provided one for building use and one for ship water supply. Potable water for the building use will be supplied gravitationally from the elevated water tank to the sanitary fixtures in the various buildings. Water distribution main pipe sizes will be designed in accordance with the peak hourly water demand or plumbing fixture unit method. Water velocity in pipes shall not exceed 2.0 m/s at the peak design flow rates, and water distribution main will be buried at approx. 1.0 m in depth.

Potable water main for ship water supply will be provided separately, the main pipe size has been determined to feed 40 m^3/h water and adopted 100mm nominal diameter pipe size. Four (4) x 65mm diameter water hydrants (shore to ship connector) at each jetty will be provided along the edge of jetty front.

As for the incoming water pipe from the public main, 100mm diameter pipe will be provided and it is possible to fill the water storage tank within a half day.

The alternative pipe materials which can be used in the water distribution network are ductile iron, galvanized steel, high density poly-ethylene (HDPE) and un-plasticized poly-vinyl chloride (UPVC) pipe. HDPE pipe, however, is recommended for its proven reliability, no corrosive and ease in installation as water pipe systems.

(11) Fuel Supply System

Fuel station of diesel is planned in the terminal. The diesel will be used for the equipment as below for the cargo handling in the terminal. It is not considered for selling to outside trailers. STS Gantry is operated by electronic power. Fuel station is located at the middle of the terminal. Container track, fork lift and Tank lorry will come to the fuel station. RTG (Rubber Tire Gantry Crane) and 45t Reach Stacker will not come to the fuel station and they are taken on tank lorry or others. Mobile crane can be installed for the Project in Phase I. But mobile crane for general cargos cannot be used when full container operation of 200,000TEU.

1) Fuel Consumption of equipment

Average of fuel consumption is estimated as below table.

Table 4.2-30 Estimated fuel consumption of each equipment

Type	Condition	Unit Rate	Little /nos.	Tank Capacity	Numbers
Rubber Tire Gantry Crane	For handling operation of 16 laden (14t) containers per hour	9.0 L/Hr./nos.	900	5400L	6
45t Reach Stacker	For handling operation of 30 empty containers per hour Or For handling operation of 10 laden(14t) container per hour	6.0 L/Hr./nos.	550	1650L	3
3.5t Folk Lift	For normal continuous operation	3.5 L/Hr./nos.	105		2
Trailer with Chassis	For 20 cycle per hour for loading to ship or unloading from ship operation	4.5 L/Hr./nos.	400		6
Mobile Crane			300		1

Source : Study Team

2) Container Handling Capacity per year and week

Container Handling Capacity per year and week is estimated as below.

Handling Capacity : 200,000TEU/year

If the ratio of TEU/BOX is assumed 1.33,

- 150,000 boxes/years will be handled.

If the ratio of Laden : Un-laden = 0.85 : 0.15,

- Full container will be estimated at 127,500 (150,000 x 0.85) boxes/year and empty container will be 22,500 (150,000 x 0.15) boxes/year.

Container packaged at the CFS in the terminal is assumed 5%,

- It is estimated 4,500 TEU/year.

Weekly handling container box will be estimated as bellows base on the assumption of 52 weeks per year.

Total container : 2,885 boxes/week
Full container : 2,452 boxes/week
Empty container : 433 boxes/week
Container packaged at CFS : 65 boxes/week

3) Fuel consumption of each equipment

Weekly fuel consumption of each equipment is calculated as below.

Table 4.2-31 Weekly Estimate of fuel consumption of each equipment

	Boxes /week	boxes /hr	For ship & gate	little/hr		Little /week	working hr/week
Rubber Tire Gantry Crane	2,452	16	2	9	=	2,759	51
Reach Stacker for Empty Container	400	30	2	6	=	160	13
Reach Stacker for cargo handling at CFS	65	10	2	6	=	78	7
Terminal Trailer/Chassis	2,885	20	2	4.5	=	1,297	48
	hr/day /nos.	nos.	days /week	little/hr			
Fork Lift	8	2	6	3.5	=	336	
200t Mobile Crane	assumed 20 % of above total					926	
Total						5,557	
= 7,939 Little/ 10days							

Source : Study Team

4) Capacity of fuel tank

It is assumed that the fuel will be restocked 10 days minimum. The fuel tank capacity will be needed 7,939 litters from the result of above calculation. So the capacity of the fuel tank is decided 8,000 litters. In case of the increasing of the cargo handling equipment in the future, frequency of the fuel supply will be needed to increase. The fuel station will be provided with two 4 kl fuel tanks and two fuel dispensers. The fuel tank will be constructed with double wall steel welded tanks to avoid oil leaking from the tanks. The fuel dispenser will be self-contained dispenser equipped with heavy duty pumping unit and continuous duty motor with 25mm diameter hose.

(12) Electrical Works

1) Code and Standard

This design basically follows the JIS Standard as reference ones.

2) Environmental Condition

The works are designed based on the following condition.

- Temperature : up to 45ºC
- Relative Humidity : up to 90%

- Elevation : up to 50m
- Salt Laden Air : negligible

3) Electrical System

The words are designed based on the following electrical system.

- Incoming : 33KV, 3phase 3 wire, 50Hz
- Medium Voltage : 6.6KV, 3phase 3 wire, 50Hz
- Low voltage : 400/230V, 3 phase 4 wire, 50Hz

4) Design Concept

The Electrical Works including Building Electrical Works will be designed based on the following concepts to secure required necessary reliability, durability, functionality and the like within minimum cost under the local circumstances.

a) Redundancy

The works shall be secured against possible power failure by means of dual incoming and stand-by generator and UPS with Battery.

b) Reliability

The works shall be reliable in operation with applying appropriate protection schemes and highly specified materials even if there is any accident or human error.

c) Durability

The works shall be maintained in performance for whole its lifetime with applying appropriate protection schemes and highly specified materials under the given circumstances.

d) Cost

Both of initial and running cost shall be minimized with applying profound engineering involving materials, method of works and specification related.

e) Energy Saving

Energy consumption shall be reduced through proper mentoring system with control scheme and employing high efficiency and energy saving devices.

f) Safety

Whole the system shall be designed so as to prevent accident resulting in injury or death including damage to the facility whatever may happen.

g) Maintenance

Whole the system shall be able to renewed and /or repaired easily and economically as the need arises with keeping necessary space.

(13) Lighting and Security related System

According to basic concept that described in Draft Final Report chapter 5.7 Port Security Measure, following security related facility will be installed in restricted area to ensure the terminal security.

- Fence and Gate
- Area Lighting
- CCTV Camera
- Public Address (PA) system

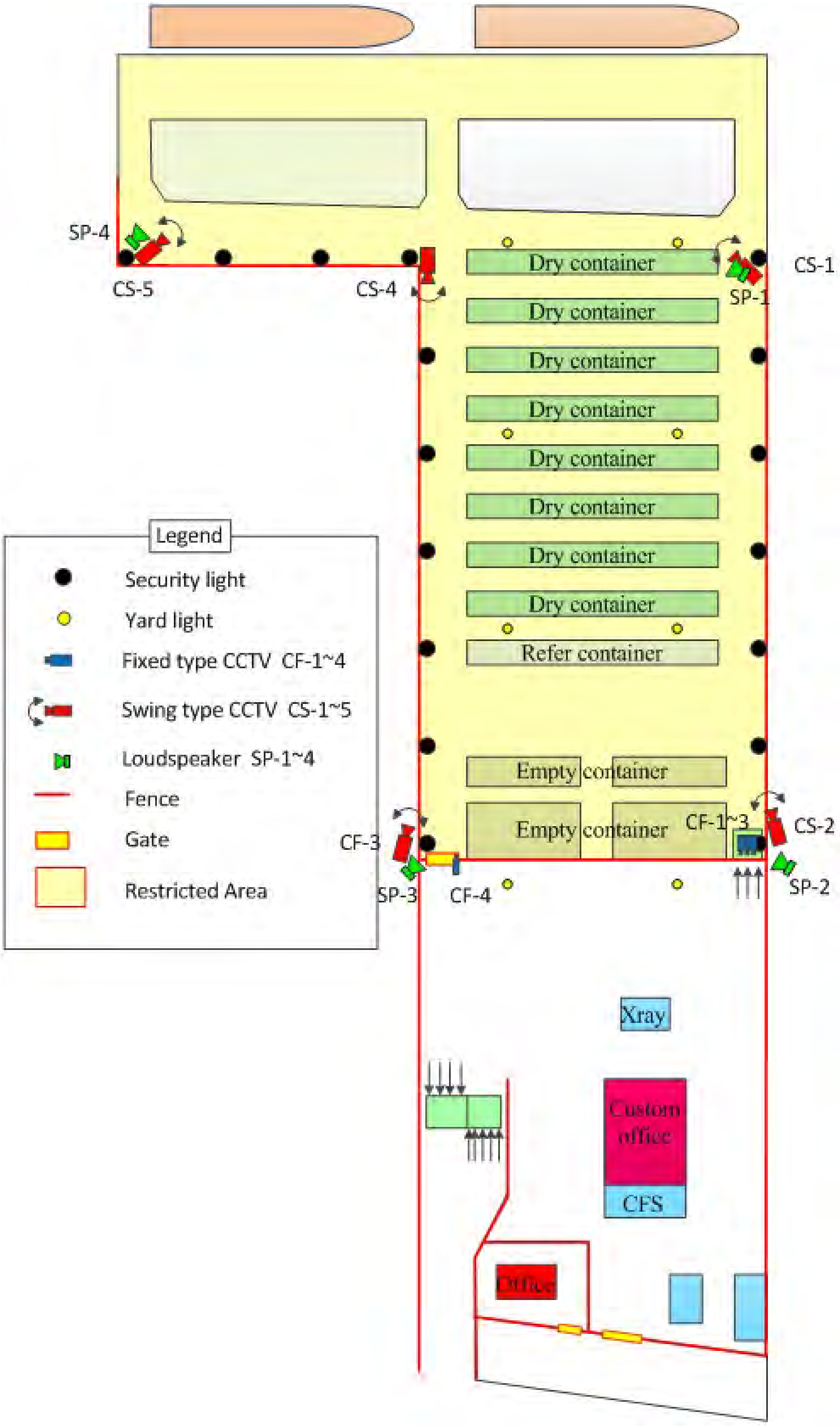
Hereafter, arrangement plan of these facilities is described.

1) General Arrangement plan

It is necessary to establish a restricted area in designing equipment of the system. When setting up the restricted area, it is necessary to consider the usage and operation method of conditions and to conduct proper access control, monitoring and control cargo without disturbing the efficient use of the port facility.

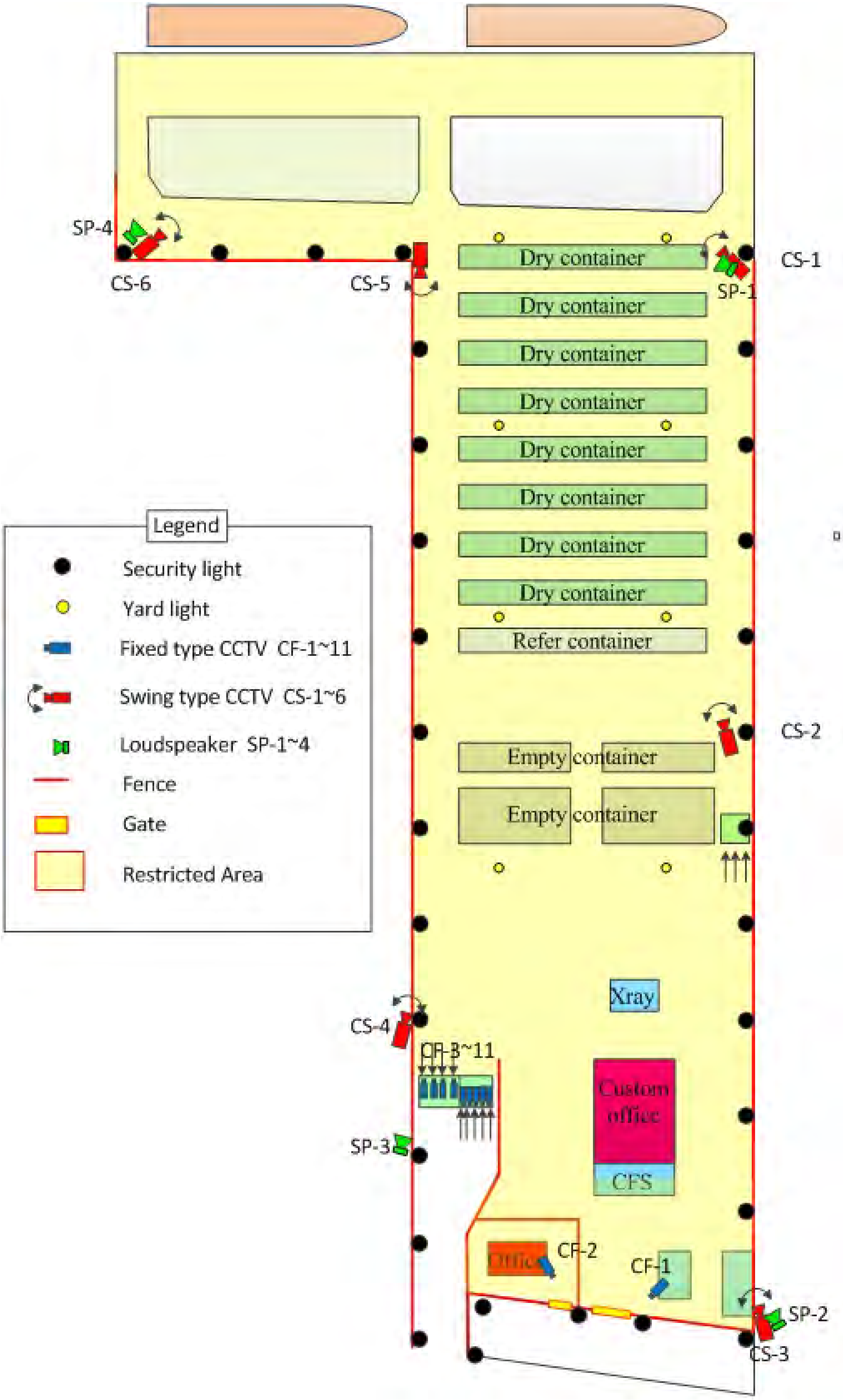
Many people attend the door-opening inspection at the customs in this port. Therefore, two cases, not include the inspection area in the restricted area (hereinafter called Case 1) and include the inspection area in the restricted area (hereinafter called Case 2) can be considered.

Each case of restricted area is shown in Figure 4.2-23 and Figure 4.2-24 respectively.



Source : Study Team

Figure 4.2-23 The Security Equipment Deployment Plan (Case 1)



Source : Study Team

Figure 4.2-24 he Security Equipment Deployment Plan (Case 2)

The restricted area shall be minimized in the Case 1, but it is necessary to conduct access control at the monitor room as a restricted area. In case the door-opening inspection shall be conducted outside of the container yard and only CFS function shall be remained in the future, it is better to transit to Case 2 restricted area.

On the other hand, it will require some effort to the people who want to attend the door-opening inspection. He has to go through procedure at the entrance gate and obtain a visitor pass before attending the door-opening inspection.

When comparing Case 1 and Case2, Case 1 requires less initial investment, but if the usage of the container yard changes in the future, additional security lights, CCTVs and loudspeakers shall be required.

Case 2 is a common way to set the restricted area to control the people who want to enter into the restricted area at the gate.

As the results of consideration, Case1 will be adopted on this project.

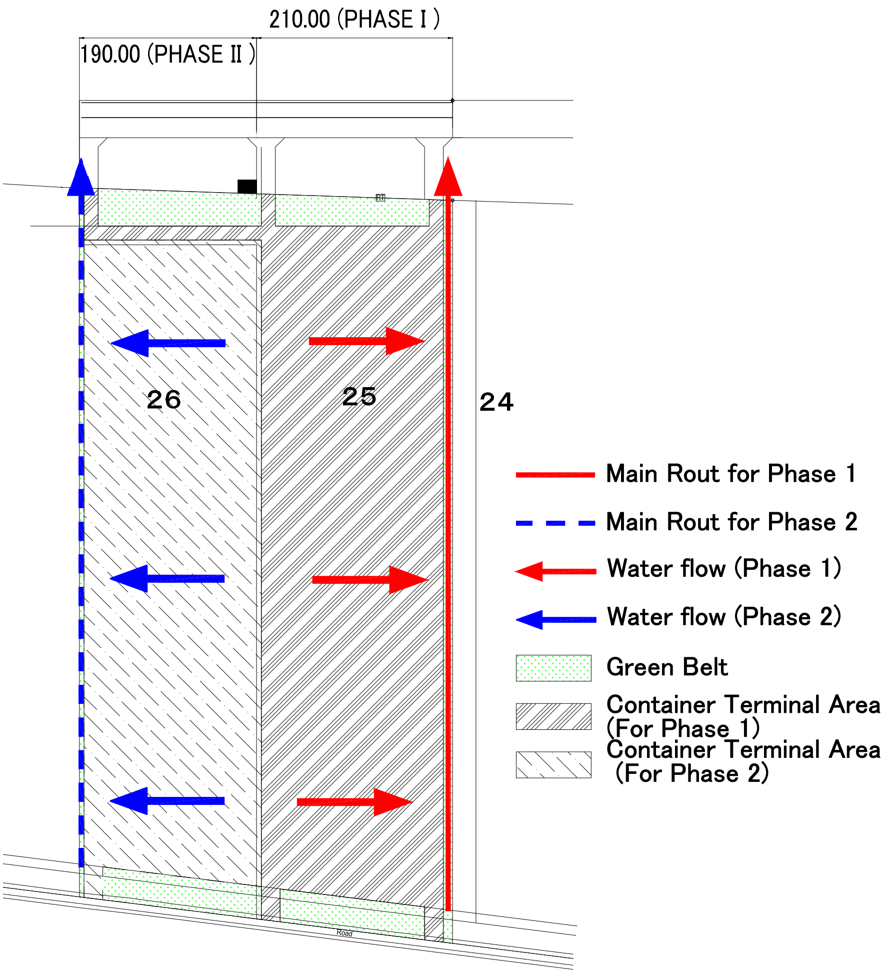
Design concept and general layout of each security facility is described in 4.3.8 Design of Terminal Facilities- Security Related Facilities.

(14) Storm Drain System

1) Planning Condition for Storm Drain System

a) Development plan for Storm Drain System

Container terminal of the plan, be developed in stages in Phase 1 and Phase 2. Drainage route is also in place in each stage as well. The Development plan for Storm Drain System is shown in Figure 4.2-5.



Source : Study Team

Figure 4.2-25 Development plan for Storm Drain System

b) The Tide level

The Tide level of Yangon river is shown in Table 4.2-6.

Table 4.2-32 Tide of Yangon River

Item	Details	
Tide level	H.H.W.L	+7.10m
	H.W.L	+6.24m
	M.W.L	+3.28m
	L.W.L	+0.33m
	C.D.L	+0.00m

Source : Urgent Rehabilitation Project of Yangon Port and Inland Water Transport, JICA

c) Ground Level

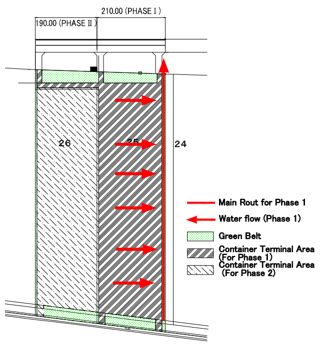
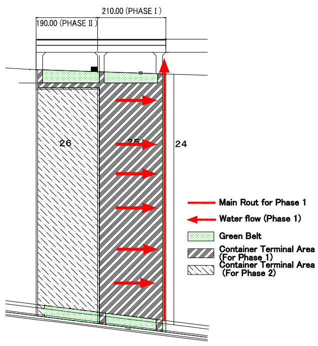
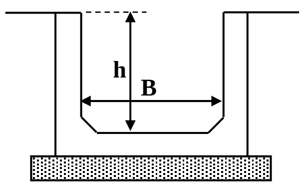
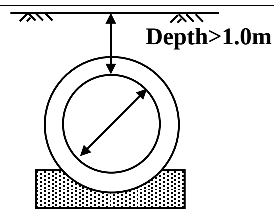
Ground level is +7.5m by F.S.

2) Comparison of Type of Culvert for Main Drainage

a) Comparison of Type of Culvert for Main Drainage

The comparison of the types of culvert for main drainage is shown in Table 4.2-33. In case of Comparison of Type of Culvert for Main drainage, the Bottom elevation of outlet (+5.48m : Open culvert, +3.48m : Pipe culvert) is lower than H.W.L. (+6.24m) and the storm water cannot be drained when outlet is fully under water. Therefore, change of Ground elevation and water slope of drainage in the next section.

Table 4.2-33 Comparison of Type of Culvert for Main Drainage

	Open (Box) Culvert	Pipe Culvert
General Plan		
General Section		
Dimension of Culvert	B =1.0～1.5m, h = 0.9m ~ 1.5m	ϕ = 1.0m ~ 1.8m
Hydraulic Slope	0.20 %	0.20 %
Elevation of Culvert	Top : +7.50m Bottom : +6.60m ~ +**5.48m**	Top : +6.50m ~ +5.27m Bottom : +5.70m ~ +**3.48m**
Evaluation	Not recommendable due to relation between elevation of outlet and tidal level (storm water will not be drained in H.W.L.)	

Source : Study Team

b) Determination of ground level for drainage plan

Desirable Ground elevation was determined from Drainage Planning from below Item.

- The Bottom elevation of outlet is more higher than H.W.L (+6.24m).
- Drainage slope is 0.15%

Determination of ground level for drainage plan is shown in Table 4.2-8. Determination of ground level for drainage plan is Open culvert +8.00m, Drainage Pipe; +9.50m. Therefore, Ground Level is +8.0 m, Type of culvert for Main Drainage is Open culvert.

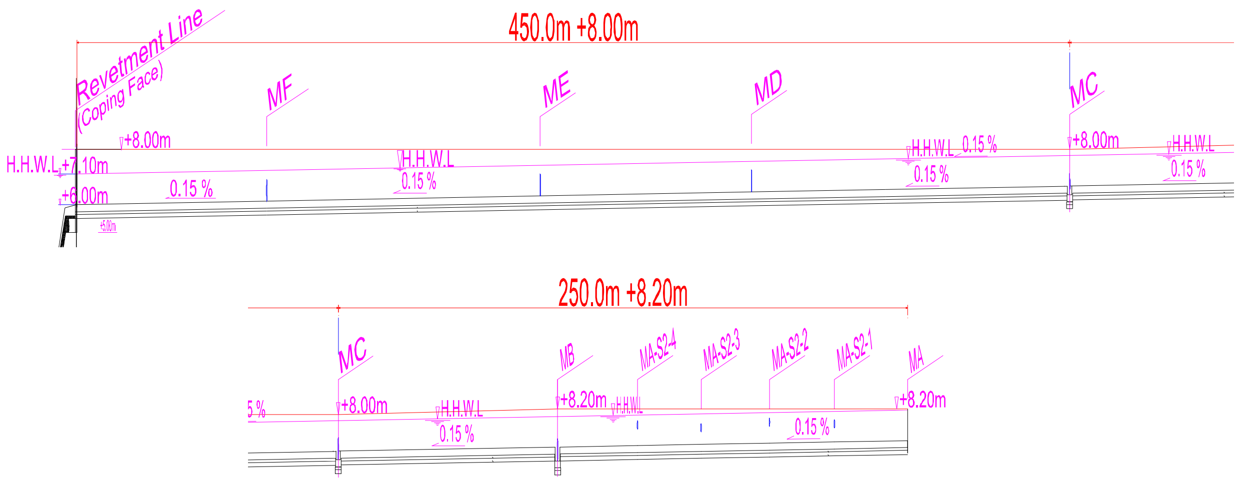
Table 4.2-34 Determination of Ground Level for Drainage Plan

	Open (Box) Culvert	Pipe Culvert
Dimension of Culvert	B =1.0～1.5m, h = 0.9m ~ 2.0m	ϕ = 1.0m ~ 1.8m
Hydraulic Slope	0.15 %	0.15 %
Elevation of Culvert	Bottom :+6.60m ~ +**5.53m**	Bottom : +5.70m ~ +**3.83m**
Elevation of Container Yard	+6.24-+5.53≒0.50m +7.50+0.50=**+8.00m**	+6.24-+3.83≒2.00m +7.50+2.00=**+9.50m**
Evaluation	recommendable	Not recommendable due to relation between elevation of outlet and tidal level (storm water will not be drained in H.W.L.)

Source : Study Team

c) Determination of Ground Level from Tide Level of Yangon River

Tide level of Yangon river is H.H.W.L=7.10m、H.W.L=6.24m.The difference level elevation is around 1.0m. Therefore, Examined the Ground level of container terminal yard is not flooded even H.H.W.L. The hydraulic gradient of the high tide level on the mains drainage plan longitudinal is shown in Figure 4.2-26. The Ground level of range of 450m from the Yangon river is +8.0m, and later the range is +8.20m is that does not flooded.



Source : Study Team

Figure 4.2-26 Mains Drainage Plan Longitudinal

3) Oil – Water Separator

Oil water separator catch basins will be placed in the following facilities.

- Container Wash Area
- Container Repair Area
- RTG Depot.
- Maintenance and Repair Shop Area.

(15) Sewage and Wastewater System

1) Outline of the Sewage and Wastewater Collection

Sewage and wastewater from the sanitary equipment at the various buildings will be collected by the gravity flow sewage piping system and discharged into the storm water drainage system after treatment by the sewage treatment plant(s).

Sewage and wastewater main pipe size will be designed based on the peak hourly flow rate. Minimum velocity for the gravity sewage flow will be 0.6 m/s to maintain self-cleansing of any sediments and maximum velocity should not exceed 2.5 m/s to avoid scouring of sewage.

Manholes will be provided at every changes of slope, direction and at pipe connection points for cleaning and maintenance. The spacing of manhole will be varied depending on the sewage pipe diameter to facilitate maintenance of the sewage network but does not exceed 60 m.

In the case of sewage pipe needs to be buried deeply in underground due to long horizontal pipe run, lift pump station(s) may be provided at the appropriate location to lift-up sewage.

The polyvinylchloride pipe (PVC) will be used for all gravity sewage pipe system and high density poly-ethylene pipe (HDPE) for pressure pipe system.

A grease interceptor(s) will be provided at the appropriate location to remove oil, grease and fat content in wastewater discharged from the kitchen(s) and maintenance facility before being discharged to the sewage pipe network or storm water network. Each grease interceptor will have a capacity of 30 minutes detention time of the average hourly flow rate.

2) Sewage Treatment Plant and Disposal

a) Arrangement of the Sewage Treatment Plant

Sewage and wastewater discharged from the various buildings will be collected by the gravity piping system. A central sewage treatment plant requires long horizontal pipe run since each facilities are widely spread in all-over the site area, therefore, it is recommended to utilize decentralized sewage treatment plant system. Amount of the sewage and wastewater discharged is assumed to be 100% water consumption.

From the overall facility layout, utilization of three (3) sewage treatment plants are proposed with the following treatment capacity :

Table 4.2-35 Amount of Wastewater

Sewage Treatment Plant	Intended Facility	Sewage m^3/day	Plant Capacity (Minimum)
No.1	Administration Building	17.1	26.9 m^3/day
	Container Freight Station	6.0	
	Terminal Gate*	2.4	
	X-ray Check Facility	1.0	
	Security Post	0.4	
No.2	Fuel Station	0.2	3.4 m^3/day
	Maintenance Shop	1.6	
	Container Repair Shop	1.0	
	Second Gate*	0.6	
No.3	Marin Workers' Lounge	14.16	14.2 m^3/day

Note * these buildings do not provided with toilet facilities, however, it is assumed that occupants will use toilet in nearby building.

Source : Study Team

Design of the sewage treatment plants will be based on the maximum flow rate and each sewage treatment plant will have the following capacities :

Table 4.2-36 Capacity of Sewage Treatment Plants

Treatment Plant No.	Operation Hour	Average Flow m^3/h	Maximum Flow m^3/h	Treatment Cap. m^3/day
No.1	8	3.36	6.72	26.9
No.2	8	0.43	0.86	3.4
No.3	24	0.60	1.20	14.2

Source : Study Team

b) Sewage and Wastewater Quality

The sewage treatment plant(s) will be designed to meet the following design conditions, and the effluent discharge quality will be in accordance with the requirements of "Water and Air Pollution Control Plan (Standing Order No.3)" by the government of the Union of Myanmar (MOI) as follows :

Table 4.2-37 Standard of Wastewater Quality

Item	Influent Quality mg/liter	Effluent Quality mg/liter
pH	6 - 9	6 – 9
BOD	300	30
COD(Mn)	200	30
COD(Cr)	300	50
SS	300	30
Oil Content	5	5

Source : Study Team

c) Treatment Process

Proposed treatment process will be of activated sludge method so called “Extended Aeration”. Outline of the sewage treatment process is described in hereunder :

i) Inlet Bar Screen

A bar screen will be proved at the influent port to remove unusually large solids from the incoming raw sewage.

ii) Flow Equalization Chamber

A flow equalization chamber will be supplied with a volume designated to handle 25% to 100% of the design flow. The flow equalization chamber allows for a constant flow through the plant by equalizing flow surges that may be incurred during peak flow time.

iii) Sludge Holding Chamber

The chamber will be of the aerated type and volume of the sludge holding chamber is 0.1m3 per capita.

iv) Aeration Chamber

The aeration chamber will be of sufficient capacity to provide a minimum of 24 hours retention of average daily flow, and/or maximum loading of 0.15kgBOD/m3/day of aeration tank volume.

v) Clarifier Chamber

The clarifier chamber will be sized to provide a minimum of 4 hours retention, based upon the same design flow rates governing the aeration chamber, and will have proper baffling to prevent short circuiting and to provide maximum uniform retention.

vi) Sludge Recirculation System

There will be installed within the clarifier chamber, a positive sludge recirculation system consisting of airlift sludge return assemble per hopper.

vii) Scum Recirculation System

The will be installed each clarifier chamber a positive scum and skimming recirculation system consisting airlift skimming device.

viii) Chlorine Contact Chamber

A chlorine contact chamber will be provided for proper disinfection of the treated wastewater prior to discharge from the plant.

ix) Air Diffusion System

Air distribution manifold with diffusers will be installed longitudinally on one side along the entire length of the plant to provide optimum diffusion and mixing of the sewage in the vessel.

4.3. Design of Terminal Facilities

Design of the terminal facilities do a design on the construction which is shown in Table 4.3-1.

Table 4.3-1 Design Facilities of Terminal Facilities

No.	Design Facilities
1	Port Facilities
2	Container Yard
3	Soil Improvement
4	Pavement
5	Cargo Handling Equipment
6	Buildings
7	Inspection Facility
8	Lighting Facility
9	Security related Facilities
10	Drainage Facility

Source：Study Team

4.3.1. Port Facilities

Port facilities do a design on the construction which is shown in Table4.3-2.

Table 4.3-2 Estimated Myanmar Population by Region

No.	Port Facilities
1	Jetty
2	Trestle
3	Revetment

Source：Study Team

(1) Jetty

1) Design Condition

a) Plan Condition

Plan depth : D.L.-10.0m
Design depth : D.L.-11.0m(Consideration 1.0 m of back-break)
Crown height of Jetty : D.L.+7.50m
Apron width : 40m
Jetty length : 400m

b) Availability Condition

i) Object Ships

- Container Ship

Tonnage 20,000 DWT
Ship Length(Loa) : 177m
Length between perpendiculars (Lpp) : 165m
Ship width (B) : 27.1m
Moulded Depth : 14.2m
Full load Draft (d) : 9.0m
Berthing Velocity (V) : 0.10m/s

- Barge Ship

Fault own vessel on a voyage
Ship Length(L) : 60m
Ship Width(B) : 14m
Moulded Depth : 2.43m～3.05m

Full load Draft (d) : 1.50m～2.00m

- Push Boat

Tonnage :100 GT
Ship Length (L) : 30m
Ship Width(B) : 7m
Full load Draft (d) : 3.5m

ii) Design use duration and provision against anti-corrosion

Design use duration : 50 years

- Provision against anti-corrosion

<Painting>

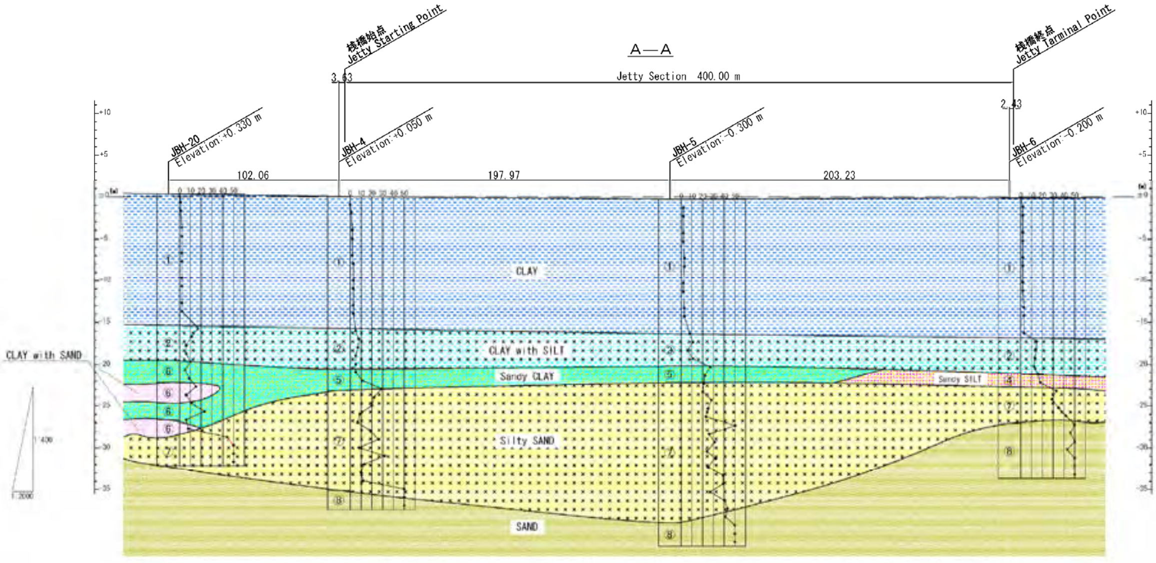
As for equal to or more than -1.0 m of L.W.L. of the jacket steel part and the steel pipe pile, it does a heavy anti-corrosion.
It makes an anti-corrosion effectiveness in this case 100 %.

<Cathodic-protection>

As for the part which is deeper than -1.0 m of L.W.L. of the steel pipe pile, it does a cathodic-protection.
It makes a cathodic-protection durability in 50.
But, it makes an anti-corrosion effectiveness in this case 90 %.

c) Soil Condition

A soil-layer bedding chart (normal parallel deflection) is shown in Figure 4.3-1 and a soil character fixed number is shown in Table4.3-3.



Source : Study Team

Figure 4.3-1 Soil Character Bedding Chart (Normal Parallel Deflection)

Table 4.3-3 Soil Character Fixed Number

River Side								
No	Soil Name	Elevation (m)	Mean N-Value	Cohesion C kN/m²	Friction angle φ(°)	Unit Weight γ(KN/m³)	Unit Weight γ'(kN/m³)	Modulus of Elasticity E (kN/m²)
1	CLAY	G.L -16.5	2	C=1.79·Z+25.81 (Z=0 at ±0.00)	-	17	7	1300
2	CLAY with silt	-16.5 -18.0	10	C=1.79·Z+25.81 (Z=0 at ±0.00)	-	19	9	6600
3	Silty CLAY	-18.0 -19.0	12	50	-	18	8	8000
4	Sandy SILT	-19.0 -19.5	25	50	-	18	8	16600
5	Sandy CLAY	-19.5 -20.0	16	50	-	19	9	10600
6	Sandy CLAY and CLAY with sand interbedded	-20.0 -22.0	17	50	-	19	9	11300
7	Silty SAND	-22.0 -39.0	30	-	32	19	10	21000
8	SAND	-39.0	40	-	34	20	10	28000

Source : Study Team

d) Surcharge

Mooring (Ordinary) : 20 kN/m^2

Berthing : 10 kN/m^2

Working : 10 kN/m^2

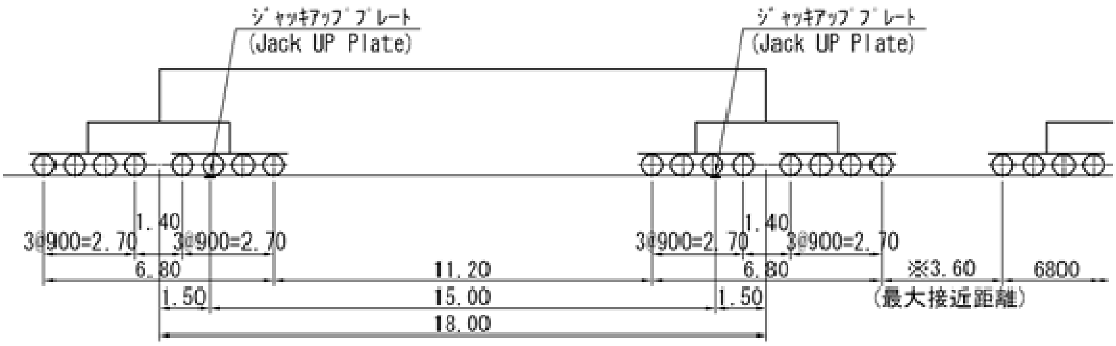
During an earthquake : 10 kN/m^2

e) Cargo Handling Equipment Load

i) Gantry crane

- Wheel Load

Wheel arrangement of the gauntry is shown in Figure 4.3-2 and wheel load is shown in Table4.3-4.



Source : Crane maker

Figure 4.3-2 Gauntry Wheel Arrangement Plan

Table 4.3-4 Wheel Load

Unit :kN/Wheel

Condition	Position	Direction of action load		
		Vertical direction	Horizontal direction	
			River side → Land side	Land side → River side
Ordinary (Mooring)	River side	154.8	-7.8	7.8
	Land side	330.3	-7.8	7.8
Working Wind velocity 20m/s	River side	368.5	-25.5	25.5
	Land side	321.4	-22.5	22.5
Storm Wind velocity 60m/s	River side	424.3	-73.5	73.5
	Land side	599.8	-73.5	73.5
During earthquake kh=0.15	River side	467.5	-31.4	31.4
	Land side	457.7	-31.4	31.4

Notes :

1) Above-wheel load is a high value under each causal.

2) As for the vertical direction load, the down load is a positive value and as for the horizontal direction load, the load for river side from land side is a positive value.

3) The unit load per travel wheel when considering 20m/s wind-speed in the boom up condition is always (mooring) shown.

Source :Crane maker

Gauntry accessory equipment load

- Jacking up reaction

River side : 1348.5 kN/Corner Land side : 2224.6 kN/Corner

Mooring facility force(Note : Combined use hardware of prevention of escape and the prevention of fall)

- Force of anchoring device

River side : 1000.6 kN/Rail Land side : 1258.3 kN/Rail

- Fall arrester force

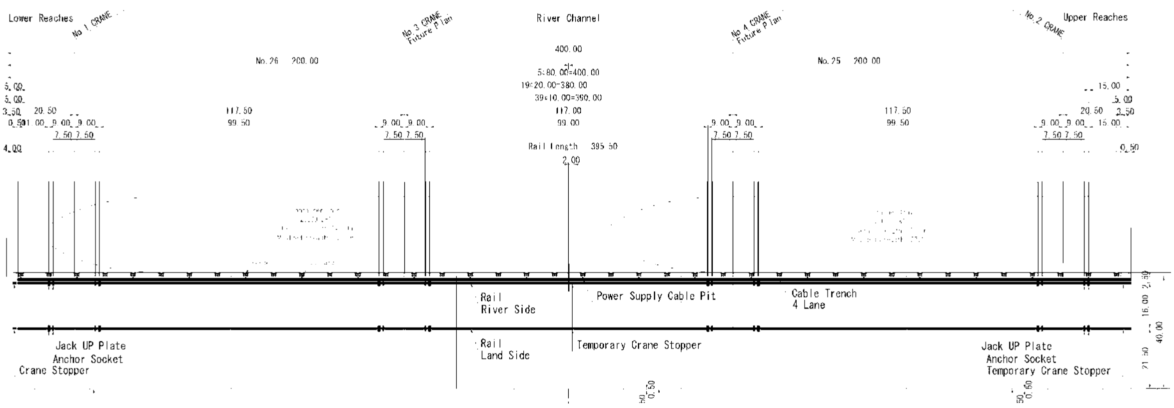
River side : 1460.2 kN/Corner Land side : 51.0 kN/Corner

Upswing load (Rise force)

- End stopper collision force

229.3 kN/Buffer

Accessory equipment arrangement plan of the gantry is shown in Figure 4.3-3.



Source : Study Team

Figure 4.3-3 Accessory Equipment Arrangement Plan of the Gantry

ii) Mobile Crane

Mobile Crane uses for the cargo handling of the general cargo on the jetty and in the yard. Maximum lift load is 2000kN.

- Wheel load

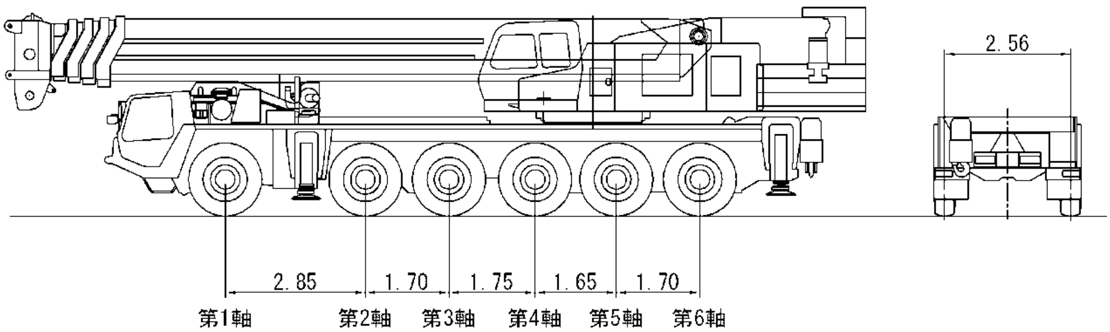
In travel-motion : Gross vehicle weight 979 kN (There being boom, no being counterweight)

A unit load per travel wheel is shown in Table4.3-5 and travelling wheel arrangement plan is shown in Figure 4.3-4.

Table 4.3-5 Unit Load per Travel Wheel at Yard Internal-transmigration

	No1 Axis	No2 Axis	No3 Axis	No4 Axis	No5 Axis	No6 Axis
Wheel Load (kN)	75.0	75.0	82.3	82.3	82.3	82.3
Tire earth width (m)	0.355	0.355	0.355	0.355	0.355	0.355
Tire bearing area (m^2)	0.13	0.13	0.137	0.137	0.137	0.137
Tire tread pressure (kN/m^2)	576.9	576.9	600.7	600.7	600.7	600.7

Source : Crane maker



Source : Crane Maker

Figure 4.3-4 Wheel Arrangement Plan of Mobile Crane

- Outrigger reaction force at working

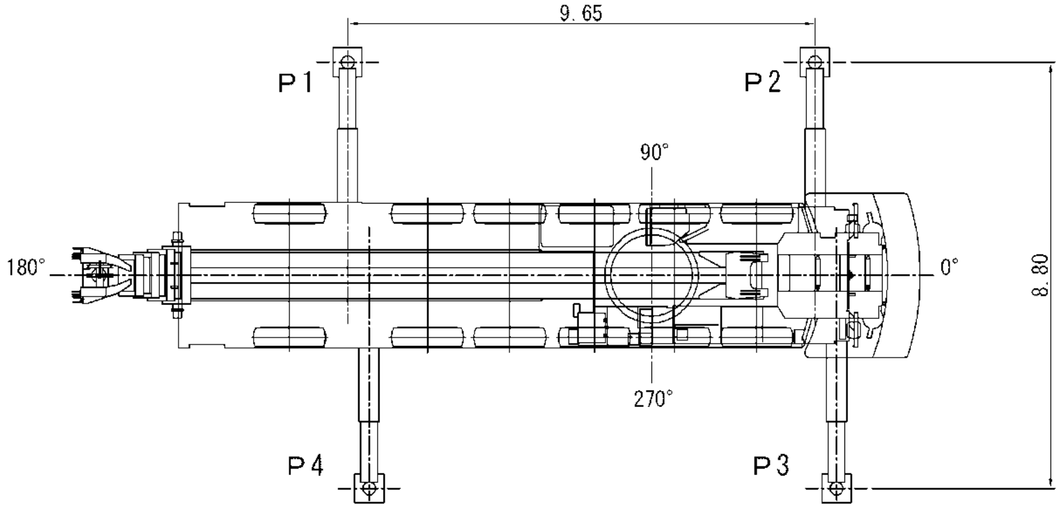
Outrigger reaction force at working-state is shown in Table4.3-6.

Table 4.3-6 Outrigger Reaction Force at Working-state

Turning Angle	Outrigger reaction force (kN)			
	P1	P2	P3	P4
137°	906.5	533.12	210.7	357.7
51°	352.8	**1145.62**	390.04	120.54
314°	130.34	416.5	1113.28	347.9
224°	366.52	198.94	507.64	934.92

Source : Crane maker

Overhang of outrigger is shown in Figure 4.3-5.



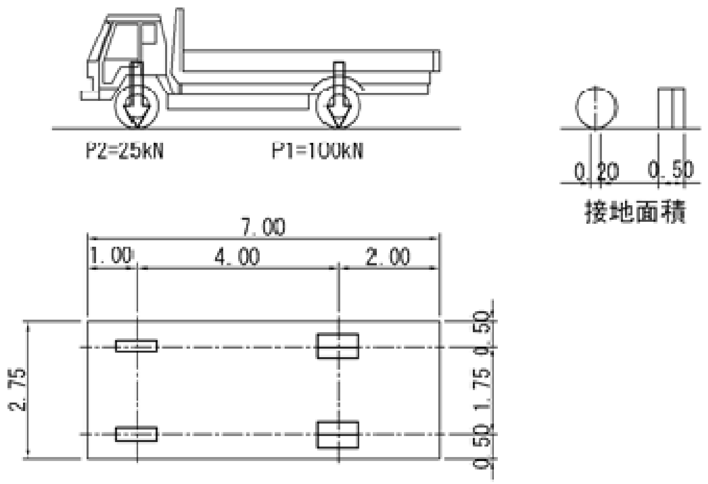
Source : Crane Maker

Figure 4.3-5 Inland Water Network

iii) Truck

Truck Type :T－250

Load on wheel at truck and arrangement plan of wheel are shown in Figure 4.3-6.

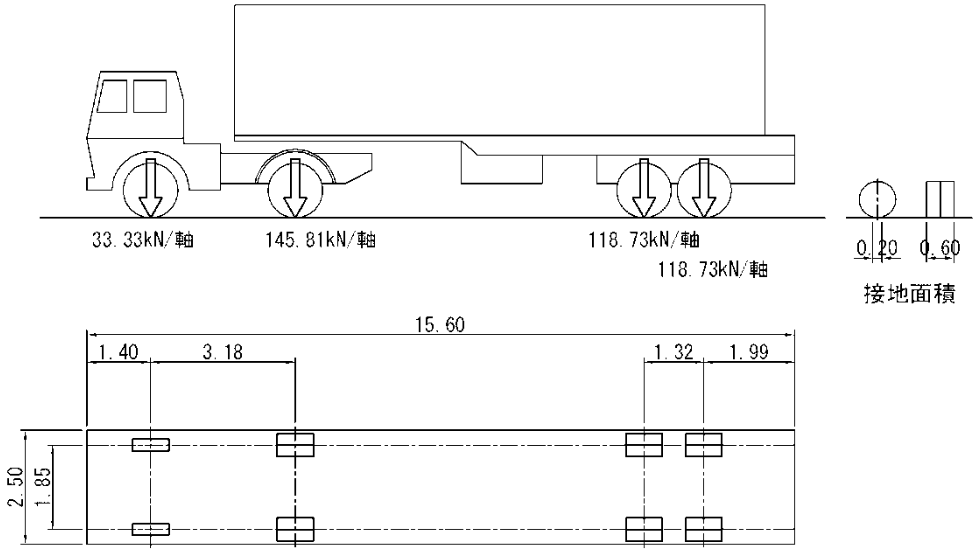


Source : Truck maker

Figure 4.3-6 Load on Wheel at Truck and Arrangement Plan of Wheel

iv) Tractor Trailer

Load on wheel and wheel arrangement plan of tractor trailer are shown in figure 4.3-7.

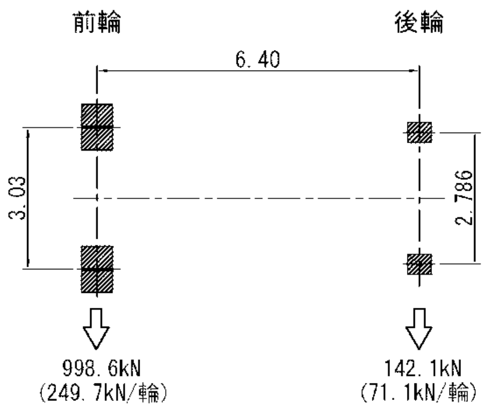


Source : Cargo handling machine maker

Figure 4.3-7 Inland Water Network

v) Reach stacker

Reach stacker load on wheel and a wheel arrangement plan are shown in Figure 4.3-8.



Source : Cargo handling machine maker

Figure 4.3-8 Reach stacker Load

f) Ship Berthing Force

Berthing energy of ship Ef=166.39 kN.m
Use Fender Cell Type 800H 2 Fenders (Per one place)
Fender Reaction R=800 kN
Installation interval : 10 m

g) Mooring Force

Mooring Force T=700 kN
Installation interval ; 20 m

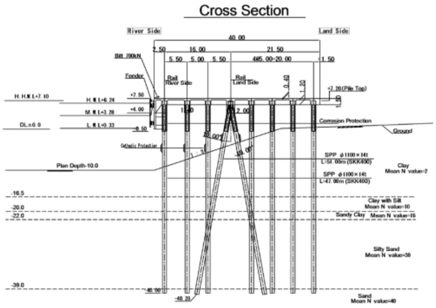
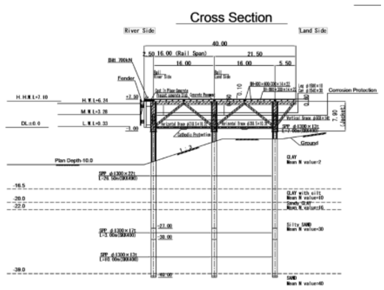
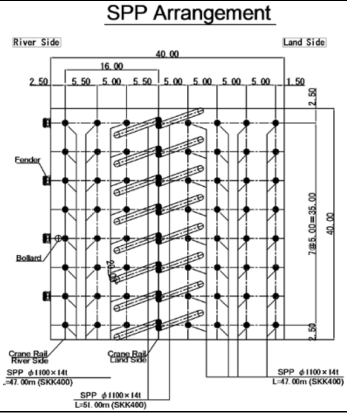
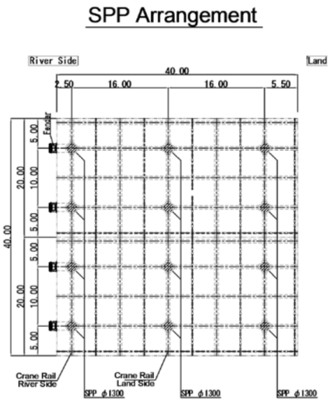
h) Design standard and reference book

- Technical Standers for Port and Harbour Facilities in Japan, Japan Port and Harbour Assoc., SEP, 2007
- Port and Harbor structure design casebook, Costal Development Institute of Technology, MAR, 2007
- Standard Specification for Concrete Structures, Japan Society of Civil Engineers, MAR, 2008
- Specifications for Highway Bridges, Japan Road Assoc., MAR, 2012
- Jacket method of construction technique manual, Costal Development Institute of Technology, JAN, 2000
- Steel structure construction design construction guidance, Japan Society of Civil Engineers, MAR, 2001
- Land bridge use pre-cast floor version design and fabrication manual, Japan Society of Civil Engineers, JUL, 2004

2) Decision of Jetty construction Type

In comparison about batter pile type jetty and jacket type jetty decides an optimal structure. Architecture comparative chart at jetty is shown in Table 4.3-7.

Table 4.3-7 Architecture Comparative at Jetty

	Batter pile type	Jacket type
Section		
Pile arrangement		
Characteristic of structure	・ There are many numbers of the pile compared with the jacket type. ・ As for the batter-pile, a steel pipe pile is often used. ・ For the vertical and batter pile type, the strength to the horizontal-force is bigness. ・ As for the batter-pile, the special execution machine is necessary to Piling. ・ Because all kinds of construction are a site construction, in the construction period, it is long.	・ There are few numbers of the pile compared with the batter pile type. ・ The application accuracy of the piling by the pile and the installation of the jacket is necessary. ・ It is strong in the horizontal-force because the structure above upper deck is strength. ・ Large-sized Crane of the installation of the jacket is necessary. ・ The construction duration in on the water is short to manufacture a jacket in the land.
Cost	73.5 mi$	73.7 mi$
Duration	20 months	17 months
Evaluation	△	○(Adopt)

Notes：

For every 400 m of the cost of construction

For every 200 m in the construction period

Source : Study Team

There was a characteristic like the following in the workability from the situation of the river at the site and the thing that at the site and on the water the working term is short very judged that it is important about the structure selection.

- The current velocity is fast with 6 kt and the tidal level reverses a current direction.
- The difference with tidal level is very big at equal to or more than about 6 m.
- The transparency of the river water is very bad and the work in the water is difficult.
- In the rainy season, the environment of these rivers is specifically aggravated.

The construction cost at the jacket type jetty is rather expensive compared with the batter pile type jetty but in the construction period, it is 3 months short. Because it is possible to open port early because the construction period is short and it is assumed that the difference with the profit exceeds 0.2 million USD of the finite difference with cost of construction, as for the cost effectiveness, the jacket type jetty is greater.

It judges above items, being general and it makes the jacket tepe jetty an adoption construction type.

3) Division of design section

The Topographical Information to the direction of the normal line at the jetty is the depth of water of almost 0.0 m, but at the edge in the upstream side, it becomes the depth of water of -4 m from -11 m.

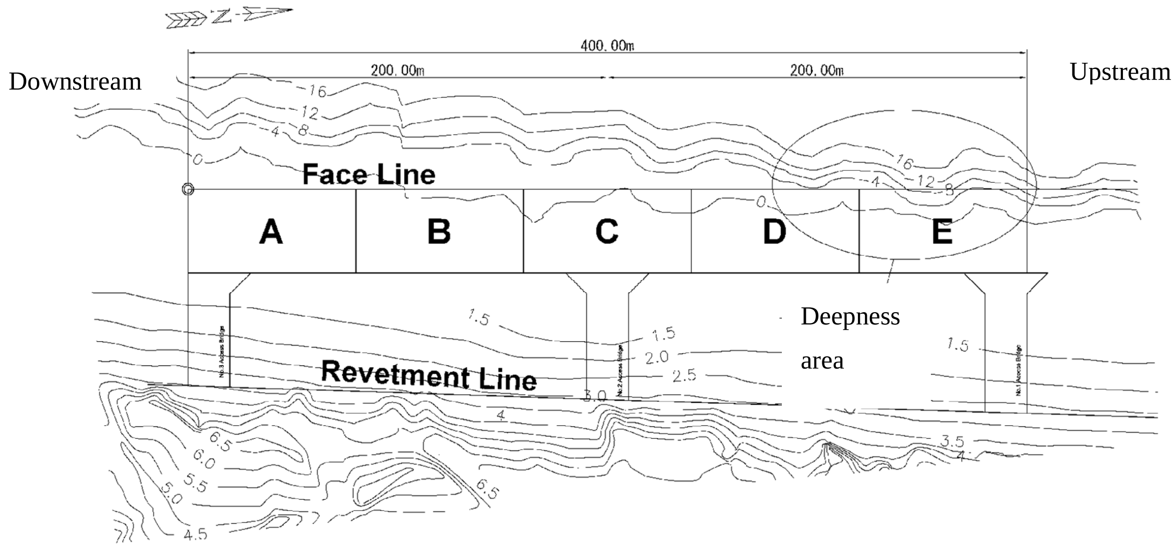
The direction of the river crossing becomes deep rapidly on the side of the river from 0.0 m.

Specifically, in the upstream side, this determination is remarkable.

It considers, it divides an effect in the Topographical Information into 2 sections and it does a design.

- 1 Section (Shallowness area : Berth center and downstream side) – Block : A, B, C, D
- 2 Section (Deepness area : Upstream side) – Block : E

Division of design section is shown in Figure 4.3-9.



Source : Study Team

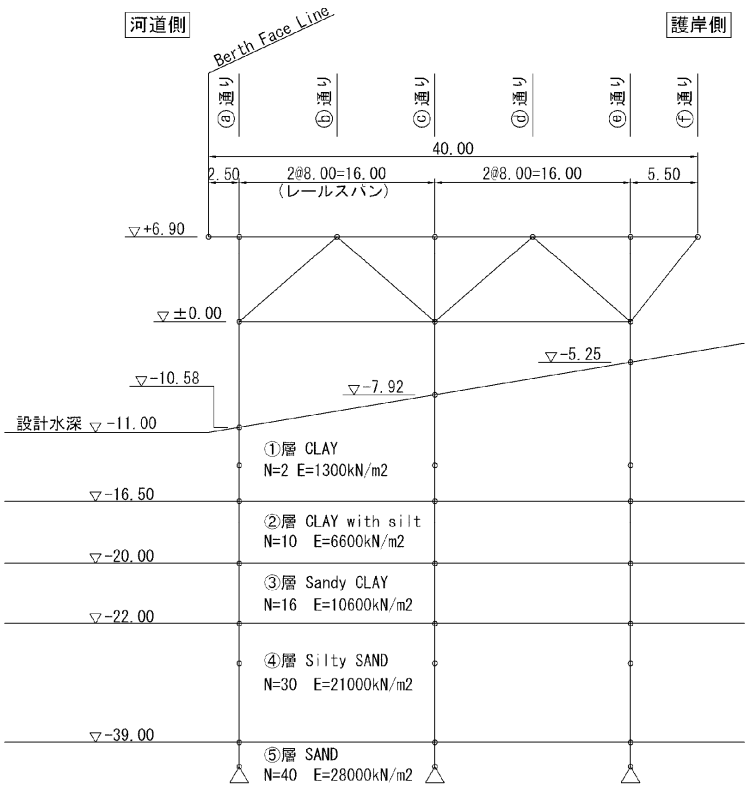
Figure 4.3-9 Division of design section

4) Structural analysis

The structural analysis model analyzes a jacket structure and a pile with the united space frame model.

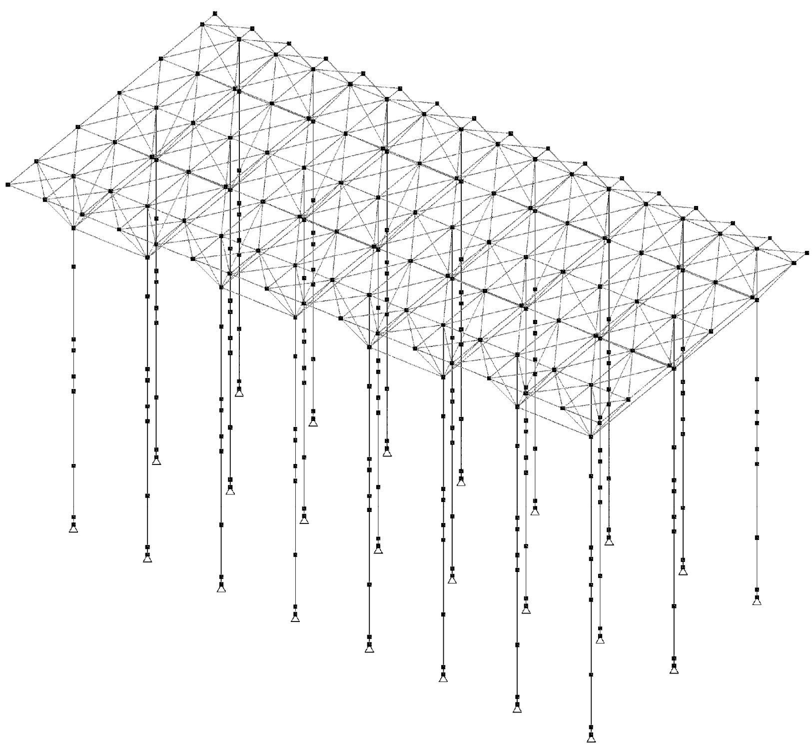
It does an analysis using " STAN/3D " (Kozo Keikaku Engineering Inc.).

An framework analytic-model cross section is shown in Figure 4.3-10 and a structural analysis model three-dimensional space is shown in Figure 4.3-11.



Source : Study Team

Figure 4.3-10　Framework Analytic-model Cross section



Source : Study Team

Figure 4.3-11　Structural Analysis model Three-dimensional space

It combine the arithmetic case and the load which shows the input load which is shown in Table4.3-8 in Table4.3-9 and it does a structural-calculation.

Table 4.3-8 Input load

Vertical load	Horizontal load
Slab weight	
Steel weight(H.W.L.)	
Steel weight(L.W.L.)	
Surcharge(Ordinary)	
Surcharge(Unusual)	
Crane wheel load	Crane wheel load
	Birthing force
	Mooring force
Uplift	
	Wave force
	Current force
	Earthquake force of inertia
	Earthquake force of inertia of surcharge

Source : Study Team

Table 4.3-9 Combine Computation case and Load

Computation case	Working load		Note
	Vertical load	Horizontal-load	
1.Mooring	①②④⑥	⑥⑧⑪	
2.Berthing	①③⑤	⑦	
3.Working	①③⑤⑥	⑥	
4.Storm (Non-Crane load)	①②⑨	⑩⑪	
5.Storm (On-Crane load)	⑥⑨	⑥⑩⑪	Crane load direction Land side→River side
6.Storm (On-Crane load)	⑥⑨	⑥⑩⑪	Crane load direction River side→Land side
7.In earthquake	①③⑤⑥	⑥⑫⑬	Earthquake force direction Land side→River side
8.In earthquake	①③⑤⑥	⑥⑫⑬	Earthquake force direction River side→Land side

Note : The number of the action load is the load number of Table 4.3-8.

Source : Study Team

5) Structural member

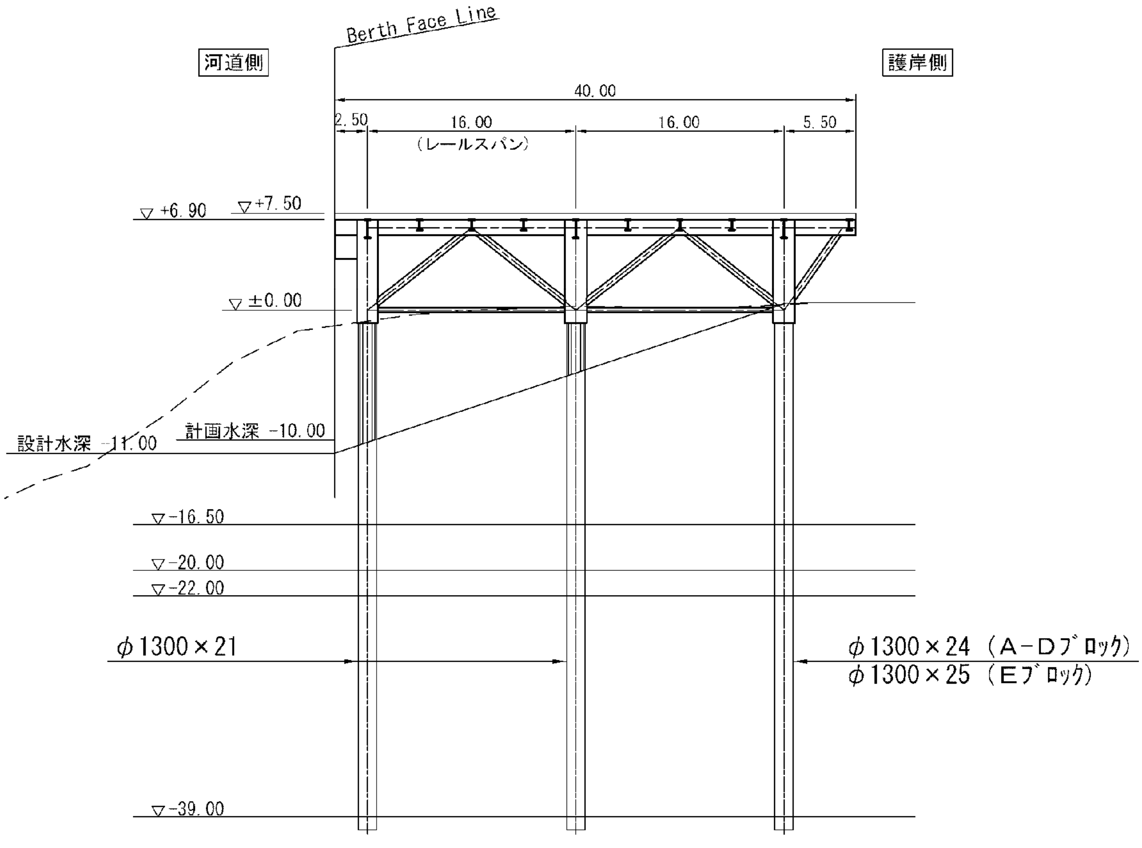
Structural member does the analysis which is shown in Table 4.3-10 and decide member cross sections.

Table 4.3-10 Structural member examining

Structural member	Examining
Section of foundation pile	Pile stress
Length of foundation pile	Pile bearing capacity
Beam	Beam stress
Vertical brace	Brace stress
Horizontal brace	Brace stress

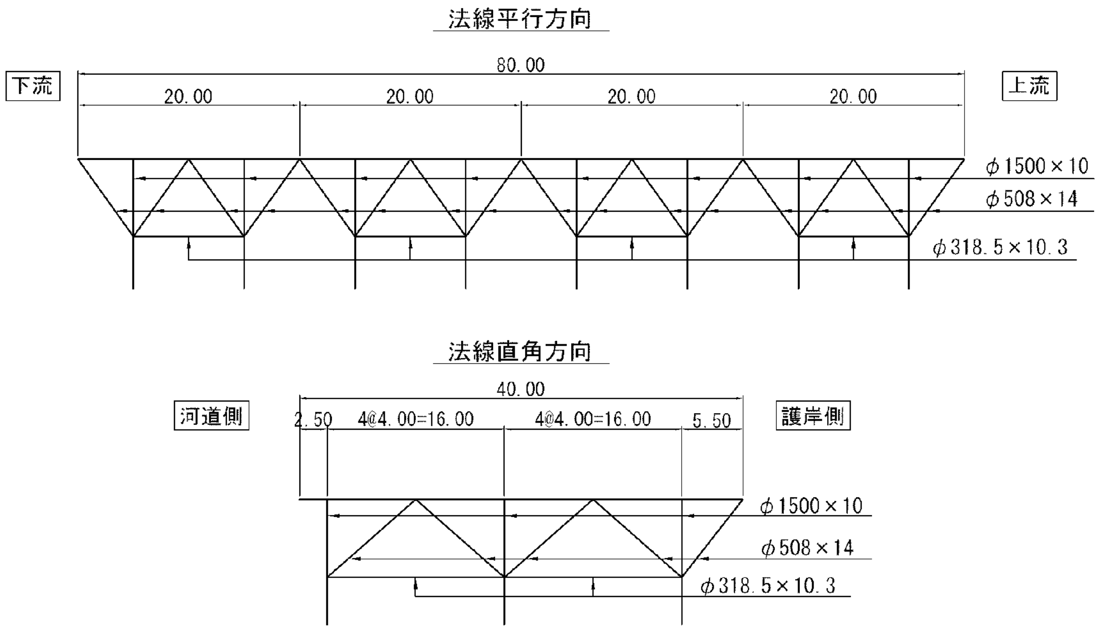
Source : Study Team

The factor of the foundation pile is shown in Figure 4.3-12 and the factor of the reg and the brace is shown in Figure 4.3-13.



Source : Study Team

Figure 4.3-12 Factor of Foundation Pile



Source : Study Team

Figure 4.3-13 Factor of Reg and Brace

6) Scour protection

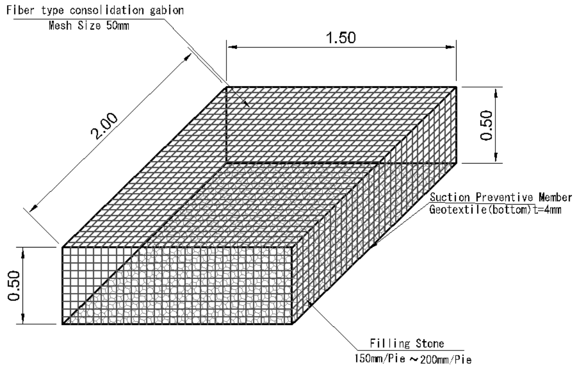
The jetty establishment part is the part which receives a scour by the stream flow.

It installation a prevention of scour protection carpenter in the purpose to do a protection on the dredging surface under the jetty.

The scour protection makes duplication high powerfulness polyester fiber a core material for the following reason, uses the wire rod which was coating with the high density polyethylene and uses the gabion which filled a stone into it.

- The transparency of the river-water is bad and it is difficult for the covering stone mason method to be level covering stone. The gabion method of construction doesn't need level.
- Because it has an airspace, doing a stone, the gabion is good for the living in field and the becoming environment of the living beings such as the fish.
- There is a flexibility and it is easy for the gabion to follow subsidence.
- The concrete block needs a fabrication yard but the gabion can do installation just as it is by filling a stone at the quarry and carrying it to the site with the barge.
- The concrete block needs a concrete cure but the gabion becomes shortening in the construction period because it doesn't need cure.

Gabion structure is shown in Figure 4.3-14.

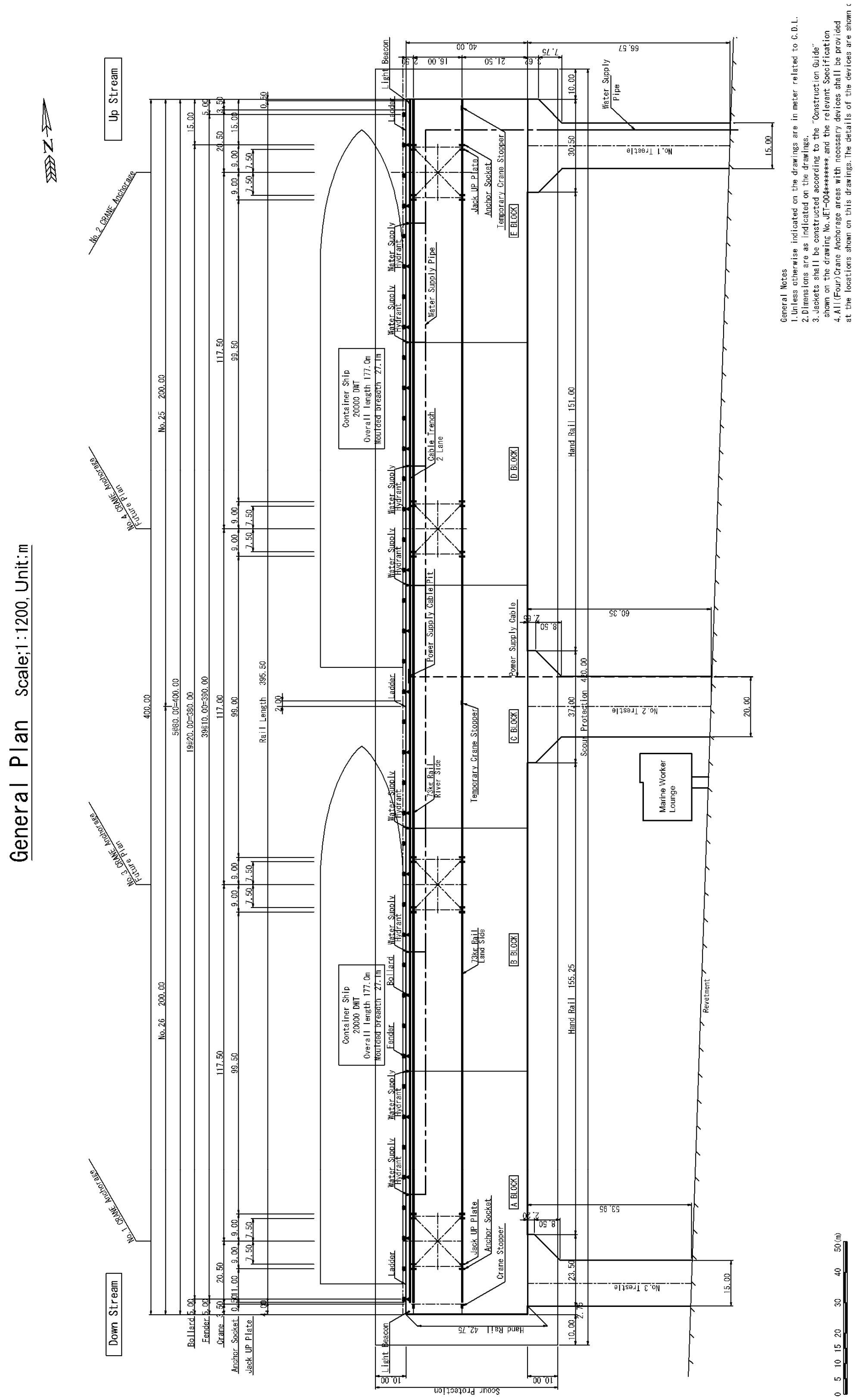


Source : Study Team

Figure 4.3-14 Gabion Structure

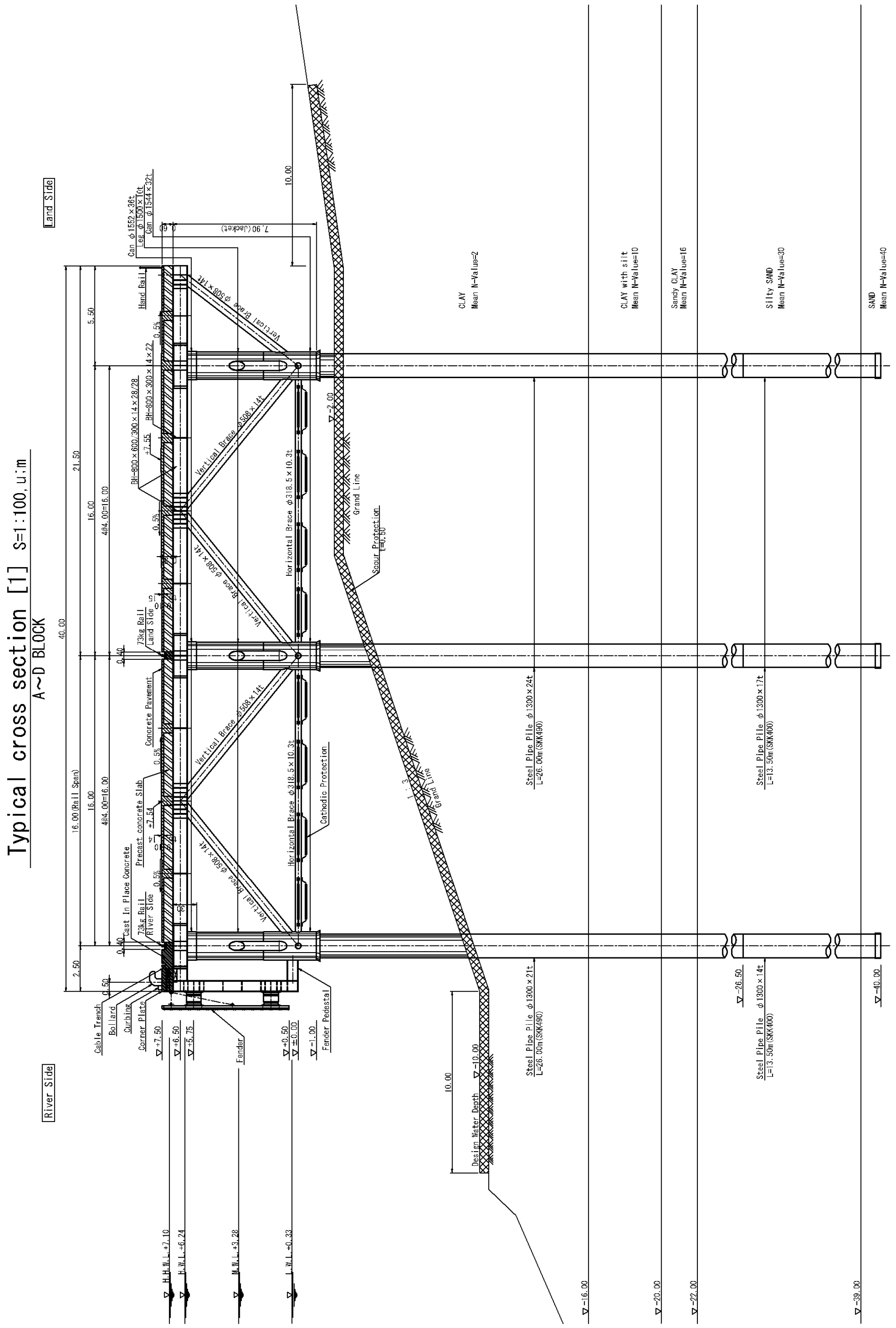
7) Jetty Drawing

Jetty plan is shown in figure 4.3-15 and Jetty cross section is shown in figure 4.3-16.



Source : Study Team

Figure 4.3-15 Jetty Plan



Source : Study Team

Figure 4.3-16　Cross Section

(2) Trestle

1) Design Condition

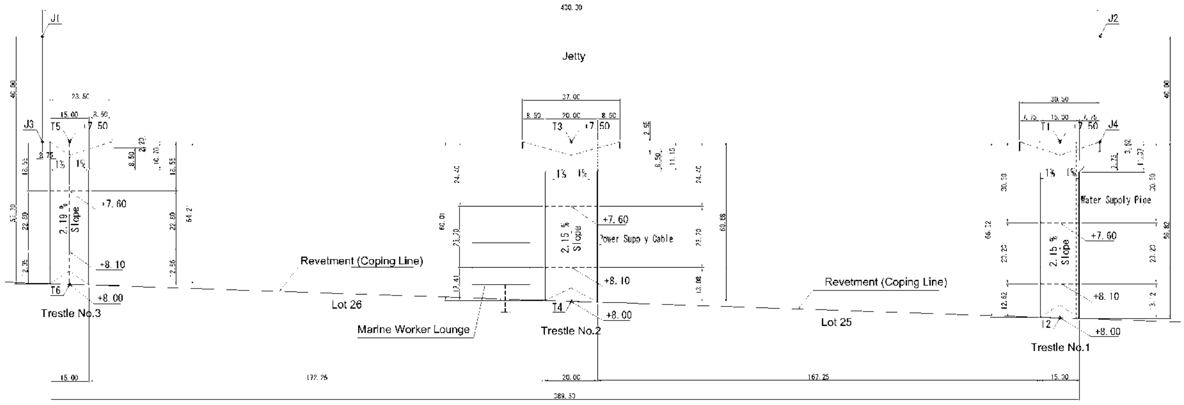
a) Plan Condition

Trestle install three part which access container yard and jetty by trestle.

The floor height of the trestle is the side of the jetty, is +7.50 m, the side of the yard and makes +8.00 m.

Trestle Width :15.m, 20m

Trestle arrangement plan is shown in Figure 4.3-17.



Source : Study Team

Figure 4.3-17 Trestle Arrangement Plan

b) Use condition

- Design use duration : 50 years
- Provision anti-corrosion

Equal to or more than -1.0 m of L.W.L. of the steel pipe pile do the heavy anti-corrosion of coating.

It makes the part which is deeper than -1.0 m of L.W.L. depending on the thickness allowance because the anchoring of pipe line in the cathodic-prote against corrosion protection anode doesn't form in the steel pipe pile in being -2 m - +3 m the height of the ground and the shallowness of it.

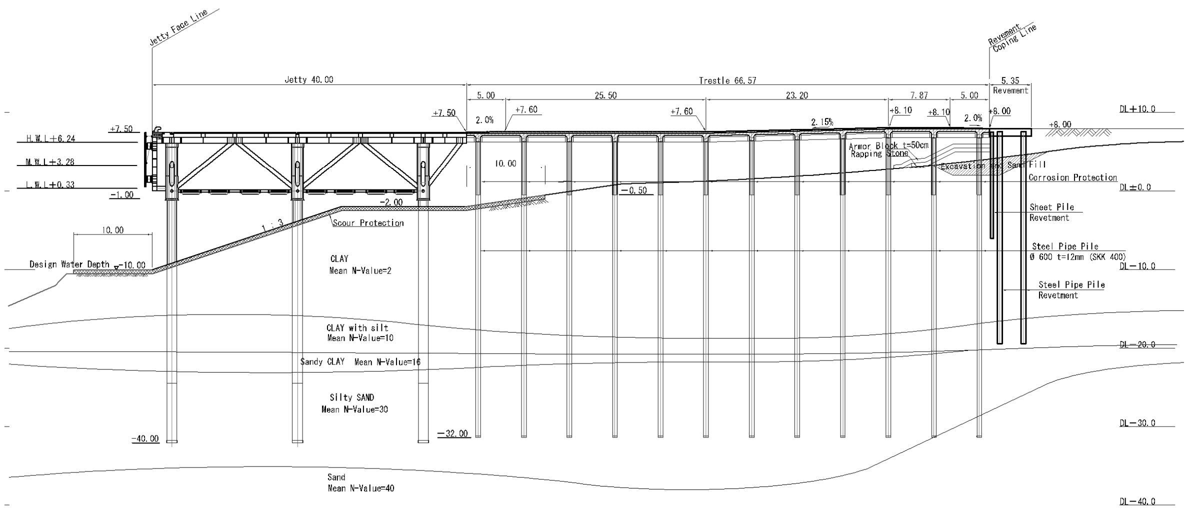
c) Soil Condition

The soil character longitudinal-section of trestle No.1 to No.3 are shown in the outside-back-cover.4.3-11 soil character constant, Figure 4.3-18 to 20.

Table 4.3-11 Soil character fixed number

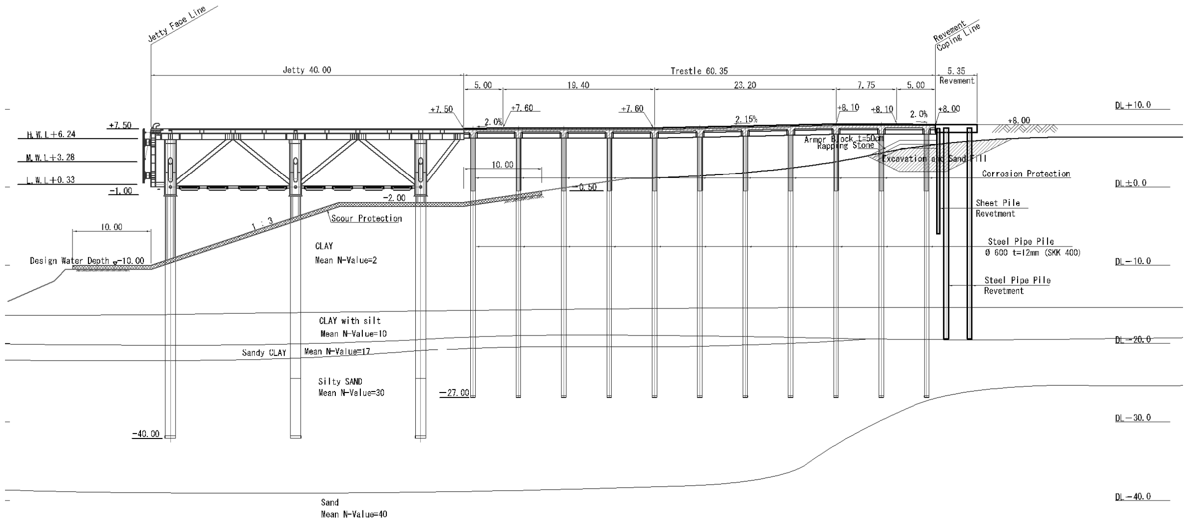
No	Geological feature name	Mean N-Value	Cohesion C (kN/m^2)	Angle of internal friction ϕ (°)	Unit Weight γ (kN/m^3)	Unit Weight γ ’(kN/m^3)	Modulus of deformation E (kN/m^2)
1	Clay	2	C=−1.79 Z+25.81 (Z=0 at D.L ±0.00)	—	17	7	1300
2	Clay with Silt	10	C−1.79 Z+25.81 (Z=0 at D.L ±0.00)	—	19	9	6600
3	Silty Clay	12	50	—	18	8	8000
4	Silty Clay	25	50	—	18	8	16600
5	Sandy Clay	16	50	—	19	9	10600
6	Sandy Clay	17	50	—	19	9	11300
7	Silty Sand	30	—	32	19	10	21000
8	Sand	40	—	34	20	10	28000

Source : Study Team



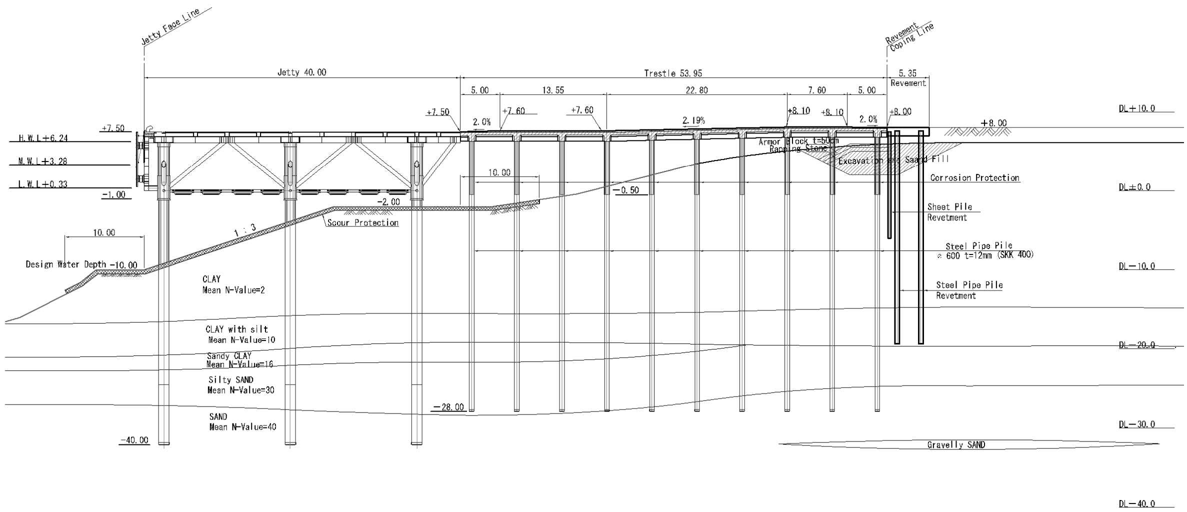
Source : Study Team

Figure 4.3-18 Trestle (No.1) Soil-layer Longitudinal-section



Source : Study Team

Figure 4.3-19 Trestle (No.2) Soil-layer Longitudinal-section



Source : Study Team

Figure 4.3-20 Trestle (No.3) Soil-layer Longitudinal-section

d) Load Condition

i) Surcharge

Ordinary : 20 kN/m2
In earthquake : 10 kN/m2

ii) Live Load

<u>Mobile Crane</u>

It designs with the wheel load at the time of the mobile crane move

Maximum lift load : 2000kN

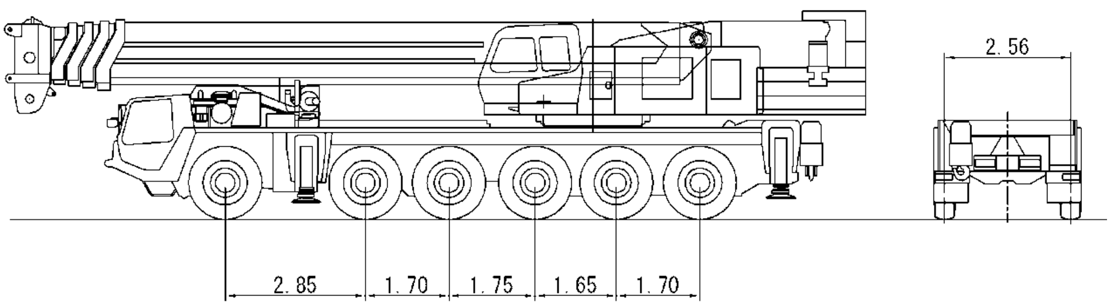
In travel-motion : Gross vehicle weight 979 kN (There being boom, no being counterweight)

A unit load per travel wheel is shown in Table4.3-12 and travelling wheel arrangement plan is shown in Figure 4.3-21.

Table 4.3-12 Unit load per travel wheel at yard internal-transmigration

Axis	No1	No2	No3	No4	No5	No6
Wheel Load (kN)	75.0	75.0	82.3	82.3	82.3	82.3
Tire earth width (m)	0.355	0.355	0.355	0.355	0.355	0.355
Tire bearing area (m^2)	0.13	0.13	0.137	0.137	0.137	0.137
Tire tread pressure (kN/m^2)	576.9	576.9	00.7	600.7	600.7	600.7

Source：Crane maker



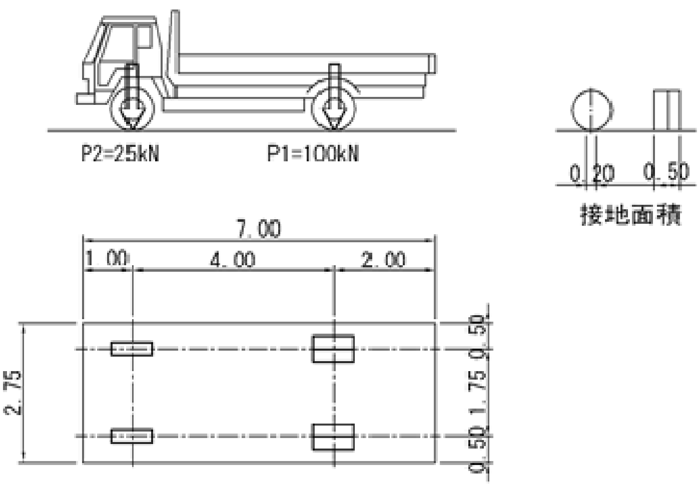
Source : Crane maker

Figure 4.3-21 Wheel arrangement plan of mobile crane

Truck

Truck Type :T-250

Load on wheel at truck and arrangement plan of wheel are shown in Figure 4.3-22.

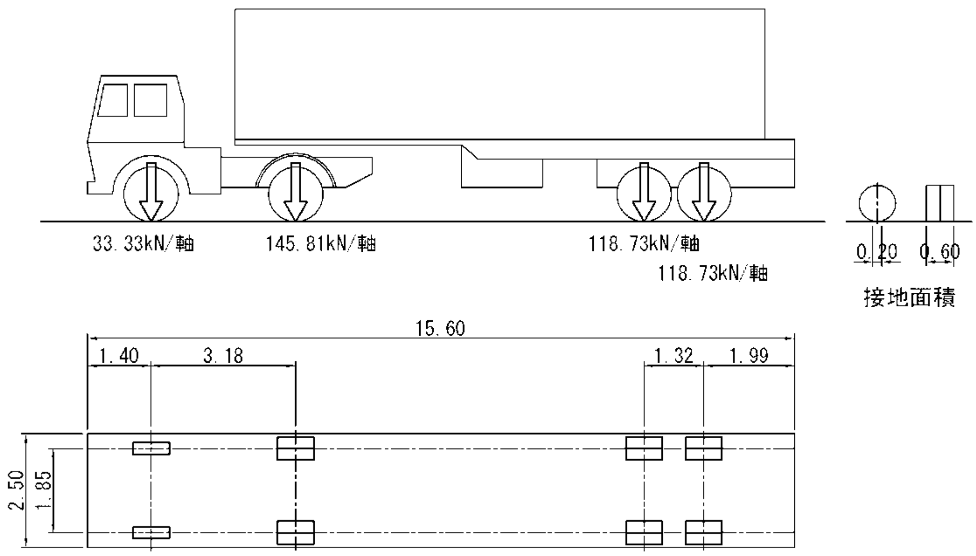


Source : Truck maker

Figure 4.3-22 Load on wheel at truck and arrangement plan of wheel

Tractor Trailer

Load on wheel and wheel arrangement plan of tractor trailer are shown in Figure 4.3-23.

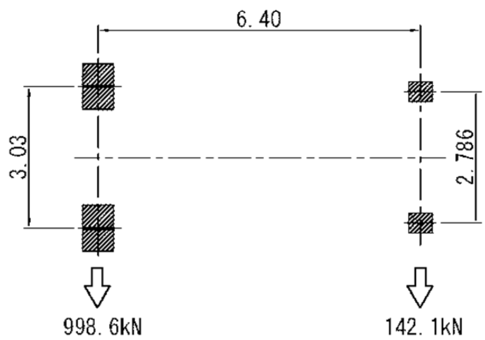


Source : Cargo handling machine maker

Figure 4.3-23 Tractor trailer Load

Reach stacker

Reach stacker load on wheel and a wheel arrangement plan are shown in Figure 4.3-24.



Source : Cargo handling machine maker

Figure 4.3-24 Reach stacker Load

e) Design standard and reference book

- Technical Standers for Port and Harbour Facilities in Japan, Japan Port and Harbour Assoc., SEP, 2007
- Standard Specification for Concrete Structures, Japan Society of Civil Engineers, MAR, 2008

- Specifications for Highway Bridges, Japan Road Assoc., MAR, 2012

2) Structural-calculation

The structure of the trestle is the architecture of the jetty type (Steel pipe pile).

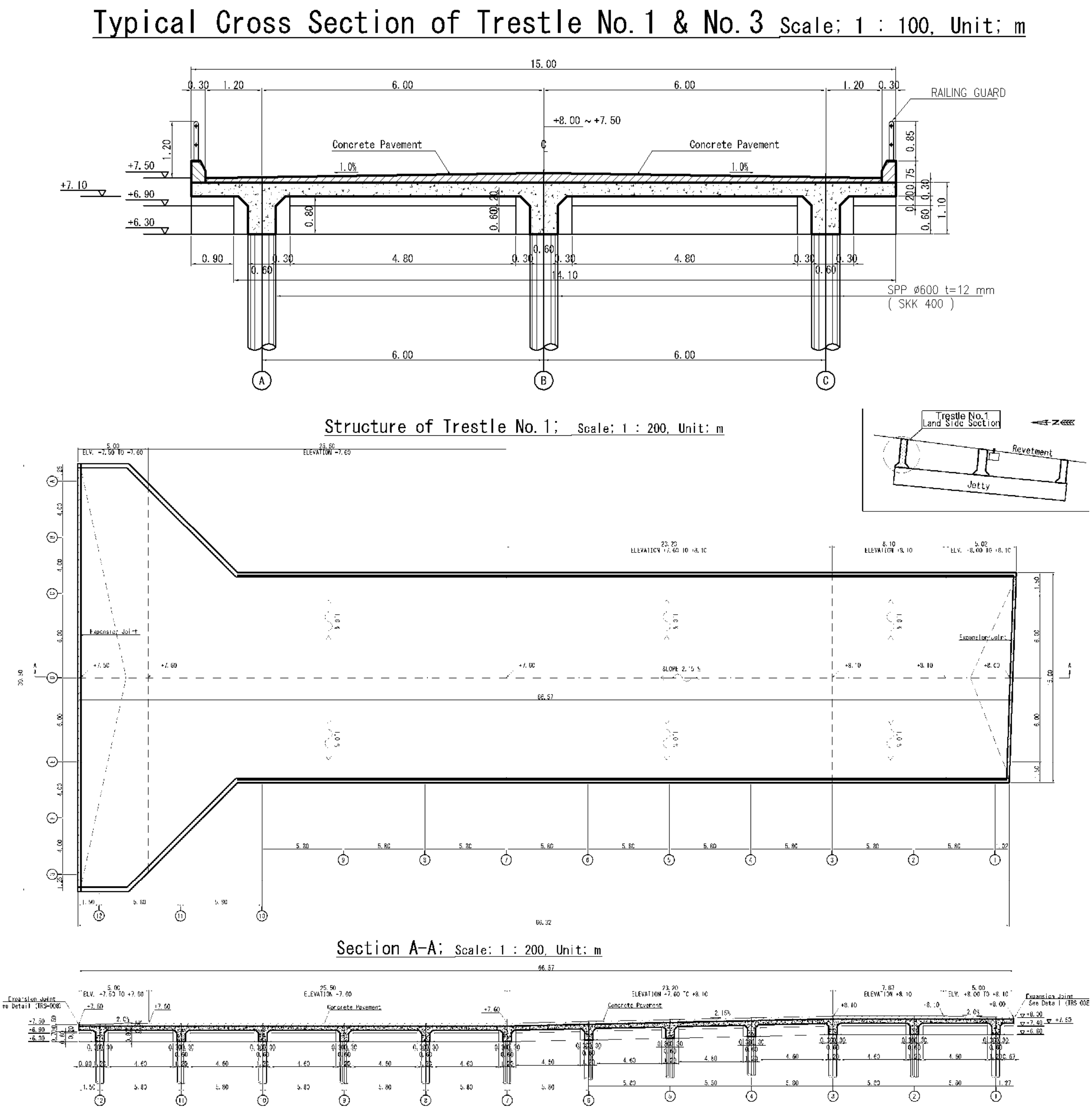
It decide the setting-depth length of the foundation pile (steel pipe pile) cross section and the pile in the structural-calculation in frame component design section computation " SAP2000 (Computers and Structures Inc) ".

The beam does an reinforcing bar arrangement calculation to consider a surcharge and a live load, and to calculate section force (Bending-moment, Shear) by the continuous-beam the bearing of which are piles and to satisfaction an allowable-stress.

The slab does an reinforcing bar arrangement calculation to consider a surcharge and a live load, and to calculate section force (Bending-moment, Shear) at the fixing plate the support-point of which is a beam and to satisfaction an allowable-stress.

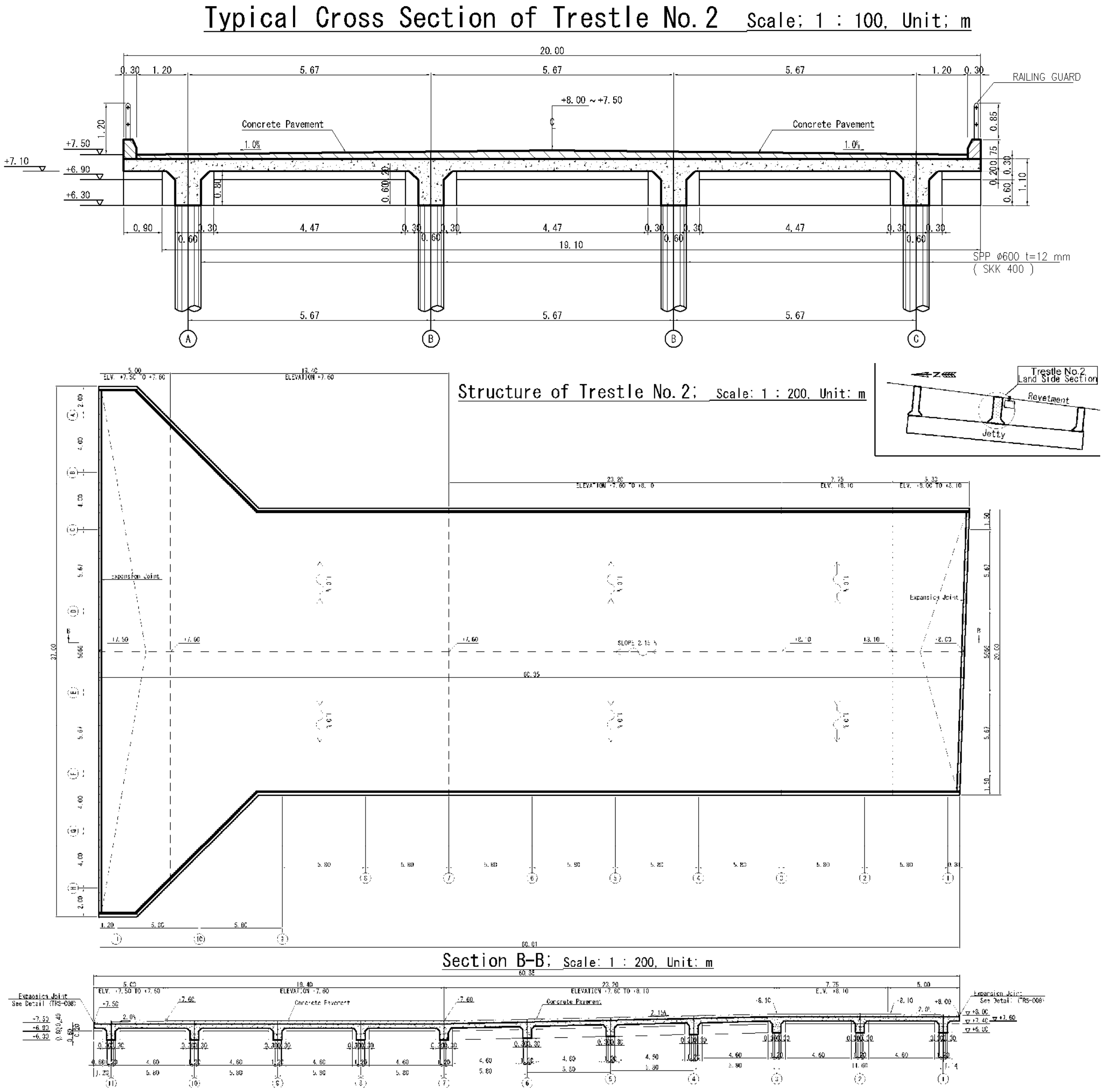
3) Structural Drawing

The structural drawing of trestle No.1 to No.3 are shown in Figure 4.3-25 to 27.



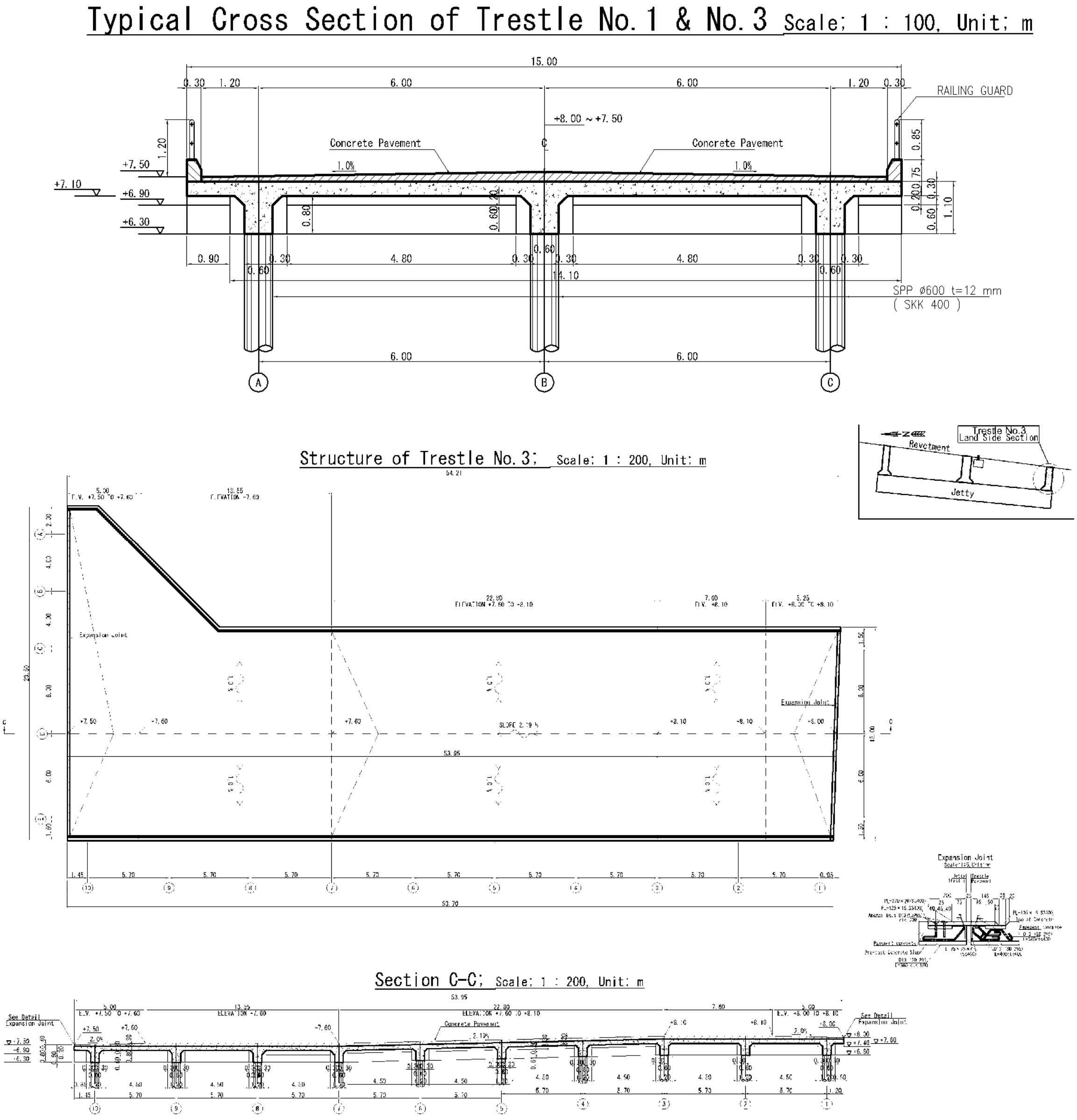
Source : Study Team

Figure 4.3-25 Trestle No.1 Structural Drawing



Source : Study Team

Figure 4.3-26 restle No.2 Structural Drawing



Source : Study Team

Figure 4.3-27 Trestle No.3 Structural Drawing

(3) Design of Revetment

1) Design Conditions

a) Design Criteria

The revetment is designed by the following standards in Japan.

- Technical Standards and Commentaries for Port and Harbour Facilities in Japan by Overseas Coastal Area Development Institute of Japan, 2009
- Standard Specifications for Concrete Structures by Japan Society of Civil Engineers,

2007

- Specifications For Highway Bridges by Japan Road Association, 2002 and 2012

b) Facility Dimensions

- Existing condition : natural river bank
- Crown Height : +8.00m (Crown Height of Superstructure)
- Life time : 50 years

c) Natural Condition

i) Tide Condition

H.H.W.L.	Highest water level	D.L.+7.10 m
H.W.L.	Mean high water level	D.L.+6.24 m
M.W.L.	Mean water level	D.L.+3.28 m
L.W.L.	Mean lowest level	D.L.+0.33 m
D.L.	Datum level	D.L.+0.00 m

ii) Current Velocity and Direction

Based on the hearing results to MPA, maximum current speed is decided as below. The direction is based on survey by Study Team in 2012.

Current velocity : 6 knots = 3.1 m/s,

Upperstream : south to north

Downstream : north to south

iii) Wave

From the DF/R 1 on this Study, design wave direction and significant wave height and period are decided as below.

Wave direction	H1/3(m)	T1/3(s)
SW，NW	1.7	3.5
NW	1.7	3.5

iv) Seismic Coefficient

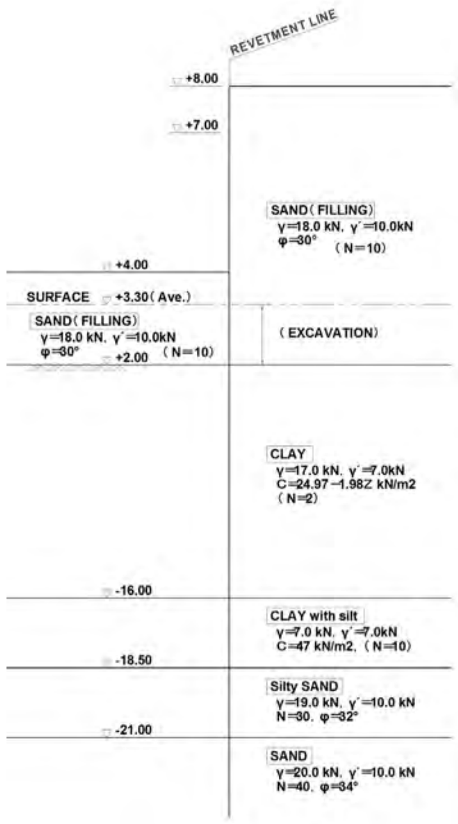
From the DF/R 1 on this Study, design seismic coefficients are decided as below.

Horizontal : kh = 0.15

Vertical : kv = 0.00

v) Soil Condition

Geotechnical design parameters of each layer are set as shown in the below figure based on the survey report of “Repot on Soil Investigation for Part A”. The existing grand level of the south side is higher than that one of the north side. The difference of the height is about 1.0m. The existing grand level for design is assumed at 3.3 m (average).



Source : Study Team

Figure 4.3-28 Designed Soil Condition

vi) River Bank Erosion

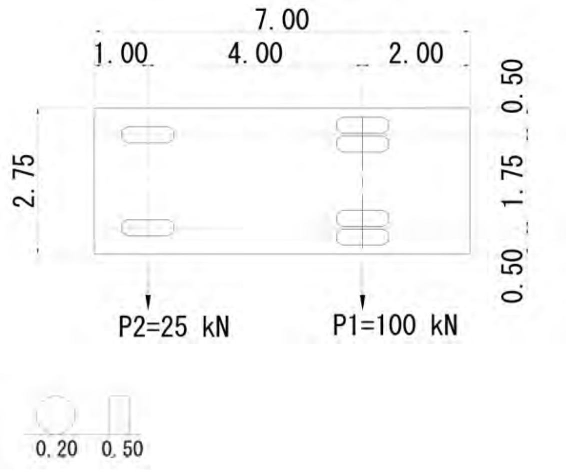
Refer to the DF/R 1, erosion has been occurred several meters a year at a river bank line at the site of the Project, because of the high speed current both upper-stream and downstream. So it is needed to do a counter measure such as installing a covering material.

d) Surcharge and Live Load

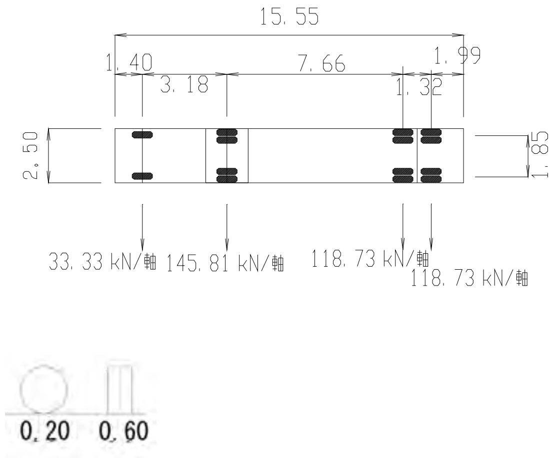
i) Surcharge

Ordinary Condition (q1) : 20kN/m2
Seismic Condition (q2) : 10kN/m2

ii) Track and Tractor Trailer Load



Track load



Tractor Trailer Load

Source : Study Team

Figure 4.3-29 Load of Track and Tractor Trailer

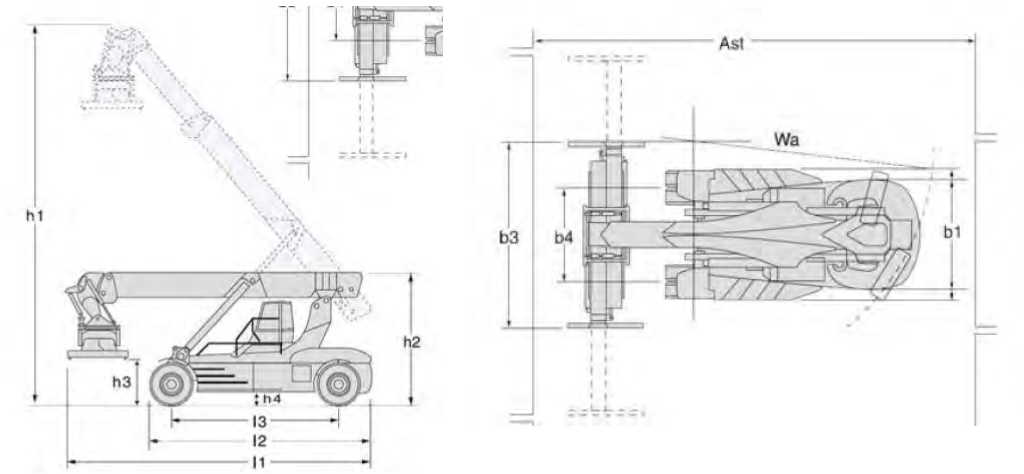
iii) Reach Stacker

Dimensions of reach stacker are shown as below.

Table 4.3-13 Dimensions of Reach-stacker

Number of the maximum container (9' 6") product upper sections		5 lows
Vehicle weight		689.92 kN
Axle load (on-load)	Front	998.62 kN
	Back	142.10 kN
Number of the tires	Front	4 nos.
	Back	2 nos.
Full length (In case of the boom storage) (l1)		11.618 m
Full length (boom / body to exclude) (l2)		8.41 m
Width (body) (b1)	Front	4.18 m
Full length (boom to exclude) (l2)	Back	3.40 m
Wheel base (l3)		6.40 m
Axis distance (b4)	Front	3.03 m
Wheel base (l3)	Back	2.786 m

Source : Study Team



Source : Crane Maker

Figure 4.3-30 Load of Track and Tractor Trailer

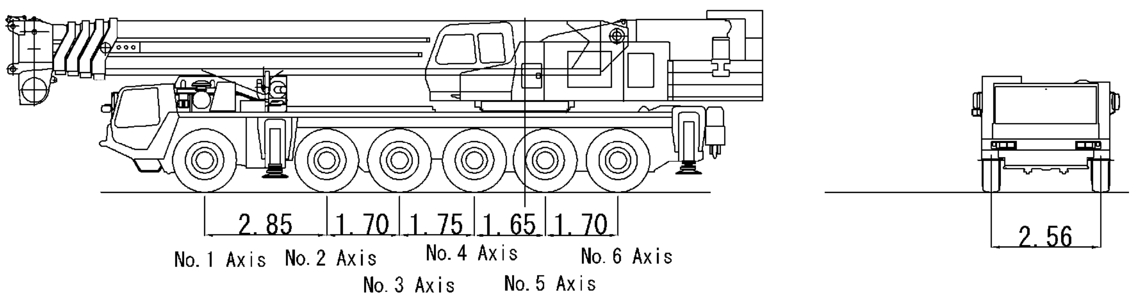
iv) Mobile Crane

Maximum of lifting loads is 200ton. The load of wheels are shown in the below.

Table 4.3-14 Dimensions of Mobile Crane

Item	NO.1 Axis	No2 Axis	No.3 Axis	No.4 Axis	No.5 Axis	No.6 Axis
Load on wheel (kN)	75.0	75.0	82.3	82.3	82.3	82.3
Tire grounding width (m)	0.355	0.355	0.355	0.355	0.355	0.355
Tire bearing area (m2)	0.13	0.13	0.137	0.137	0.137	0.137
Tire contact area pressure (kN/m2)	576.9	576.9	600.7	600.7	600.7	600.7

Source：Crane Maker



Source : Crane Maker

Figure 4.3-31 Load of Mobile Crane

e) Corrosion Rates of Steel

Corrosion rates of steel materials are designed as below by Japanese Standard.

Table 4.3-15 Corrosion Rates of Steel

Corrosive environment		Corrosion Rate(mm/Year)
Sea side	Above H.W.L	0.30
	H.W.L～L.W.L-1.0m	0.20
	L.W.L-1.0m～the sea bottom	0.15
	Below the sea bottom	0.03
Land side	In marine atmosphere	0.10
	In soil(above the residual water level)	0.03
	In soil(below the residual water level)	0.02

Source : Technical Standers for Port and Harbour Facilities in Japan

f) Soil Improvement

Soil improvement of the whole Project site is planned. Revetment structure is planned to construct after the soil improvement.

Refer to the Chapter "Soil Improvement", Quantity of Subsidence of the ground after improvement operation is 15cm or less and the influence on structure caused by quantity of Subsidence has negligible impact. So the subsidence after improvement operation is taken no thought.

2) Selection of Structural Type

a) Comparison of Four Types

Four structural types are compared as shown in the below table. The characteristic of them is also shown in the table.

i) Points of Selection

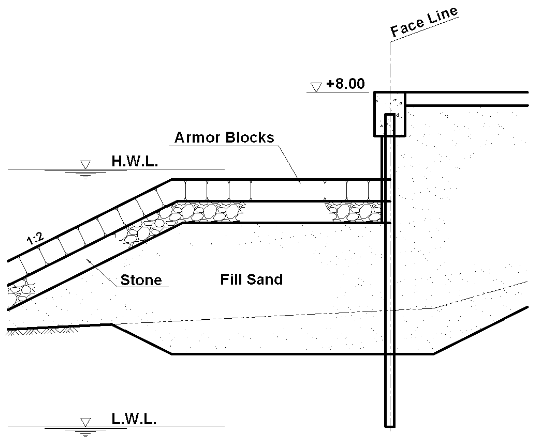
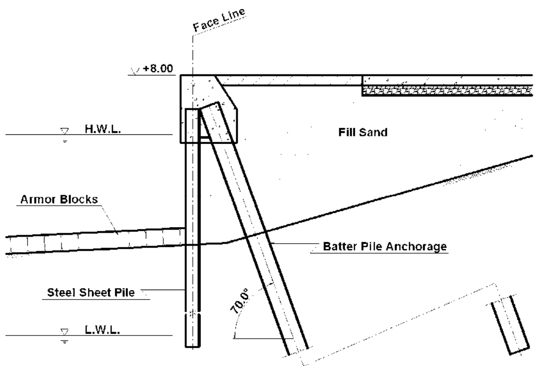
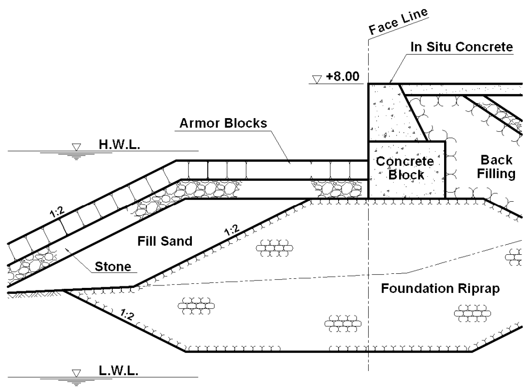
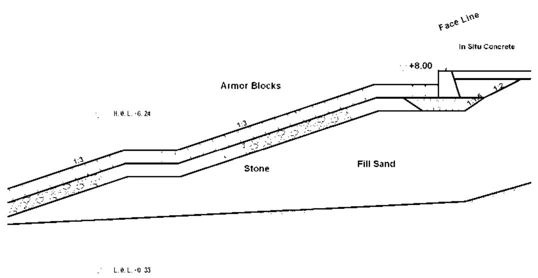
The following three-points are important for the selection of the structure type.

- Small blockade cross section area for river flow
- Possibility of high speed construction
- Certainty of construction

ii) Material of the Sheet Pile

Sheet pile has two type materials of steel and reinforced concrete. Steel material of sheet pile is often selected for berth structure because of its easy to casting, cost, structural characteristic, and others in Japanese. And by a superior rust prevention technology, it can’t become the problem that easiness of rust of steel materials. As the result of the Study, steel sheet pile is selected as better than RC sheet pile in this project, too.

Table 4.3-16 Comparison of Revetment Structure Type

 Cantilever Sheet Pile - TYPE	Cantilever Sheet Pile Type Advantage : - Blockade cross section area is small. - It is possible to rapid construction. Disadvantage : - Need the excavation and fill sand to -2.0m.
 Batter Pile Anchorage-TYPE	Batter Pile Anchorage Type Advantage : - Blockade cross section area is small. - Horizontal displacement is very small. Disadvantage : - Need length of batter pile anchorage is very long. - Construction cost is higher than cantilever sheet pile type.
 Concrete Gravity - TYPE	Concrete Gravity Type : Advantage - Blockade cross section area is small. - Certainty of construction. Disadvantage : - Large amount of soil and the wide area of land side to ground improvement - It is impossible to rapid construction.
 Gentle Slope - TYPE	Gentle Slope Type Advantage : Low cost to construction. Disadvantage : Blockade cross section area is very large.

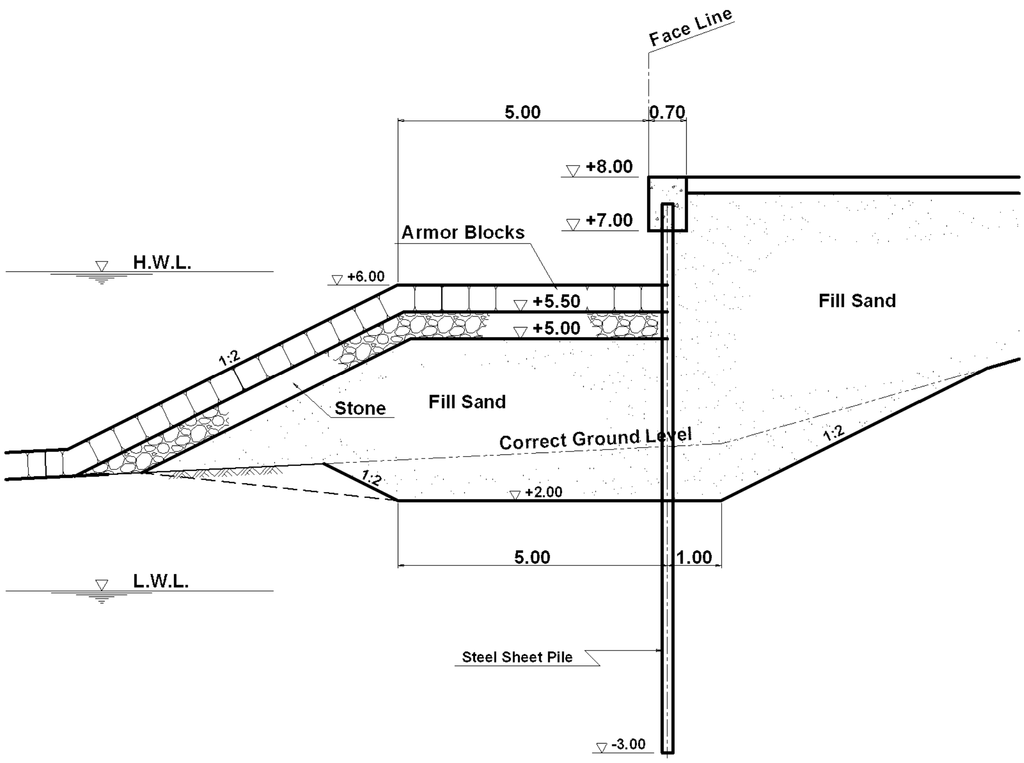
Source : Study Team

b) Selection Result

As a result of examination, Cantilever sheet pile type is selected as the superior construction.

c) Maintenance at Operation Stage

Armor concrete blocks are installed on the top of some layers of soil and stones in front of sheet pile structure. Because the river bank area is vulnerability zone by the lateral erosion, monitoring and maintenance of armor block sounding and sheet pile degrees will be needed at the operation stage.



Source : Study Team

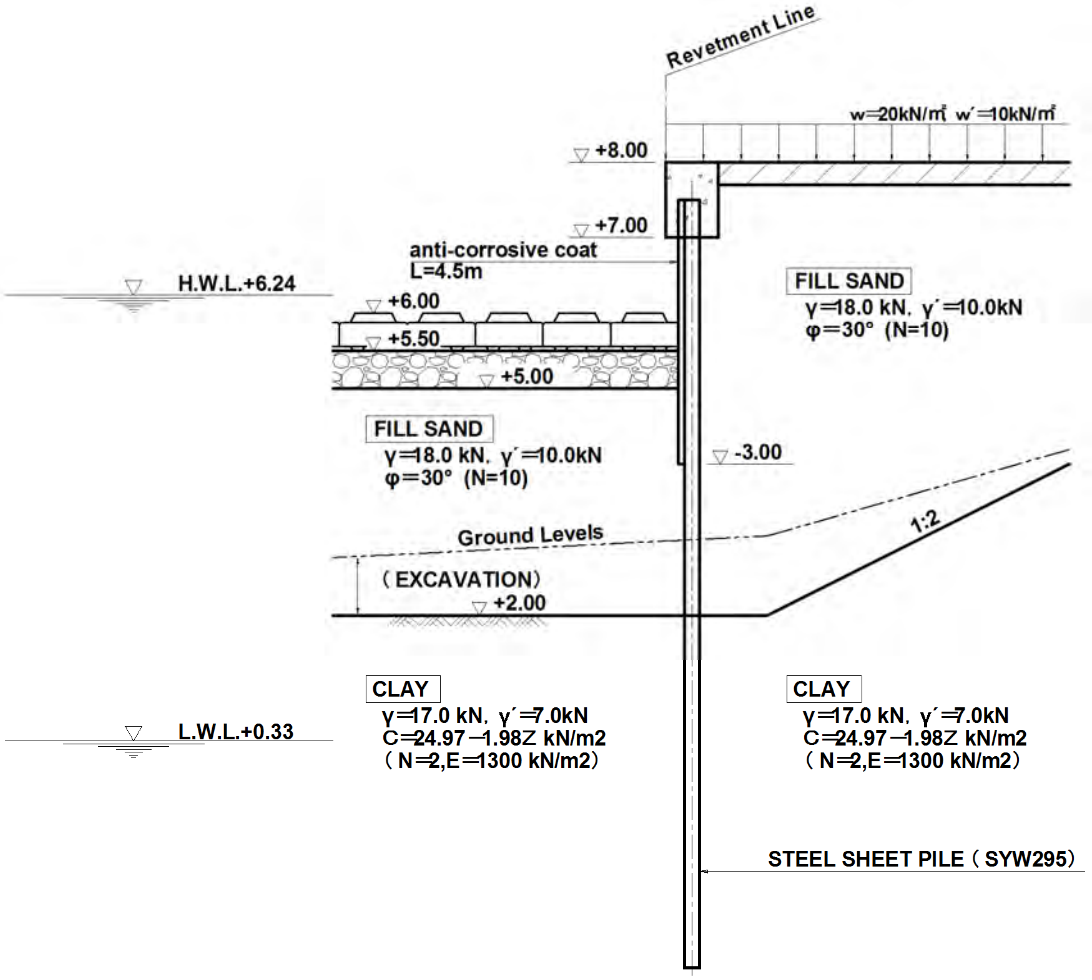
Figure 4.3-32 Selected Type for Revetment

3) Detail Design

a) Design of General Part

i) Model for Stability Analysis

Stability of the revetment is analyzed by the model as below figure.



Source : Study Team

Figure 4.3-33 Typical Cross Section for Design Calculation

ii) Analysis Conditions

In this study, two types of conditions are assumed.

CASE1	Permanent Condition	Ordinary condition
CASE2	Seismic Condition	Level 1 earthquake ground motion

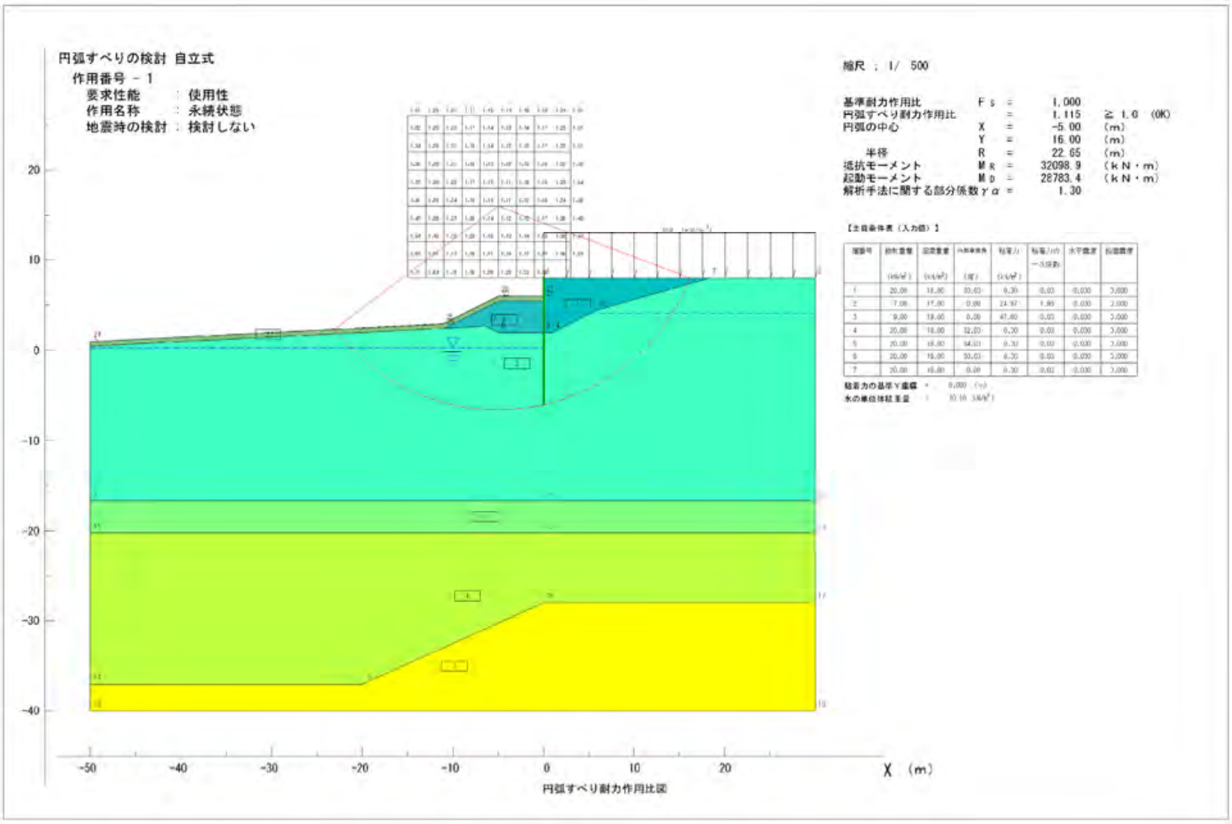
iii) Result of Calculation

The below table shows the result of calculation.

Table 4.3-17 Comparison of Revetment Structure Type

	Corrosion	Value			Evaluation
		Unit	Calculation	Limit	
Stress	Before	N/mm2	69.4	295	O.K.
	After	N/mm2	90.2	295	O.K.
Displacement	Before	cm	2.499	10	O.K.
	After	cm	2.598	10	O.K.
Circular Slip			1.115	1	O.K.
Penetration length	Before	m	5.924	11	O.K.
	After	m	5.843	11	O.K.

Source : Study Team



Source : Study Team

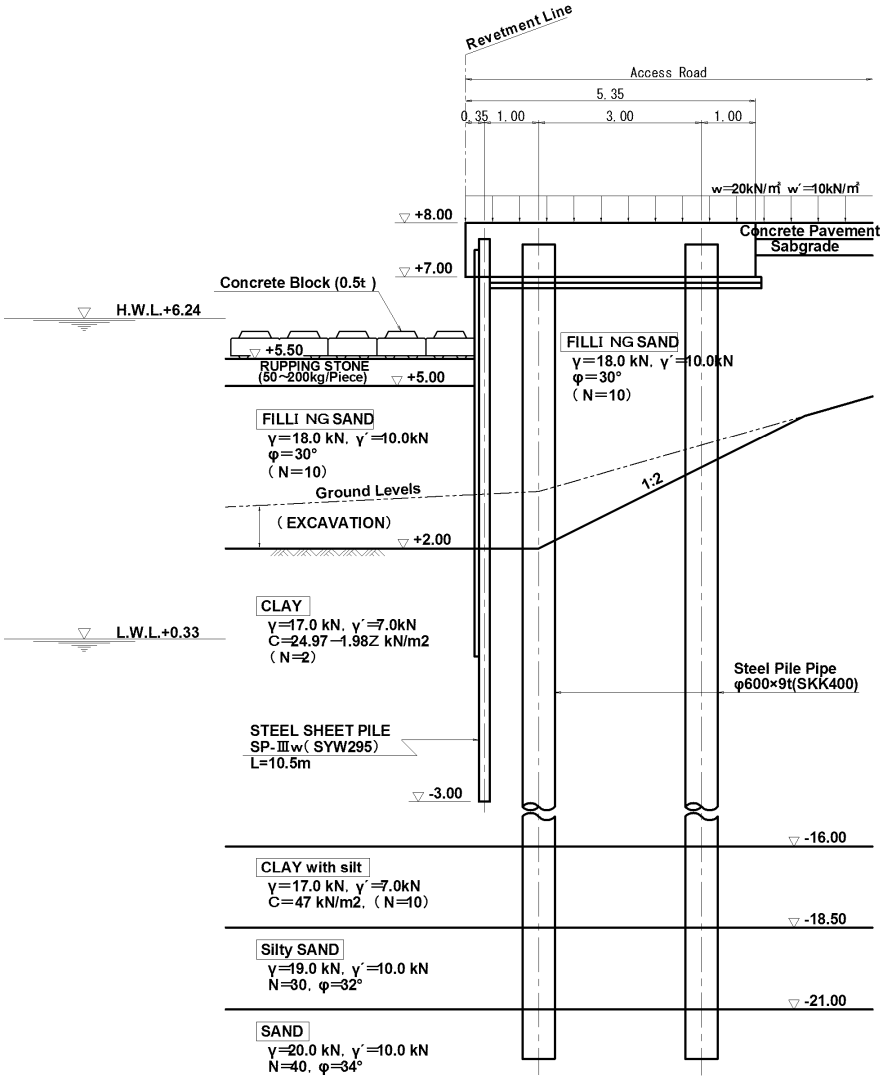
Figure 4.3-34 Result of Circular Slip Analysis

b) Design of Armor Concrete Block

The soil portions in front of sheet pile structure have to be covered against erosion. Concrete armor blocks are selected as the covering material because of cost and procurement condition. Minimum weight of block (Required Mass for Stability) is estimated at one ton by formula by Japanese standard.

c) Design of Connection Part

The below figure is the typical cross section for the design of connection parts between trestle and yard.



Source : Study Team

Figure 4.3-35 Typical Cross Section of Connection Point

i) Case of Conditions

In this study, two types of conditions are assumed.

Table 4.3-18 Estimated Myanmar Population by Region

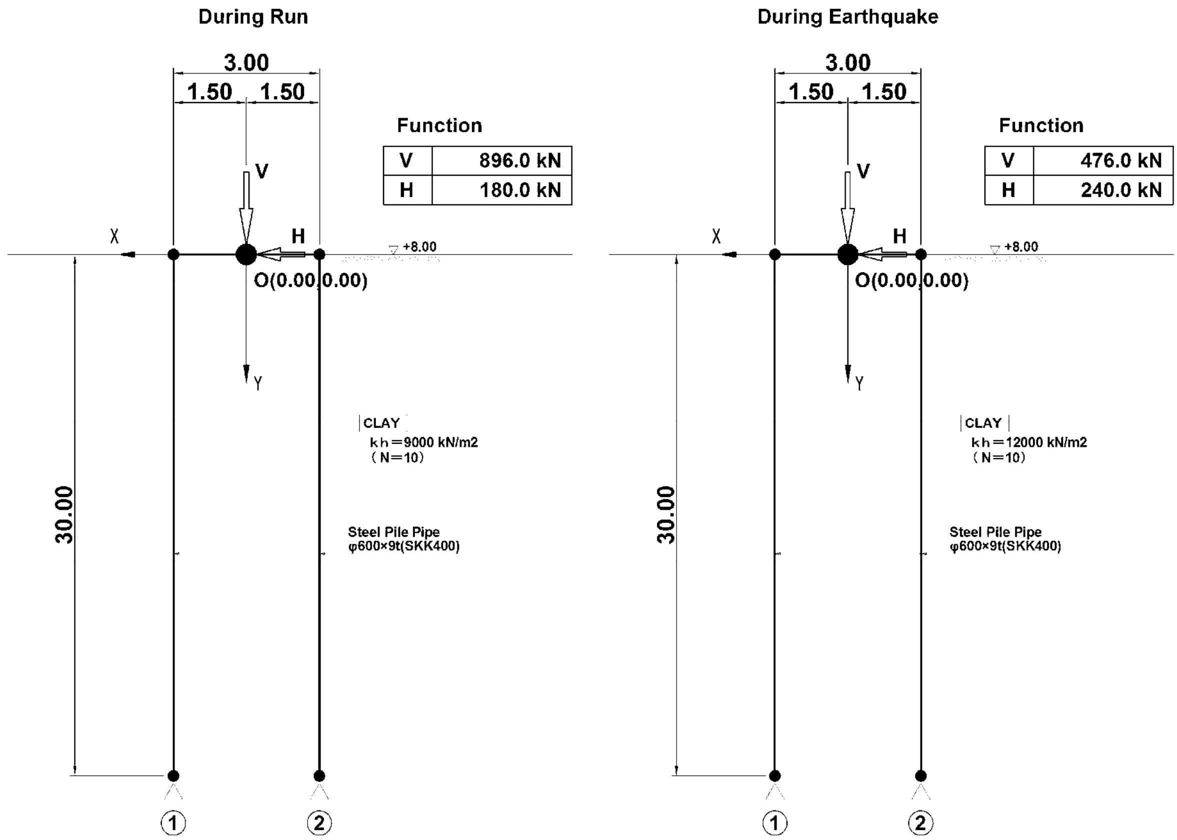
CASE1	Vehicle load condition	loading of vehicles as shown above Clause (3) 1) d)
CASE2	Seismic condition	Level 1 earthquake ground motion

Conditions	Vertical Force			Horizontal Force	
	Dead Load	Surcharge	Live Load	Earth Pressure	Seismic Force
Vehicle load	○		○	○	
Seismic	○	○		○	○

Source：Study Team

ii) Structural Analysis

The stress of pile calculated used to the 3D-Frame analysis program of “RADO”. The model of calculation and result is shown below.



Source : Study Team

Figure 4.3-36 3D Calculation Model of Connection Point

Table 4.3-19 Calculation Result of Pile Stress

Situation	No.	Pd (kN)	Rtd (kN)	γa	Ratio	Judgment
Vehicle load condition	①	578.71	902.88	1.0	1.56	OK
	②	317.29	902.88	1.0	2.85	OK
Seismic Earthquake	①	399.48	1489.75	1.0	3.73	OK
	②	76.52	1489.75	1.0	19.47	OK

Source：Study Team

4.3.2. Soil Improvement

Soft clay layer deposits in the project area with a thickness of around 22m. It is predicted that significant settlement occurs over a long period of time after fill construction on the soft ground. To protect the settlement problem, some measures for soft ground improvement were studied in the basic design stage. As a result of comparing some methods, Prefabricated Vertical Drain (PVD) with surcharging was selected as a most suitable method from a view of economy, social environment and workability. In this section, the detailed design for soft soil improvement by PVD with surcharging is described.

(1) Design Condition

Design condition is set based on Feasibility Study (FS) Report.

1) Utility condition

Service life of port facilities is set to 50 years.

2) Natural Condition

a) Tide level

The tide levels computed by a harmonic analysis based on tide level observation in the Thilawa area for one year (2009-2010) are summarized in the following Table.

Table 4.3-20 Tide Level

TIDE	HEIGHT
HHWL	+7.10m
HWL	+6.24m
MWL	+3.28m
LWL	+0.33m
CDL	+0.00m

Source : Urgent Rehabilitation Project of Yangon Port and Inland Water Transport, JICA

b) Current

Followings are set based on FS report.

- The flow velocity (Max velocity) : 6kt = about 3.1(m/s)
- Current Direction (Maximum velocity) is ebb tide flow.

c) Wave

Followings are set based on FS report.

Table 4.3-21 Design Wave

Height H1/3(m)	H1/3=1.7m
Period T1/3(m)	T1/3=3.5s
Wave direction	SW,NW

Source：Study Team

d) Earthquake

Followings are set based on FS report.

Horizontal seismic coefficient: Kh = 0.15

Vertical seismic coefficient : Kv = 0

(2) Design of Soil Improvement

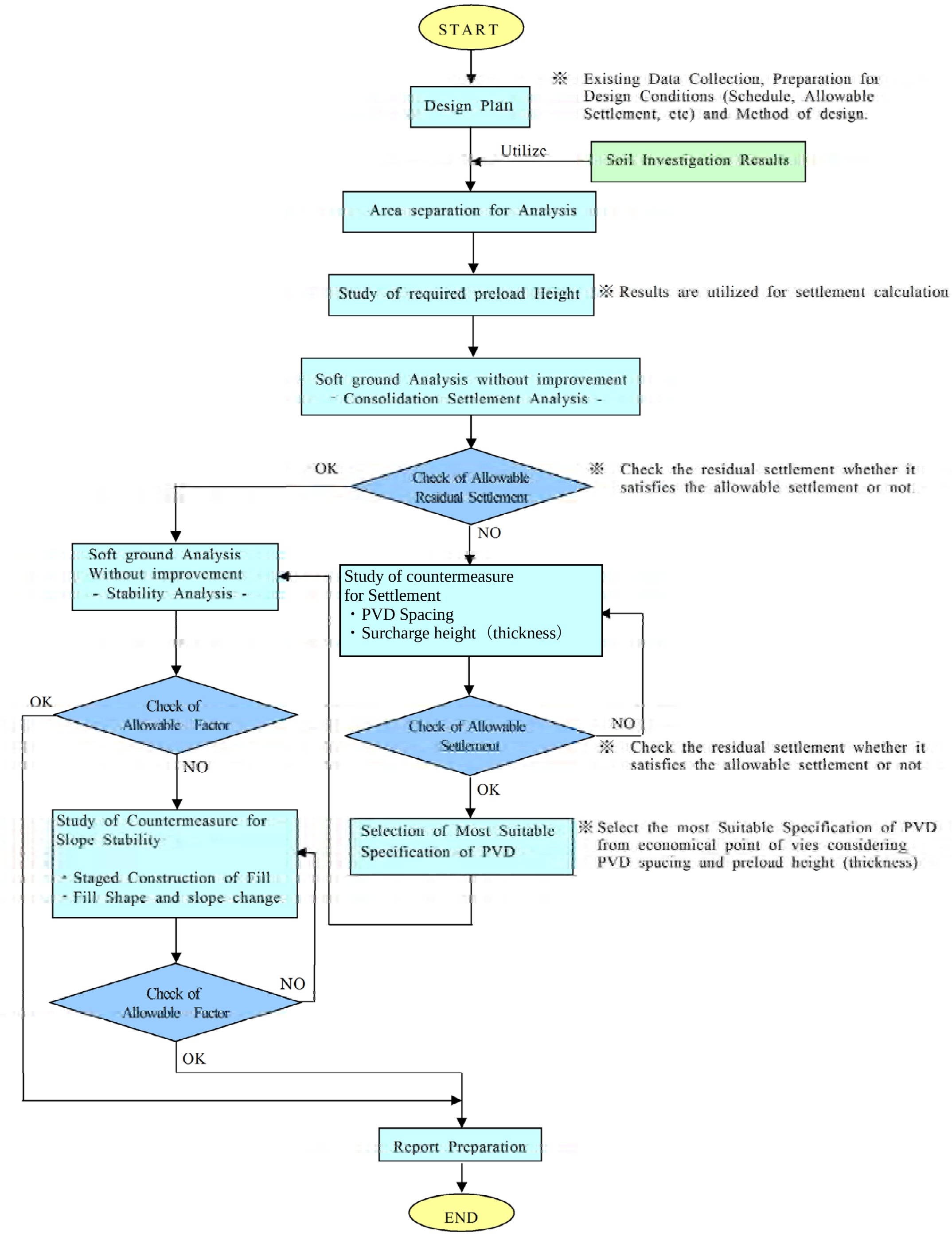
1) Outline

PVD with surcharge method is adopted to the site as a soil improvement method. PVD with surcharge method is most common as a soil improvement method aiming at accelarating consolidation and also it has been used succeessfuly.

In this section, the detailed desighn for solil improvement using PVD with surcharge is describved.

2) Procedure of design

The flow of soil improvement is shown in Figure 4.3-37.



Source : Study Team

Figure 4.3-37 Flow of Soil Improvement

3) Design criteria and design condition

Design criteria and design condition are shown in Table 4.3-22.

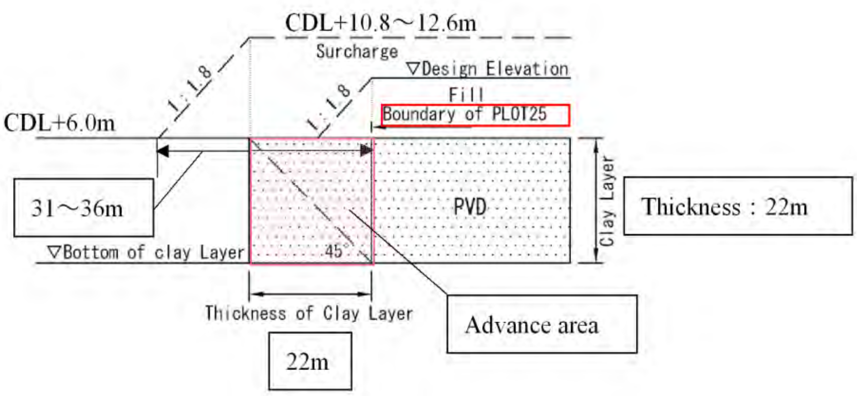
Table 4.3-22 Summary Table of Design Criteria and Design Condition

Item	Design Criteria and Condition
(a) Allowable Safety Factor for Slope Stability	・Short Term : Fsa≧1.10 (During Construction) ・Long Term : Fsa≧1.30 (After completion of construction)
(b) Lateral Coefficient of Consolidation (Ch)	・Lateral Coefficient of Consolidation Ch=1×Cv (Cv : Vertical Coefficient of Consolidation)
(c) Removal of Surcharge Fill	・More 90% of Primary consolidation shall be completed. ・Allowable residual Settlement at opening of port : less than 20% of settlement generated for 20 years after opening of port.(Including secondary consolidation) ・Allowable residual settlement at opening of port : less than 30cm of settlement generated for 20 years after opening of port.(Including secondary consolidation)
(d) Design Load (q)	During construction : q＝10kN/m^2(Load of construction equipment) After opening of port : Container yard q＝50kN/m^2, Building area q＝20kN/m^2
(e) Water Level	・HWL (High Water Level) : CDL+6.24m ・MWL (Mean Water Level) : CDL+3.28m (for Consolidation Settlement Analysis) ・LWL(Low Water Level) : CDL+0.33m (for Slope Stability Analysis : River Side) ・RWL(Residual Water Level) : CDL+6.00m (for Slope Stability Analysis : Land side) CDL+2.30m (for Slope Stability Analysis : Jetty side)
(f) Design Elevation	・ CDL+9.00m(Subgrade level = Surcharge removal level = CDL+8.50m, Pavement = 50cm)
(g) Construction Progress Ratio	・PVD Installation : 35,000m/day with 7 parties → 58 days /construction total area ・Sand Mat : 3,000 m^3/day → 0.1m height/week /construction total area ・Surchage : 5,000m^3/day → 0.2m height/week /construction total area ・Removal of Surchage : 2,800m^3/day→ 0.1m height/week /construction total area
(h) Period for Fill Work	・Period for Fill Work including Subsoil Improvement : 15.0 months
(i) Retaining Period of Surcharge	・6 months
(j) Influence Range of settlement by loading*)	・Influence range of settlement by loading : Equivalent to thickness of clay layer (45 degree).

*) Contiguous Area to Future Site

After opening of port (PLOT25), cracks and settlement of existing pavement might be formed by the looseness and settlement of subsoil caused by the fill load of future's expansion work next to this project area. The dimensions impacted by the future fill works will be considered as shown in the following figure. The influence distance from the boundary of future expansion site will be about 22 m (Lowest bottom level CDL-16m and Status Elevation of Port area CDL+6.0m ≈ 22m). Accordingly, this area will be improved in this project in advance as following drawing.

Source : Study Team



Extra improvement area considering future impact at next to project area

4) The Details of Design Conditions

a) Load condition

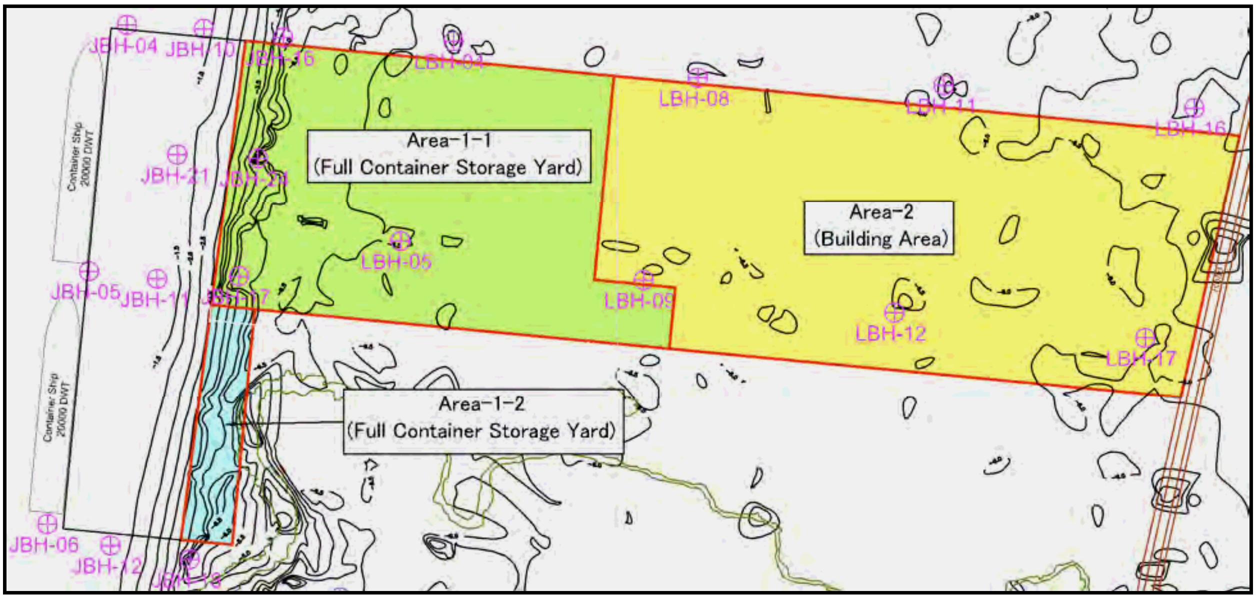
In the project area, soft layer deposits from the ground surface to the depth of around CDL-16.0m as shown in following soil profile. The thickness of the soft layer is at maximum 22m and the thickness is almost uniform in the project area. The project area is classified in three area in consideration of the load condition from a viewpoint of land use in future.

Accordingly, the load condition after opening of port is set as followings. During the construction period, the load condition is set 10 kN/m^2 as a construction equipment load for the stability analysis.

- Area-1-1 :Container area (including Bulk area). Opening of port is at end of November 2015. This area is to stock container outside (hereinafter referred to as "Full Container Storage Yard"). The load of the Container is set to be 50kN/m^2.

- Area-1-2 :Container area. Opening of port is at end of December 2016. This area is to stock container outside (hereinafter referred to as "Full Container Storage Yard"). The load of the Container is set to be 50kN/m^2.

- Area-2 :Building Area except Area-1-1 and Area-1-2. The load of Building is set to be 20kN/m^2(exclude pile foundation load).



Source : Study Team

Figure 4.3-38 Area Classification

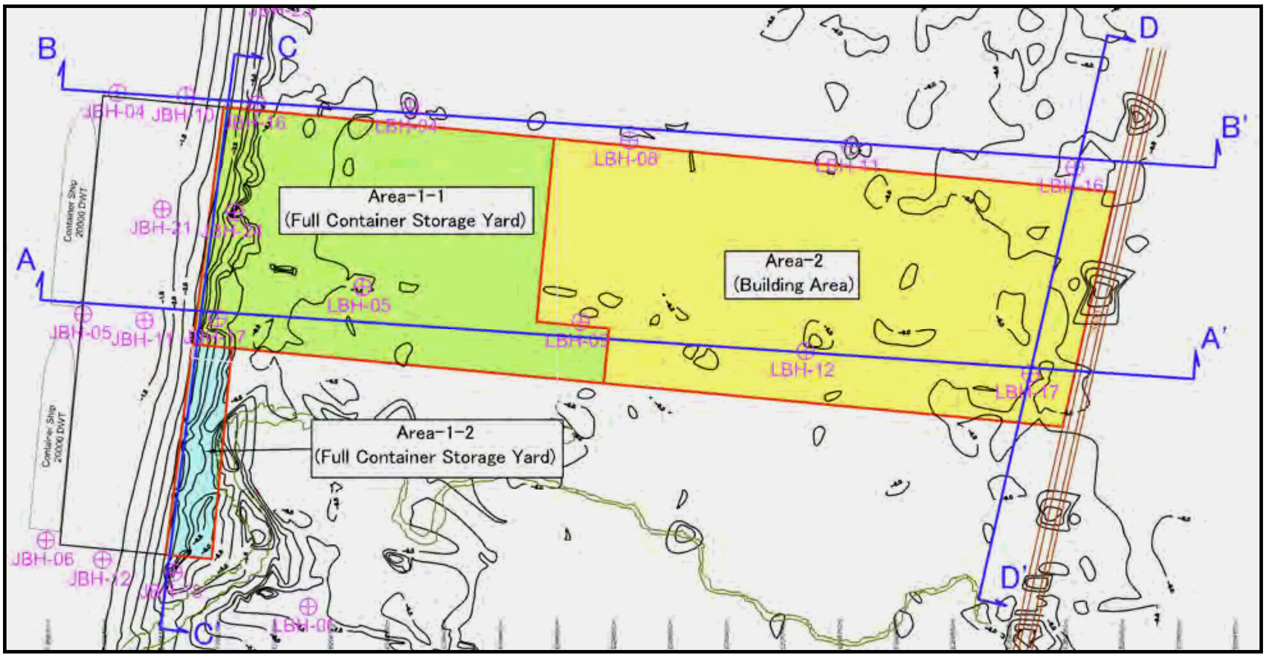
b) Ground Condition

The location of existing boring points and representative soil profile at the project area is shown in Figure 4.3-39～4.3-41. In the project area, significant soft soil deposits from the ground surface to the depth of CDL-16m. Under the soft soil layer, Silt with clay layer deposits up to the depth of CDL-23m and then, Sand with silt layer deposits up to CDL-27m. Under the layer, comparatively dense Sand layer deposits and N-value becomes over 50 at the depth of around CDL-35m.

The object layer for settlement analysis in the design is soft soil layer depositing at upper portion. Even though the thickness of soft soil layer tends to decrease forwarding to west river side from east existing road side in the direction of longitudinal section, significant difference of the thickness can not be seen significantly.

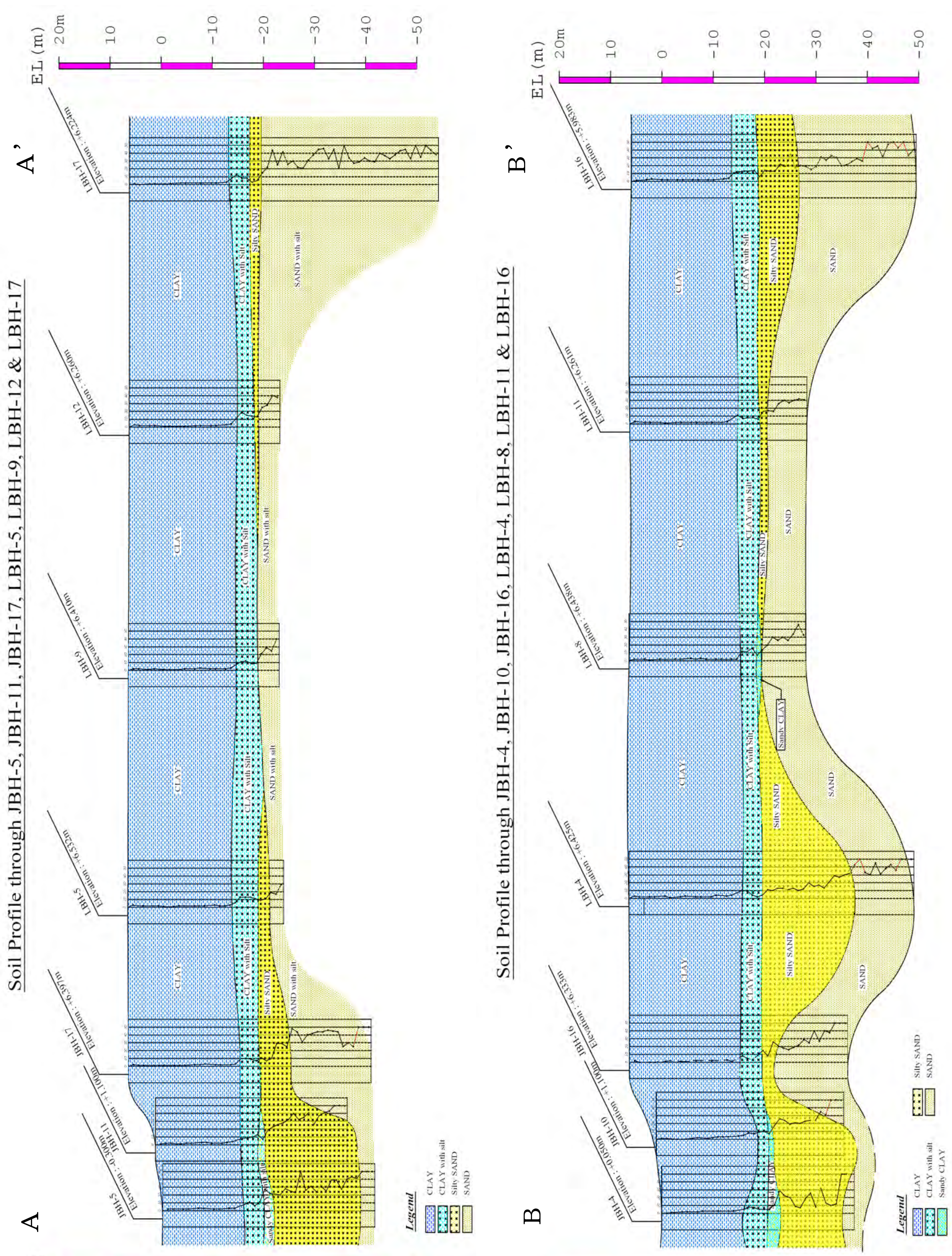
The original ground level is around CDL+6.0m and the thickness of soft clay layer is around 22m at maximum (the bottom of Clay layer is CDL-16m).

Soil parameters applied for the design is set based on existing soil laboratory test results (FS Report) and shown in Table 4.3-23.



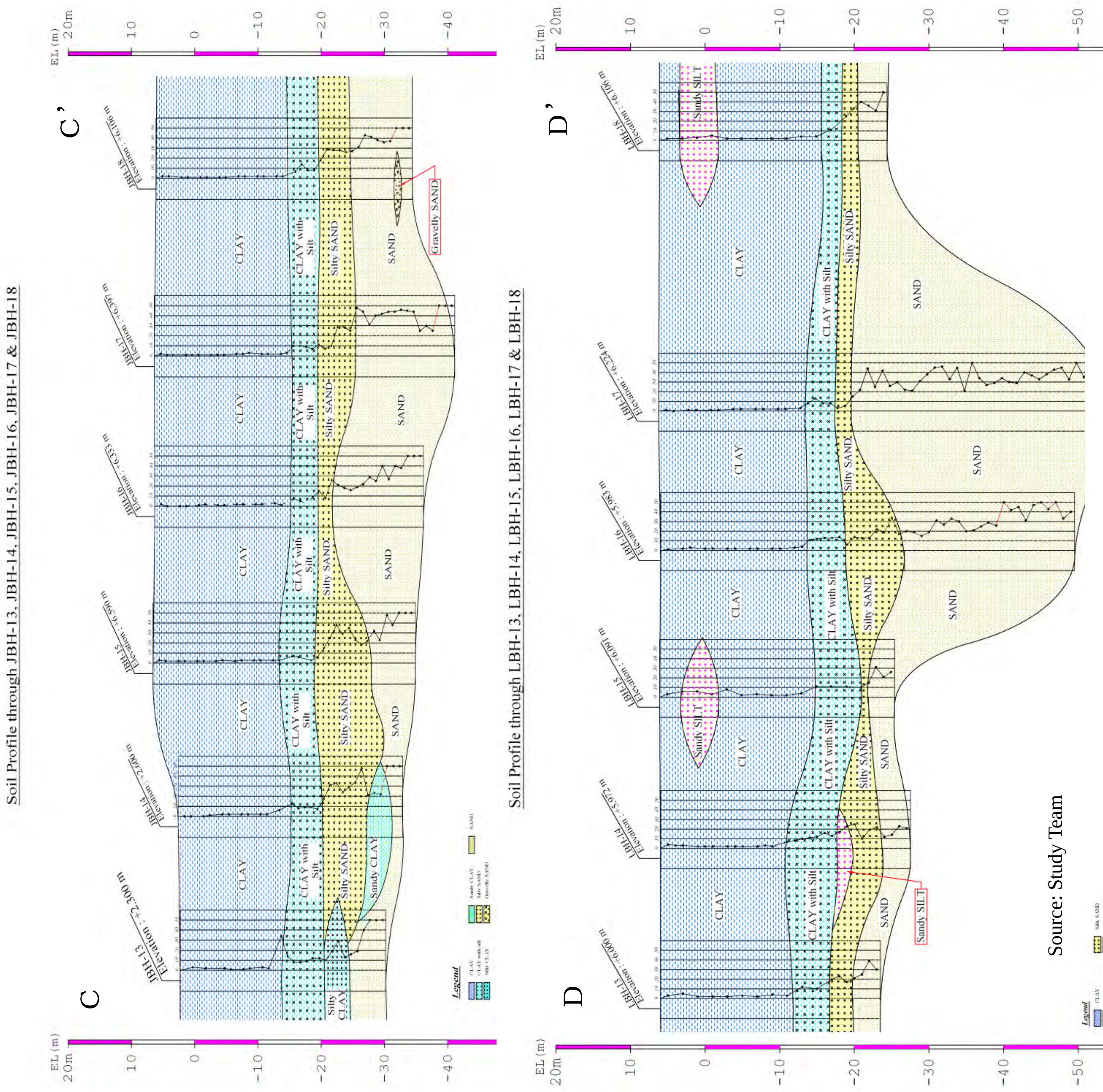
Source : Study Team

Figure 4.3-39 Location of Existing Boring Points



Source: Study Team

Figure 4.3-40 Soil Profiles (A-A' and B-B' sections)



Source: Study Team

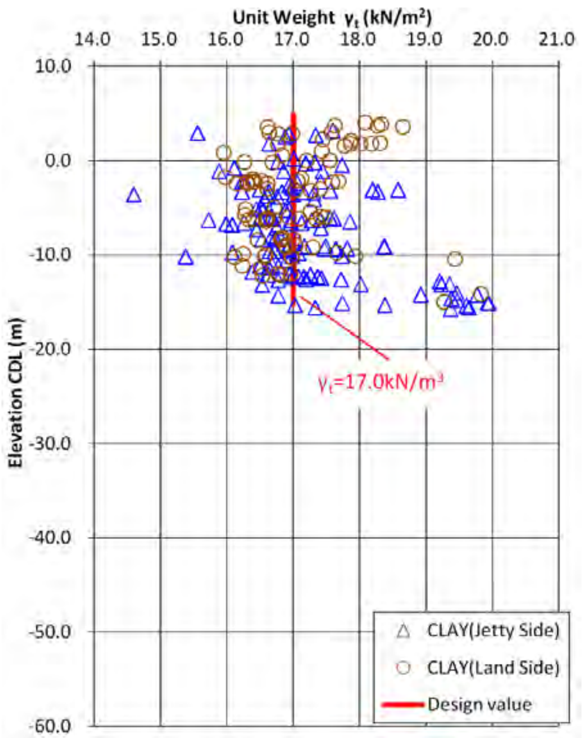
Figure 4.3-41 Soil Profiles (C-C' and D-D' sections)

Table 4.3-23 Soil Parameters Selected for Subsoil Improvement Design

Typical Soil Type	SPT-N	γt (kN/m³)	γ' (kN/m³)	cu (kN/m²)	φ (°)	C_α (%)	Pc (kN/m²)	e～logP curve	Cv(OC) (cm²/day)	Cv(NC) (cm²/day)	cu/p for NC
CLAY (Jetty Side)	2	17.0	7.0	−1.98Z+24.97 (Z=0 at CDL±0.00)	0.0	0.59	124	see the Figure 4.3.3-8	500	50	0.2
CLAY (Land Side)	2	17.0	7.0	−1.46Z+30.89 (Z=0 at CDL±0.00)	0.0	0.59	124	see the Figure 4.3.3-8	500	50	0.2

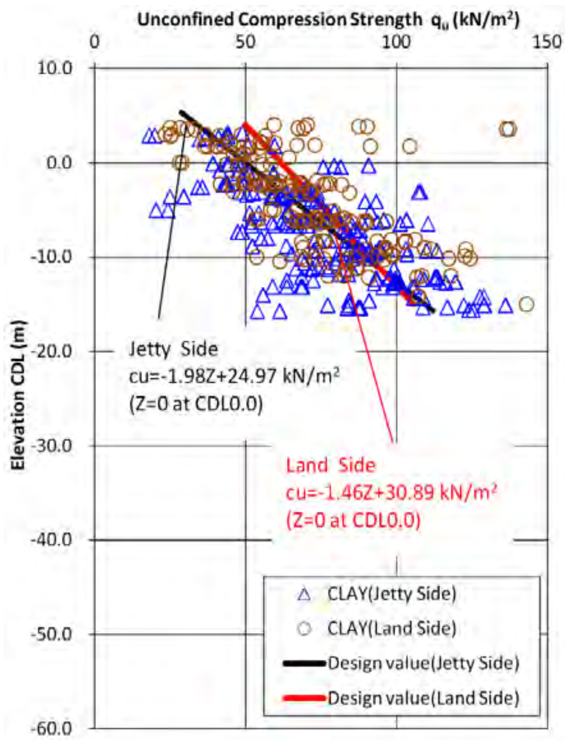
*NC: Normal conslidated State OC: Over consolidated State Z: Elevation

Source : Study Team



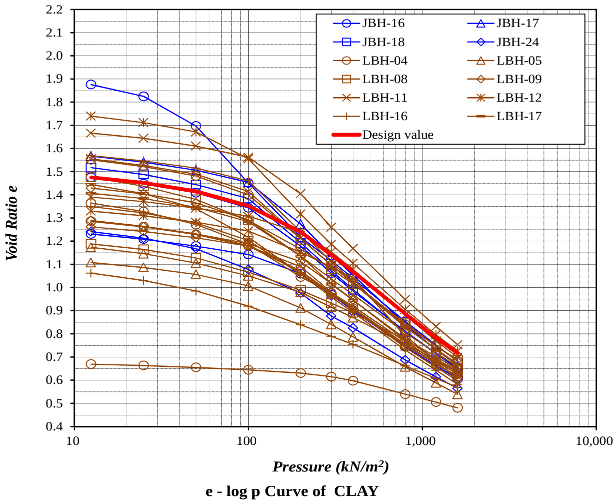
Source : Study Team

Figure 4.3-42 Unit weight γ_t with Depth



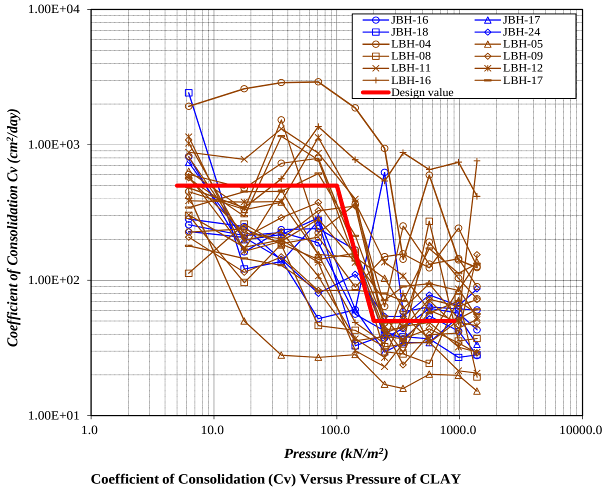
Source : Study Team

Figure 4.3-43 Strength qu with Depth



Source : Study Team

Figure 4.3-44 e～logP curve



Source : Study Team

Figure 4.3-45 Coefficient of Consolidation

c) Fill Construction

The final plan level is CDL+9.0m. Pavement thickness is set to be 50cm. The final fill level in gthe design is set to be CDL+8.5m which is same as subgrade level.

For the fill material borrowed from land site, the transportation distance is so far that it costs. Therefore, fill material is assumed to be river sand which is cheap and easily transported to the site. Design soil parameters for fill material is set by considering use of river sand as shown in Table 4.3-24.

Table 4.3-24 Design Soil Parameter for Fill Material

Wet density γ t(kN/m^3)	Saturated density γ sat(kN/m^3)	Internal frictional angle ϕ (°)
18.0	20.0	30

Source：Study Team

d) Construction schedule

In the construction schedule, it assumes that soil improvement is preferentially carried out for the area where the date of services commencement is at the end of November 2015.

Accordingly, for the construction schedule, about half quantity is proceded to the whole quantity of soil improvement. The construction schedule adopted to the design is shown in Table 4.3-25.

Table 4.3-25 Construction Schedule for Design of Soil Improvement

Item	Q'ty	Team Number	Productivity	Duration
Sand Mat	170,000m3	1 ship	3,000m3/day	2.0 months
PVD Driving	2,000,000m	7 machines	5,000m/day/machine	2.0 months
Surcharge	550,000m3	1 ship	5,000m3/day	4.0 months
Retain the Surcharge				6.0 months
Removal of Surcharge	350,000m3	4 machines	700m3/day/month	5.0 months

Source：Study Team

5) Method of Study

a) Consolidation Settlement Analysis

It is predicted that significant settlement will occur due to the fill construction on the soft ground. Therefore, residual settlement at opening of port also might be large and it will affect port facilities. The calculation of consolidation settlement is carried out based on "Technical Standards and Commentaries for Port and Harbor Facilities in Japan (October, 2009". The design criteria is as followings (refer to Table4.3-22).

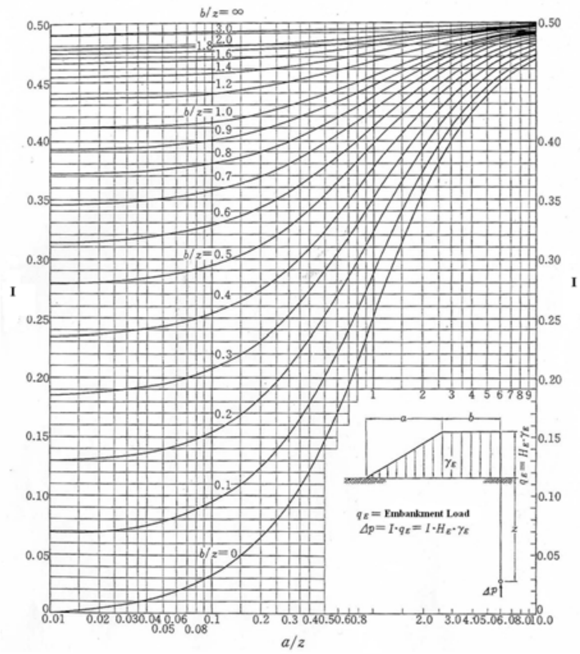
- Over 90% of Primary consolidation shall be completed.
- Allowable residual Settlement at opening of port : less than 20% of settlement generated for 20 years after opening of port.(Including secondary consolidation)
- Allowable residual settlement at opening of port : less than 30cm of settlement generated for 20 years after opening of port.(Including secondary consolidation)

i) Consolidation Settlement (Primary Consolidation Settlement of Clay)

Calculation of in-situ stress increment by filling load

Stress increment by Land Fill load and surcharge is calculated using the following Osterberg's Figure. This figure gives the stress influence factors "I" with function of a/z and b/z (refer to the following Figure 4.3-46). Vertical stress increment at depth "z" can be obtained by the following formula.

$$\sigma_z = I \times q$$



Source : Road Earthwork -Guideline for Soft Ground Measures Mechanic- Japan Road Association

Figure 4.3-46 Stress Influence Factor by Osterberg

Final Settlement Calculation

Final Settlement is calculated as sum of primary consolidation settlement and secondary consolidation settlement by the following formula.

$$Sf = \frac{CrH}{e_0+1}\log\left(\frac{p_c}{p_0}\right) + \frac{CcH}{e_0+1}\log\left(\frac{p_0+\Delta p}{p_c}\right)$$

Where,

Sf : Final Primary consolidation settlement (m)
Cc : Compression Index
Cr : Re-compression Index
e_0 : Initial void ratio
p_0 : Initial stress (Overburden pressure) (kN/m^2)
pc : Consolidation yielding stress)(kN/m^2)
Δp : Stress Increment (kN/m^2)
H : Thickness of layer (m)

ii) Time and Settlement Relation

Time and settlement relation is calculated by the followings;
Without improvement -- Terzaghi’s Theory

Mono Layer (Without Improvement)

In case of unimproved ground, water inside the clay is discharged only to the vertical direction as shown in Figure 4.3-37. Time and settlement relation is calculated using Terzaghi's one dimensional consolidation theory which gives relation between consolidation degree and time factor as shown in Figure 4.3-48. The formula for calculations is shown as follows;

$$St = U \cdot Sc$$

$$U = 1 - \frac{8}{\pi^2}\sum_{n=0}^{\infty}\frac{1}{(2n+1)^2}\exp\left[-\left(\frac{2n+1}{2}\cdot\pi\right)^2\cdot T_V\right]$$

$$T_V = \frac{C_V \cdot t}{D^2}$$

Where,

St : Settlement (m)

Sc : Final settlement by primary consolidation (m)

U : Consolidation Degree (%)

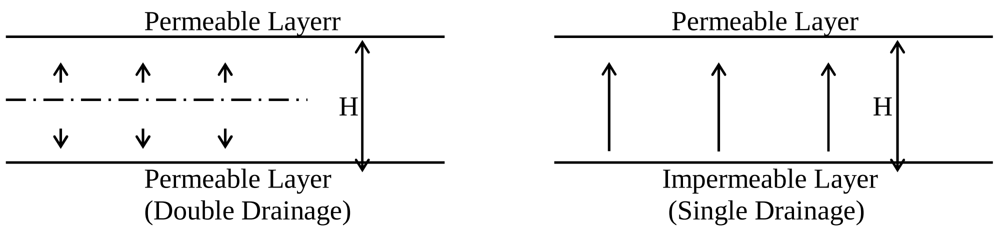
Tv :Time Factor (vertical)

Cv : Coefficient of Consolidation (vertical) (cm^2/day)

t : time (days)

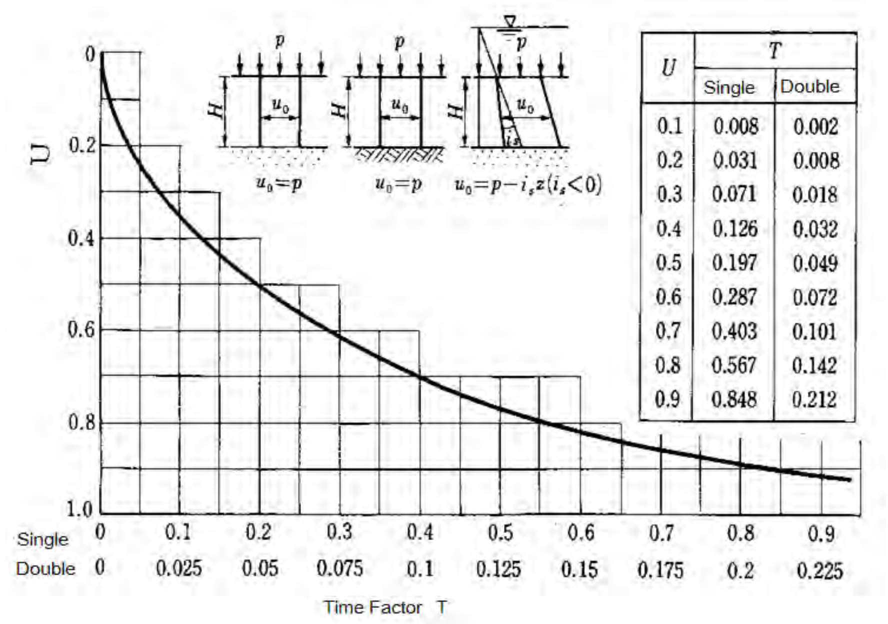
D : Maximum drainage length (cm)

D=H/2 for double drainage, D=H foe single drainage



Source : Study Team

Figure 4.3-47 Concept of One Dimensional Consolidation



Source : Technical Standards and Commentaries for Port and Harbor Facilities, Japan Port and harbor Association

Figure 4.3-48 Relationship between Consolidation Degree U and Time Factor Tv

<u>Multiple Layers (Without Improvement)</u>

In case of unimproved multiple layer ground, equivalent layer thickness method is used for calculation of time and settlement relations. Equivalent layer thickness method is to calculate the time and settlement relation of multiple layers as one layer using equivalent layer thickness converted by Cv values by following formula;

$$H_0 = \sqrt{\frac{C_{V0}}{C_{Vi}}} \cdot H_i$$

Where,

H_0 :Equivalent thickness (m)

Hi :Thickness of each layer (m)

Cv_0 : Representative coefficient of consolidation (cm^2/day)

Cv_i :Coefficient of consolidation of each layer (cm^2/day)

Time and settlement relation of multilayered ground is calculated as one layer using above H_0 and Cv_0.

iii) Secondary Consolidation Settlement

Secondary consolidation settlement is estimated by following method.

$C\alpha\varepsilon = 0.0001\ w_n$

Where,

$C\alpha\varepsilon$: Coefficient of secondary consolidation

w_n : Natural water content of clay(%)

According to the subsoil investigation results in the study area, water content of clay is assumed to be about 59%. Coefficient of Secondary Consolidation $C\alpha\varepsilon$ for clay layer is estimated by the following formula as follows;

$$C\alpha\varepsilon = 0.0059$$

(Assumed w_n=59%)

Secondary consolidation settlement (Ss) is calculated by the following formula;

$$Ss = C\alpha\varepsilon H \log\left(\frac{tf}{tp}\right)$$

Where,

Caε : Coefficient of secondary consolidation

H : Thickness of layer (m)

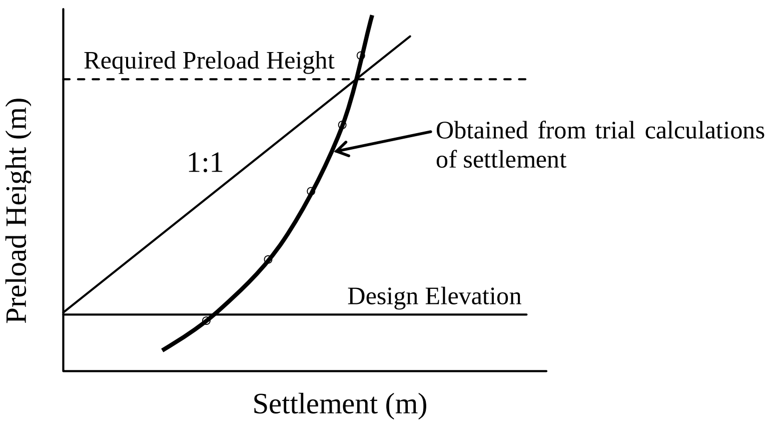
tp : Time of over 90% of primary consolidation

tf : Time of period to consider the secondary consolidation settlement (Assumed 20 years after opening of the Port)

iv) Required Surcharge Height

In case of fill works on soft ground, consolidation settlement becomes larger with increase of fill height (load). Accordingly, extra fill height equivalent to settlement will be necessary to retain the design elevation of the area.

In this design, required surcharge height is calculated to retain the design height when final settlement occurs, using relation curve between surcharge height and settlement.



Source : Study Team

Figure 4.3-49 Required Surcharge Height

b) Slope Stability

i) Study of Slope Stability by Circular Slip Method

The slope stabilities of Land Fill and surcharge are examined by circular slip analysis using the modified Fellenius's method described in "Technical Standards and Commentaries for Port and Harbor Facilities in Japan (July, 2007)". The required safety factors of stability analysis shall be as follows :

For long term period (After completion of fill) ; Fs = 1.3

For short term period (During fill) ; Fs = 1.1

To meet the requirements of safety factors, stability of surcharge embankment is examined using the following formula.

$$Fs = \frac{\Sigma\left[c \cdot l + (W - u \cdot b)\cos\alpha \cdot \tan\phi\right]}{\Sigma(W \cdot \sin\alpha)}$$

Where,

Fs : Safety Factor

c : Cohesion of soil (kN/m^2)

l : Length of slip surface for one element of soil mass (m)

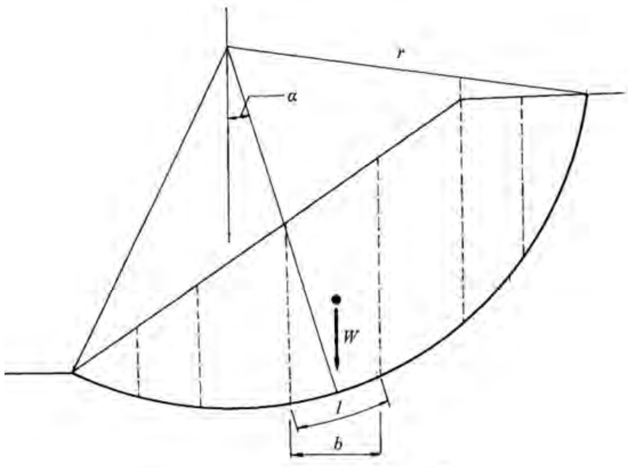
W : Weight of one element of soil mass (kN/m)

U : Porewater pressure (kN/m^2)

B : Width of one element of soil mass (m)

α : Angle between two lines, the line drawn between center of circular slip circle and center of slip surface of element of soil mass, the vertical line (degree)

ϕ : Angle of shear resistance (degree)



Source : Study Team

Figure 4.3-50 Slope Stability Analysis by Circular Slip Surface Method

ii) Increase of Shear Strength of Clay

In this slope stability calculation, increase of shear strength by consolidation progress is considered. Increased shear strength (cu) is calculated by the following formula;

$$cu = cu_0 + m \cdot (p_0 - pc + \Delta p) \cdot U$$

$$p_0 + \Delta p \leqq pc \rightarrow cu = cu_0$$

$$p_0 + \Delta p > pc \rightarrow cu = cu_0 + m \cdot (p_0 - pc + \Delta p) \cdot U$$

Where,

cu : Increased shear strength with consolidation progress (kN/m^2)

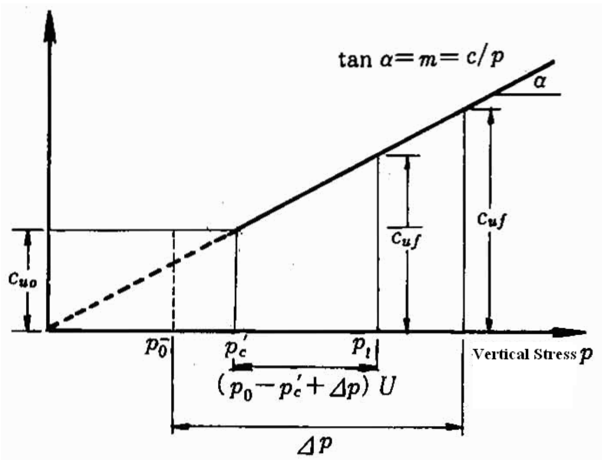
cu_0 : Initial shear strength before Land Fill work (kN/ m^2)

m : Increase ration of shear strength

p_0 : Initial stress (Overburden pressure) (kN/ m^2)

pc :Consolidation yielding stress (kN/ m^2)

U : Consolidation degree (%)



Source : Road Earthwork, Guideline for Soft Ground Measures Mechanic, Japan Road Association

Figure 4.3-51 Increased Shear Strength with Consolidation Progress

c) Soil Improvement Method

i) PVD Method

PVD Method is one of vertical drain methods which install the artificial drainage in the soil to accelerate the consolidation progress.

<u>Calculation of Primary Consolidation Settlement</u>

Relation between time and settlement for improved ground by PVD Method is calculated by the following Barron's formula.

$$St = U \cdot Sc$$

$$U = 1 - \exp\left(\frac{-8T_h}{F(n)}\right)$$

$$T_h = \frac{C_h \cdot t}{d_e^{\ 2}}$$

$$F(n) = \frac{n^2}{n^2 - 1} \cdot \log_e n - \frac{3n^2 - 1}{4n^2}$$

Where,

St : Settlement qt time t (m)

Sc : Final primary consolidation settlement (m)

U : Consolidation degree (%)

Th : Time Factor (Horizontal)

Ch : Coefficient of Consolidation (Horizontal) (m2/day)

t : Time (days)

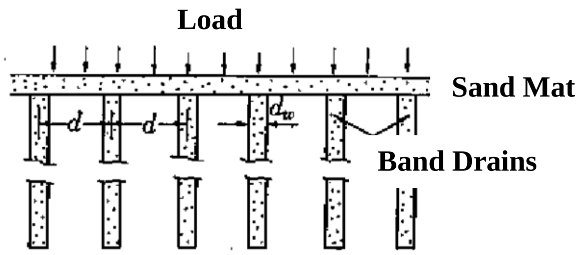
d_e : Diameter of effective circle (m)

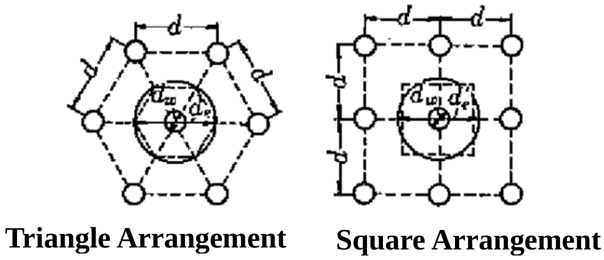
d_e=1.05d (Triangle arrangement)

d_e=1.13d (Square arrangement)

d : PVD installation interval

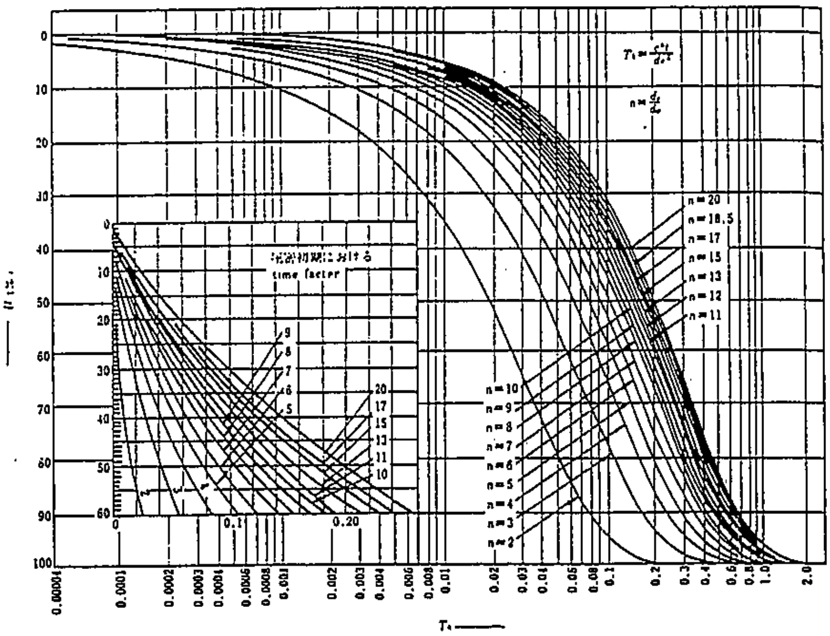
d_w : Diameter of PVD (Drain) (m)





Source : Soft Ground Measures Method of Construction –Survey, Design and Construction-Japan Geotechnical Society

Figure 4.3-52 Effective Circle



Source : Technical Standards and Commentaries for Port and Harbor Facilities, Japan Port and harbor Association

Figure 4.3-53 Consolidation Degree and Time factor Curves of Vertical Drain

<u>Details of Vertical Drain</u>

Drain material and its installation intervals to be studied are adopted as follows;

- ・Drain material : Plastic board drain
- ・Diameter of drain : d_w=0.05m
- ・Drain installation interval : d=1.0m - 2.2m (Square arrangement)
- ・Ch = Cv (Ch, Cv : Coefficient of consolidation for vertical and horizontal drainage respectively.)

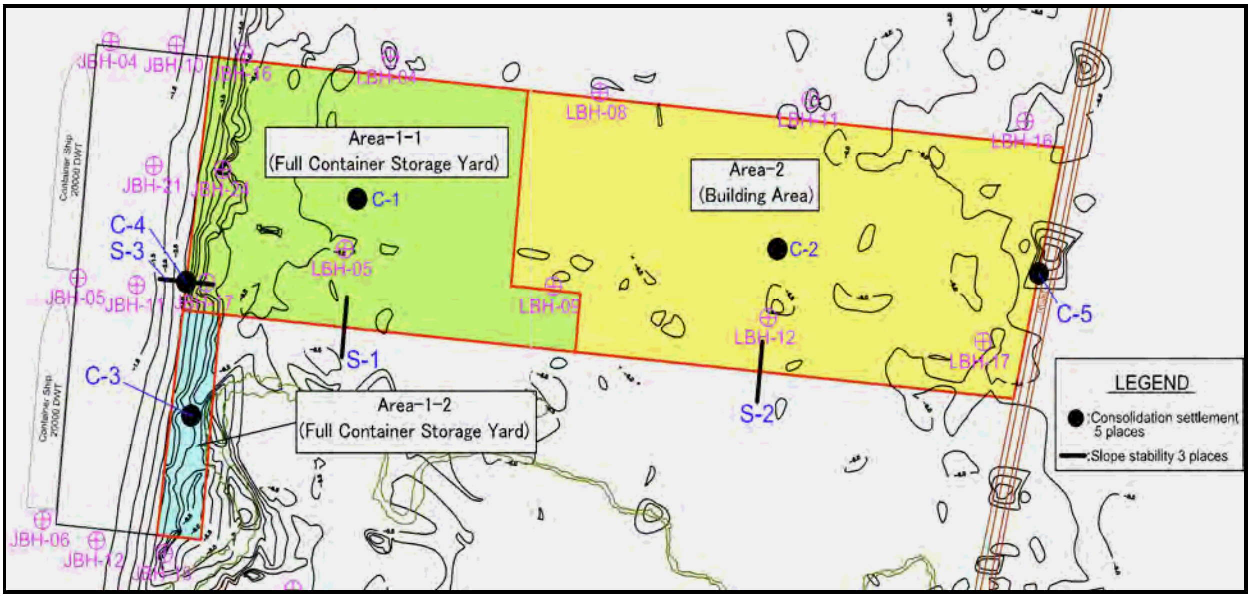
d) Slope Stability Analysis for improved soil

Method of slope stability analysis is same as the case of without improvement. Shear strength increment with consolidation progress is to be considered.

(3) Study Result

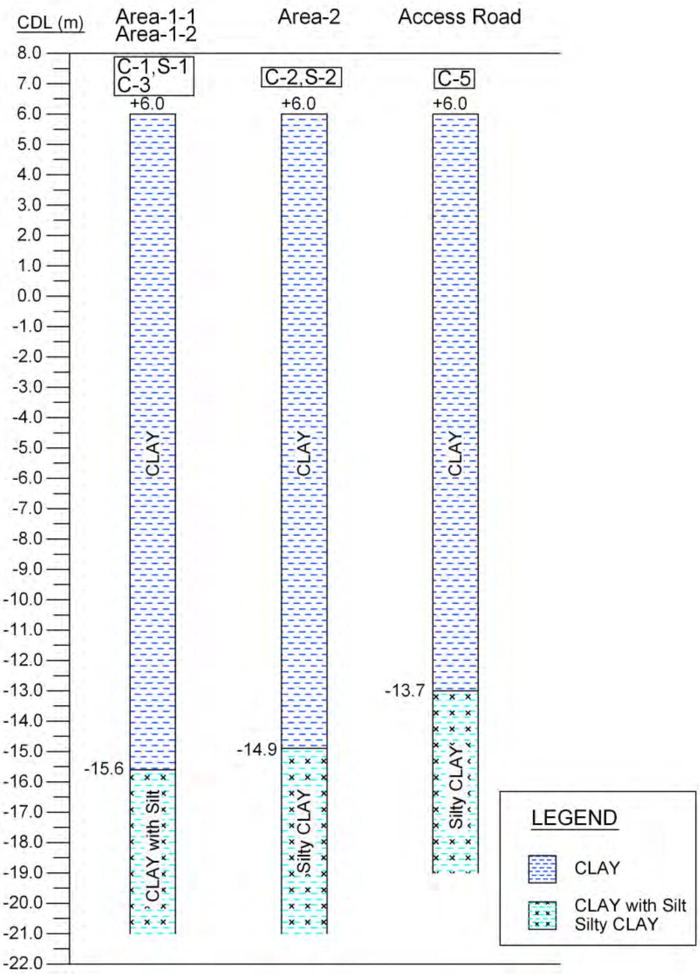
1) Study Area and Study Model

Study area and study model are shown in Figure 4.3-54 and Figure 4.3-55 respectively. As shown in Figure 4.3-54, consolidation settlement analysis is carried out at 5 points and slope stability is carried out at 3 points. Soil parameter shown in Table 4.3-23 and Table 4.3-24 are used for the analysis.



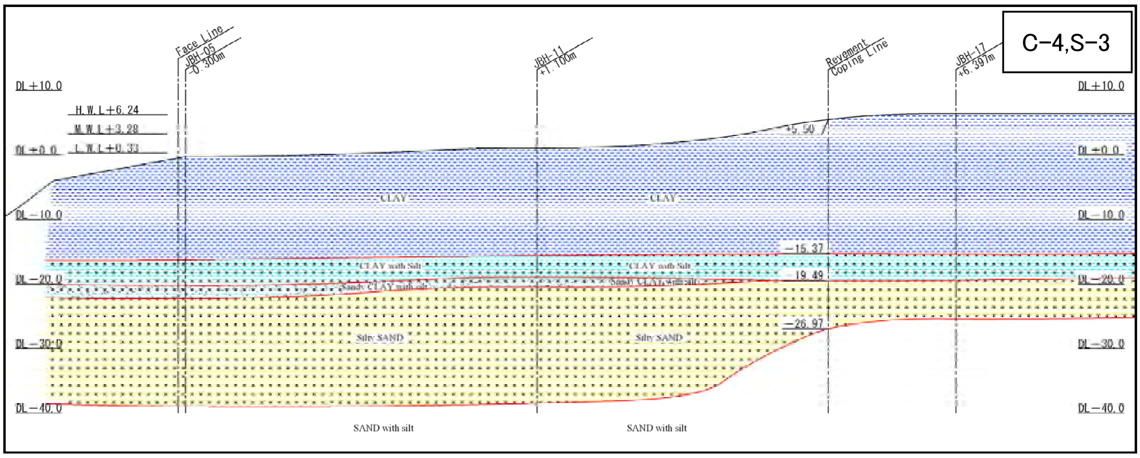
Source : Study Team

Figure 4.3-54 Study Area for Consolidation Settlement and Slope Stability



Source : Study Team

Figure 4.3-55 Ground Analysis Model



Source : Study Team

Figure 4.3-56　Ground Analysis Model at Revetment Area

2)　Consolidation Settlement Analysis Result

a)　Analysis for Present ground Condition (Non-improvement)

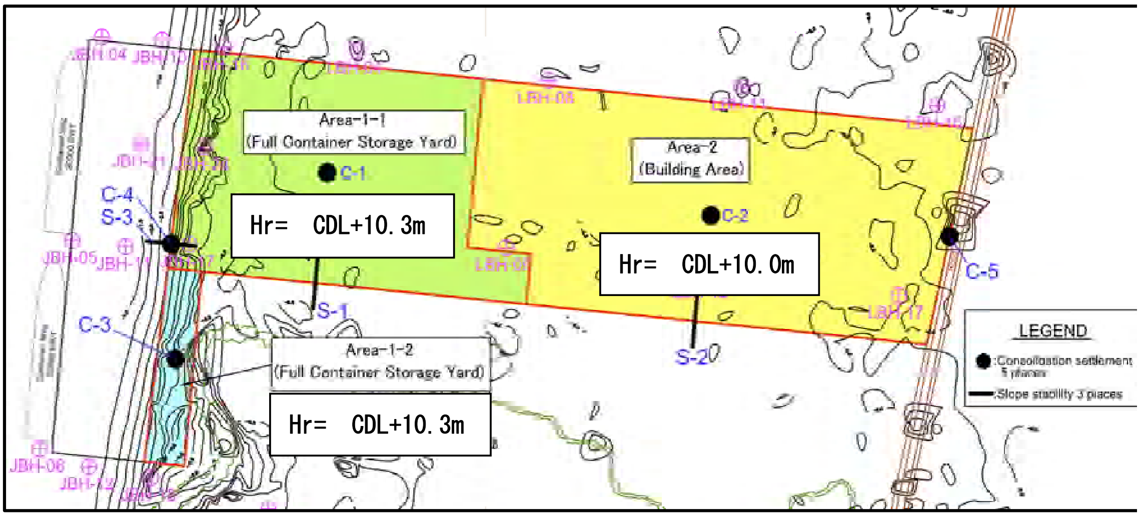
Consolidation settlement analysis result for present ground condition is shown in Figure 4.3-58～Figure4.3-60. In the analysis, required filling height is estimated in order to ensure the design height (CDL+9.0m) at the time of final settlement. The analysis is carried out for 3 points (C-1, C-2, C-3) representative of Area1-1, Area1-2 and Area-2 classified by land use purpose respectively. The analyzed settlement is primary settlement.

As a result of analysis, required filling height for each area is CDL+10.0m to CDL+10.3m (Required thickness = 4.0m to 4.3m) as shown in Table 4.3-26 and Figure 4.3-57. And in case of non-improvement soil, it indicates that it needs long period until final settlement generation.

Table 4.3-26　Required Filling Height (Non-improvement)

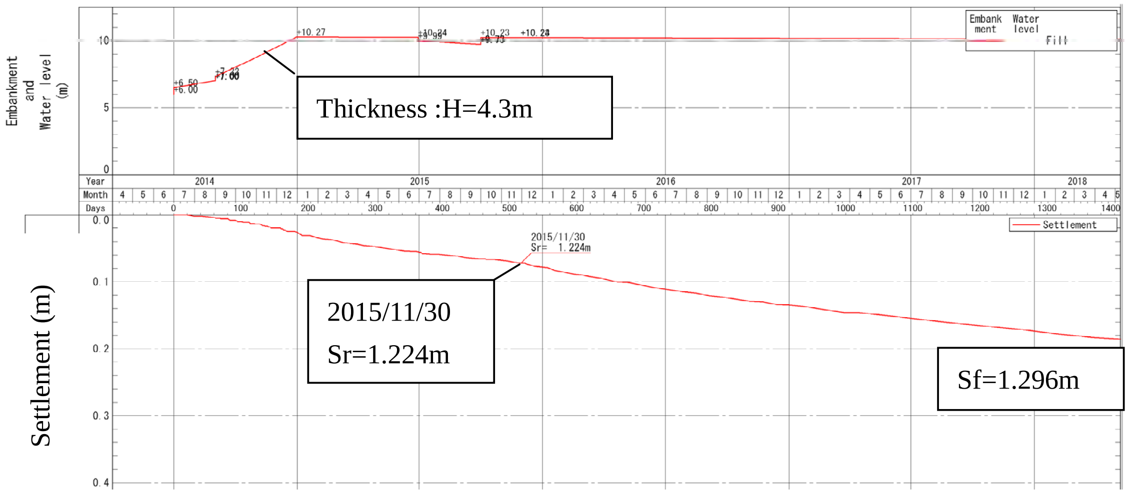
Area		Analysis point	Design Elevation	Required Filling Height (Thickness)
Full Container Storage Yard	Area−1−1	C−1	CDL+9.0m	CDL+10.3m (4.3m)
	Area−1−2	C−3	CDL+9.0m	CDL+10.3m (4.3m)
Building Area	Area−2	C−2	CDL+9.0m	CDL+10.0m (4.0m)

Source：Study Team



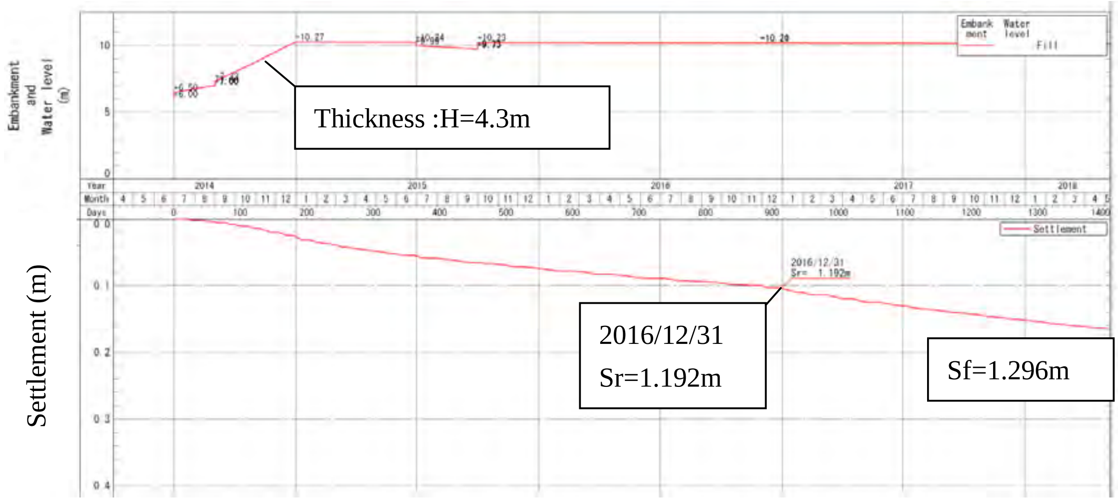
Source : Study Team

Figure 4.3-57 Required Filling Height (No-improvement)



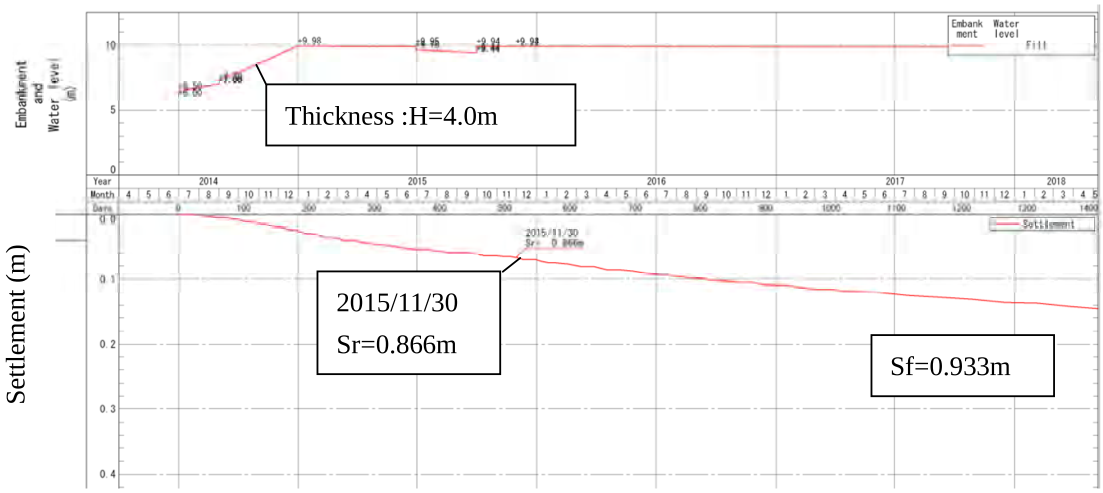
Source : Study Team

Figure 4.3-58 Settlement Curve for C-1(Area-1-1) Non Measure



Source : Study Team

Figure 4.3-59 Settlement Curve for C-3 (Area-1-2) Non Measure



Source : Study Team

Figure 4.3-60 Settlement Curve for C-2 (Area-2) Non Measure

b) Analysis for Improved Soil

i) Container and Building Area

In case of non-improved soil, it takes time to reach the period of final settlement because the thickness of soft clay layer is thick. It means that the residual settlement generating after opening of port is predicted to be large and it affects port facilities. In this section, the result of consolidation settlement analysis for improved soil by PVD with surcharge method is described.

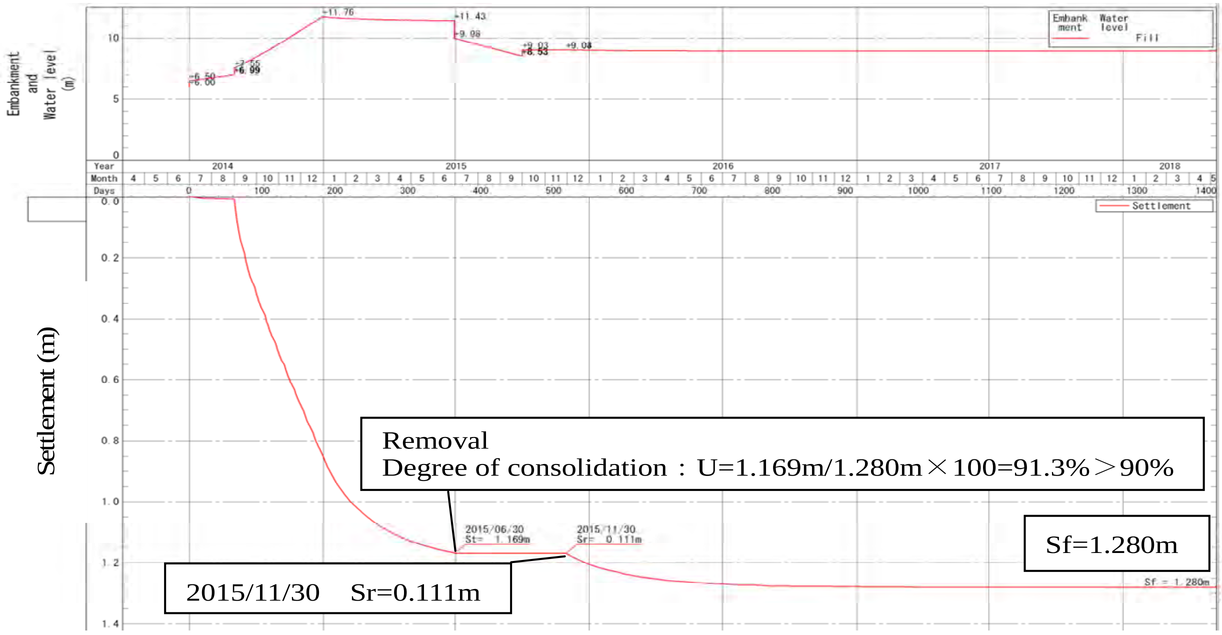
The analysis results are shown in Figure 4.3-61 to Figure 4.3-69 and summarized in Table 4.3-27. The results shown in Figure 4.3-61 to Figure 4.3-63 are analyzed for primary settlement and the results shown in Figure 4.3-64 to Figure 4.3-66 are analyzed for both primary and secondary settlement.

As an analysis results for each area, residual settlement for primary settlement ranges from 1cm to 12 cm. Residual settlement generating 20 years after opening of port ranges from 12 cm to 27 cm. Surcharge thickness shown in Table 4.3-27 satisfies the allowable residual settlement for each area. Specification of PVD with surcharge method is shown in Figure4.3-67.

Table 4.3-27 Consolidation Settlement Analysis Results

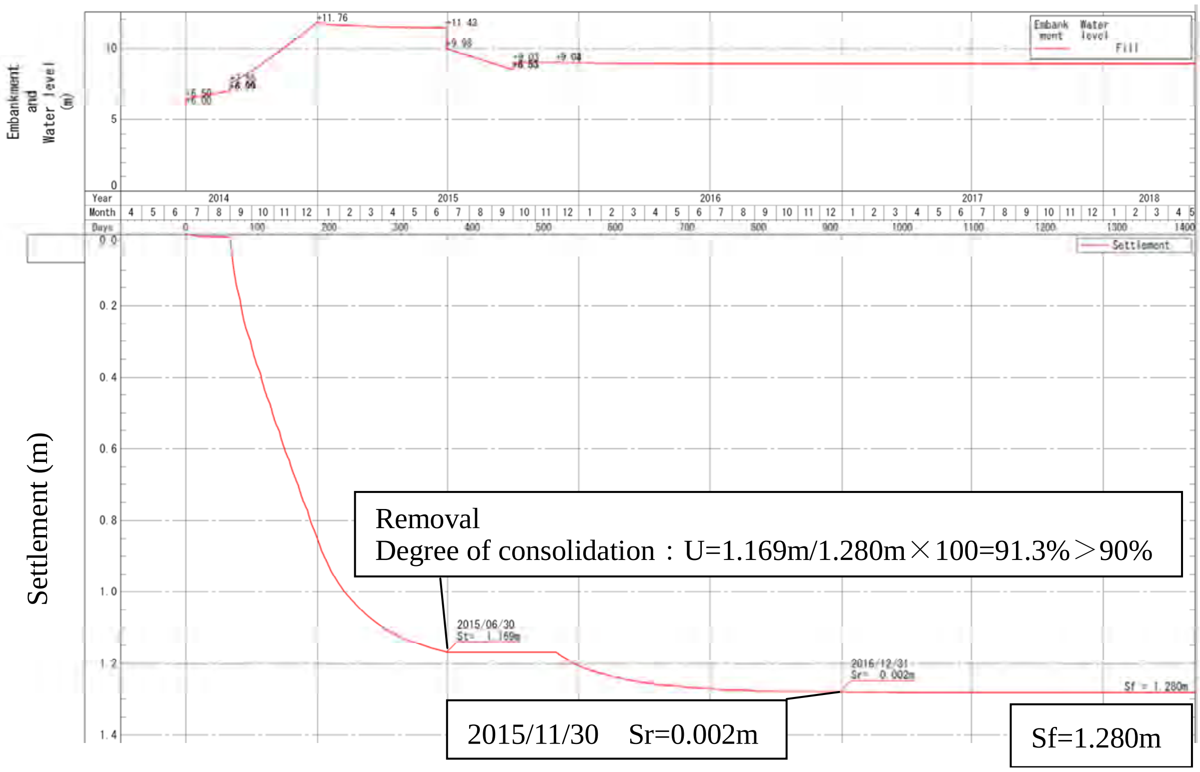
Area	Full Container Storage Yard				Building Area	
	Area-1-1		Area-1-2		Area-2	
Case	Primary Consolidation	PrimaryConsolidation +Secondary Consolidation	Primary Consolidation	PrimaryConsolidation +Secondary Consolidation	Primary Consolidation	PrimaryConsolidation +Secondary Consolidation
Final Settlement	1.280m	**1.454m**	1.280m	**1.454m**	0.916m	**1.093m**
Residual Settlement after Port Opening	0.111m	Residual Settlement **0.261m**≦0.3m OK (After 20 years of the opening port)	0.002m	Residual Settlement **0.120m**≦0.3m OK (After 20 years of the opening port)	0.059m	Residual Settlement **0.205m**≦0.3m OK (After 20 years of the opening port)
	—	Residual Settlement degree **18.0%**≦20% OK (After 20 years of the opening port)	—	Residual Settlement degree **8.3%**≦20% OK (After 20 years of the opening port)	—	Residual Settlement degree **18.8%**≦20% OK (After 20 years of the opening port)
PVD Spacing(Square) (m)	1.1		1.1		1.1	
Surcharge(Thickness) (m)	5.6		5.6		3.8	
Sand Mat (Thickness : m)	1.0		1.0		1.0	
Removal of Surchage (Thickness : m)	2.9		2.9		1.4	

Source：Study Team



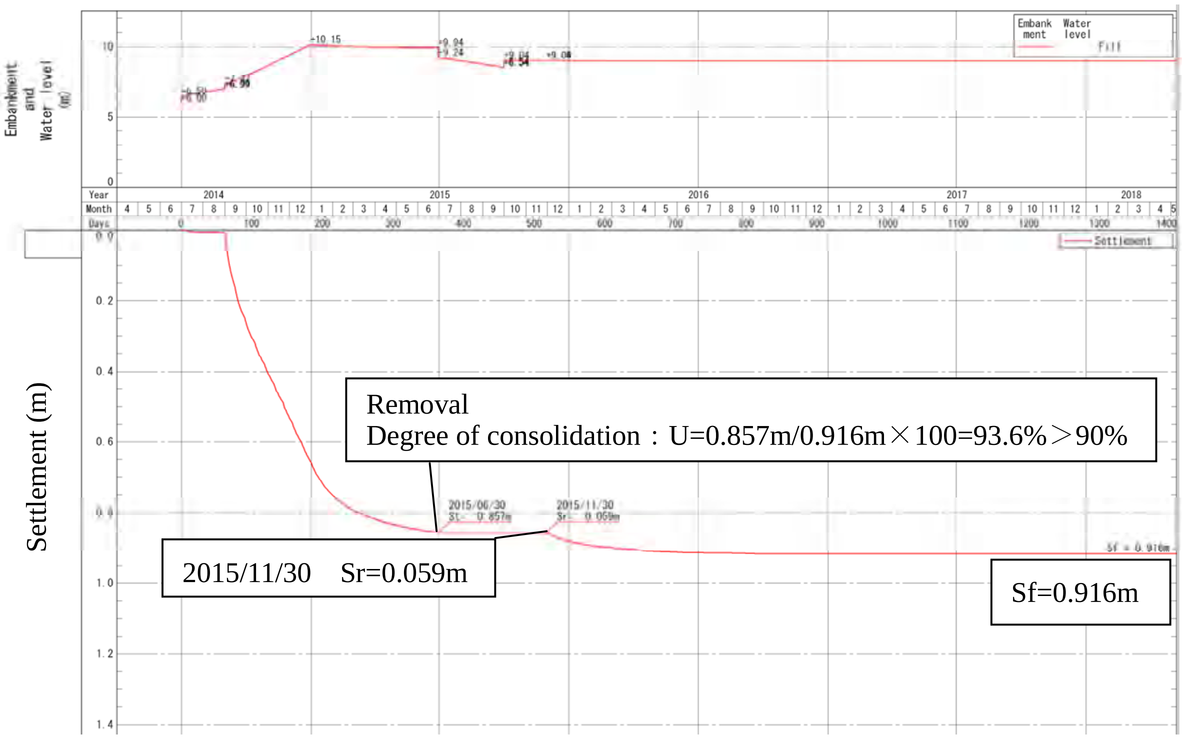
Source : Study Team

Figure 4.3-61　Settlement Curve at C-1(Area-1-1), PVD d=1.1m　: Primary Consolidation



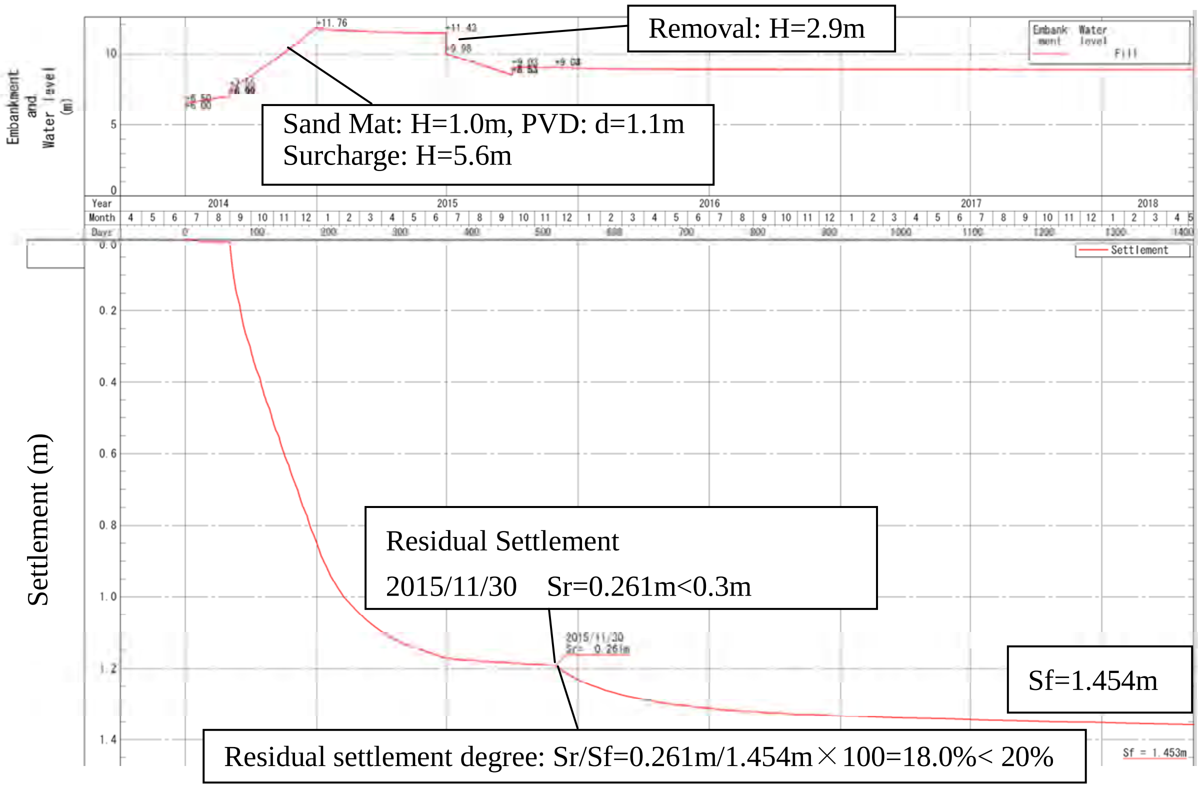
Source : Study Team

Figure 4.3-62　Settlement Curve at C-3(Area-1-2), PVD d=1.1m : Primary Consolidation



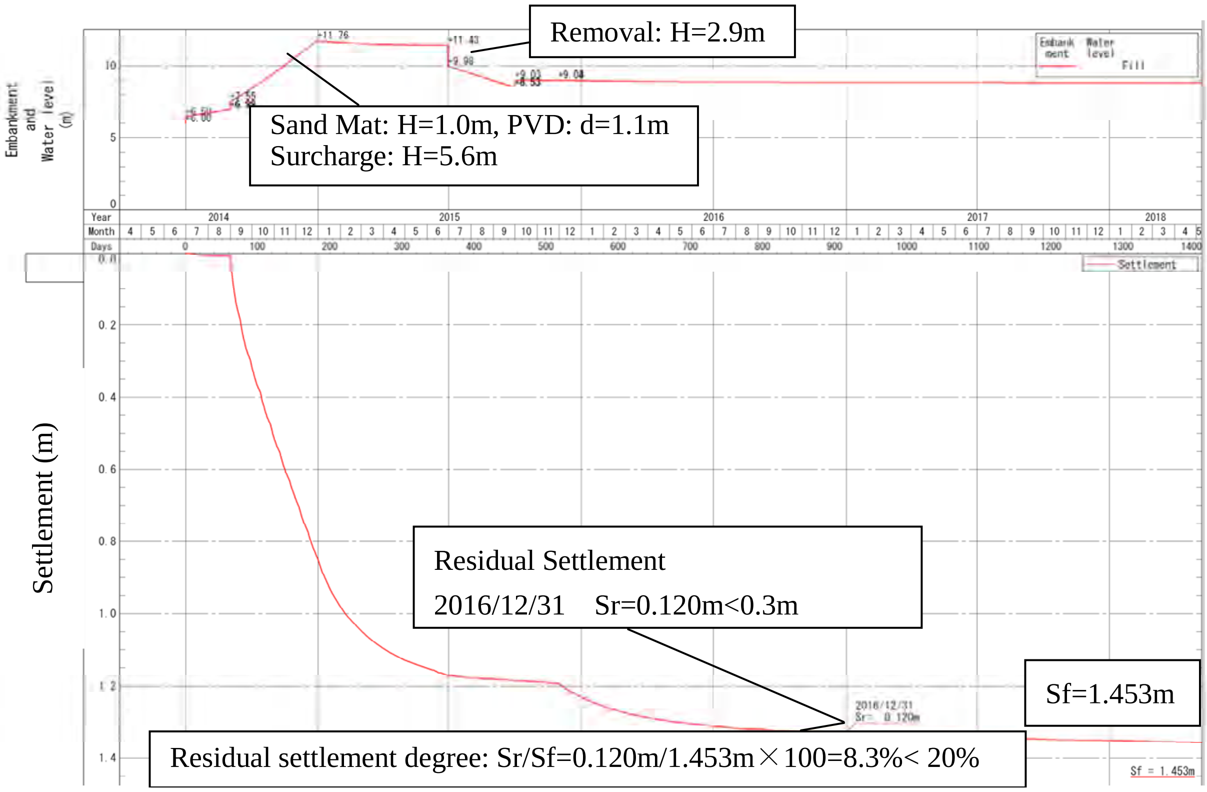
Source : Study Team

Figure 4.3-63　Settlement Curve at C-2 (Area-2), PVD d=1.1m : Primary Consolidation



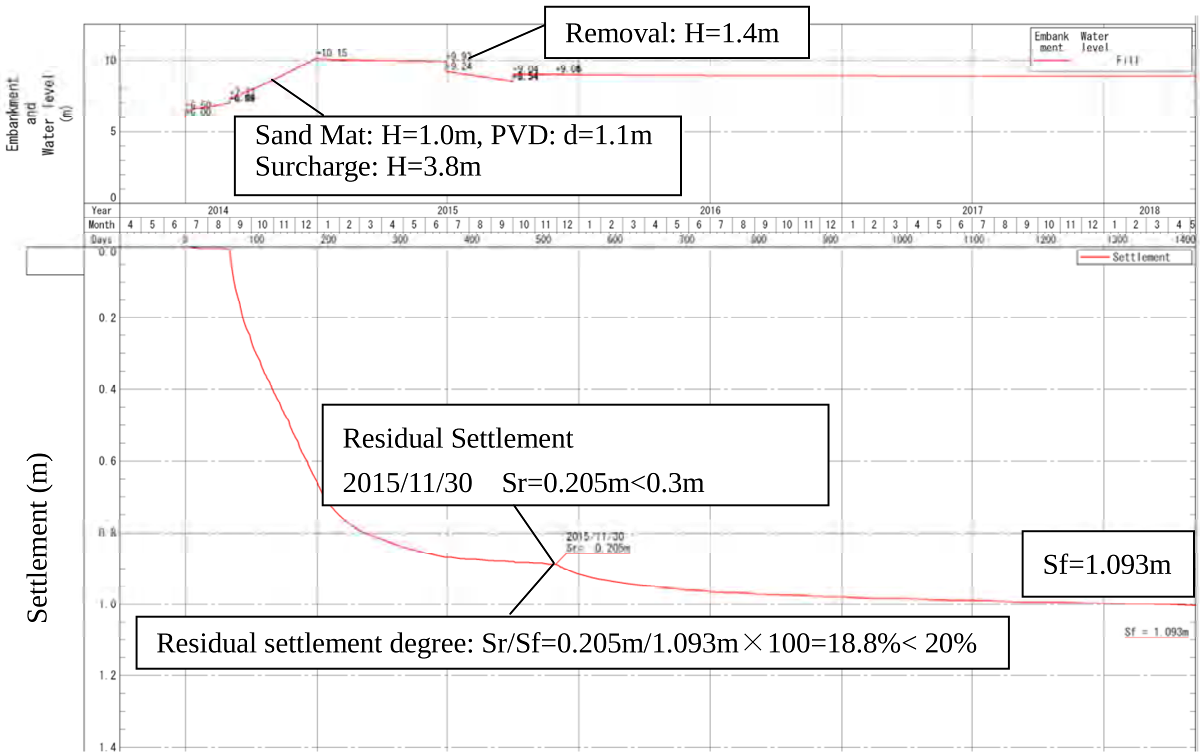
Source : Study Team

Figure 4.3-64　Settlement Curve at C-1 (Area-1-1), PVD d=1.1m : Secondary Consolidation



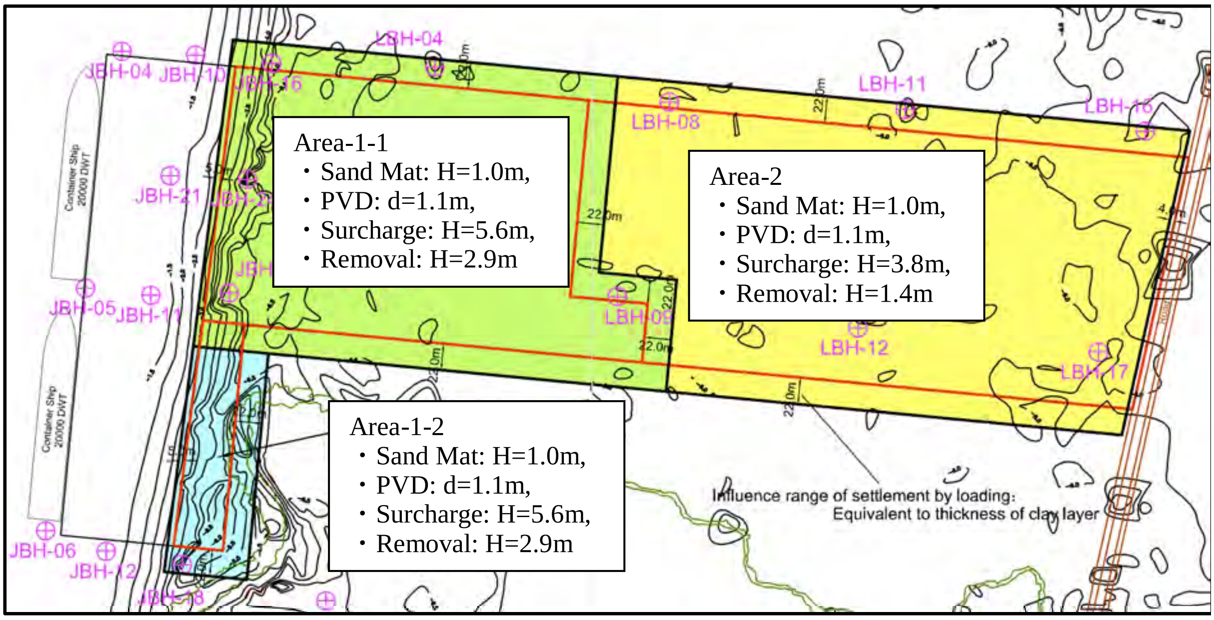
Source : Study Team

Figure 4.3-65 Settlement Curve at C-3 (Area-1-2), PVD d=1.1m : Secondary Consolidation



Source : Study Team

Figure 4.3-66 Settlement Curve at C-2 (Area-2), PVD d=1.1m : Secondary Consolidation)



Source : Study Team

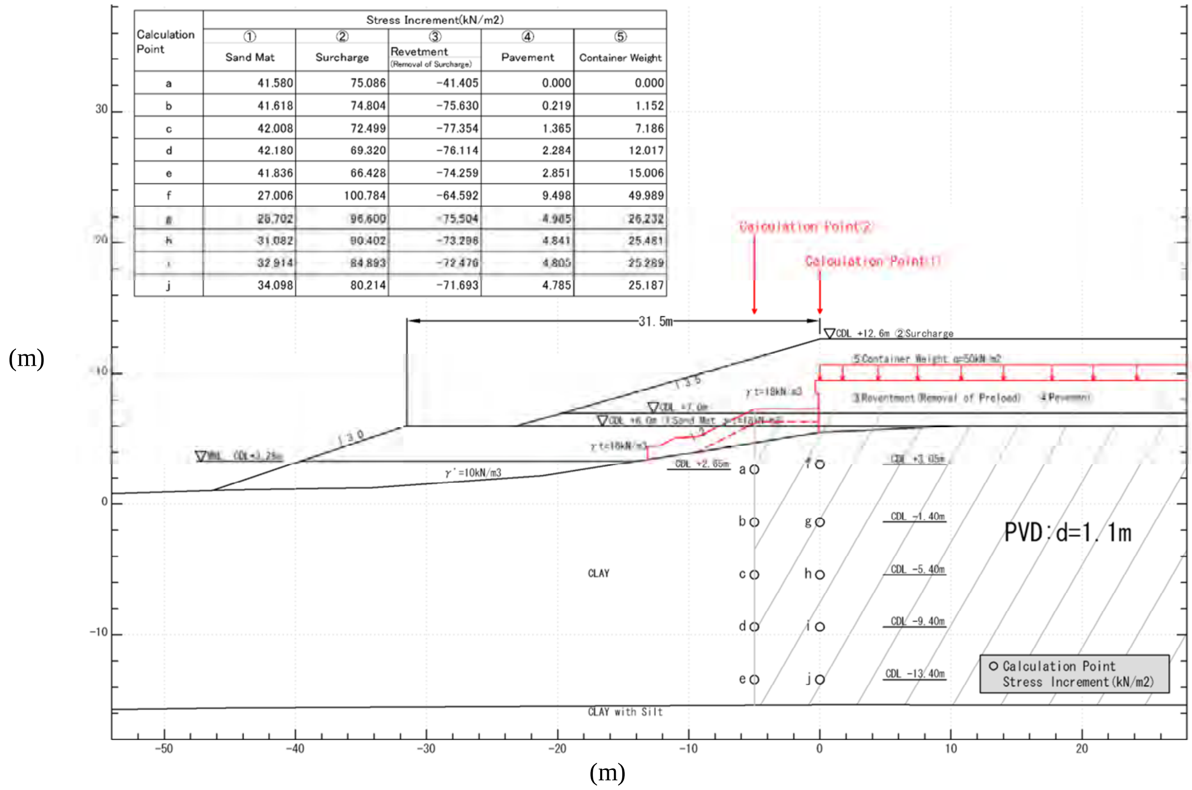
Figure 4.3-67　Specification of Soil Improvement for Each Area

ii)　Revetment Area

Residual settlement for revetment area (C-4) is analyzed based on specification of PVD installation interval and surcharge thickness designated by examination for Container yard area. The analysis result of in-situ increasing stress and consolidation settlement is shown in Figure 4.3-68 and Figure 4.3-68 respectively. This analysis is conducted for the center of face line of jetty (Point①) as shown in Figure 4.3-68. The dimension of cross section of surcharge fill applied to the analysis is based on the one applied to the stability analysis described later in the report.

As an result, residual settlement considering secondary settlement for revetment area is around 17cm at the time of removal of surcharge (2015/6/30) and around 15cm at the time of opening port (2015/11/30). The residual settlement satisfies the allowable settlement (Sr≦30cm).

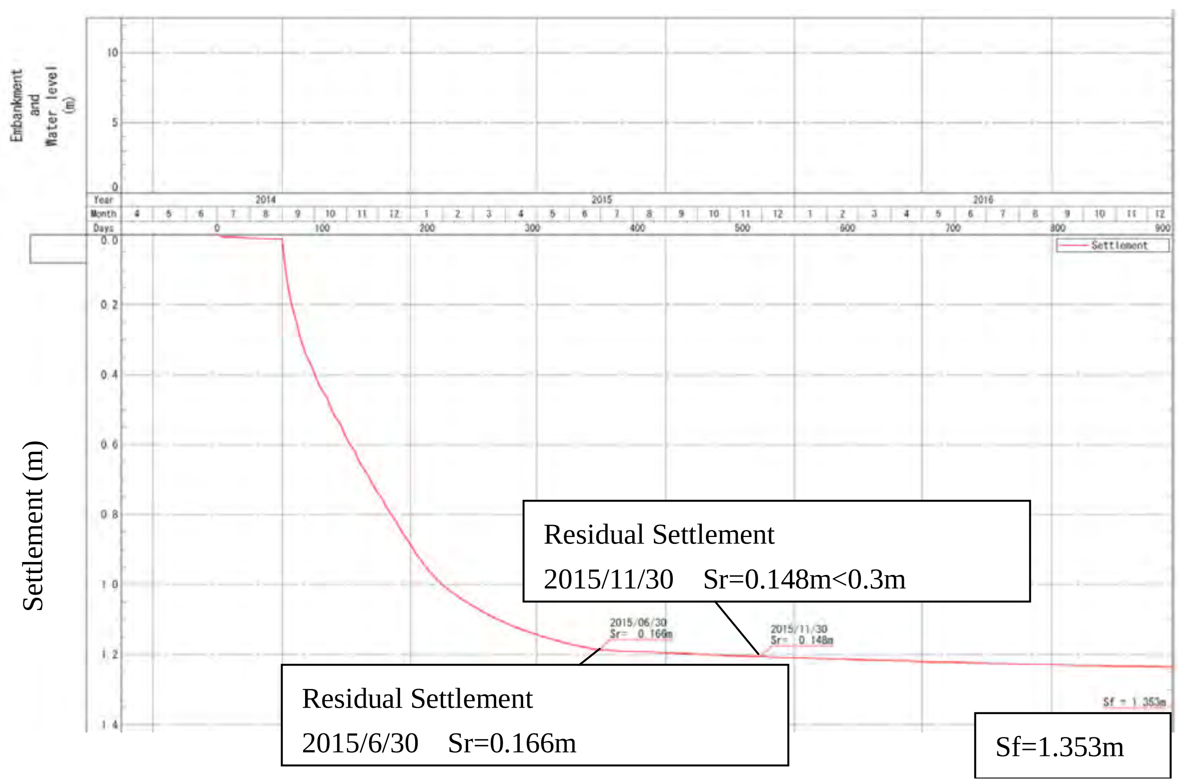
For reference, the settlement analysis result conducted for Point②, 5m far from revetment front side is shown in Figure 4.3-70 and Figure 4.3-71 respectively. The Point② is located at the boundary area of improvement area. Therefore, the consolidation settlement generating at Point② is estimated to be between settlement amount analyzed based on improvement condition by PVD (Figure 4.3-70) and the one based on non-improvement condition (Figure 4.3-71). Accordingly, for the boundary area of soil improvement, final settlement is estimated to be 34cm to 125cm and residual settlement is estimated to be around 16cm at the time of removal opf surcharge and around 14cn after opening of port.



Calculation Point	Stress Increment(kN/m2) ① Sand Mat	② Surcharge	③ Revetment (Removal of Surcharge)	④ Pavement	⑤ Container Weight
a	41.580	75.086	−41.405	0.000	0.000
b	41.618	74.804	−75.630	0.219	1.152
c	42.008	72.499	−77.354	1.365	7.186
d	42.180	69.320	−76.114	2.284	12.017
e	41.836	66.428	−74.259	2.851	15.006
f	27.006	100.784	−64.592	9.498	49.989
g	26.702	96.600	−75.504	4.985	26.232
h	31.082	90.402	−73.298	4.841	25.481
i	32.914	84.893	−72.476	4.805	25.289
j	34.098	80.214	−71.693	4.785	25.187

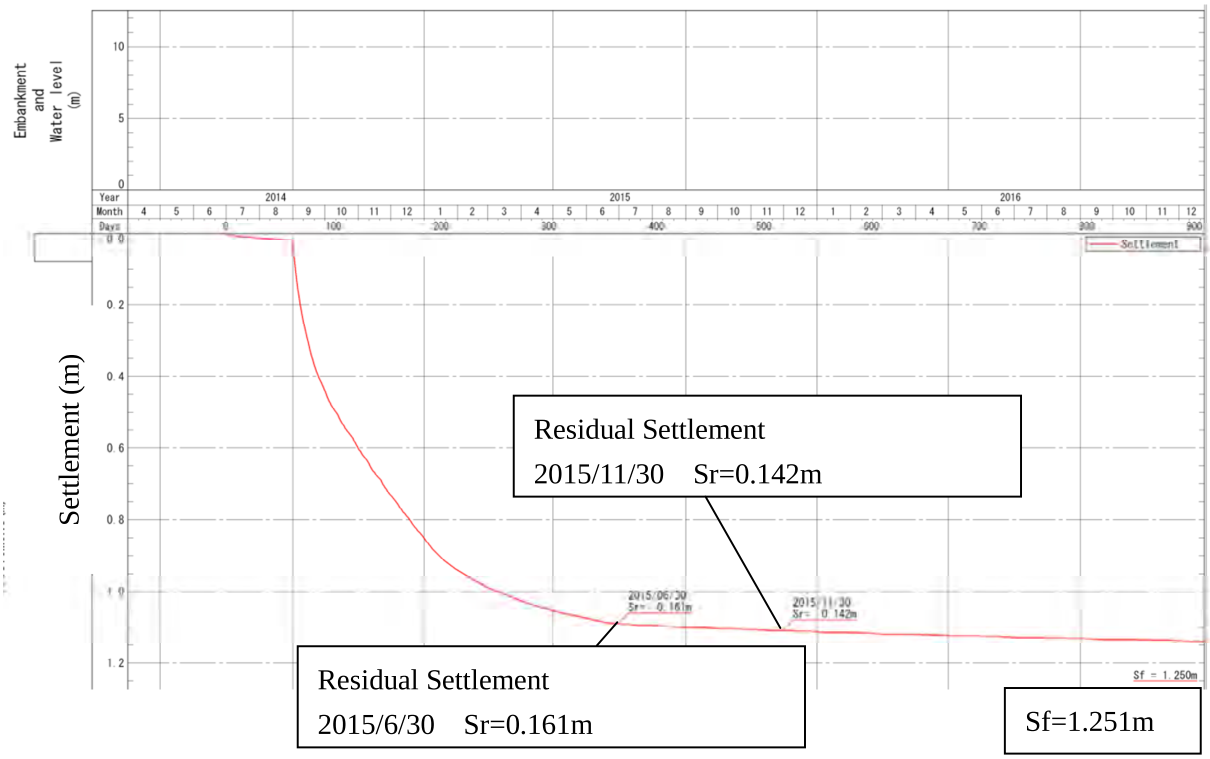
Source : Study Team

Figure 4.3-68 Analysis Result for In-situ Stress Increment



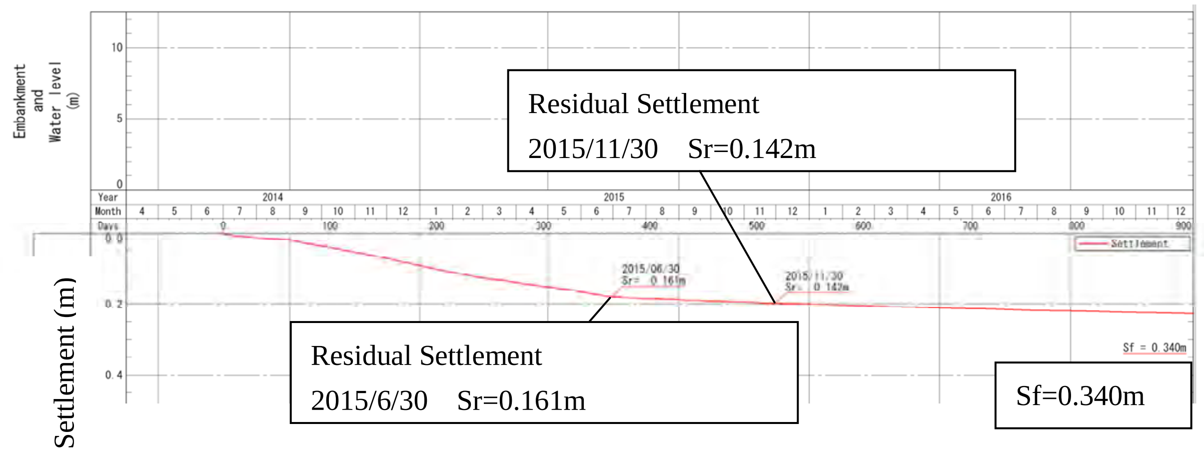
Source : Study Team

Figure 4.3-69 Settlement Curve including Secondary Settlement (Point 1, PVD d=1.1m)



Source : Study Team

Figure 4.3-70 Settlement Curve including Secondary Settlement (Revetment Area, Point 2 PVD d=1.1m)



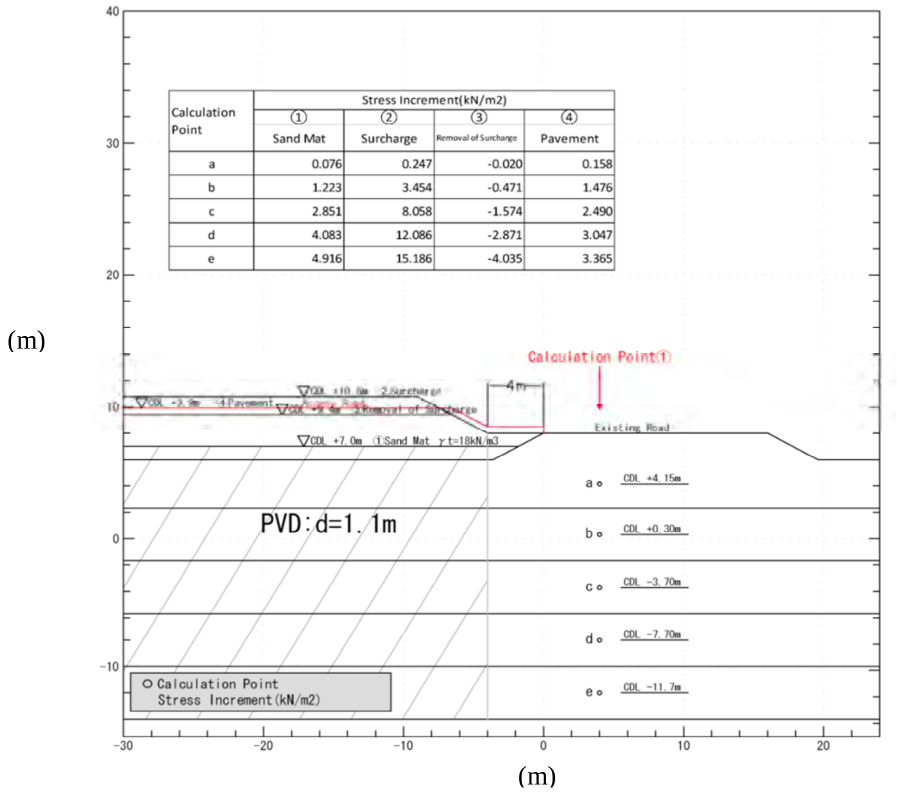
Source : Study Team

Figure 4.3-71 Settlement Curve including Secondary Settlement (Revetment Area, Point 2 Non-improvement)

iii) Access Road Area

For access road area, it is predicted the settlement generated by surcharge fill load will affect the existing road. For this reason, in order to check the influence on the existing road, consolidation settlement analysis for access road area (C-5) is carried out. The elevation of surcharge fill is CDL+10.8m applied for the analysis for Building area. The analysis point (Point①) is located at the edge of pavement of existing road (non-improved area) as shown Figure 4.3-72. The analysis result of in-situ ground increase stress and settlement with time are shown in Figure 4.3-72 and Figure 4.3-73 respectively. In the settlement shown in Figure 4.3-73, primary settlement is only considered.

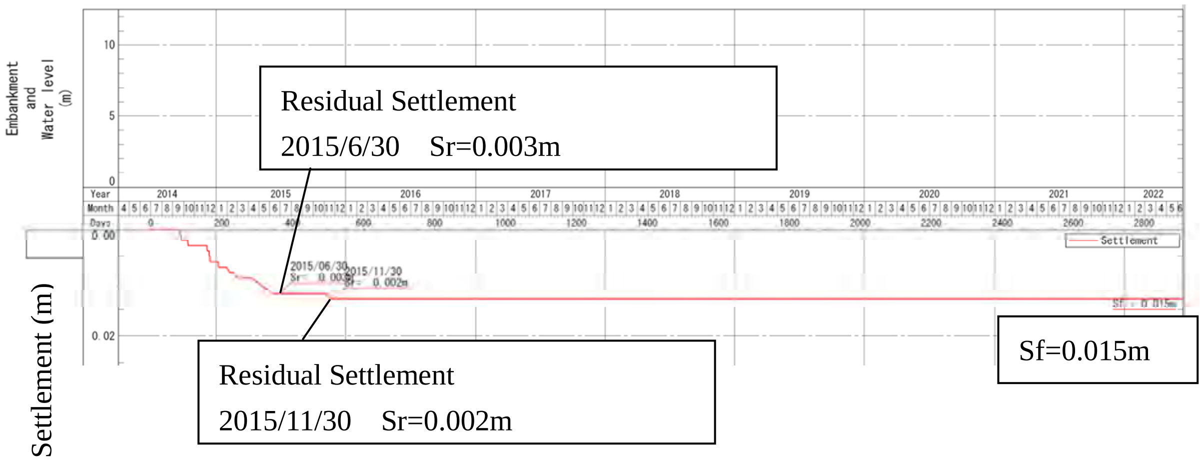
As a result, the settlement will occur around 1.5cm at the edge of existing road due to the surcharge fill. The evaluation of necessity of maintenance and repair of the concrete road is conducted dependent on level of road. According to “Guideline for Road Maintenance and Repair, Japan Road Association”, the criteria of the necessity of road maintenance is 1.5cm in level difference of road surface for the general road with busy traffic. As shown in Figure 4.3-73, the settlement at the time of removal of surcharge fill is 1.2cm (Residual settlement is 0.3cm) which is less than 1.5cm (Criteria value). However, the evaluation of necessity of existing road maintenance shall be done according to actual settlement condition and traffic situation. In case of considering secondary settlement, the settlement generating at the edge of existing road is around 11cm. For the level difference amount 1.5cm generating after removal of surcharge fill, the repair of road is estimated every 10 years to 30 years.



Calculation Point	Stress Increment(kN/m2)			
	① Sand Mat	② Surcharge	③ Removal of Surcharge	④ Pavement
a	0.076	0.247	-0.020	0.158
b	1.223	3.454	-0.471	1.476
c	2.851	8.058	-1.574	2.490
d	4.083	12.086	-2.871	3.047
e	4.916	15.186	-4.035	3.365

Source : Study Team

Figure 4.3-72 Analysis Result for In-situ Increase Stress



Source : Study Team

Figure 4.3-73 Settlement Analysis Result (Access Road Area, Non-improvement : Primary settlement)

3) Stability Analysis Result

a) Present Ground (Non-improvement)

Stability analysis is carried out for the slope stability at the time during filling work and after completion of filling work. The analysis point is S-1 to S-3 as shown in Figure 4.3-54. S-1 is representative of Area1-1 and Area1-2, S-2 is representative of Area2 and S-3 is representative of revetment area.

The result of stability analysis is shown in Figure 4.3-74 to Figure 4.3-78 and the summary of the result is shown in Table 4.3-28. At Point S-3 (Revetment area), since it becomes revetment structure in the future, the stability analysis after completion of the revetment construction is carried out in another section “Revetment”. Accordingly, the stability analysis in this section is carried out at the time only during filling work. The shear strength used for analysis after completion of filling work is refer to Table 4.3-29 in consideration of increasing shear strength by fill load (80% of consolidation degree).

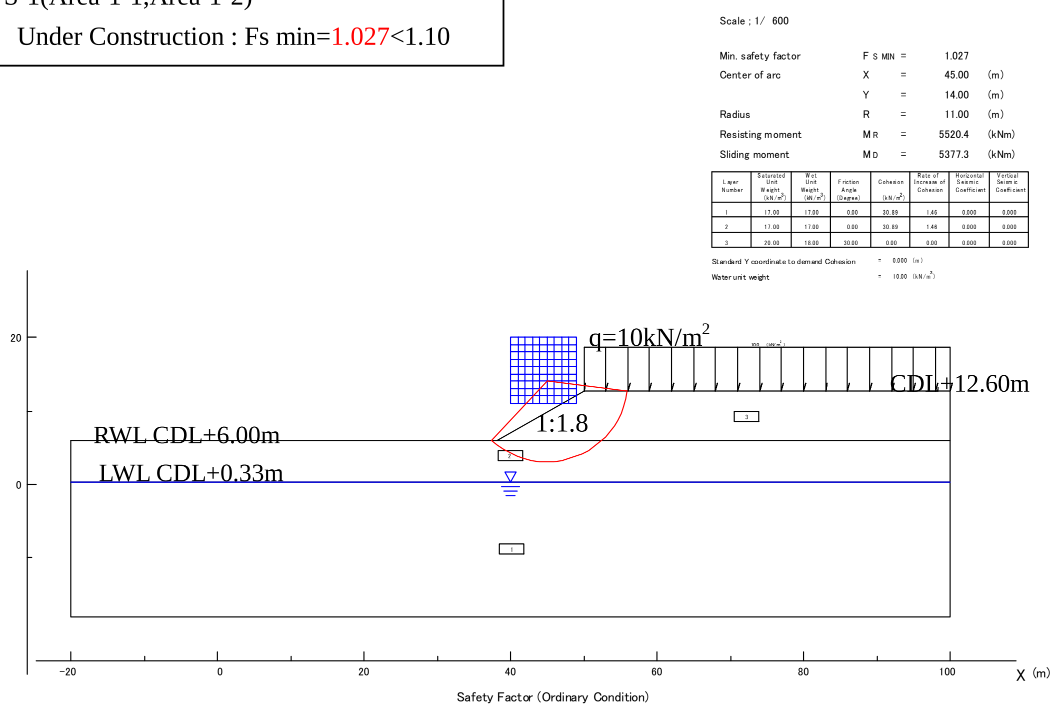
As a result of analysis, safety factor for point S-2 (Building area) satisfies the required safety factor for both during construction and after completion of construction. However, safety factor for Point S-1 in Area1-1 and Area 1-2 (Container Area) and Point S-3 (Revetment Area) can not satisfy the required safety factor during construction. Therefore, it is considered that it needs some measures for the stability of the area.

Table 4.3-28 Estimated Myanmar Population by Region

Area		Analysis point	Under Construction		Completion	
			Obtained Minimum Safety Factor	Required Safety Factor	Obtained Minimum Safety Factor	Required Safety Factor
			Fsmin	Fsa	Fsmin	Fsa
Full Container Storage Yard	Area-1-1	S-1	1.027	1.10	2.721	1.30
	Area-1-2					
Building Area	Area-2	S-2	1.262		2.543	
Revetment		S-3	0.869		—	

Source : Study Team

S-1(Area-1-1,Area-1-2)
Under Construction : Fs min=1.027<1.10



Source : Study Team

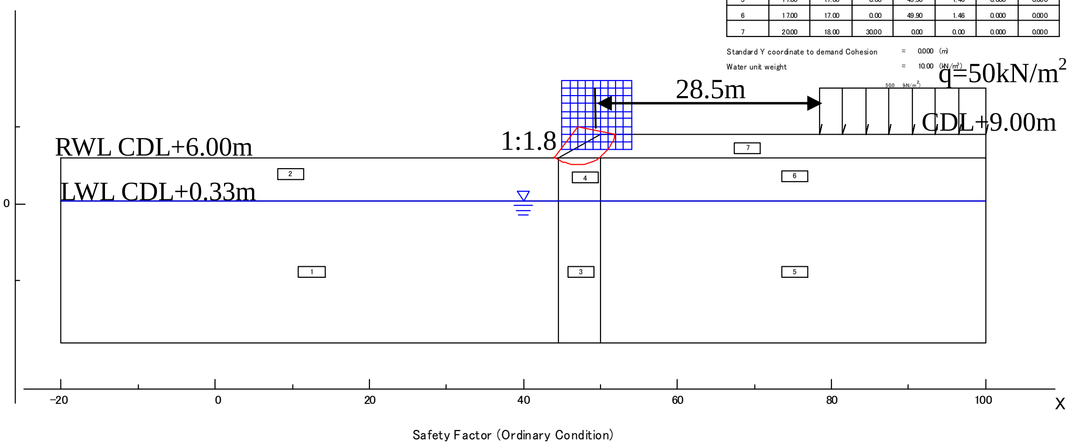
Figure 4.3-74 Stability Analysis Result for Point S-1 (During Construction)

S-1(Area-1-1,Area-1-2)
Completion : Fs min=2.721>1.30

Min. safety factor	F S MIN	=	2.721	
Center of arc	X	=	47.00	(m)
	Y	=	10.00	(m)
Radius	R	=	5.00	(m)
Resisting moment	M R	=	1136.3	(kNm)
Sliding moment	M D	=	417.7	(kNm)

Layer Number	Saturated Unit Weight (kN/m^3)	Wet Unit Weight (kN/m^3)	Friction Angle (Degree)	Cohesion (kN/m^2)	Rate of Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	17.00	17.00	0.00	30.89	1.46	0.000	0.000
2	17.00	17.00	0.00	30.89	1.46	0.000	0.000
3	17.00	17.00	0.00	40.39	1.46	0.000	0.000
4	17.00	17.00	0.00	40.39	1.46	0.000	0.000
5	17.00	17.00	0.00	49.90	1.46	0.000	0.000
6	17.00	17.00	0.00	49.90	1.46	0.000	0.000
7	20.00	18.00	30.00	0.00	0.00	0.000	0.000

Standard Y coordinate to demand Cohesion = 0.000 (m)
Water unit weight = 10.00 (kN/m^3)



Source : Study Team

Figure 4.3-75 Stability Analysis Result for Point S-1 (After Completion)

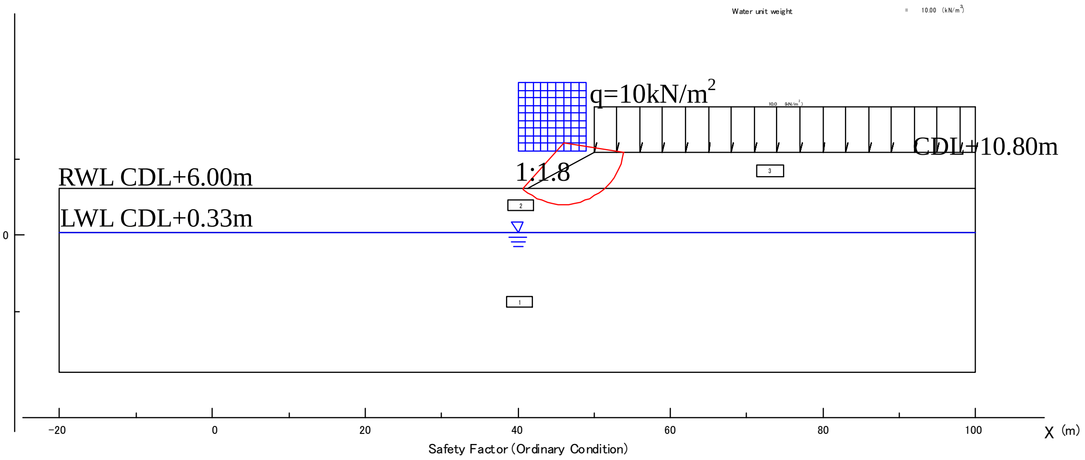
S-2(Area-2)
Under Construction : Fs min=1.262>1.10

Scale ; 1/ 600

Min. safety factor	F S MIN	=	1.262	
Center of arc	X	=	46.00	(m)
	Y	=	12.00	(m)
Radius	R	=	8.00	(m)
Resisting moment	M R	=	2625.6	(kNm)
Sliding moment	M D	=	2080.9	(kNm)

Layer Number	Saturated Unit Weight (kN/m^3)	Wet Unit Weight (kN/m^3)	Friction Angle (Degree)	Cohesion (kN/m^2)	Rate of Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	17.00	17.00	0.00	30.89	1.46	0.000	0.000
2	17.00	17.00	0.00	30.89	1.46	0.000	0.000
3	20.00	18.00	30.00	0.00	0.00	0.000	0.000

Standard Y coordinate to demand Cohesion = 0.000 (m)
Water unit weight = 10.00 (kN/m^3)



Source : Study Team

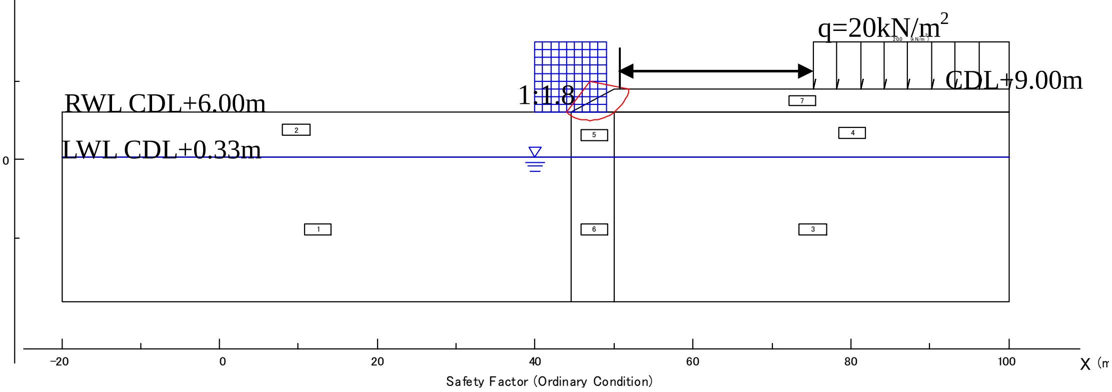
Figure 4.3-76 Stability Analysis Result for Point S-2 (During Construction)

S-2(Area-2)
Completion : Fs min=2.543>1.30

Min. safety factor	$F_{S\,MIN}$	=	2.543	
Center of arc	X	=	47.00	(m)
	Y	=	10.00	(m)
Radius	R	=	5.00	(m)
Resisting moment	M_R	=	1062.3	(kNm)
Sliding moment	M_D	=	417.7	(kNm)

Layer Number	Saturated Unit Weight (kN/m^3)	Wet Unit Weight (kN/m^3)	Friction Angle (Degree)	Cohesion (kN/m^2)	Rate of Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	17.00	17.00	0.00	30.89	1.46	0.000	0.000
2	17.00	17.00	0.00	30.89	1.46	0.000	0.000
3	17.00	17.00	0.00	44.71	1.46	0.000	0.000
4	17.00	17.00	0.00	44.71	1.46	0.000	0.000
5	17.00	17.00	0.00	37.80	1.46	0.000	0.000
6	17.00	17.00	0.00	37.80	1.46	0.000	0.000
7	20.00	18.00	30.00	0.00	0.00	0.000	0.000

Standard Y coordinate to demand Cohesion = 0.000 (m)
Water unit weight = 10.00 (kN/m^3)



Source : Study Team

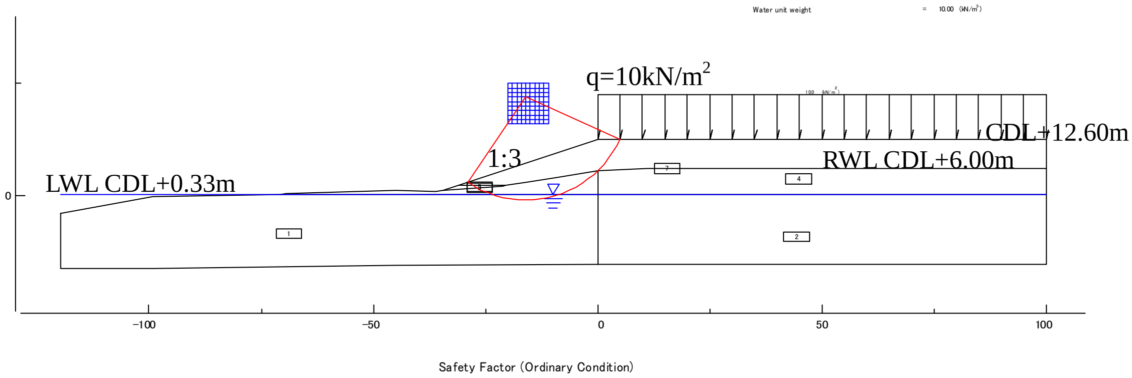
Figure 4.3-77 Analysis Result for Point S-2 (After Construction)

S-3(Revetment)
Under Construction : Fs min=0.869<1.10

Min. safety factor	$F_{S\,MIN}$	=	0.869	
Center of arc	X	=	−16.00	(m)
	Y	=	22.00	(m)
Radius	R	=	23.00	(m)
Resisting moment	M_R	=	19174.6	(kNm)
Sliding moment	M_D	=	22076.8	(kNm)

Layer Number	Saturated Unit Weight (kN/m^3)	Wet Unit Weight (kN/m^3)	Friction Angle (Degree)	Cohesion (kN/m^2)	Rate of Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	17.00	17.00	0.00	24.97	1.98	0.000	0.000
2	17.00	17.00	0.00	30.89	1.46	0.000	0.000
3	17.00	17.00	0.00	24.97	1.98	0.000	0.000
4	17.00	17.00	0.00	30.89	1.46	0.000	0.000
5	20.00	20.00	30.00	0.00	0.00	0.000	0.000
7	20.00	18.00	30.00	0.00	0.00	0.000	0.000

Standard Y coordinate to demand Cohesion = 0.000 (m)
Water unit weight = 10.00 (kN/m^3)



Source : Study Team

Figure 4.3-78 Stability Analysis Result for Point S-3 (During Construction)

Table 4.3-29 Shear Strength of Clay in consideration of Shear Strength Increment (UU)

Area	S−1 (Area−1−1,Area−1−2)		S−2 (Area−2)	
	Bottom of fill	Slope of fill	Bottom of fill	Bottom of fill
C_{u0}(kN/m^2) Initial shear strength	−1.46Z+30.89 (Z=0 at CDL±0.00)		−1.46Z+30.89 (Z=0 at CDL±0.00)	
ΔP(kN/m^2) Stress increment	Preload thickness : H=6.6m Wet density : γ_t=18kN/m^3 $\Delta P=\gamma_t\times H$=118.8kN/m^2	Preload thickness : H=3.3m Wet density : γ_t=18kN/m^3 $\Delta P=\gamma_t\times H$=59.4kN/m^2	Preload thickness : H=4.8m Wet density : γ_t=18kN/m^3 $\Delta P=\gamma_t\times H$=86.4kN/m^2	Preload thickness : H=2.4m Wet density : γ_t=18kN/m^3 $\Delta P=\gamma_t\times H$=43.2kN/m^2
cu/p Increase ratio of shear strength	0.2		0.2	
U(%) Consolidation degree	80		80	
Cu(kN/m2) Increased shear strength with consolidation progress	Cu=C_{uo}+ΔP･cu/p･U =−1.46Z+49.90kN/m^2	Cu=C_{uo}+ΔP･cu/p･U =−1.46Z+40.39kN/m^2	Cu=C_{uo}+ΔP･cu/p･U =−1.46Z+44.71kN/m^2	Cu=C_{uo}+ΔP･cu/p･U =−1.46Z+37.80kN/m^2

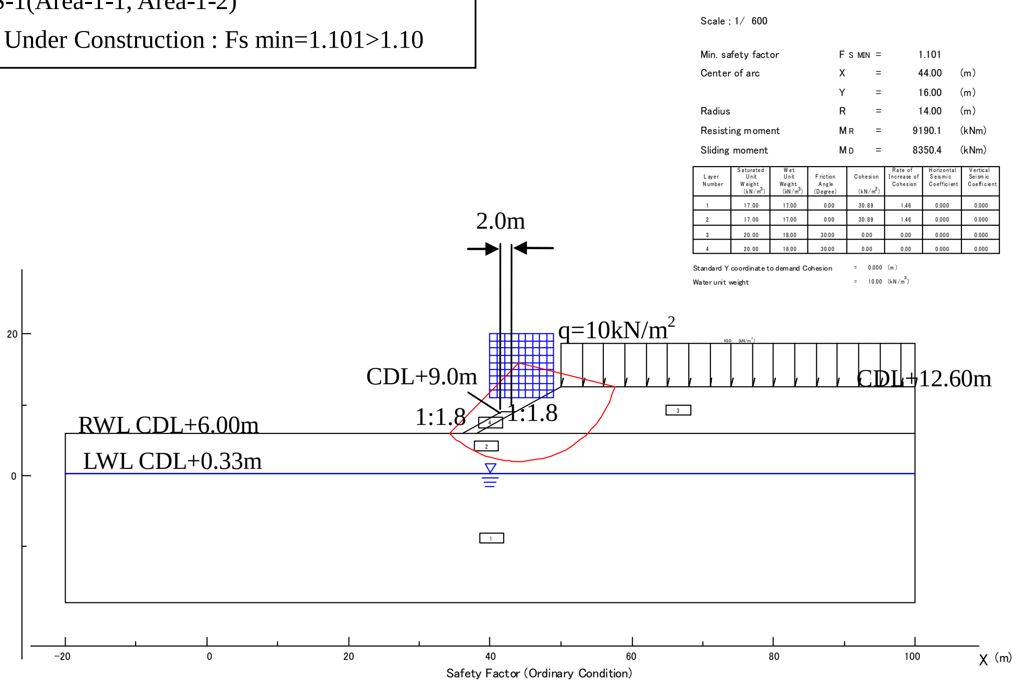
Source：Study Team

b) Study of Measures for Slope Stability

As a result of analysis for present ground condition (Non-improvement), it is confirmed that safety factor for Point S-1 in Area1-1 and Area 1-2 (Container Area) and Point S-3 (Revetment Area) can not satisfy the required safety factor during construction. Therefore, measures for slope stability for the area is examined and stable fill dimension is examined.

Analysis result for Container area is shown in Figure 4.3-79 and analysis result for Revetment area is shown in Figure 4.3-80. Accordingly, allowable safety factor (Fsa=1.10) can be satisfied by setting of counterweight (Fill construction) as shown in the figure. .

S-1(Area-1-1, Area-1-2)
Under Construction : Fs min=1.101>1.10



Source : Study Team

Figure 4.3-79 Stability Analysis Result for Measures ; Point S-1 (During Construction)

S-3(Revetment)

Under Construction : Fs min=1.110＞1.10

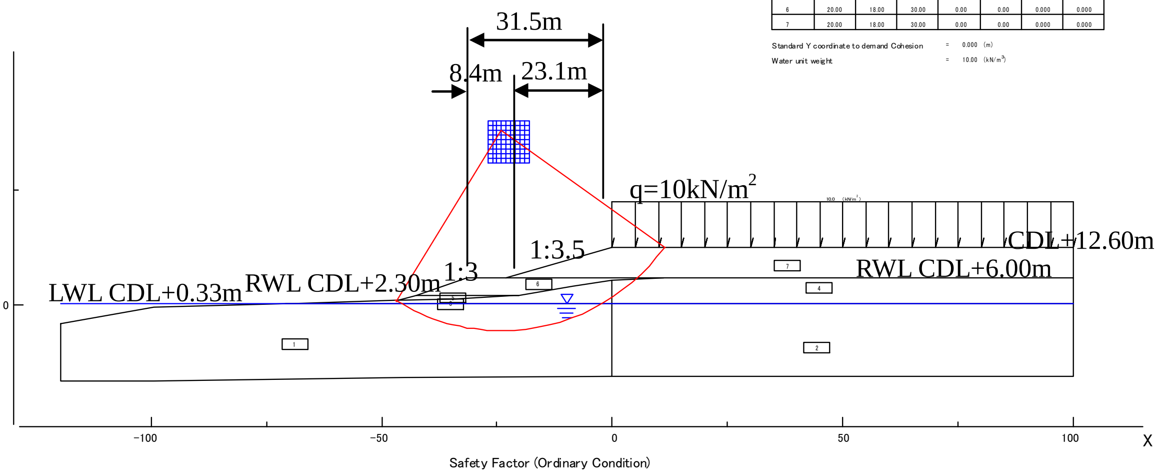
Scale : 1/ 1000

Min. safety factor	F S MIN	=	1.110	
Center of arc	X	=	−24.00	(m)
	Y	=	38.00	(m)
Radius	R	=	43.50	(m)
Resisting moment	M R	=	81781.1	(kNm)
Sliding moment	M D	=	73705.9	(kNm)

Layer Number	Saturated Unit Weight (kN/m^3)	Wet Unit Weight (kN/m^3)	Friction Angle (Degree)	Cohesion (kN/m^2)	Rate of Increase of Cohesion	Horizontal Seismic Coefficient	Vertical Seismic Coefficient
1	17.00	17.00	0.00	24.97	1.98	0.000	0.000
2	17.00	17.00	0.00	30.89	1.46	0.000	0.000
3	17.00	17.00	0.00	24.97	1.98	0.000	0.000
4	17.00	17.00	0.00	30.89	1.46	0.000	0.000
5	20.00	20.00	30.00	0.00	0.00	0.000	0.000
6	20.00	18.00	30.00	0.00	0.00	0.000	0.000
7	20.00	18.00	30.00	0.00	0.00	0.000	0.000

Standard Y coordinate to demand Cohesion = 0.000 (m)

Water unit weight = 10.00 (kN/m^3)

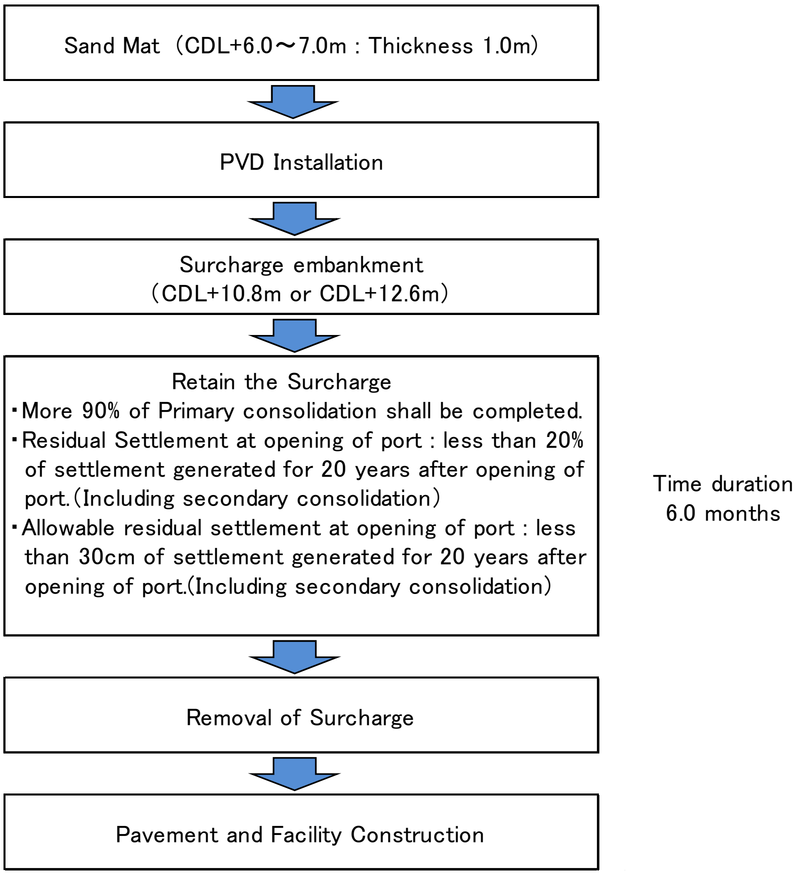


Source : Study Team

Figure 4.3-80 Stability Analysis Result for point S-3 (During Construction)

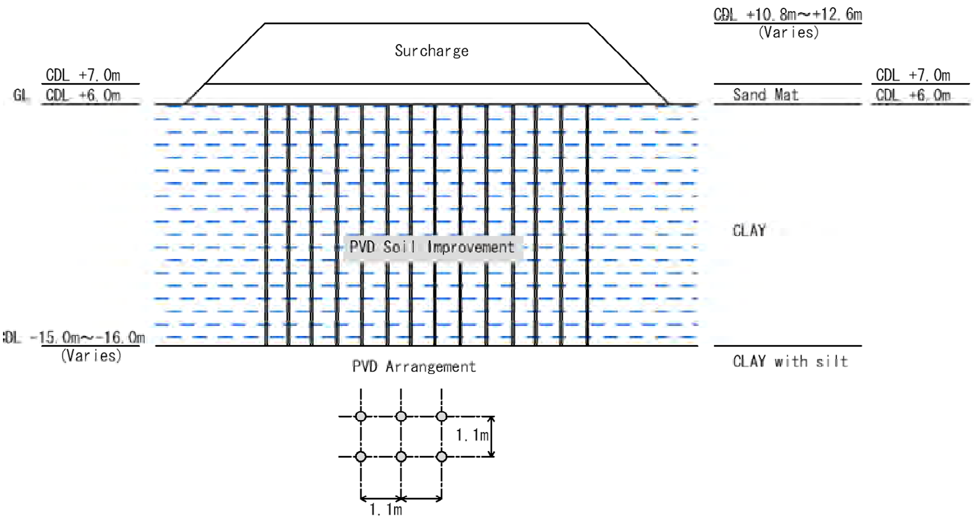
(4) Procedure of PVD with Surcharge Method

The procedure of PVD with Surcharge method is shown in Figure 4.3-81. Representative section of the method is shown in Figure 4.3-82.



Source : Study Team

Figure 4.3-81　Procedure of Soil Improvement by PVD with Surcharge



Source : Study Team

Figure 4.3-82　Representative Section for Soil Improvement

(5) Construction of Sand Mat and PVD with Surcharge

The plan map of whole area for soil improvement is shown in Figure 4.3-83 and representative section for the soil improvement area is shown in Figure 4.3-84 and Figure 4.3-85.

1) Sand Mat

Sand mat is spread from CDL+6.0m to CDL+7.0m with 1.0m thickness.

The sand mat material shall have the following grading characteristics to keep the good permeability.

- Organic Content < 5%
- 0.25mm grain or bigger size weight > 50%
- 0.074mm grain or smaller size weight < 5%
- $D_{60} / D_{10} > 6$ or $1 < (D_{30})^2 / D_{10} \cdot D_{60} < 3$
- Permeability > 1×10^{-4} m/sec

2) PVD

PVD is installed from the top of the sand mat (CDL+7.0m) to the bottom of clay layer. Although the bottom of clay layer is assumed to be around CDL-15.0m to CDL-16.0m, PVD shall be installed up to the bottom of clay layer on actual installation work.

In order to ensure the acceleration of the consolidation of clay layer, the PVD material shall keep good permeability and continuity. The plane configuration of PVD installation is square arrangement (1.0m * 1.0m). The cut length of PVD on the ground after completion of PVD installation is around 20cm.

The PVD material shall satisfy following specification.

- The filter jacket shall be a non-woven polyester fabric or similar, complying with effective opening size (O_{95}) not bigger than 75 μm and minimum filter jacket permeability of 1.0 x 10^{-4} m/sec. Burst strength is over 900kN/m^2
- Grab strength and Puncture resistance is over 350 N and 100 N respectively.
- Width of PVD is 100mm ± 0.05 (5%) and Thickness is 3mm.
- Tensile strength of drain is 2kN/m.
- Elongation at break ≥ 20%
- Discharge capacity of PVD

  Straight drain at hydraulic gradient i = 1.0 and 250 kPa ≥ $90*10^{-6}$ m^3/sec

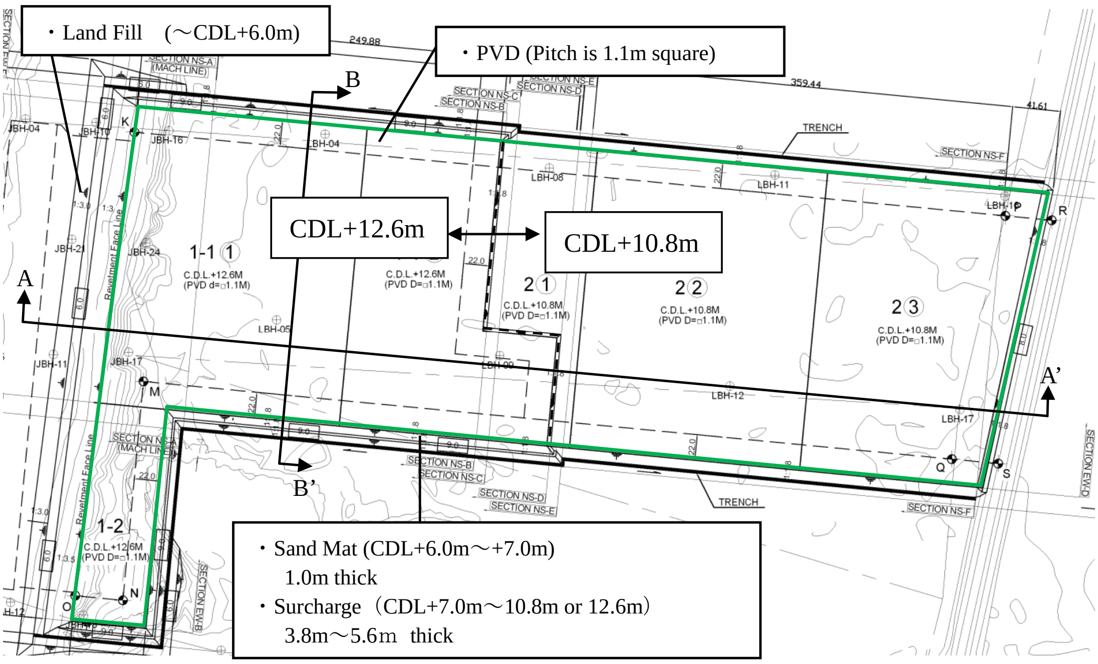
  Buckled drain at hydraulic gradient i = 1.0 and 250 kPa ≥ $50*10^{-6}$ m^3/sec

3) Land Fill and Surcharge Fill

Land fill is to fill the sand up to the level of CDL+6.0m and surcharge fill is to fill the sand above the sand mat (top of sand mat : CDL+7.0m). Surcharge fill is temporary fill retaining until the consolidation degree of the soft ground can reach to target consolidation degree. The target consolidation degree is over 90 % for primary consolidation settlement and minimum retaining period of surcharge fill is 6 months on design condition. After reach of the target consolidation degree, the surcharge fill is removed up to planed subgrade level.

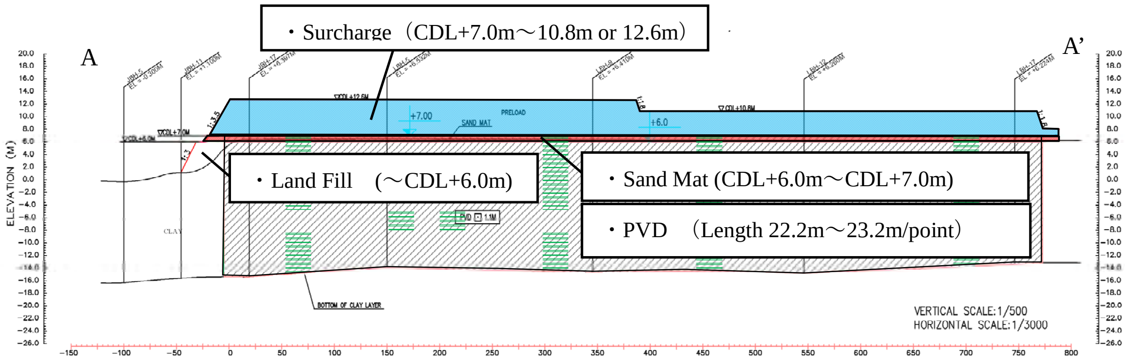
In order to accelerate the consolidation by transferring the surcharge fill load effectively to the original soft ground, following suitable sand material shall be used. Sand material used for the land fill is also same as one of the surcharge fill.

- Organic Content < 5%
- Calcium carbonate content < 3%
- Silt and clay content (size <0.075 mm) < 15%
- Density of the surcharge fill ≧18kN/m^3



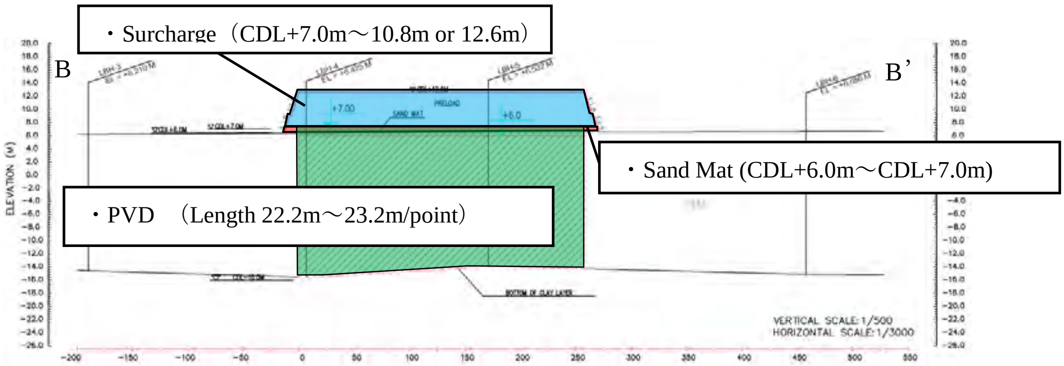
Source : Study Team

Figure 4.3-83 Plan Map of Soil Improvement



Source : Study Team

Figure 4.3-84　Section of Soil Improvement (A-A' section)



Source : Study Team

Figure 4.3-85　Section of Soil Improvement (B-B' section)

4)　Quantity of Soil Improvement Work

Required quantity of land fill, sand mat, PVD, Surcharge fill and removal of surcharge fill is summarized as follows. The quantity of removal of surcharge fill is estimated in condition that the average subgrade level for whole area of Plot 25 is assumed to be CDL+8.0m.

- Land fill : 103,368.5m^3
- PVD : 3,996,997.8m
- Sand mat : 237,352.3m^3
- Surcharge fill : 1,042,845.5m^3
- Removal of Surcharge fill : 675,156.0 m^3

The detailed quantity based on design drawing is shown in Table 4.3-30 and Table 4.3-31.

Table 4.3-30 Quantity of PVD installation

Area	Block	PVD spacing (m)	Amount (point)	PVD length (m)	Total length (m)
Area-1-1	1-1①	1.1	44,102	23.2	1,023,166.4
	1-1②	1.1	29,570	23.2	686,024.0
Area-1-2	1-2	1.1	10,265	23.2	238,148.0
Area-2	2①	1.1	12,836	22.2	284,959.2
	2②	1.1	42,406	22.2	941,413.2
	2③	1.1	37,085	22.2	823,287.0
TOTAL			**176,264**		**3,996,997.8**

Source : Study Team

Table 4.3-31 Quantity of land fill, Sand mat and Surcharge fill

	DISTANCE	LAND FILL			SAND MAT			SURCHARGE		
		AREA (M2)	AVERAGE (M2)	VOLUME (M3)	AREA (M2)	AVERAGE (M2)	VOLUME (M3)	AREA (M2)	AVERAGE (M2)	VOLUME (M3)
	-	0.0	-	—	0.0	-	—	0.0	-	—
	12.00	143.8	71.9	862.8	0.0	0.0	0.0	0.0	0.0	0.0
EW-A	9.00	143.8	143.8	1,294.2	0.0	0.0	0.0	0.0	0.0	0.0
EW-B	13.88	181.5	162.7	2,258.3	98.0	49.0	680.1	443.8	221.9	3,080.0
EW-C	171.91	195.9	188.7	32,439.4	92.6	95.3	16,383.0	413.4	428.6	73,680.6
EW-D	16.09	211.8	203.9	3,280.8	93.1	92.9	1,494.8	456.4	434.9	6,997.5
EW-E	256.00	226.8	219.3	56,140.8	84.4	88.8	22,732.8	408.0	432.2	110,643.2
EW-F	13.88	238.7	232.8	3,231.3	0.0	42.2	585.7	0.0	204.0	2,831.5
	9.00	238.7	238.7	2,148.3	0.0	0.0	0.0	0.0	0.0	0.0
	13.94	0.0	119.4	1,664.4	0.0	0.0	0.0	0.0	0.0	0.0
SUBTOTAL		—	—	103,320.3	—	—	41,876.4	—	—	197,232.8
NS-A	—	0.0			282.0			1498.0		
	249.88	0.0	0.0	0.0	282.0	282.0	70,466.2	1498.0	1498.0	374,320.2
NS-B	3.24	0.7	0.4	1.3	278.7	280.4	908.5	1192.3	1345.2	4,358.4
NS-C	10.62	0.7	0.7	7.4	276.7	277.7	2,949.2	1188.3	1190.3	12,641.0
	50.75	0.7	0.7	35.5	276.7	276.7	14,042.5	1188.3	1188.3	60,306.2
NS-D	3.24	0.4	0.6	1.9	273.5	275.1	891.3	1002.8	1095.6	3,549.7
NS-E	10.64	0.0	0.2	2.1	271.5	272.5	2,899.4	998.8	1000.8	10,648.5
NS-F	359.44	0.0	0.0	0.0	271.9	271.7	97,659.8	998.8	998.8	359,008.7
	41.61	0.0	0.0	0.0	0.0	136.0	5,659.0	0.0	499.4	20,780.0
SUBTOTAL		—	—	48.2	—	—	195,475.9	—	—	845,612.7
TOTAL		—	—	**103,368.5**	—	—	**237,352.3**	—	—	**1,042,845.5**

Source：Study Team

Table 4.3-32 Quantity of Removal of Surcharge Fill

	DISTANCE	REMOVAL		
		AREA (M2)	AVERAGE (M2)	VOLUME (M3)
	—	0.0	—	—
	12.00	88.1	44.1	529.2
EW-A	9.00	88.1	88.1	792.9
	31.88	88.1	88.1	2,808.6
EW-B	4.00	406.6	247.4	989.6
EW-C	149.91	414.6	410.6	61,553.0
EW-D	16.09	446.3	430.5	6,926.7
	234.00	446.3	446.3	104,434.2
EW-E	22.00	460.8	453.6	9,979.2
EW-F	13.88	138.1	299.5	4,157.1
	9.00	138.1	138.1	1,242.9
	13.94	0.0	69.1	963.3
SUBTOTAL		—	—	194,376.7
NS-A	—	904.7		
	249.88	904.7	904.7	226,066.4
NS-B	64.55	653.1	778.9	50,278.0
NS-C	13.94	496.0	574.6	8,009.9
	327.50	496.0	496.0	162,440.0
NS-D	31.93	866.9	681.5	21,760.3
	28.20	0.0	433.5	12,224.7
SUBTOTAL		—	—	480,779.3
TOTAL		—	—	**675,156.0**

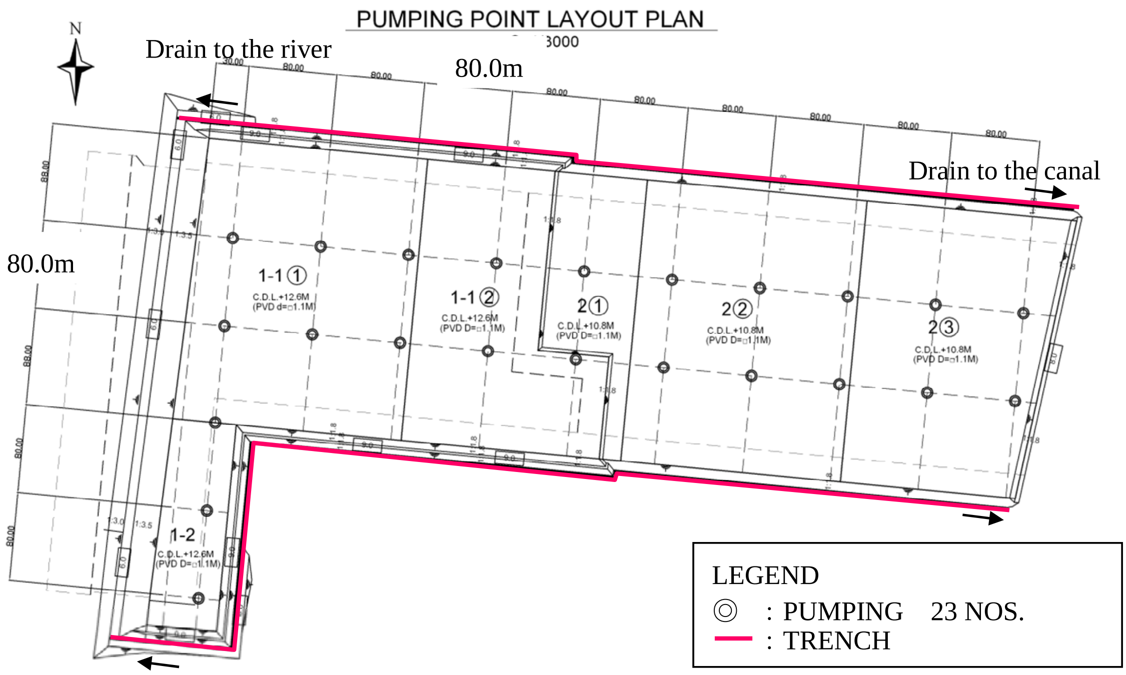
Source : Study Team

(6) Pumping Well and Drainage

PVD installation is to accelerate the consolidation by shortening the discharge distance. However, in case the permeability of sand mat is low, time-lag of consolidation may occur due to mat resistance. Therefore, to effectively conduct soil improvement by PVD method, it is important to drain the water immediately. Dredged river sand is planned to be used for fill material, there is a possibility of occurring time-lag consolidation dependent on permeability of the fill material. Accordingly, pumping well is planned to be installed as shown in Figure 4.3-86.

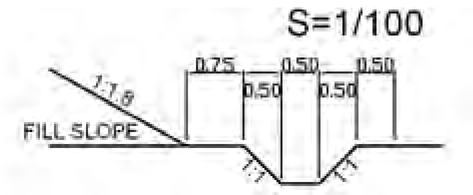
The pumping wells are arranged at the intervals of approximately 80m and the drainage layer (Sand mat) is connected to the pumping wells. Pumped up water by the submerged pump installed under the ground water (Figure 4.3-88) is discharged to the outside.

Collected consolidation water from the pumping well and sand mat are discharged to the river and irrigation canal through drain trench installed at the toe of slope as shown in Figure 4.3-86. Section of drain trench is shown in Figure 4.3-87.



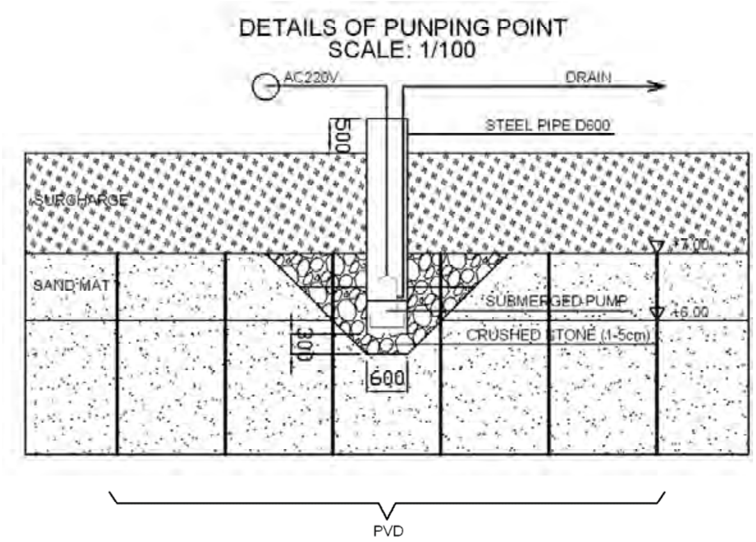
Source : Study Team

Figure 4.3-86 Plan map for Pumping Well and Drain Trench



Source : Study Team

Figure 4.3-87 Section of Drain Trench



Source : Study Team

Figure 4.3-88 Detailed Section of Pumping Up System

＜The Design Calculations of Pumping Well＞

Drained Water from PVD

From Figure 4.3-89, the maximum rate of settlement is S= 1.17 m/300days = 0.0039m/day . (Area-1-1 block)

The volume of drained water is estimated same as the settlement amount of soil. The drained water from one PVD is calculated as follows :

PVD installation pitch is 1.1m square in Area-1-1 block

Water amount from one PVD = 0.0039m/day x (1.1m x 1.1m) = 0.0047m^3/day

According to Figure 4.3-90, PVD discharge capacity is generally in range of 1.2 x $10^{-3}m^3$/min =1.73m^3/day. Thus, PVD discharge capacity is sufficient for the estimated water amount drained from PVD.

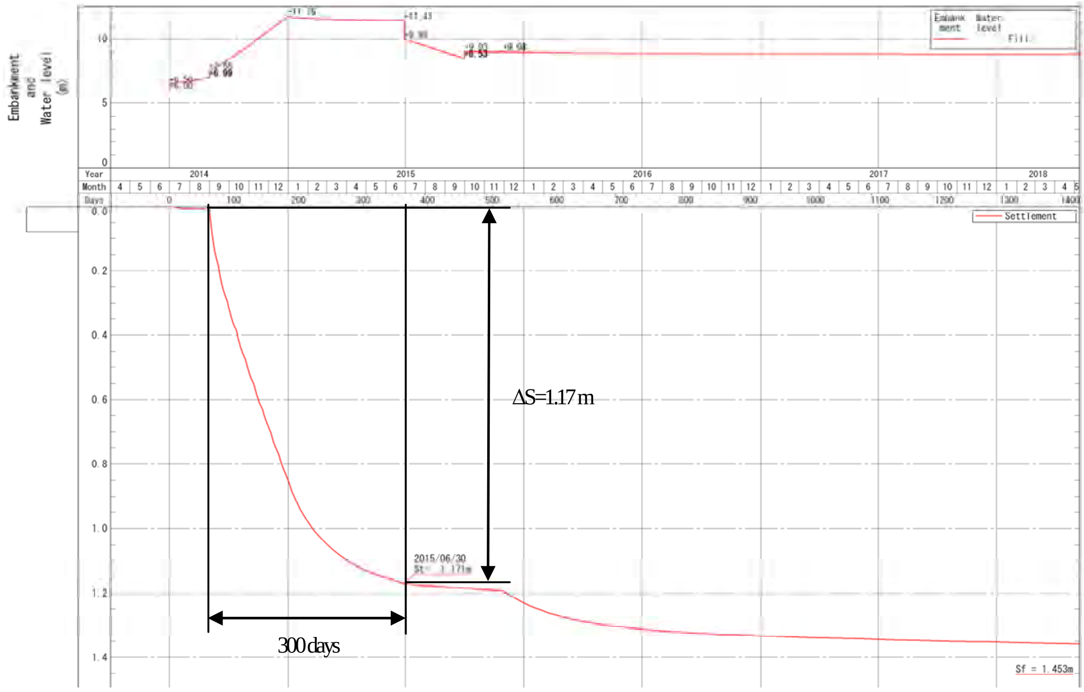
Pumping Well

The interval of pumping well is around 80m. The water amount flowing into pumping well is estimated as follows :

Number of PVD in one area surrounded 80m square : (80m x 80m)/(1.1m x 1.1m)=5,290 Points

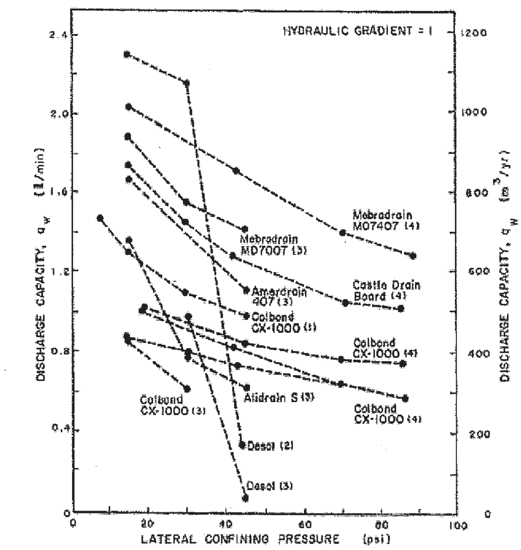
The maximum water flow to one pumping well = 5,290 points x 0.0047 m^3/day = 24.9 m^3/day = 1.1 m^3/hr.

Accordingly, required pump capacity is over 2m^3/hour=0.1m^3/min.



Source : Study Team

Figure 4.3-89 Consolidation settlement amount at the removal of Surcharge Fill (Area-1-1 block)

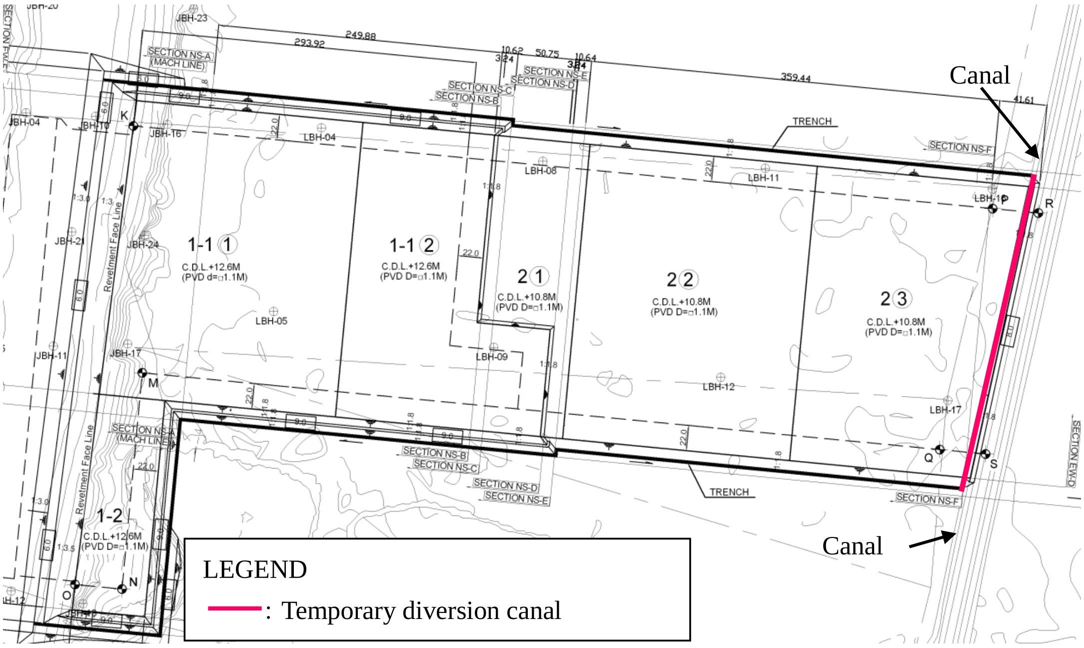


Source : Rixner et al. 1986

Figure 4.3-90 Discharge capacity of Drain material in general

(7) Temporary Diversion Canal

The existing irrigation ditch along the existing road will be blocked by the surcharge fill in the soil improvement work. Therefore, it needs to install temporary diversion canal at the place during soil improvement work as shown Figure 4.3-91. Since some consolidation settlement will occur during the surcharge period at the area, flexible material which can follow such deformation shall be used for the temporary diversion canal.

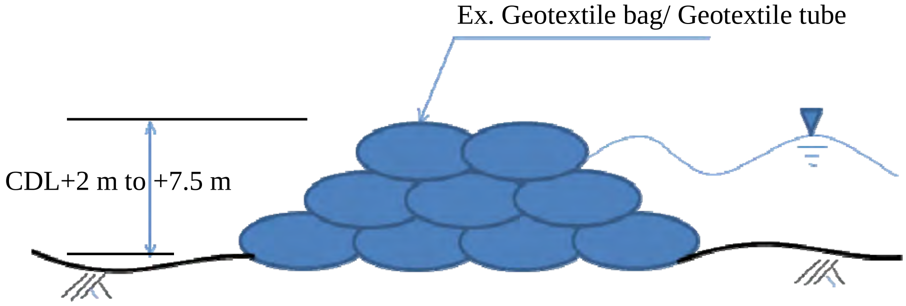


Source : Study Team

Figure 4.3-91 Temporary Diversion Canal

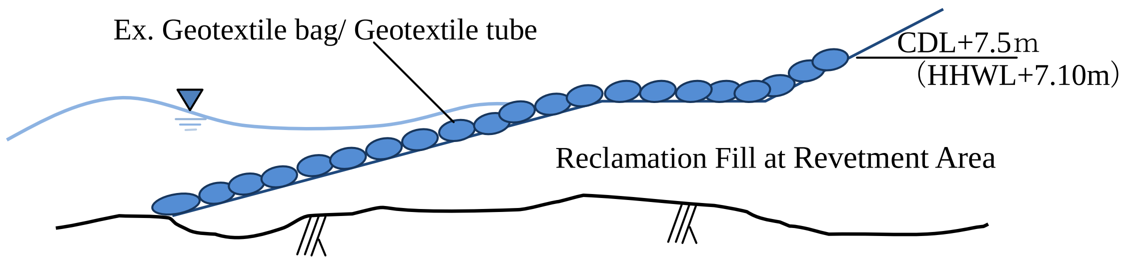
(8) Slope Protection

Surcharge fill is temporary fill for the purpose of accelerating the consolidation for the original soft ground. As the section shape of the slope is designed considering stability of the fill, it needs to protect the slope from damages during surcharge fill. It is necessary especially against erosions by high wave during the windy and rainy season. There are several methods to implement temporary slope protection as followings.



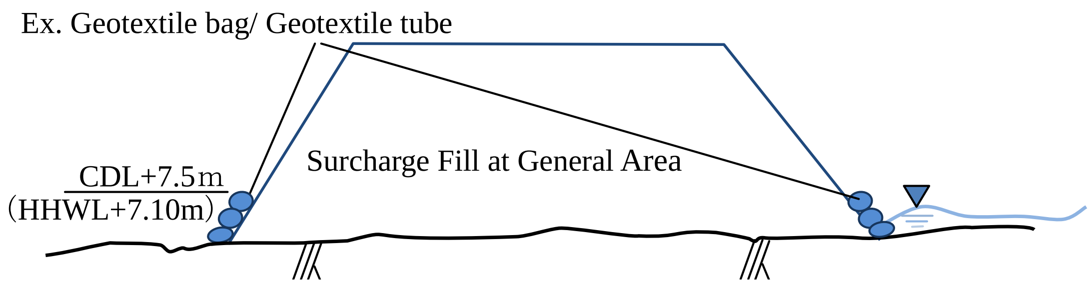
Source : Study Team

Figure 4.3-92 Temporary Slope Protection Method



Source : Study Team

Figure 4.3-93 Slope Protection at Revetment Area

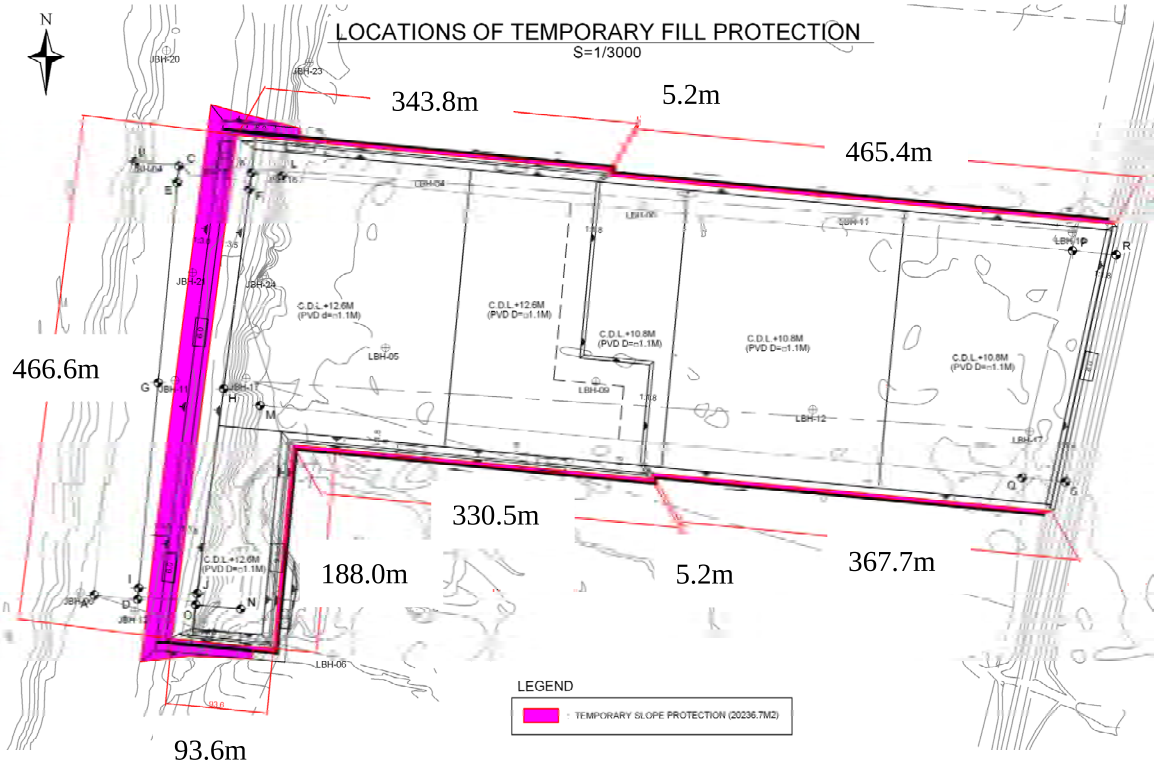


Source : Study Team

Figure 4.3-94 Slope Protection/ at General Area

Required slope protection area is shown in Figure 4.3-95. Quantity of slope protection sis as followings;

- Length of slope protection : 2,300 m
- Area of slope protection : 20,300 m^2



Source : Study Team

Figure 4.3-95 Area of Temporary Slope Protection

(9) Monitoring

1) General

In the project area, there is a soft clay layer depositing with a thickness of over 20m. To protect a significant settlement problem and construct a stable fill land, some measures for soft ground is needed.

As for the land filling work on the soft ground, cautions are required. In case the filling work on the soft ground is conducted rapidly, ground failure might occur. And once such ground deformation occurs, it becomes very difficult to protect proceeding ground failure. Settlement monitoring is needed to confirm the consolidation progress of the ground and evaluate the appropriate commencement time of the pavement work.

Thus, it is very important to conduct the monitoring control during the construction period. In general, the detail of monitoring is planned carefully with additional soil investigation plan. It means monitoring plan shall be made understanding the soil property and soil characteristics by loading.

2) Procedure of Settlement and Stability Control

Monitoring and Observation flow for this project is shown in Figure 4.3.3-58. When filling work is on-going, stability control is to be carried out based on monitored data of horizontal and vertical displacements of ground. If unstable condition of slope reaching to failure can be anticipated, filling is suspended and leaving it for some period for fill or surchargeing slope to become stable. In case slope become stable, filling can be proceeded, on the other hand, in case slope cannot cover the stability, some countermeasures such as counter weight fill or etc. shall be studied and executed. Thus filling and surchargeing work is to execute up to required elevation with monitoring the ground deformation and confirming the slope stability.

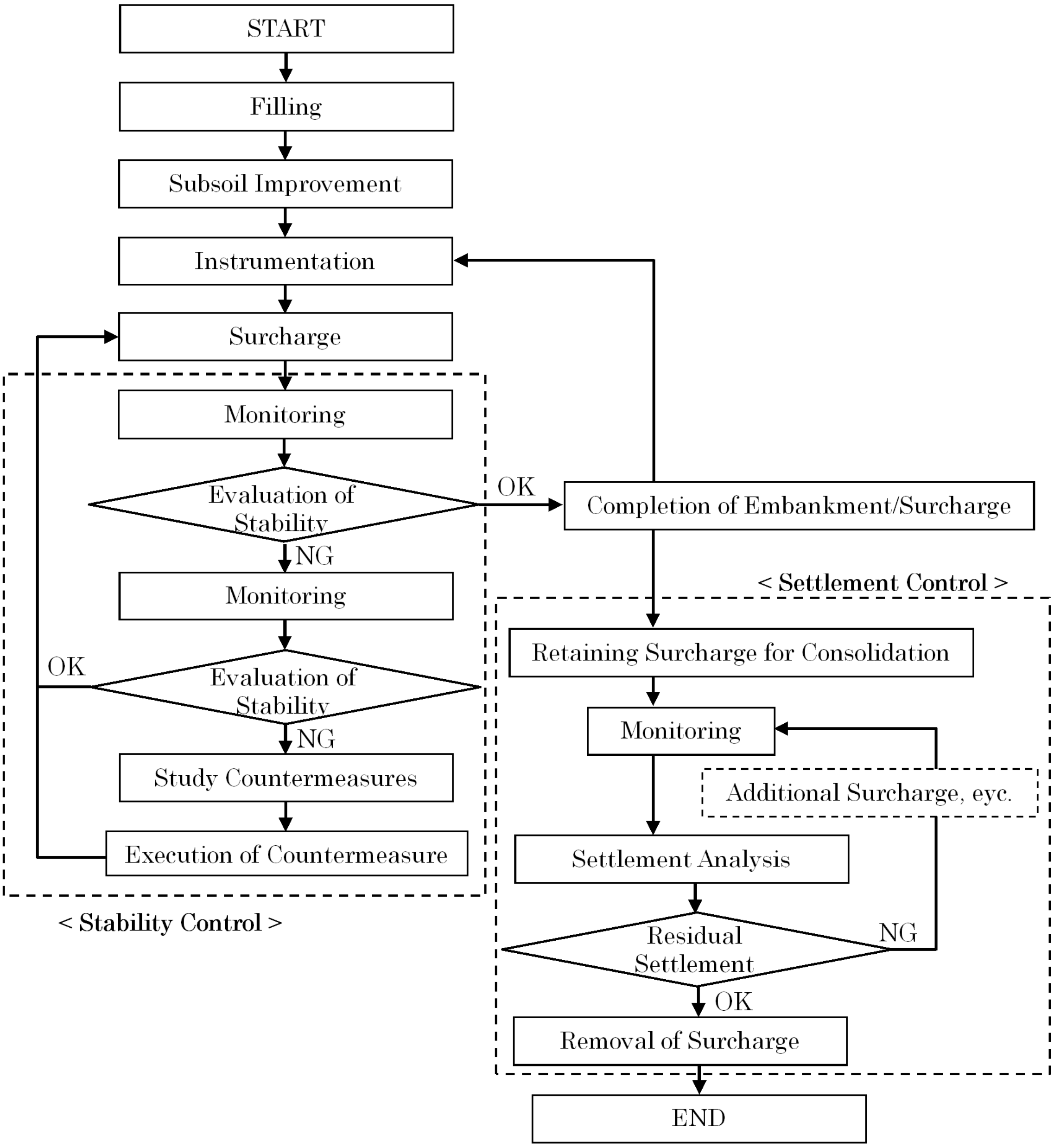
During retaining period of filling and surcharge, the following settlement analysis are to be carried out based on monitored data of settlement.

(1) Comparison between theoretical consolidation settlement (designed value) and monitored value
(2) Prediction of future settlement by monitored settlement data
(3) Evaluation of residual settlement and Consolidation Degree

Time of surcharge removal have to be judged based on evaluation result whether residual settlement can be within required value after designated surcharge retaining period. If there is considerable deviation between theoretical settlement (design value) and monitored one, theoretical calculation is to be carried out again to fit the monitored one and appropriate time of surcharge removal is to be evaluated.

Future settlement anticipation is to be carried out not only at the time of surcharge removal but at the middle of surcharge retaining period. If surcharge removal cannot be executed due to consolidation delay, countermeasures such as additional surcharge, etc. are to be studied and implemented earlier.

When evaluation of shear strength increase by consolidation, boring investigation shall be planned and executed to take the undisturbed samples of clays.



Source : Study Team

Figure 4.3-96 Flow of Monitoring

3) Monitoring Plan

a) Monitoring Instruments

It is very important to understand the actual ground behaviors and evaluate the monitored data properly to perform the soil improvement target as designed and as scheduled.

The soil problems estimated at this project are as follows;

- Consolidation settlement and its duration
- Stability of revetment (Ground deformation and Increase of undrained shear strength)

The following monitoring instruments are necessary to control the performance of soil improvement and analysis of the monitored data as shown in Table 4.3-33.

Table 4.3-33 Monitoring Instruments

Monitoring Instruments	Measurement Item
1) Settlement Plate	Settlement at the existing ground surface
2) Magnetic Extensometer	Settlement or heave at each layer
3) Electric Piezometer	Pore water pressure
4) Stand Pipe	Ground water level
5) Inclinometer	Horizontal movement each ground depth
6) Alignment Stakes	Horizontal and vertical movement

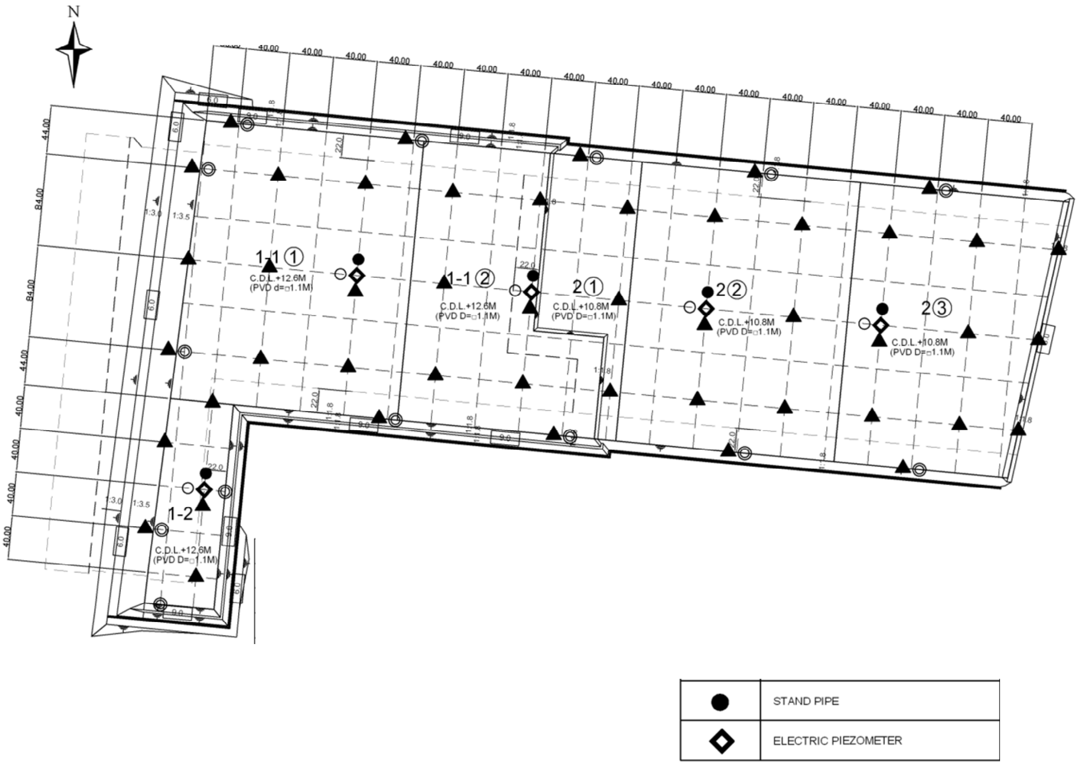
Source：Study Team

b) Layout of Monitoring Instrument Installation

Layout Plan for monitoring instruments at Reclamation Area including Revetment portion is shown in Figure 4.3-97. Basically monitoring instrument layout shall be planned considering actual working schedule and procedure not to give any damages to monitoring instruments. Cross sections for installed conditions of monitoring instruments are shown in Figure 4.3-98 and Figure 4.3-99.

Layout plan for monitoring instruments are planned considering the following conditions.

- Monitoring instruments are selected based on actual performance and experiences in Japan or South East Asia country.
- Monitoring instruments are located at as close points to existing boring points as possible to clarify and obtain the subsoil conditions at installed points of instruments for later analysis and evaluation of monitored data.
- Settlement plates are located in about 80 m to 100 m intervals in the project area.
- To analyze the consolidation settlement for each layer, totally 5 detailed monitoring points are placed with a set of instruments such as Magnetic Extensometer, Electric Piezometer, Pore Water Pressure and Stand Pipe. However actual arrangement of these detailed monitoring points shall be layout at earlier construction blocks to utilize and feed forward the analysis result of monitored data to later construction blocks.
- Settlement monitoring targets of Magnetic Extensometer shall be installed at proper depths (every 5m to 8m interval of depth) to catch the settlement of each layer.
- Electric Piezometer shall be installed at center of each layer to monitor the dissipation of excess pore water pressure of each layer (Every 5m to 8m interval of depth).
- Only one Electric Piezometer shall be installed in one borehole to catch the accurate excess pore water pressure. It shall be installed at 50cm below the bottom of borehole by smooth penetration.
- Inclinometers are installed at points to which shall be attention for stability such a shoulder of the surcharge fill slope with settlement plate.



Source : Study Team

Figure 4.3-97 layout of Monitoring Instrument Installation

Table 4.3-34 Quantities of Monitoring Instruments

Monitoring Instruments	Unit	Qty.	Remarks
1) Settlement Plate	Nos.	47	
2) Magnet Extensometer	Nos.	5	
3) Inclinometer	Nos.	14	
4) Stand Pipe	Nos.	5	
5) Electric Piezometer	Nos.	20	5 locations x 4 layers

Source : Study Team

c) Frequency of Monitoring

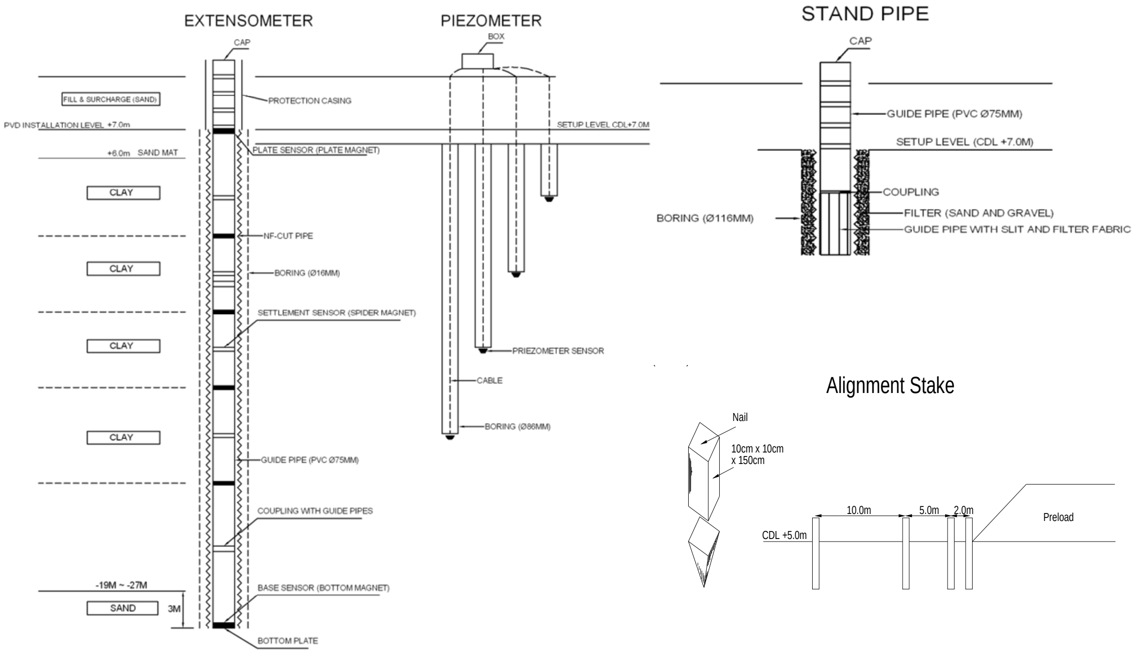
The frequency of monitoring of all instruments shall be determined by a number of factors including the rate of filling, the consolidation periods, level of stability against slip failure and the presence of any observable or suspected distress in the embankments or underlying soils.

The basic frequency of monitoring for the affected areas during construction is shown in Table 4.3-35. Basically monitoring frequency shall be modified and changed dependent on the condition of site work and ground deformation.

Table 4.3-35 Frequency of Monitoring

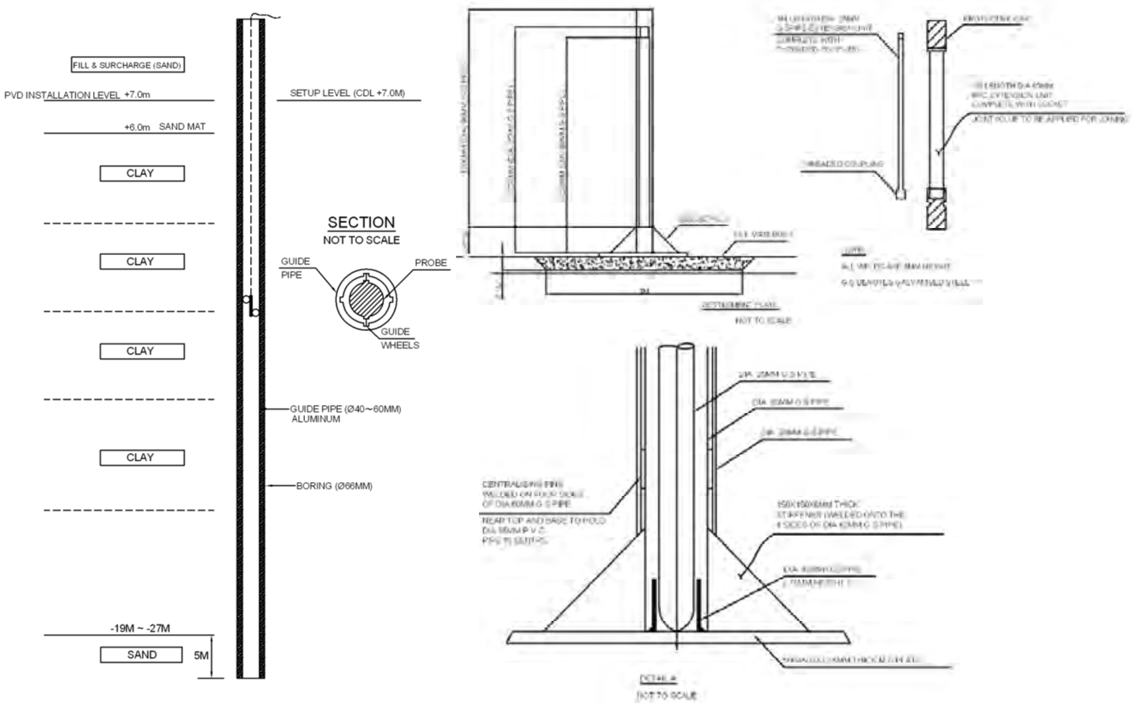
Instrument	During construction of Surcharge Fill	After Completion of Surcharge Fill			After Removed Surcharge Fill
		First 1 month	1 to 3 months	Over 3 months	
Settlement Plate	Once a day	Once/2days	Once/1week	Once/2week	Timely
Magnet Extensometers	Once a day	Once/2days	Once/1week	Once/2week	Timely
Inclinometers	Once a day	Once/2days	Once/1week	Timely	―
Stand pipe	Once a day	Once/2days	Once/1week	Once/2week	Timely
Electric Piezometer	Once a day	Once/2days	Once/1week	Once/2week	Timely

Source : Study Team



Source : Study Team

Figure 4.3-98 Detail of Extensometer, Piezometer, Stand Pipe and Alignment Stake



Source : Study Team

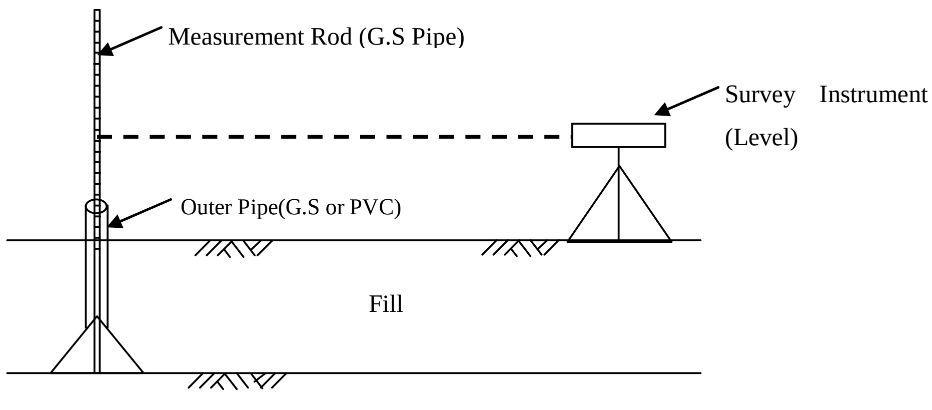
Figure 4.3-99 Inland Water Network

d) Monitoring Procedure for Each Instrument

There are several monitoring methods to obtain field data. In this section, some typical monitoring methods are shown as follows.

i) Settlement Plate

The settlement monitoring for settlement plate is usually carried out by level survey as shown in Figure 4.3-100. The settlement amount can be obtained to calculate both difference initial level and measured level of settlement plate. The outer pipe (G.S or PVC pipe) which cuts the friction induced by the fill earth pressure will be extended before the next filling work.



Source : Study Team

Figure 4.3-100 Method of Monitoring of Settlement Plate

ii) Extensometer

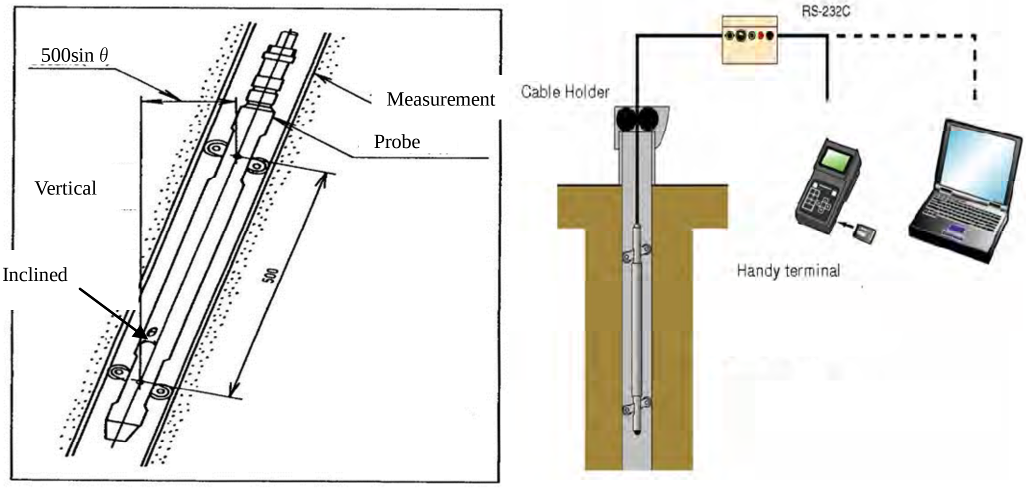
Released spider magnet attached to NF cut pipe generates magnetism by passing the sensor (Detector) up and down in the measurement pipe. The position of the spider magnet can be obtained by detecting the change of the magnetism generated by the spider magnet. The settlement amount can be estimated by comparing both initial data and current observed data.

At first, the detector inserted in the bottom of the pipe shall be left for a while until the detector adapting to a water temperature in the hole. After then, zero adjustment of the indicator shall be made and the measurement starts passing the detector up and down in the measurement pipe. The level of top of the pipe shall be measured by level survey at every measurement time.

iii) Inclinometer

Measurement for inclinometer is usually carried out by taking the inclined angle of guide pipe at each measurement depth. The principle of measurement mechanism is shown in the Figure 4.3-101. The observed data is recorded in data logger (Handy terminal) at site and transfer to the computer at office as shown in Figure4.3-101.

Principle of measurement mechanism

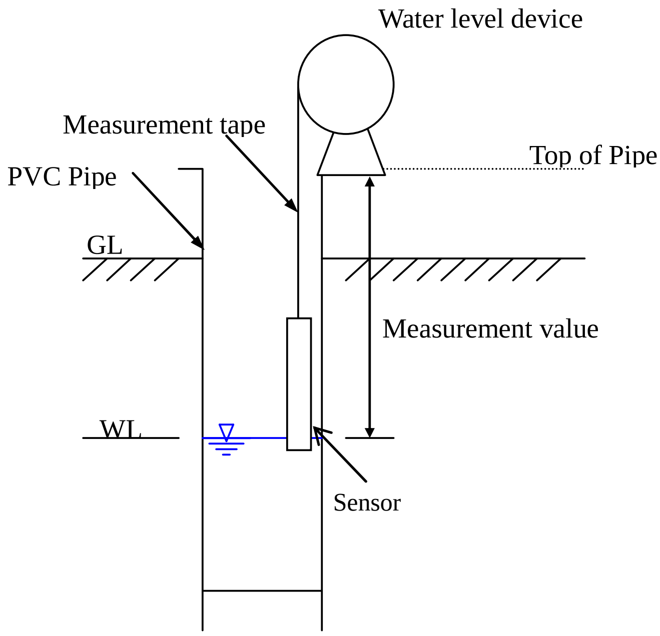


Source : Product Catalogue

Figure 4.3-101 Monitoring Method of Inclinometer

iv) Stand Pipe

The monitoring of ground water level is usually carried out by using a water level meter as shown in Figure 4.3-102. Monitoring is carried out by manual control. The level of the top of pipe is measured by level survey.

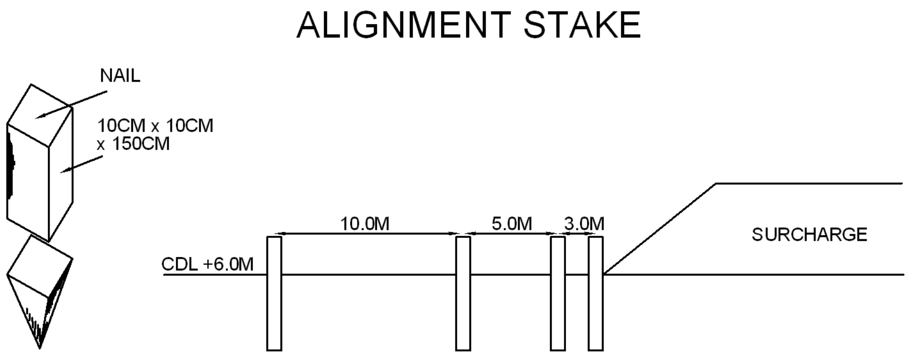


Source : Study Team

Figure 4.3-102 Monitoring Method of Stand Pipe

v) Alignment Stake

Alignment stakes shall be installed at the toe of surcharge fill as shown in Figure4.3-103. It is necessary to secure a stability of the surcharge fill by monitoring lateral displacement. Although the lateral displacement can be monitored by inclinometer, since the interval of inclinometer installation is large (around 160m), alignment stale is installed to interpolate the large space. Actual interval of alignment stake installation shall be designated by actual site condition for securing slope stability.



Source : Study Team

Figure 4.3-103 Schematic Figure of lateral Displacement Stake

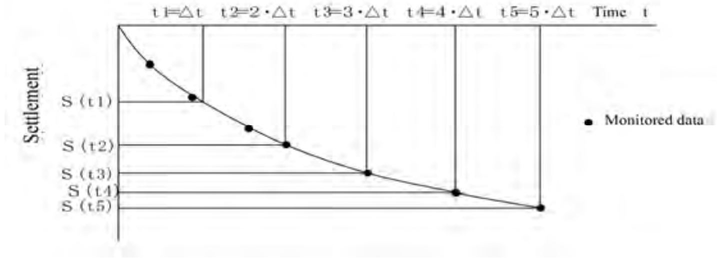
(10) Future Settlement Prediction Method and Confirmation Progress

1) Future Settlement Prediction Method

There are some future settlement prediction methods proposed by several researchers. However **as** a future settlement prediction method, Asaoka method has been commonly used at many projects in South East Asia Country. Therefore, the analysis of settlement prediction is carried out by using Asaoka's method as following formula;

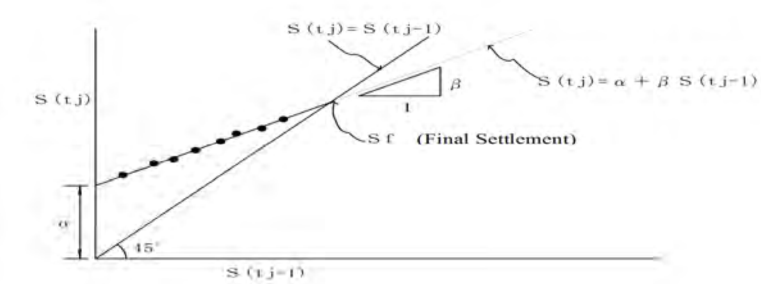
$$Sj = \beta o + \Sigma\beta i \cdot Sj\text{-}1 : (i=1\ ton)$$

Final settlement (S_∞) can be estimated by plotting practical data on the chart as shown in Figure 4.3-104 and Figure 4.3-105.



Source : Soft Ground Measures Method of Construction –Survey, Design and Construction-Japan Geotechnical Society

Figure 4.3-104 Relation tj - S(tj) by Asaoka's Method



Source : Soft Ground Measures Method of Construction –Survey, Design and Construction-Japan Geotechnical Society

Figure 4.3-105 Relation of S(tj) - S(tj-1) by Asaoka's Method

2) Confirmation of Consolidation Progress

In the design, surcharge period by PVD with surcharge method is set 6 months, and target consolidation degree at the time is 90%. The example of procedure of confirmation for consolidation progress is as followings;

(1) **1st Time** : Settlement prediction analysis by Asaoka's method is done at the time of three (3) months after surcharge fill completion. In case that the consolidation degree is more than 70% according to the analysis result, it is evaluated that the consolidation is progressing on schedule. In case of less than 70% of consolidation degree, additional measures, additional surcharge filling or extension of surcharge fill period shall be examined.

(2) **Step2** : Settlement prediction analysis by Asaoka's method and theoretical consolidation settlement analysis based on monitoring settlement data are done at the time of six (6) months after surcharge fill completion. In case that estimated consolidation degree at the removal time is more than 80% and residual settlement analyzed by theoretical consolidation settlement analysis can satisfy design criteria, it is evaluated that the surcharge fill period is terminated and removed.

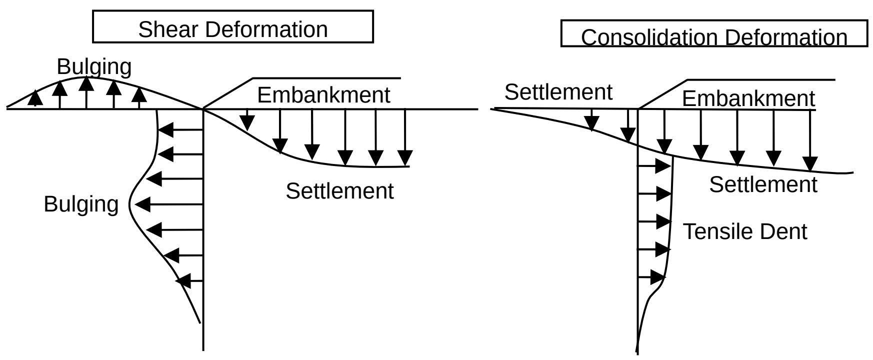
The examination and decision for the additional measures to accelerate the consolidation shall be done in the analysis stage of Step1. In the analysis stage of step2, a final evaluation for the consolidation progress shall be done. The settlement analysis is carried out for the area where the settlement plate is installed.

After confirmation of consolidation degree up to the target degree based on monitoring data, it is recommended to carry out a check boring or in-situ site test such as CPTu and Field Vane Shear test to confirm the consolidation progress from the view of change of soil property.

(11) Stability Control for Filling Work

In this Section, the method of stability control based on the monitoring data is described. Required monitoring data used for the stability control are lateral movement at the toe of fill slope and vertical settlement at the top of fill slope.

The deformation of the ground occurred by fill loading is not simply explained, because of its complicated deformation mechanism. Generally, the ground deformation during construction work is occurred complicating shear failure and consolidation settlement as shown in Figure 4.3-106. In case that consolidation settlement exceeds the shear deformation in the amount, the ground is considered to be stable. On the other hand, in case that shear deformation exceeds consolidations settlement, the ground is considered to be unstable.



Source : Study Team

Figure 4.3-106 Typical Schematic Figure of Ground Deformation

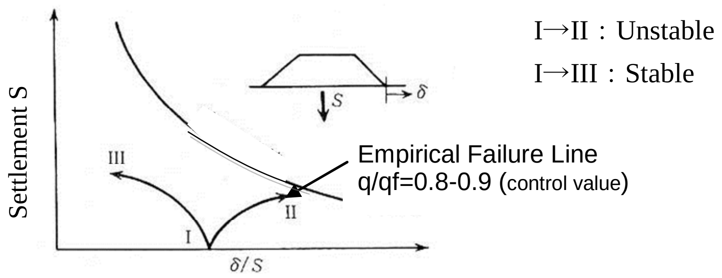
The characteristic tendency of the ground occurring shear failure or becoming unstable are as follows;

- Hair cracks are appeared at the top or toe of fill slope
- Lateral deformation at the toe of fill slope rapidly increases toward the out of fill
- The ground around the toe of fill slope is rapidly bulged

Three (3) methods for slope stability control commonly used are explained as follows;

(1) Matsuo-Kawamura Method

The data of S and δ/S obtained from monitoring data, vertical settlement (S) and lateral movement (δ) are plotted in the chart as shown in Figure 4.3-107. In case the plotted data is proceeding toward the failure line, it indicates unstable, and in case of proceeding toward the opposite of the failure line, it indicates stable.

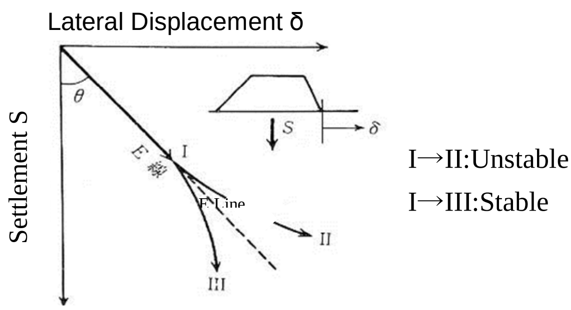


Source : Soft Ground Measures Method of Construction –Survey, Design and Construction-Japan Geotechnical Society

Figure 4.3-107 Matsuo – Kawamura method

(2) Tominaga-Hashimoto Method

Vertical settlement (S) and lateral movement (δ) are plotted in the chart as shown in Figure 4.3-108. In case lateral movement (δ) exceeds vertical settlement (S), it indicates unstable due to shear deformation. And in case vertical settlement (S) exceeds lateral movement (δ), it indicates stable due to consolidation settlement.



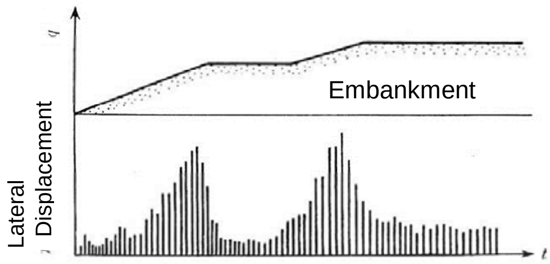
Source : Soft Ground Measures Method of Construction –Survey, Design and Construction-Japan Geotechnical Society

Figure 4.3-108 Tominaga - Hashimoto Method

(3) Kurihara -Mochinaga Method

This method is to manage the stability control by observing lateral movement speed (Δδ/Δt).

Criteria of the movement speed (Δδ/Δt) shall be set before commencement of construction work for the control of safe filling work.



Source : Soft Ground Measures Method of Construction –Survey, Design and Construction-Japan Geotechnical Society

Figure 4.3-109 Kurihara-Mochinaga Method

During construction of fill, the stability control based on the monitored data is essential for the safety construction work. Above three stability control methods are summarized in Table 4.3-36. In addition to stability control below, it is necessary to carry out the daily visual check for abnormality, deformation etc at site.

Table 4.3-36 Method of Stability Control

Method of Name	Monitoring Data for use	Control Method (Stability Control Chart)	Example of Stability Control Criteria *
Tominaga-Hashimoto (S – δ) Method	S : Settlement δ : Lateral Displacement	Plot monitoring data in (S – δ) Chart (refer to Figure 4.3.3-69)	Check the trend of the angle (θ= δ/S) I → II : Unstable I → III : Stable It can be judged as unstable when δ/S is bigger than δ/S at initial stage of filling.
Matsuo-Kawamura (S – δ/S) Method	S : Settlement δ :Lateral Displacement	Plot monitoring data in (S – δ/S) Chart (refer to Figure 4.3.3-70)	Check the trend of the plot data I → II : Unstable I → III : Stable Comparison with empirical Failure Line (q/qf) Plot data < (q/qf) = 0.8-0.9 (control value) It can be judged as unstable when plot data approached the empirical failure line (q/qf = 1.0).
Kurihara・Mochinaga (Δδ/Δt – t) Method	δ : Lateral Displacement	Plot monitoring data in (Δδ/Δt – t) Chart (refer to Figure 4.3.3-71)	Ratio of speed of lateral displacement Δδ/Δt < 1 to 2 cm/day (control value) It can be judged as unstable when plot data approached control value.

* The criteria (control value) shall be finally determined by discussion of concerned organization based on monitored data.

Source：Study Team

4.3.3. Pavement

(1) Type of Pavement

Type of Pavement for Container Terminal is Concrete Pavement and ICB Pavement. The asphalt concrete pavement is not selected because there is no asphalt plant of a private company.

(2) Pavement classification

1) Interlocking concrete block pavement (ICB Pavement)

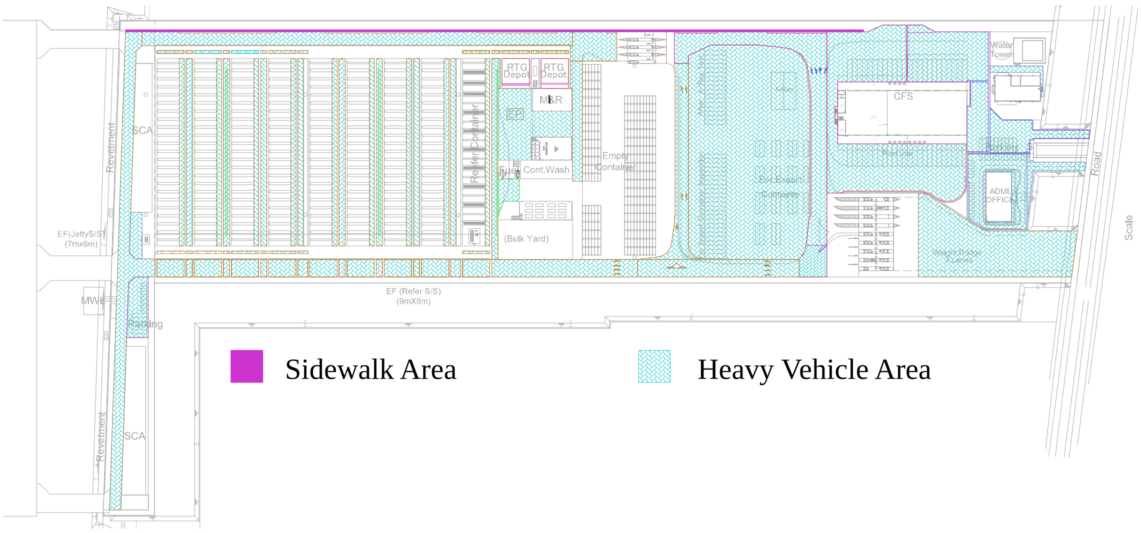
Area of Interlocking concrete block pavement (ICB Pavement) are Moving Area for heavy vehicle (trailers, etc.) and sidewalk for worker.

a) Heavy vehicle (trailers, etc.) Area

Moving Area and Working Area for heavy vehicle (trailers, etc.) are shown in Figure 4.3-110.

b) Sidewalk

Sidewalk is shown in Figure 4.3-110.



Source : Study Team

Figure 4.3-110 Interlocking concrete block pavement

2) Concrete pavement

The area of the concrete pavement is Heavy traffic areas and working Areas.

The area of the concrete pavement is shown in Figure 4.3-111.

a) Heavy traffic areas I (Working Areas for Reach Stacker)

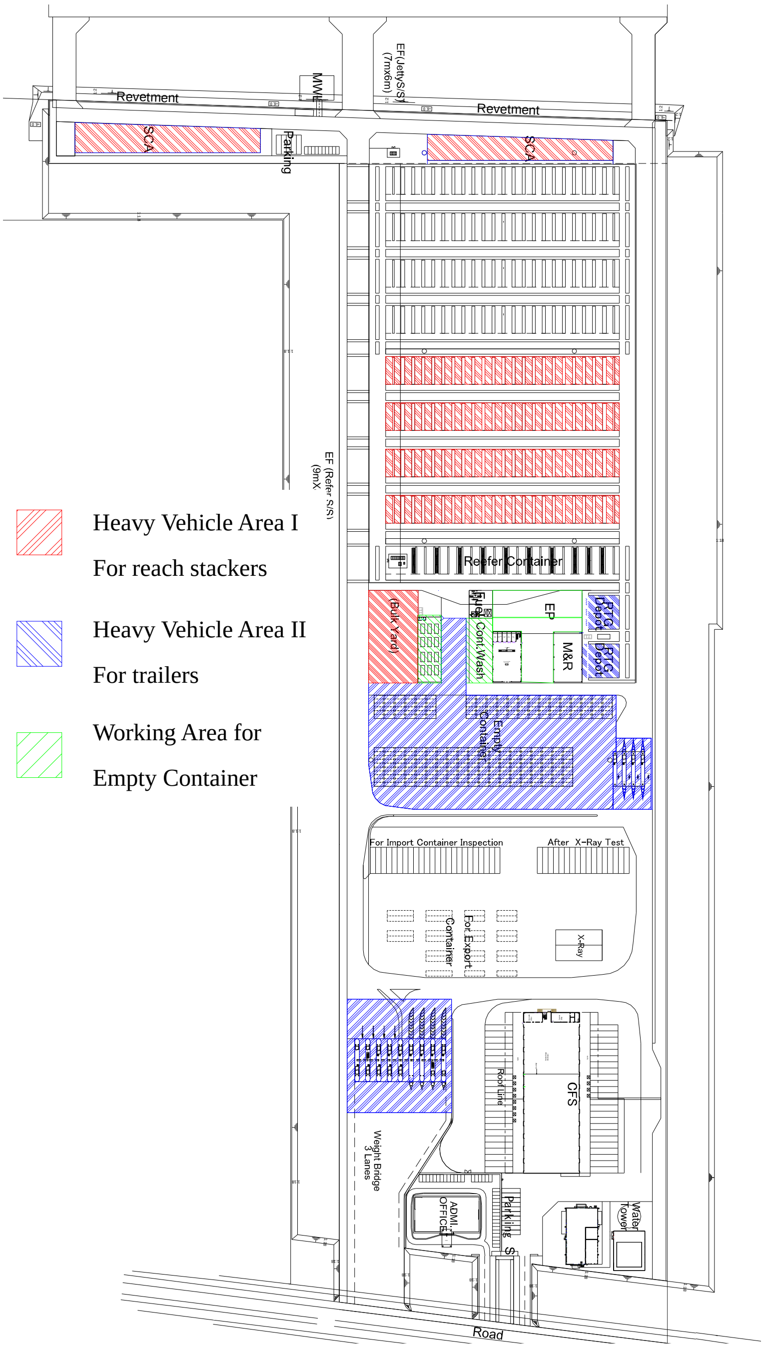
Working Area for Reach stacker (Frequent) is Heavy traffic area I.

b) Heavy traffic areas II (Working Areas for Reach Stacker)

Working area for Reach stacker (Occasionally), and trailer traffic are Heavy traffic areas II.

c) Working Area for Empty Container Yard

Working Area for Empty Container Yard are Container washing area and Container Repair Area.

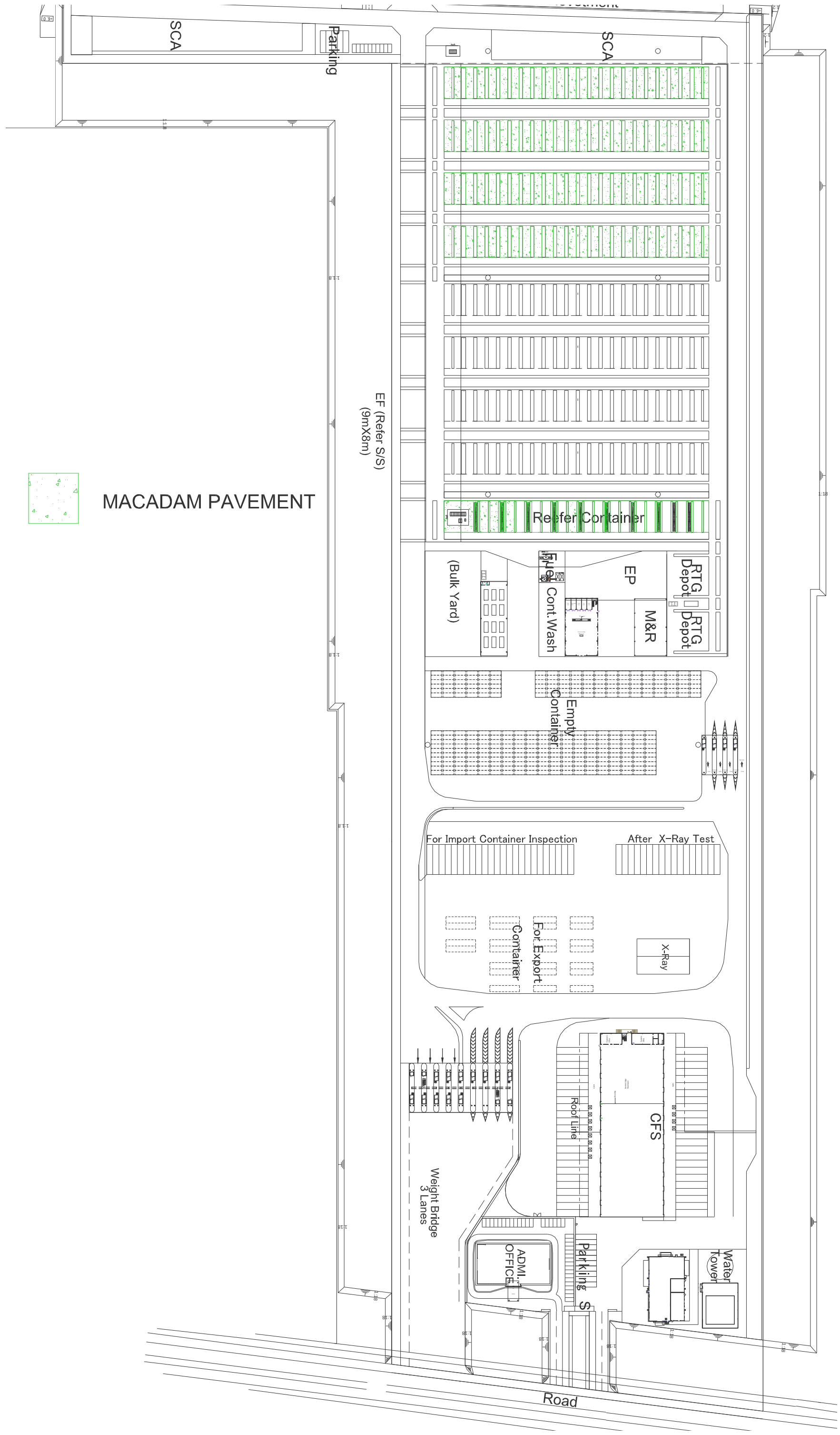


Source : Study Team

Figure 4.3-111　Concrete Pavement

3) Macadam Pavement

Macadam pavement area is small traffic or no traffic Area.
Macadam pavement area is shown in Figure 4.3-112.

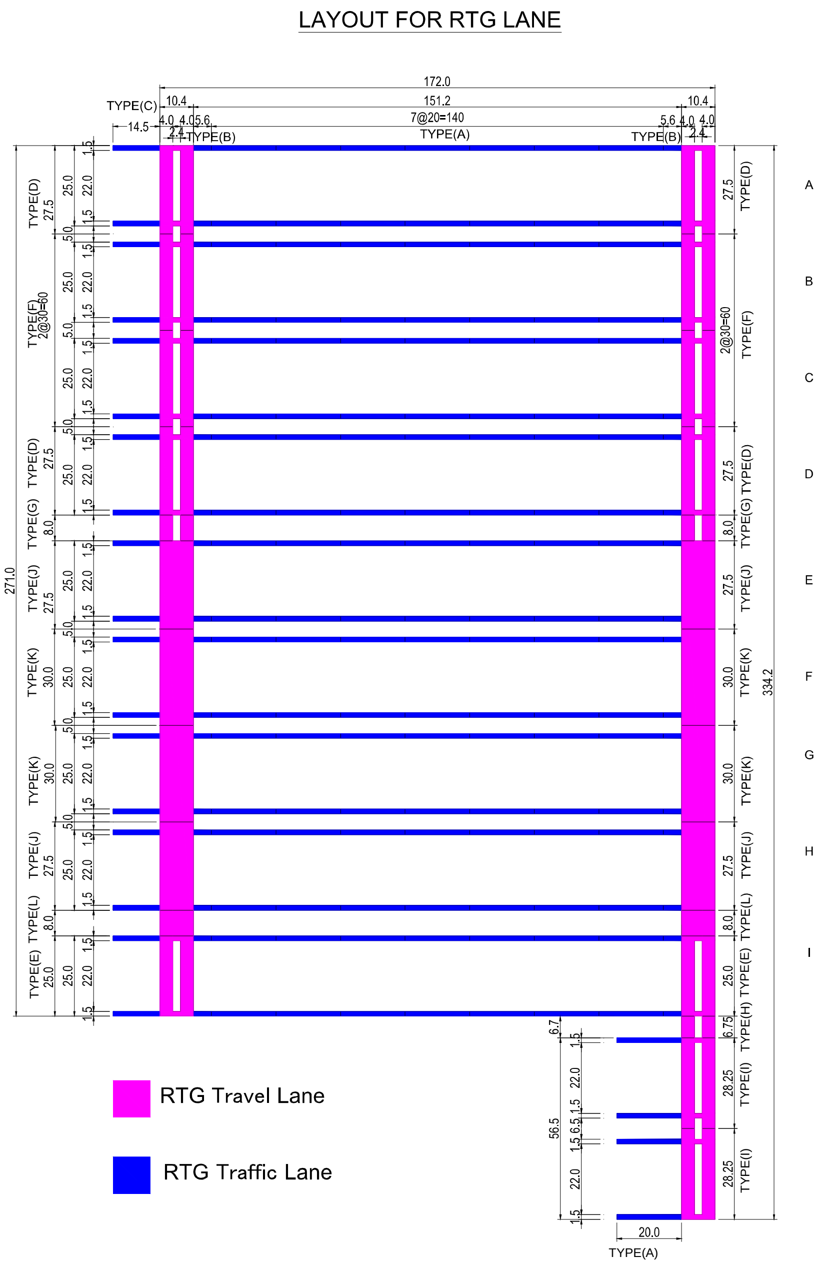


Source : Study Team

Figure 4.3-112 Macadam Pavement

4) RTG Lane

Travel Lane and Traffic Lane for RTG Lane is Concrete Pavement.
Concrete pavement Area is shown in Figure 4.3-113.



Source : Study Team

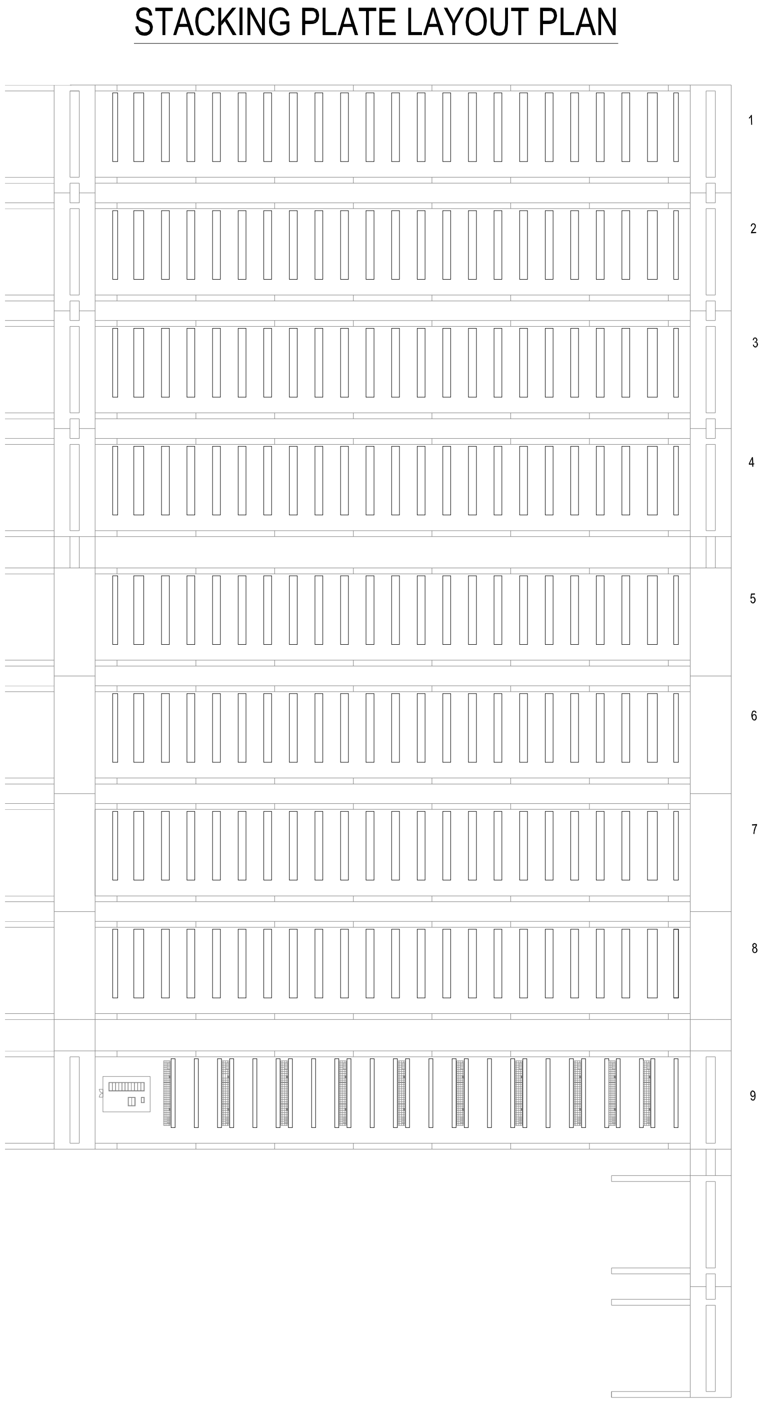
Figure 4.3-113 RTG Lane

5) Container Stacking Plate

The container stacking area installs stacking plate.

In addition, the container yard has the Working area for Reach stacker, and the working area for only RTG. The Working area for Reach stacker is Concrete Pavement. The working area for RTG is Macadam Pavement.

Container Stacking Plate Layout Plan is shown in Figure 4.3-114.



Source : Study Team

Figure 4.3-114 Container Stacking Plate Layout Plan

(3) Design of Pavement Structure

1) Design Condition

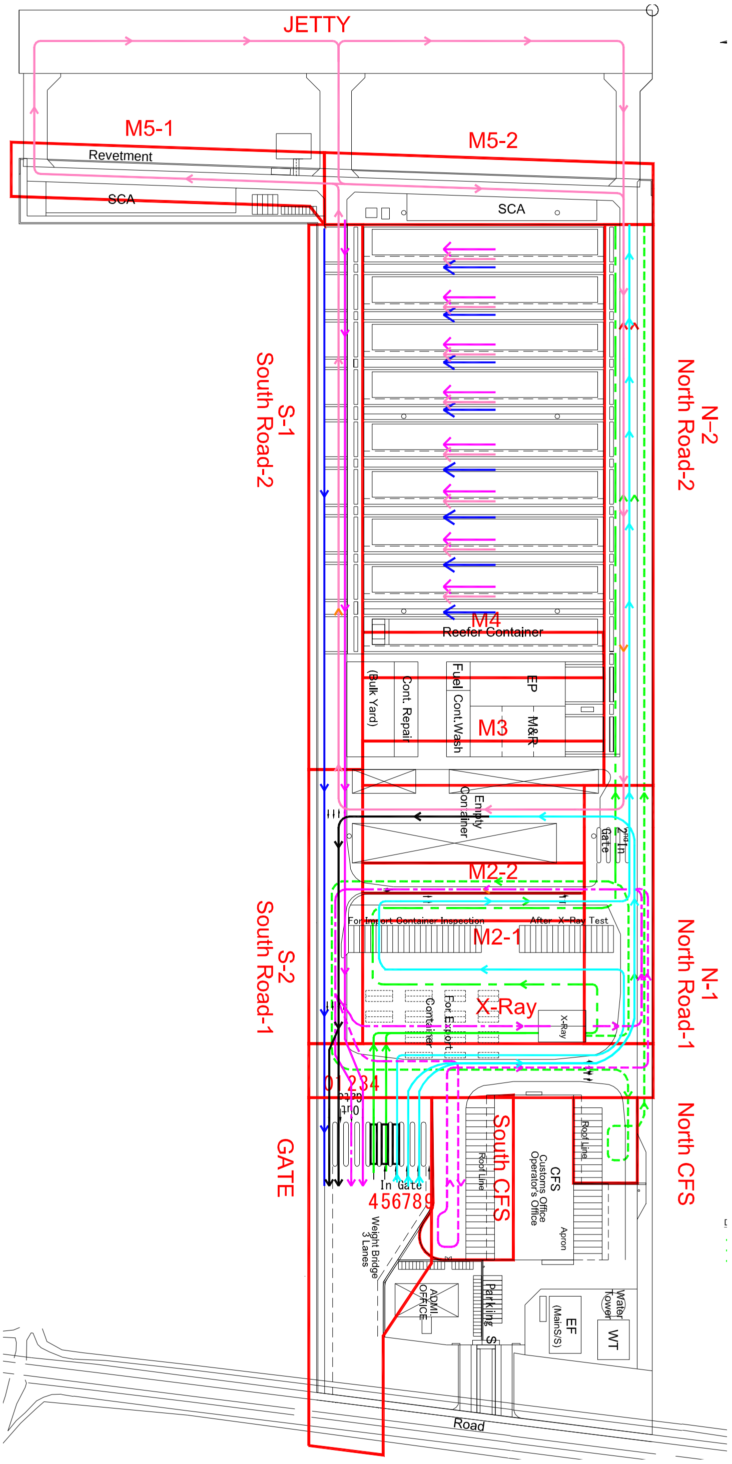
a) Design CBR

Design CBR is 20.

b) Traffic Volume

The design traffic volume is assumed based on the future predicted traffic volume.

Traffic route is shown in Figure 4.3.115, and The future predicted traffic volume is shown in Table 4.3-37.



Source : Study Team

Figure 4.3-115 Traffic Route

Table 4.3-37 Future Predicted Traffic Volume

GATE No.	Traffic Volume (Annual)	GATE	North Road		South Road		M-1 No.1GATE to North CFS	M2-1	M2-2	M-3	M-4	M5-1	M5-2	Empty Container	X-ray	North of CFS	South of CFS
			N-1 North CFS to M-3	N-2 M-3 to Contaner Yard	S-1 M3 to No1 Gate	S-2 Container Yard to M-3											
Exit-0	90,000	90,000	0	0	90,000	90,000	0	0	0	0	0	0	0	0	0	0	0
		100%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Exit-0&1	126,000	126,000	0	0	126,000	0	0	0	0	0	0	0	0	0	0	0	0
		100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Exit-2&3	90,000	90,000	31,500	0	121,500	90,000	13,500	0	31,500	0	0	0	0	0	18,000	0	13,500
		100%	15% 20%	0%	100% 35%	100%	15%	0%	35%	0%	0%	0%	0%	0%	20%	0%	15%
In - 4&5	90,000	90,000	18,000	90,000	9,000	0	0	81,000	9,000	0	0	0	0	0	90,000	9,000	0
		100%	10% 10%	90% 10%	10% 0%	0%	0%	90%	10%	0%	0%	0%	0%	0%	100%	10%	0%
In - 6	90,000	90,000	90,000	90,000	0	0	90,000	90,000	0	0	0	0	0	0	90,000	0	0
		100%	100%	100%	0% 0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%
In - 7&8	126,000	126,000	126,000	0	0	0	126,000	0	0	0	0	0	0	126,000	0	0	0
		100%	100% 0%	0% 0%	0% 0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Sub - Total		612,000	265,500	180,000	346,500	180,000	229,500	171,000	40,500	0	0	0	0	126,000	198,000	9,000	13,500
Peak ratio (Phase 1)	1.78	2,985	1,295	878	1,690	878	1,119	834	198	0	0	0	0	614	966	44	66
Phase 2	X 2	5,970	2,590	1,756	3,380	1,756	2,238	1,668	396	0	0	0	0	1,228	1,932	88	132
			Jetty to Container Yard														
		GATE	North Road-2		South Road-1		M-1 No.1GATE to North CFS	M2-1	M2-2	M-3	M-4	M5-1	M5-2	Empty Container	X-ray	North of CFS	South of CFS
			M5-2 to Container Yard			M5-2 to Container											
Jetty to Container Yard	200,000	0	0	200,000	0	200,000	0	0	0	0	0	200,000	200,000	200,000	0	0	0
		0%	100%	100%	0%	100%	0%	0%	0%	0%	0%	50%	50%	20%	0%	0%	0%
Peak day(Phase 1)	182.5	0	0	1,096	0	1,096	0	0	0	0	0	548	548	219	0	0	0
Phase 2	X 1.5	0	0	1,644	0	1,644	0	0	0	0	0	822	822	329	0	0	0
GATE No.	Traffic Volume (Annual)	GATE	North Road		South Road		M-1 No.1GATE to North CFS	M2-1	M2-2	M-3	M-4	M5-1	M5-2	Empty Container	X-ray	North of CFS	South of CFS
			N-1 North CFS to M-3	N-2 M-3 to Contaner Yard	S-2 M3 to No1 Gate	S-1 Container Yard to M-3											
Total		5,970	2,590	3,400	3,380	3,400	2,238	1,668	396	0	0	822	822	1,557	1,932	88	132
Condition of Pavement Design		6,000	3,000	4,000			3,000	2,000		1,000				2,000	2,000	1,000	
Paving Type		Class E	Class C	Class D			Class C										

Source : Study Team

2) Interlocking concrete block pavement (ICB Pavement)

a) Classification of Interlocking concrete block pavement

Classification of Interlocking concrete block pavement are classified Class L, A, B, C, D and E based on Traffic volume and Design Wheel Load.

Classification of Interlocking concrete block pavement is shown in Table 4.3-38.

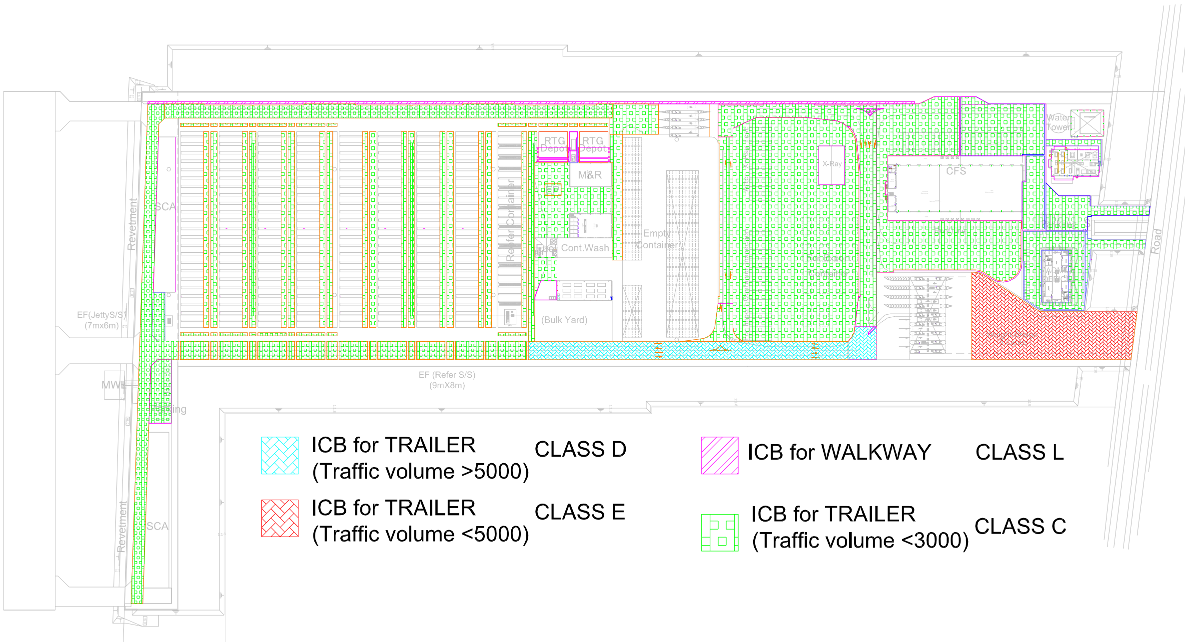
And Pavement classification of ICB pavement is shown in Figure 4.3-116.

Class L is pavement structure of the sidewalk.

Table 4.3-38 Classification of Interlocking Concrete Block Pavement

Design Wheel Load(kg/cm^2)	Traffic volume (No/day/lane)	Category of Equipment	Category of Traffic
Less than 3	Less than 100	Vehicle	L
3	100 to 250	Vehicle	A
5～8	250 to 1000	Vehicle	B
5～10	1000 to 3000	Trailer	C
10～15	3000 to 5000	Reach Stacker	D
More than 15	5000 or more	RTG	E

Source : Study Team



Source : Study Team

Figure 4.3-116 Pavement classification of ICB pavement

b) Thickness of ICB Pavement

i) Thickness of Surface Course of ICB

Thickness of Surface Course of ICB is shown in Table 4.3-39.

Table 4.3-39 Thickness of Surface Course of ICB

Class	Thickness of ICB
L, A	60 mm
B	100 mm
C	100 to 120 mm
D, E	120 to 150 mm

Source : Study Team

3) Interlocking concrete block pavement (ICB Pavement)

a) Classification of Interlocking concrete block pavement

Classification of Interlocking concrete block pavement are classified Class L, A, B, C, D and E based on Traffic volume and Design Wheel Load. Classification of Interlocking concrete block pavement is shown in Table 4.3-40. And Pavement classification of ICB pavement is shown in Figure 4.3-41. Class L is pavement structure of the sidewalk.

Table 4.3-40 Classification of Interlocking concrete block pavement

Class	Thickness of ICB
L, A	60 mm
B	100 mm
C	100 to 120 mm
D, E	120 to 150 mm

Source : Study Team

b) Target values of TA and H

Target values of TA and H is shown in Table 4.3-41.

Table 4.3-41 Target Values of TA and H

Design CBR	Target (cm)							
	Class A (L)		Class B		Class C		Class D (E)	
	TA	H	TA	H	TA	H	TA	H
2～3	21 (17)	61 (52)	29	74	39	90	51 (65)	105 (123)
3～4	19 (15)	48 (41)	26	58	35	70	45 (57)	83 (97)
4～6	18 (14)	41 (35)	24	49	32	59	41 (52)	70 (82)
6～8	16 (12)	32 (27)	21	38	28	47	37 (47)	55 (65)
8～12	14 (11)	27 (13)	19	32	26	39	34 (43)	46 (54)
12～20	13 (-)	21 (-)	17	26	23	31	30 (38)	36 (42)

Source : Study Team

c) Conversion Coefficient for the Calculation of TA

Conversion Coefficient for the Calculation of TA is shown in Table 4.3-42

Table 4.3-42 Conversion Coefficient for the Calculation of TA

Pavement Course	Method and Material ofConstruction	Conditions	Coefficient Surface
Surface &Binder course	Hot asphalt mix for Surface and binder course		1.00
Base	Butuminous Stabilization	Hot-mixed Stability more than 350kg	0.80
		Cold-mixed Stability more than 250kg	0.55
	Cement Stabilization	Unconfirmed compression (7days)=2.9MPa	0.65
		(7days)=0.98MPa	0.55
	Lime Stabilization	Unconfirmed compression (10days)=0.98MPa	0.45
	Crushed stone For mechanical Stabilization	Modified CBR value= more than 80	0.35
	Slag for Mechanical Stabilization	Modified CBR value= more than 80	0.55
	Hydraulic slag	Unconfirmed compression(14days)=1.2MPa	0.55
	Macadam		0.35
Sub-Base	Crushed-Run, Slag, Sand	Modified CBR value= more than 30	0.25
		Modified CBR value= 20 to 30	0.20
	Cement Stabilization	Unconfirmed compression (7days)=0.98MPa	0.25
	Lime Stabilization	Unconfirmed compression (10days)=0.70MPa	0.25

Source : Study Team

d) Calculation of ICB Pavement Thickness

Calculation of ICB Pavement Thickness is as below.

The value of ICB thickness, TA', and accumulated thickness, H, could be calculated using the formula below.

TA' =a1 x h1+a2 x h2+･･････････+an x hn

Where,

an : conversion coefficient

hn : thickness of each layer (cm)

The calculated values are then compared with the target values.

TA, which is converted using the coefficient in Table 4.3.40, should be larger than the target values. Moreover, accumulated thickness, H, should be 20% larger than the target values. The target values of TA and H are shown in Table 4.3-43.

Table 4.3-43 Calculation of ICB Pavement Thickness

		Class L		Class C		Class D		Class E	
Traffic Volume(Nos/day/lane)				1000 to 3000		3000 to 5000		3000 to 5000	
Categoly of Equipument		Walkway		Trailer		Trailer		Reach Stacker	
Pavement Type		ICB		ICB		ICB		ICB	
Target Values	TA			23		30		38	
	H			31		36		42	
minimum thickness of the H	H×(1-0.2)			25		29		38	
Thickness	ICB	6		12		12		12	
Base									
CementStabilization	0.75			15		20		25	
Crushed stone	0.35	15				0			
Subbase									
Crushed Stone	0.25			15		20		30	
	TA'			27	> 23	32	> 30	38.2	> 38
	H			42	> 25	52	> 29	67	> 38

Source : Study Team

4) Concrete Pavement

a) Thickness of Concrete Pavement

thickness type of concrete pavement is shown in Table 4.3-44.

Table 4.3-44 Thickness type of concrete pavement

Class	Thickness of Concrete
L	150mm
A	200mm
B	200~250mm
C	250mm
D	250~300mm
E	300~350mm

Source : Study Team

b) Thickness of the concrete pavement of base course

Thickness of the concrete pavement of base course is shown in Table 4.3-45. Thickness of the Macadam pavement is same as concrete pavement base course.

Table 4.3-45 Thickness of Concrete Pavement of Base Course

Design CBR Sub-grade (%) or Sub-base	Class L,A	Class C,D,E
2	500mm	600mm
3	350mm	450mm
4	250mm	350mm
5	250mm	300mm
6	200mm	250mm
7	200mm	250mm
8	150mm	200mm
12 or more	150mm	150mm

Source : Study Team

c) Thickness of the concrete pavement

Thickness of the concrete pavement is shown in Table 4.3-46.

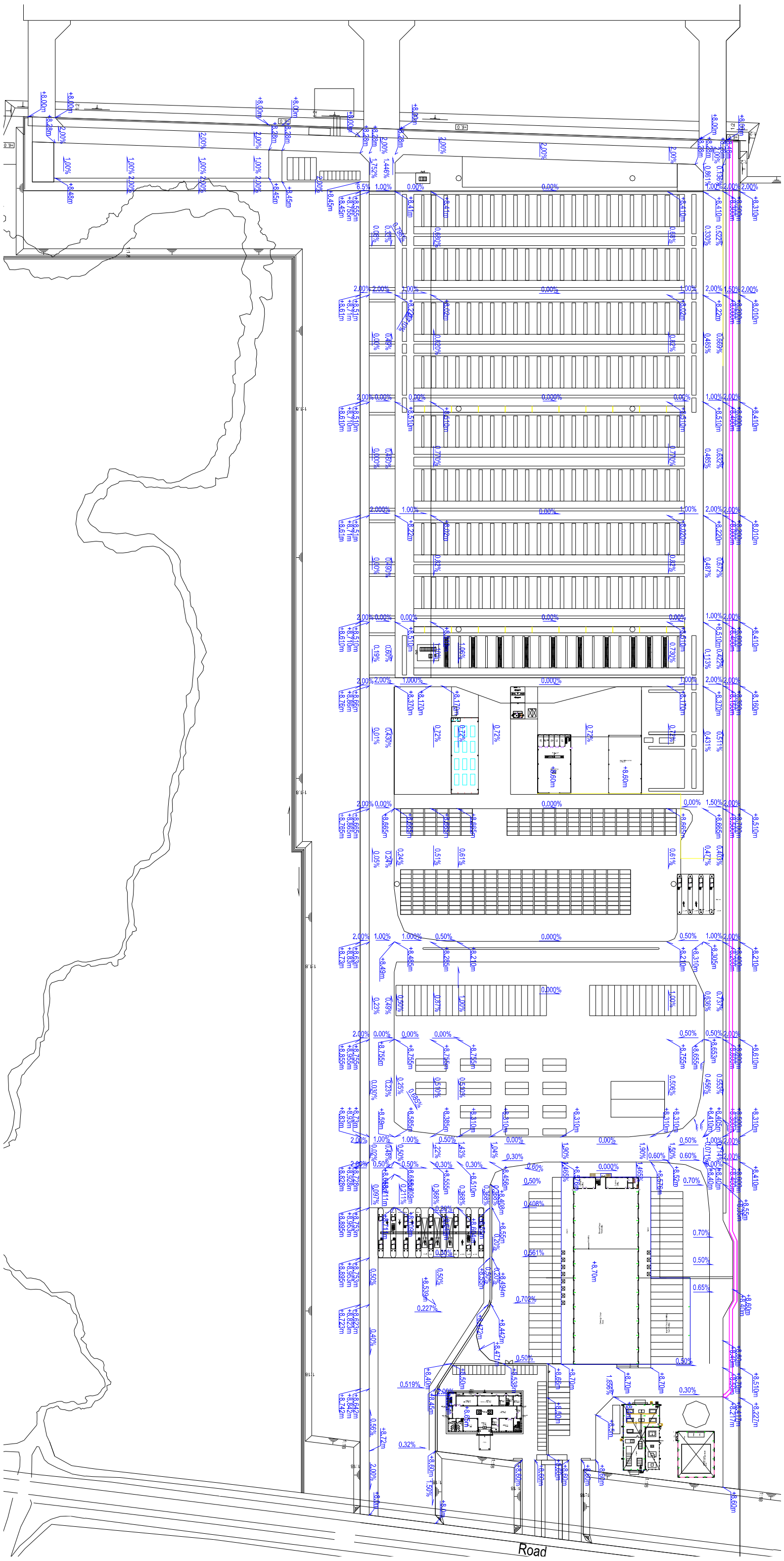
Table 4.3-46 Thickness of Concrete Pavement and Macadam Pavement

	Class L	Class C	Class D	Class E
Traffic Volume(Nos/day/lane)		1000 to 3000	3000 to 5000	more 5000
Categoly of Equipument	Small Car	Trailer (Occational) Reach Stacker(Occational)	Trailer (Frequent) Reach Stacker(Occational)	Reach Stacker(Frequent) Trailer (more 5000)
Area	RTG of Stacking Area	Area of Containere washing, and Repair	No.2 Gate, Empty Container, Road of Washing and Repair	No.1 Gate, Bulk Yard, SCA, RTG of Stacking Area
Pavement Type	Macadam	Concrete	Concrete	Concrete
Thickness of Concrete	-	25	30	35
Base Course				
CementStabilization			15	15
Crushed stone	15	15		
Subbase Course				
Crushed Stone	-	-	15	15

Source : Study Team

(4) Elevations and Gradient of Container yard

Elevations and Gradient of Container yard is shown in Figure 4.3-117.



Source : Study Team

Figure 4.3-117 Elevations and Gradient of Container Yard

4.3.4. Cargo Handling Equipment

(1) Planning of Gantry Crane

1) General Technical Specifications

Though the design head of the port is-9m, the difference of tide level is remarkably larger than that of common port. It means that the port is able to accommodate even a Panamax ship of 20,000DWT during good tide condition. By considering the special situation, two STS Gantry Cranes applicable for a Panamax ship shall be provided on the quay of the port.

The main technical specifications designed for the Gantry Crane are indicated below.

a) Load

Lifting load under spreader	40.6 t
Lifting load under lifting beam	48.0 t
Hatch cover load	35.5t

b) Main dimension

Out reach		35.0 m
Back reach		11.0 m
Span		16.0 m
Height under portal beam	more than	14.0 m
Clearance between legs	more than	16.8 m
Lift of spreader	above seaside rail	30.0 m
	under seaside rail	15.0 m
	Total lift	45.0 m
Max. width of crane(buffer to buffer)		27.0 m or less
Gantry wheel pitch		0.9 m or more
Number of gantry wheel		8 wheels/corner
Gantry rail		JIS 73Kg/m rail

c) Main speeds

Main hoisting speed	with full load	65.0 m /min
	With no load	130.0 m /min
Trolley traversing speed		180.0 m /min
Gantry traveling speed		45.0 m /min
Boom hoisting/lowering speed		8.0 min/cycle

d) Sub function

Spreader tilting angle	Trim	±5 degrees
	List	±5 degrees
	Skew	±5 degrees

e) Power supply system

Trolley power supply	Festoon system
Crane power supply	Cable reel system
Crane main power	AC6.0KV，50Hz、3 phases

2) Notable features of STS Gantry Crane

- The STS Gantry Crane shall be provided with Seismic Isolation System to increase the strength of crane and quay construction against intense earthquake.
- The STS Gantry Crane shall be semi-rope trolley type which has no trolley traversing ropes. The maintenance and replacement work for trolley traversing ropes shall be completely eliminated.
- All motion and switching operation of the STS Gantry Crane excepting boom motion shall be operated from the operators cab.
- All speed reduction gears of the STS Gantry Crane shall be contained in the enclosed gear boxes to reduce the maintenance work and to prevent spreading of greases on the ground.
- The STS Gantry Crane shall be provided with the electric sway control system which helps for an unskilled driver to operate handling of container with less difficulty.

(2) Planning of RTG

1) Specific Technical Specification

The RTG crane is a travelling type gantry crane with two rubber tyres at each four corners. The crane is sized to be able to straddle over one chassis lane and 6 laws of 5 high (9’6” container) stacks, and also for a spreader to be able to run over the stack with one 9’6”container under it. The RTG is driven by a Hybrid type Diesel Engine Generator Set. The RTG is provided with 90°wheel turning function which allow the crane run to the cross direction. This function enables RTG to move any stacking lane without difficulty.

The main technical specification designed for the RTG shall be indicated below.

a) Load

Lifting load under spreader 40.6t Main dimension 6

b) Main dimension

Span	23.47 m
Trolley traverse length	19.1 m or more
Lift of spreader (above ground)	18.0 m or more
Gantry wheel pitch	2.5 m
Gantry wheel base	6.4 m
Max. crane width (buffer to buffer)	abt.11.6 m

c) Main speed

Hoisting speed	with 40.6t load	23.0 m/min
	with no load	52.0 m/min
Trolley traversing speed		70.0 m/min
Gantry traveling speed		90/135 m/min

d) Other functions

Slewing of gantry wheel	±90.0° around vertical axis
Spreader skew	±5.0° around vertical axis
Trolley power supply	Festoon cable system
Crane power	Hybrid Diesel Engine Generator set on a crane

2) Specific features of RTG

- The RTG is provided with the Power Unit of Hybrid type Diesel Generator Set which enable reduction of the capacity of Diesel engine and of it’s fuel consumption. Consequently, it will be helpful to improving natural environment by reducing the outbreak of poisonous gasses and carbon dioxide, and furthermore by decreasing the noise from engine.

- The RTG is provided with Automatic Straight Traveling Control System which contributes to release a crane driver from fatigue due to the difficulty of traveling control.

- The RTG is equipped with Bay Center Detecting System which will help the crane driver stop precisely and rapidly both of the crane legs at the bay center of the target location.

(3) Planning of Reach Stacker

The main technical specifications designed for the Reach Stacker are indicated below.

1) Type

Diesel Engine Driven Type

2) Stacking capacity (Height)

	9’ 6” ISO container	8’ 6” ISO container
The 1st low	5 high stack	5 high stack
The 2nd low	4 high stack	5 high stack
The 3rd low	3 high stack	4 high stack

3) Stacking capacity (load)

The 1st low	1st high to 4th high	43 ton
	5th high of 9’ 6”stack	35 ton
	5th high of 8’ 6”stack	40 ton
The 2nd low	1st high to 5th high	26 ton
The 3rd low	1st high to 3rd high	12 ton

4) Main dimension

Load center	the 1st low	approx.2.2m
	the 2nd low	approx.3.85m
	the 3rd low	approx.6.3m
Total length (with spreader and retracted boom)		approx.12.0m
Total width (with retracted spreader)		approx. 6.2m
Total height (boom lowered to horizontal)		approx.5.0m
Max. lifting height of spreader (from ground)		approx.15.1m
Spreader slewing		-95 º /+185 º
Spreader side shift		approx.－800mm/＋800mm
Turning radius		approx.8.3m
Width of carrier passage		15.0m or less

5) Main speed

Traveling speed (without load)	forward	25 km/hr. or more
	backward	25 km/hr. or more
Hosting/Lowering speed		240 mm/sec or more

(mean speed at the 1st low with load)

(4) Planning of Fork Lift

Diesel Engine motive power, front wheels driven, rear wheels steering type Fork Lift. It is so designed as to loading and unloading LCL loads to/from a container with height of more than 8’6”. The main technical specifications designed for the Fork Lift are indicated below.

1) Type

Diesel engine driven type

2) Load

Lifting load		Min. 3.5ton
Drawbar pull		Min. 18.0 KN
Grade-ability	with load	Min. 20.0º
	without load	Min. 17.0º

3) Main dimension

Load center	approx. 0.5m
Max. lifting height of folk	approx. 3.0m from ground
Max. height of Fork Lift	approx. 4.25m
Free height of folk	not less than 0.17m
Min, mast height	not more than 2.15m
Height of over head guard	not more than 2.15m
Max. length	approx.3.9m
Max. width	approx.1.3m

4) Main speed and sub-functions

Lifting/Lowering speed		approx. 450mm/sec
Traveling speed (forward/backward)		approx.19.0km/hr.
Tilting motion of folk	to forward	Max. 6.0°
	To backward	Max.12.0°
Side-shift of folk		±100.0mm
Adjustment of Folk distance (outside)		300mm to 1090mm

4.3.5. Buildings

(1) Building Design

The following buildings are included in building works of the Terminal.

Table 4.3-47 List of Buildings in the Terminal

No	Building	Floor Area (m^2)	Number of Workers	Storey	Structure
1	Administration Building	3,436	115 (139)	5	S
2	Container Freight Station (CFS)	6,606	60	1+M	S
3	Terminal gate	1,538.5	18 (x 2shift)	1	RC + S
4	2nd gate	476.5	4 (x 2shift)	1	RC + S
5	Maintenance Shop (1)	720	16	1+M	S
	Maintenance Shop (2)	576		1	S
6	Container Repair Shop	630	10	1	S
7	Fuel Station	156.5	2	1	Canopy : RC + S Office : RC + Brick
8	Marine Workers' Lounge	450	35 (x 2shift)	2	RC + S
9	Security Post	69	4 (x 2shift)	2	RC + Brick
10	Power Supply Facility	720	-	1	S
11	Water Supply Facility	500	-	1	S
12	Water Supply Tower	20	-	-	S
13	Reefer Sub-station	-	-	-	(Equipment)
14	Jetty Sub-station	-	-	-	(Equipment)
*	X-ray Inspection Facility		(10)		(Future work)
	Total	15,898.5	264 (349)	-	-

(Note) M : Mezzanine, RC : Reinforced Concrete, S : Steel, RC+S : RC Column or Superstructure + Steel Roof Structure

Source : Study Team

1) Administration Building

a) Functions and Features

Administration Building shall have the function of administrative and operational center of the terminal, and various offices shall be located inside the building. The building shall have 5 storey high with total floor area of approximately 3,400m2, and have steel superstructure system. As for the structure of the building, it has been studied taking into consideration the scheduled construction period which is as short as a year and a few months, and prefabricated steel structure system has been adopted in order to shorten the construction period. Besides the superstructure system, prefabricated curtain wall cladding system has also been chosen to shorten the construction period.

The building has an Atrium (court yard) in the center. Upper part of the Atrium is continuously open to the roof of 4 storey high, and natural day-light is taken into the open space through sky lights of the roof. The Atrium is surrounded by corridor of each floor, and various offices, meeting rooms, conference rooms, toilets, etc. are provided along the corridor of each floor. 2 numbers of “see-through elevator” are also provided facing to the Atrium. The user of the elevator can overlook the Atrium through the observation window of the elevator. The Atrium space on the ground floor shall be utilized as dining space for office workers. Kitchen for dining is also provided, however kitchen utilities and equipment shall be finalized after kitchen operator is determined.

The building is designed fire proof building. Based on “Building Code of Japan”, columns and beams on the ground floor have 2 hour rating fire protection, and those of 1st floor and above have 1 hour rating fire protection. Walls for staircase, elevator hoistway and walls facing to the Atrium of each floor have 1 hour rating fire protection. Each floor is made of reinforced concrete slab which has enough fire protection capacity.

Large space for Banquet & Observation is provided on the top floor (penthouse floor) of the building. From the Banquet & Observation space, one can overlook both Port Terminal area, which locates on the west, and SEZ area, which locates on the east behind the terminal. Office for Control & Planning is located on the 3rd floor of the building so that operation officers are able to overlook the whole area of the terminal from this room. Director’s Office with Secretary’s Room and Office for General Affairs / Account / Sales is located on the 2nd floor, and Office for Documentation and Office for Shipper / Agent / Stevedore is located on the 1st floor. On the rear side (terminal side) of the ground floor, Electrical Room, Office for Clerks & Checkers who work for Terminal Gate, Kitchen and toilet & pantry for the workers are provided along porch corridor. Emergency exit from the staircase is also provided here.

Large enough Porte-Cochere (canopy) is provided in front of the main Entrance. Balconies are provided at the both sides of the building, where external units of air conditioning equipment shall be installed and downspouts of rain water shall also be provided.

Exterior finish of glass curtain wall shall have the combination of heat reflective glass for vision area and white color laminated glass for spandrel area. Heat reflective glass for vision area shall be effective for energy saving to prevent the heat penetration into the room and to reduce the load of air conditioning equipment.

b) List of Rooms

Rooms which consist of Administration Building are listed in the table below together with floor area, expected number of workers and explanatory notes. Workers for Security & Monitor, Clerks & Checkers have 2 shifts a day working system, therefore the number shown in the table below represents the number of workers in a shift.

Table 4.3-48 List of Rooms in Administration Building

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Office (Security & Monitor)	56	4	(x 2shifts)
	Reception	14	2	
	Office (Reception)	14		
	Entrance Hall	88	-	
	Clinic	56	2	
	WC (M/W)	56	-	
	Atrium (Court)	196	-	8 seats x 12 table = 96 seats
	Kitchen	66	6	
	Office (Clerks & Checkers)	66	20	12 Clerks + 8 Checkers (x 2shifts)
	WC(Kitchen, Clerks & Checkers)	22	-	
	Pantry	22	-	
	Elec. Room	22	2	Electrician & Mechanic
	Stairs	56	-	
	Elevators	8	-	2 lifts
	Balcony	28	-	
	Porch (Corridor)	54	-	
1F	Office (Documentation)	196	31	Container :15 + Bulk/RORO :16
	Office (Shipper/Agent/Stevedore)	196	16	2 persons x 8 Companies
	WC (M/W)	56	-	
	Pantry	28	2	
	Store	28	-	
	Stairs	56	-	
	Elevators	8	-	
	Corridor	144	-	
	Balcony	28	-	
2F	Director's Office	84	1	
	Secretary's Room	28	1	
	Conference Room 1	84	-	(20 seats)
	Office (G.A./Account/Sales)	140	10	
	Meeting Room 1	56	-	(12 seats)
	WC (M/W)	56	-	

	Pantry	28	2	
	Store	28	-	
	Stairs	56	-	
	Elevators	8	-	
	Corridor	144	-	
	Balcony	28	-	
3F	Office (Control & Planning)	196	12	
	IT	56	2	
	Conference Room 2	140	-	(40 seats)
	WC (M/W)	56	-	
	Pantry	28	2	
	Store	28	-	
	Stairs	56	-	
	Elevators	8	-	
	Corridor	144	-	
	Balcony	28	-	
RF	Banquet & Observation	284	-	
	WC (M)	22		
	WC (W)	12		
	Store	10		
	Elevators	8	-	
	Stairs	56	-	
	Total	3,436	115	(24hours total) : 139 persons

Source：Study Team

2) Container Freight Station (CFS)

a) Functions and Features

Container Freight Station (CFS) consists of 2 separate spaces, one is Bonded Cargo Warehouse managed by Customs and the other is Domestic Cargo Store managed by Operator, and 2 spaces are separated by boundary partition wall in between. Both Customs office and Operator’s office are provided separately on both ground floor and mezzanine floor. Truck driver shall come to Customs office and/or Operator’s office on the ground floor for documentation procedure. The building has total floor area of approximately 6,600m2, and steel superstructure system is adopted in order to provide a large span open space for cargo storage.

Aprons of 7 meter wide are provided on both longitudinal side of the building for container inspection by Customs and cargo handling by Operator. Aprons have the height of 1.5 meter from the ground level for container trucks accessibility. However, in order to adjust the height of the container access, some numbers of dock levelers are provided along the apron.

Along the aprons, cantilevered roof canopy which projects 5 meter from the edge of the apron is provided in order to avoid rain water to the working space of the apron, and large roof canopy is also provided at Imported Cargo Receiving Truck Parking to secure the working space for domestic cargo trucks.

Sky lights are provided on the roof to intake natural day-light to internal working space and ventilation monitor is also provided on the roof top for natural ventilation.

b) List of Rooms

Rooms which consist of Container Freight Station (CFS) are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-49 List of Rooms of Container Freight Station (CFS)

Floor	Room/Function	Floor Area (m^2)	Number of Workers	Notes
GF	Bonded Cargo Warehouse	1,152	-	
	Domestic Cargo Store	2,304	-	
	Operator’s Office	72	15	
	Customs Office	72	15	
	Pantry	9	-	
	Store	9	-	
	WC	18	-	
	Stairs & Corridor	108	-	
	Apron	1,470	-	
	Imported Cargo Receiving Truck Parking	1,056	-	Covered Area
	Forklift Ramp	24	-	Outside
	Entrance Porch & Stair	24	-	Outside
MF	Operator’s Office	72	15	
	Customs Office	90	15	
	Pantry	9	-	
	Store	9	-	
	WC	18	-	
	Stairs & Corridor	90	-	
	Total	6,606	60	

Source : Study Team

3) Terminal Gate

a) Functions and Features

Terminal Gate is planned for checking all incoming and outgoing container traffic. Total of 8 lanes with 5 lanes for incoming traffic and 3 lanes for outgoing traffic are allocated at the Gate. Besides these 8 lanes, 2 truck lanes are allocated for bulk cargo traffic at both far sides of the Gate. Clerk rooms for documentation, checker rooms for checking containers, and a catwalk for checking the roof of containers are provided under covered canopy. 3 weighbridges are provided for incoming (export) container traffic.

The Gate has reinforced concrete columns and space frame roof structure composed of steel pipes and nodes. The covered area by the canopy is planned to be approximately 1,300m2. 12 units of clerk booth, 2 units of checker booth and 2 units of truck booth are provided. 4 units of clerk booth out of 12 units are planned for extra use, for example, in case incoming traffic use 4 lanes and outgoing traffic use 4 lanes, and in case container truck use truck lanes for bulk cargo traffic.

Sky lights are provided on the roof to intake day-light to the Gate. The height up to the catwalk floor level from the ground level is 5.0 meters.

b) List of Rooms

Rooms and functions which consist of Terminal Gate are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-50 List of Rooms of Terminal Gate

Floor	Room/Function	Floor Area (m^2)	Number of Workers	Notes
GF	Canopy Area	1,368.5	-	Covered Area : 59.5m x 23m
	Clerk Booth	84	12	7m2/unit x 12units, 1person/unit (x 2shift)
	Checker Booth	8	4	4m2/unit x 2units, 2persons/unit
	Truck Booth	8	2	4m2/unit x 2units, 1person/unit
	Catwalk & Stairs	70	-	56m x 0.9m, 10m2 x 2
	Traffic Lanes	-	-	8 Lanes (5 In / 3 Out)
	Weighbridge	-	-	3 Nos.
	Total	1,538.5	18	

Source : Study Team

4) 2nd Gate

a) Functions and Features

2nd Gate is planned for checking all incoming traffic to the port terminal yard whether trucks have passed the appropriate inspection and/or documentation procedure. 3 lanes for container truck and 1truck lane for bulk cargo are allocated.

2nd Gate has almost the same structure as Terminal Gate with 4 clerk booths. However it does not have sky lights on the roof, catwalk for checking the container and weighbridges.

b) List of Rooms

Table 4.3-51 List of Rooms of 2nd Gate

Floor	Room/Function	Floor Area (m^2)	Number of Workers	Notes
GF	Canopy Area	448.5	-	Covered Area : 19.5m x 23m
	Clerk Booth	28	4	7m2/unit x 4units, 1person/unit (x 2shift)
	Traffic Lanes	-	-	3 Lanes (3 In) + 1 Truck Lane
	Total	476.5	4	

Source : Study Team

5) Maintenance Shop

a) Functions and Features

Maintenance shop consists of 2 buildings, Maintenance Shop (1) and Maintenance Shop (2). These 2 buildings locate parallel with circulation space in between.

Maintenance Shop (1) is provided for the repairing of small equipment, such as electrical circuits of the parts, tractors, forklifts, etc. in indoor workshop. The building is planned to have total floor area of 720m2. In order to provide large span open space for working area, steel superstructure system is adopted.

The Working Area on the ground floor has a space of approximately 430m2. An overhead crane of 10 ton capacity with the height under hook of 8 meter and floor pit of 1.5 meter deep are provided for maintenance and repairing of the equipment. On the ground floor Paint Store, Mechanical Store, Compressor Store, Tool Store and Parts Store are provided other than Working Area, and Office Room for workers’ rest room, Pantry, Store and Toilet are provided on the mezzanine floor. Sky lights on the roof and ventilation monitor on the roof top are provided.

Maintenance Shop (2) is provided for the repairing of large size machines, such as reach stacker, empty container lift, chasses, etc. The building has almost the same structure as

Maintenance Shop (1), however it has covered roof only and no wall is provided. Installation of overhead crane is considered as future work and not included in this work. However, the structure is designed taking into consideration the future installation of overhead crane of 10 ton capacity and brackets to support runway of crane rail is included in this work.

b) List of Rooms

Rooms which consist of Maintenance Shop are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-52 List of Rooms of Maintenance Shop (1)

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Working Area (indoor)	432	-	Overhead crane (10ton), Floor pit
	Paint Store	18	-	
	Mechanical Store	18	-	
	Compressor Store	18	-	
	Tool Store	18	-	
	Parts Store	18	-	
	Stair & Corridor	54	-	
MF	Office Room	54	16	Workers' rest room
	Pantry	9	-	
	Store	9	-	
	WC	18	-	
	Stair & Corridor	54	-	
	Total	720	16	

Source : Study Team

Table 4.3-53 List of Rooms of Maintenance Shop (2)

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Working Area (covered)	576	-	Only roof & no wall space
	Total	576	-	

Source : Study Team

6) Container Repair Shop

a) Functions and Features

Container Repair Shop is provided to accommodate 12 numbers of 20 feet container at a time. Front side of the building has 2 spans of wide opening of 19 meters each, so that not only 20 feet containers but also 40 feet containers can be carried in and out through this opening. The building has steel superstructure to provide such wide openings. Equipment Storages on both sides and small toilet for the workers are provided.

Sky lights on the roof and windows on rear side wall are provided to intake natural day-light into Working Area. Ventilation monitor on the roof top and louvers on rear side wall are also provided to exhaust the smoke caused by welding work at Working Area.

b) List of Rooms

Rooms which consist of Container Repair Shop are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-54 List of Rooms of Container Repair Shop

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Working Area	570	10	12 x 20’ Container space
	Equipment Storage	50	-	
	WC & Janitor	10	-	
	Total	630	10	

Source : Study Team

7) Fuel Station

a) Functions and Features

Fuel Station is provided to supply fuel for equipment and trucks working in the port terminal area. It consists of canopy, worker’s office building, underground oil tanks, fuel dispensers, pumps for fuel supply, etc. (Underground oil tanks, fuel dispensers, pumps for fuel supply, etc. are Mechanical Works) The canopy has covered area of 144m2 and made of reinforced concrete columns and steel roof structure. The worker’s office building consists of worker’s rest room and toilet, and the structure of the building is reinforced concrete superstructure with brick wall.

b) List of Rooms

Rooms which consist of Fuel Station are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-55 List of Rooms of Fuel Station

Floor	Room/Function	Floor Area (m^2)	Number of Workers	Notes
GF	Canopy Area	144	-	Covered Area : 8m x 18m
	Rest Room	7.5	2	
	Hand Wash	2.5	-	
	WC	2.5	-	
	Oil Tank	-	-	(Mechanical Work)
	Fuel Dispenser	-	-	(Mechanical Work)
	Total	156.5	2	

Source : Study Team

8) Marine Workers' Lounge

a) Functions and Features

Marine Workers' Lounge is planned as welfare and administration facility for the workers in port area and it is provided in the river shore adjacent to the trestle and the revetment of the port. The building will be constructed on the steel pipe piles which are similar to the foundation of trestle and jetty of the port because it is planned to construct above the surface of the Yangon River water. And the building will be accessed through the bridge from the revetment. The ground floor level of the building is planned to set 2.5 meters above the highest tide level of the river considering the possible waves and high tide. And the building shall be constructed with reinforced concrete structure considering the corrosion proofing against brine damage and durability of the building.

The ground floor of the Marine Workers' Lounge consist of a canteen and the kitchen for the use of in-house workers, and a kiosk and toilets for the visiting workers who visit the port with ships. The facilities for the visiting workers can be accessed from outdoor deck space which surrounds the building. The second floor of the building consist of a multiple use meeting room which is used for meetings at the time of commencement or rotation of work, an office for chief workers, and toilets, locker room and shower rooms for the use of in-house workers. And balconies and exterior stairs are provided around the building on the ground floor and on the first floor for the emergency exit way and also for the maintenance of the building.

b) List of Rooms

Rooms which consist of Marine Workers' Lounge are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-56 List of Rooms of Marine Workers' Lounge

Floor	Room/Function	Floor Area (m^2)	Number of Workers	Notes
GF	Canteen	83.6	35	(50 seats) (x 2shifts)
	Corridor	30.5	-	
	Kitchen	19.3	6	(x 3shifts)
	Kiosk	9.4	2	
	Locker Room (Female)	8.8	9	
	Toilet (Female)	11.0	9	
	Toilet (Male)	37.7	60	
	Storage	7.7	-	
1F	Meeting Room	86.2	54	(54 seats)
	Corridor	23.3	-	
	Office	19.7	3	
	Toilet (Male)	29.5	35	
	Locker Room (Male)	18.8	35	
	Shower Room (Male)	18.8	35	
	Staircase	27.7	-	
	Total	432.0	-	(24hours total) : 131 persons

Source : Study Team

9) Security Post

a) Functions and Features

Security Post is planned as a facility to control the in and out of the vehicles and people to the administration building area and the Container Freight Station (CFS) area. It consists of a security guard office building which will be constructed between the two entrance points, and two movable gates and the storages for both gates. The guard office building consists of common use space for toilets and lockers at the center and two guard office rooms which control each entrance gate at the both side of the building.

The Security Post is located on the boundary between the port site and buffer zone which separates the Security Post and the front road away. To give the visibility and identity of the port entrance in the vast plain field, the distinguished features of the building such as front wall façade with port sign and logo and entrance gates with portico features. The front wall façade with port sign and logo will be lighted up in the evening.

The guard office building will be constructed with box frame type reinforced concrete construction for the security and the efficiency of planning for this small building.

b) List of Rooms

Rooms which consist of Security Post are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-57 List of Rooms of Security Post

Floor	Room/Function	Floor Area (m^2)	Number of Workers	Notes
GF	Guard Office (1)	10.2	2	(x 2shifts)
	Vestibule (1)	7.8	-	
	Toilet	15.0		
	Guard Office (2)	10.2	2	(x 2shifts)
	Vestibule (2)	7.8		
1F	Locker Space	15.0	4	(x 2shifts)
	Stairs	2.4		
	Total	68.4	-	

Source : Study Team

10) Power Supply Facility

a) Functions and Features

Power Supply Facility consists of Panel Room, Generator Room, Transformer Yard and Fuel Tank Yard. Transformer Yard and Fuel Tank Yard are located outside of the building.

The necessary spaces of Panel Room and Generator Room are determined taking into consideration future extension for Phase 2 works, and the spaces of panels and generators for future use are reserved. Panel room is covered by heat insulation material on wall and ceiling inside the room, and air conditioning system is provided to prevent the damage to equipment by heat. Generator Room has cable trench with cover on the floor and 3 numbers of 2 ton capacity hoist are provided for maintenance of generator. Exterior wall of Generator Room consists of large louver panels for intake of outside air and for exhaust air when generators are in operation.

The building has single storey and steel superstructure system with ventilation monitor on the roof top of Generator Room.

b) List of Rooms

Rooms which consist of Power Supply Facility are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-58 List of Rooms of Power Supply Facility

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Panel Room	216	-	Air conditioned
	Generator Room	312	-	Cable trench, 3 x 2ton hoist
	Transformer Yard	128	-	Outside
	Fuel Tank Yard	64	-	Outside
	Total	720		

Source : Study Team

11) Water Supply Facility

a) Functions and Features

Water Supply Facility consists of Water Tank (Reservoir) Area and Pump Area inside the building. In Water Tank Area, a stainless steel water tank of 640m3 (16m long x 16m wide x 3m high – effective water level 2.5m) shall be provided. Bottom of water tank is raised by 50cm from floor level and 4 sides of the tank are surrounded by walking space for inspection and maintenance of the tank surfaces (4 sides, top and bottom). In Pump Area, various pressure pumps including fire-fighting pump shall be installed.

The building has single storey and steel superstructure system with ventilation monitor on the roof top.

b) List of Rooms

Rooms which consist of Water Supply Facility are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-59 List of Rooms of Water Supply Facility

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Water Tank Area	400	-	640m3 Water Tank
	Pump Area	100	-	
	Total	500	-	

Source : Study Team

12) Water Supply Tower

a) Functions and Features

Water Supply Tower is provided to supply service water to all the buildings and facilities including container wash in the port area except to supply water to ships through the elevated water tank by gravity. To maximize the safety for water supply, the elevated water tank will have a capacity of 40 m^3 which is equivalent to 50% of the daily water consumption for the building use and others except to supply water to ships. The height of the elevated water tank will be 35 meter above ground at lowest water level in the tank to maintain the minimum residual pressure. The Water Supply Tower will be constructed with steel plate construction to realize the simple and symbolic appearance of spherical shape.

b) List of Rooms

Rooms which consist of Water Supply Tower are listed in the table below together with floor area, number of workers and explanatory notes.

Table 4.3-60 List of Rooms of Water Supply Tower

Floor	Room	Floor Area (m^2)	Number of Workers	Notes
GF	Shaft	19.6	-	ϕ 1,800 mm ~ ϕ 5,000 mm
1F	Tank	16.6	-	ϕ 4,600 mm
	Total	36.2	-	

Source : Study Team

(2) Structural

1) Outline and Structure type for buildings

The classification of the building works, structural and foundation types for this project are shown in Table 4.3.61 below :

Table 4.3-61 Structural Outline of Buildings Designed in the Project

No.	Building	Structure, Story	Structural Type	Foundation Type
1	Administration Building	SC, 5 stories	Rigid frame of steel tube columns & H-shaped girders, 3x5 spans	PHC pile foundation
2	Container Freight Station (CFS) Building	SC, 1+M stories	Rigid frame of steel tube columns & H-shaped girders, 2x12 spans with cantilever beams	PHC pile foundation
3	Terminal Gate	RC+SC, 1 story	RC columns & steel roof structure of cylindrical 3-D truss, 1x8 spans	Spread direct foundation
4	2nd Gate	RC+SC, 1 story	RC columns & steel roof structure of cylindrical 3-D truss, 1x3 spans	Spread direct foundation
5	Maintenance Shop (1) Maintenance Shop (2)	SC, 1+M stories	Rigid frame of steel tube columns & H-shaped girders, 1x4 spans	PHC pile foundation
6	Container Repair Shop	SC, 1 story	Rigid frame of steel H-shaped columns & H-shaped girders, 1x2 spans	PHC pile foundation
7	Fuel Station	RC+SC, 1 story	RC columns & Steel roof structure	Spread (continuous) direct foundation
8	Marine Worker Lounge	RC+S, 2 stories	RC superstructure & Steel roof structure, 2x4 spans	Steel Pipe pile foundation
9	Security Post	RC, 2 stories	RC post and beams & Brick walls	Spread (mat) direct foundation
10	Power Supply Facility	SC, 1 story	Rigid frame of steel H-shaped columns & H-shaped girders, 2x6 spans	PHC pile foundation
11	Water Supply Facility	SC, 1 story	Rigid frame of steel H-shaped columns & H-shaped girders, 1x5 spans	PHC pile foundation

12	Water Supply Tower	SC, Tower	Steel Tube Tower	PHC pile foundation
	Refer Substation, AMP Substation	RC, foundation	-	Spread (mat) direct foundation

Note : The final foundation type for the buildings will be decided by the additional soil investigation at the building site.

Source : Study Team

2) Structural Design Standards

The structures of buildings are designed and calculated in accordance with the following standards.

- Standard Building Law of Japan (SBL) for the main buildings (No.1 to 5 &. 8 in the table above).
- Uniform Building Law 1993 (UBC93) for the other buildings.

The structural materials are applied to the following standards.

- Japanese Industrial Standards (JIS)

3) Design Loads

a) Dead Load

Dead loads are calculated by actual weight of finish and structural material.

b) Live Loads

Live loads are determined by the occupancy or use of room in accordance with Building Standard Law of Japan. Equipment/Vehicle Loads are determined according to use. Minimum design live loads are as shown in Table 4.3-62 below :

Table 4.3-62 Minimum Distributed Live Load (N/m²) and Equipment Concentrated Loads

Building room (use)	Floor design	Column & girder design	Seismic design	Equipment or Vehicle Loads
Administration Building Office, entrance, corridor, meeting room, banquet, roof(assembly purpose), stairs Roof (maintenance access) WC Store	2,900 1,000 1,800 7,800	1,800 600 1,300 6,900	800 400 800 4,900	none
Terminal Gate Traffic lanes, Weigh Bridge Roof (no access) Clerk &checker booth, Catwalk & stairs	Slab on grade 600 1,800	0 1,300	0 600	Truck & container trailer with freight Weigh bridge (support reaction 25 ton x6) - -
Container Freight Station Warehouse, Bonded Cargo area, Various Cargo area, Apron Store, Office, Meeting Room, Pantry WC	28,000 2,900 1,800	10,500 1,800 1,300	5,300 800 600	3.5 ton folk-lift with freight or 2.5 ton electric folk-lift with freight
Indoor Maintenance Shop Working Area Various Stores Office, Pantry, Store, Stairs WC	5,400 7,800 2,900 1,800	3,900 6,900 1,800 1,300	2,000 4,900 800 600	Truck under repair(wheel load/5 ton) Overhead Crane of 10 ton
Covered Maintenance Shop Working Area	Slab on grade 5,400	3,900	2,000	Reach stacker under repair(wheel load/35.9 ton) Overhead Crane of 10 ton
Marine Workers' Lounge Canteen, Kitchen, Balcony, Stairs, Office Locker & Shower room, WC Office, Storage, Stairs Roof(no access)	2,300 1,800 2,900 60	2,100 1,300 1,800 0	1,100 600 800 0	none
Fuel Station Access Road Other Slab on Grade Roof (no access)	Slab on grade 5,400 600	3,900 0	2,000 0	Truck & container trailer with freight -
Security Post Vestibule, Office, Utility room, etc. Roof (maintenance access)	1,800 1,000	1,300 600	600 400	none

Water Supply Tower Stairs	1,800	1,300	600	Water Tank, 40m³
Water Supply Facility Foundation of receptacle, pump, etc. Maintenance Area	Foundation 4,900	2,400	1,300	Weight of equipment and Dynamic Load, if necessary Water tank(640m3) / 2.5 Hx16 mx16 m
Power Supply Facility Foundation for generator, transformer, etc. Maintenance Area	Foundation 4,900	2,400	1,300	Weight of equipment and Dynamic Load if necessary 2 ton hoist on ceiling
Jetty Sub-station AMP Sub-station Reefer Sub-station platform	Foundation 1,800	1,300	600	Weight of equipment and Dynamic Load, if necessary
X-ray Check Facility (The system shall be determined later)				

Note 1) Equipment loads and vehicle wheel loads are calculated by planed condition.

Note 2) Floor pavements of terminal gates and fuel station are designed as same as the road pavement.

Source : Study Team

c) Wind Load

Basic wind speed will be 120 mph (53.6m/sec, 3-second gust wind speed) in Yangon Area according to Myanmar Regulations. Wind load on every building and structure is determined in accordance with UBC/IBC and ASME.

The basic wind speed is defined by V3s : 3-second gust wind speed, therefore, it is converted to the equivalent basic wind speed (fastest wind speed) to apply BSL. V3s=120 mph is equivalent to Vfm=104 mph, the fastest wind speed according to AISC/IBC. The unit of speed is changed as follows.

V3s of 120 mph= 53.6 m/sec

Vfm of 104 mph= 46.4 m/sec

The basic wind speed is employed 46 m/sec in Standard Building Law of Japan. The surface roughness categories, gust factor, distribution of wind speed in height, etc. is determined in accordance with Standard Building Law of Japan.

Basic wind speed : 46 m/sec

Surface roughness categories; II for building higher than 13m.

III for building lower than 13m

The wind load acting on the each portion of building is calculated by the following equation.

$$Wp = C \times qo \times A$$

Where;

Wp :	wind load (N)
C :	wind pressure coefficient
qo :	wind velocity pressure (N/m^2)
A :	pressure receiving area (m^2)

d) Earthquake Load

Yangon area belong to ZONE-III, Strong Zone, as shown in the following figure; SEISMIC ZONE MAP OF MYANMAR, Therefore the base shear coefficient is employed 0.20 in seismic design according to the Building Standard Law of Japan. The figure and other factors are employed as follows.

Base Shear Coefficient	Co= 0.20
Regional Zone Factor	Z. = 1.00
Important Factor (Occupancy)	I = 1.00
Ground Characteristic Factor	Rt = 1.00

The seismic design is carried out in accordance with Building Standard Law.

Water Supply Tower is higher than 30m, then seismic load shall be increased to more than 0.50 of seismic coefficient by taking dynamic effect into consideration.

4) Structural Materials and Strength

All the structural materials shall conform to JIS standards.

The allowable stress shall be defined in Building Standard Law.

a) Reinforced Concrete Structure

Concrete	:	ordinary concrete
Compressive strength	:	18 to 30 N/mm2

b) Reinforcement

Diameter smaller than/equal to D16 SD295A

- Yield stress= 295 N/mm2,
- Tensile strength= 440 N/mm^2

Diameter bigger than/equal to D19 SD345

- Yield stress= 345 N/mm^2, tensile strength= 490 N/mm^2

c) Steel Structure

- Column : SN400. SN490, BCR295, BCP325, TKR400
- Main Girder : SN400, SN490
- Secondary Beam : SS400
- Purlin and Girt : SSC400

Basic strength of materials for design : F-value
SN400, STK400, SS400, SC400 : F= 235 N/mm^2
BCR295 : F= 295 N/mm^2
SN490, BCP325 : F= 325 N/mm^2
(Note : F-value mean the minimum yield stress.)
Tensile strength;
SN400, STK400, SS400, SC400; BCR295 : F= 400 N/mm^2
SN490, BCP325 : F= 490 N/mm^2

5) Structural Design of Superstructure

The superstructure of the almost buildings are designed of steel structure by the following reasons.

- The construction periods of buildings are considered very short because of soil improvement of the site.
- The almost buildings have the large space of long span of 36m in CFS, 20m in Terminal gates, 18m in Maintenance Shops, etc. and eaves height are comparatively large,
- Administration Building is of 5-stories, middle rise.

The main superstructure of Marine Workers Lounge is designed of reinforced concrete rigid frame except the roof, because it is constructed above the river shore and the span is 6 m and not long. The superstructure of Security Post is designed of RC posts and beams with brick wall, because it is a small building.

6) Design Foundation

The soil investigation were carried out at the PREPARATORY SURVEY FOR THE PROJECT. The position of the boring holes and soil profile section are shown on this investigation report. The project buildings are planned mainly at the east side of SITE NO.25, which is surrounded by Boring holes, LBH-4,-5,-8.-9,-11,-12,-16,-17, while Marine Worker Lounge is situated near JBH-11 on the shore west beside LBH-5.

As shown in the soil profile below, the four different soil layers are observed from top to bottom at the building site. The thickness of 3RD soil layer, Silty SAND is decreased at the center area, while increased at west site area, where MARIN WORKERS' LOUNGE is planned.

Table 4.3-63 Soil Profile of Boring No. LBH-12 (Typical Soil Profile at Building Area)

Elevation	Soil Layer	Thickness of Layer	N-value	Relative density Consistency
DL+6.26m DL-14.84m	CLAY	21.10 m	1 to 4	Very soft to soft
DL-18.34	Silty CLAY	3.50 m	14 to 19	Very stiff to stiff
DL-19.09	Silty SAND	0.75 m	13 to 25	Medium dense
(DL-23.24)	SAND	≧4.15	28 to 40	Medium dense to dense

Note) This bore hole is terminated at 29.50m after confirmation.

Source : Study Team

Although the CLAY layer is improved by PVD plus soil surcharge to prevent the consolidation settlement, it cannot support the building weight of long span or multi-storied structure. The main buildings are applied to by the piled foundation. The other small buildings, shed and platform shall be applied by direct mat, continuous and/or spread foundation.

Piles on land shall be of PHC (JIS pre-stressed concrete pile), 600mm DIA, 30 m long. Piles for MARIN WORKER LOUNGE shall be of steel tube pile, 600 to 900mm DIA, 30 m long, same as the trestles. Negative friction need not be taken into account, because the pile driving shall be done after the soil improvement.

The bearing capacity shall be calculated by value of friction angle 30 degree of surcharged SAND and cannot exceed the weight of surcharged sand, 20kN/m2 at building area or 50kN/m2 at container yard.

The type of PHC is determined by the calculation of horizontal resistance at the earthquake loading.

As the additional soil investigation is not carried out under the buildings site because of social environment problem. The soil condition for each building is applied by the existing nearest boring log, therefore the designed foundations should be confirmed after the soil investigation.

The small building or light building are designed by spread/mat (direct) foundation, because the soil improved ground is considered to have the bearing capacity of more than 20 kN/m^2 by surcharge of 1 m sand layer.

7) Structural Design Concept

There are 12 buildings in total under the Project as described in Table 4.3-61 above. Each building is designed separately based on its functions using the design loading mentioned in the section above.

The design concept adopted for the main building structures is described below :

a) Administration Building

Administration buildings is located at the entrance near the main road and is planned to look out in both direction over the access roads and the container yard beyond the stacked containers. The height of stacked containers are 12m in case of 5 layers of 8 feet container, and 11.6 m in case of 4 layers of 8.5 feet container. The control & planning office is situated on 3rd floor at floor level, 12.85m above GL±0. Banquet & observation is situated on 4th floor at floor level, 16.8m above GL±0 .

Taking consideration to keeping views, the construction period and universal space for office, the structure is planned of 5-storied building and of moment resisting rigid frames of which columns and girders are made of steel tube and H-shaped rolled steel.

External walls are made of glass curtain wall. Floors are of reinforced concrete slab with H-shaped steel beams to sustain strength for vertical loads and sound insulation.

Since the building is 5-storied and the weight of unit area excess the surcharge of soil improvement, 20 kN/m2., the building foundation is designed by PHC piles of 500mm diameter.

b) Container Freight Station

The ground floor of Domestic Cargo Store and Bonded Cargo Warehouse is elevated by 1.5m to deliver freight easily from container/ truck to apron. The floor is designed of reinforced concrete suspended slab with secondary beams supported by PHC piles.

The whole ground floor is reinforced for Domestic Cargo Store to support the loads of the rack for 4 layer pallets and 2.5 ton electric folk-lift, which is severe than loads in Bonded Cargo Warehouse.

To provide a big space of 64 m span for warehouse, the superstructure is designed of moment resisting rigid frames of which columns and girders are made of H-shaped rolled steel. The cantilevered canopy of 12m are provided above the apron to protect the freight from rain falls. The supporting cantilever beams are continued from the inside girder and cambers of the beams are taken into consideration to prevent the deflection due to dead load.

c) Terminal Gate and 2nd Gate

The structure are 1-storied and of type that the cylindrical space truss roof of 20m span is supported by reinforced concrete columns. External walls are not provided and the roof is light, accordingly wind load and earthquake load are small. The member size of structure is kept small by 3-D truss structure and light roofing.

Since the weight of building is small, the foundation is designed of spread direct foundation instead of pile foundation.

d) Indoor Maintenance Shop & Covered Maintenance shop

The structure is planned of 2-storied (1+M) and of moment resisting rigid frames of which columns and girders are made of steel tube and H-shaped rolled steel.

The ground floor is used for workshop and the mezzanine floor at the end is used for a management office. Heavy vehicles are repaired on the ground floors in both Indoor & Covered Maintenance Shops, accordingly the ground floor slabs are designed of thick slab on grade supported directly by ground from the economical point of view. The footing girder under slabs on grade is not provided except the perimeters of building to avoid excessive wheel loads due to heavy vehicles.

In these buildings 10 ton overhead cranes are provided, accordingly the foundation are designed of PHC pile foundations to prevent a little differential settlement harmful for overhead crane. To increase fixing rigidity of the column bottom two PHC piles are provided under column in the direction which a footing girder is not connected.

e) Marine Workers Lounge

This is a two storied building constructed at the river shore. The structure is designed of reinforced concrete at ground floor and 1st floor and of steel roof because of humidity of river water, and of moment resisting rigid frames. The steel structure is employed to the roof to reduce weight and to cover the long span.

The foundation is applied to same steel pile as that of the neighboring trestle considering the construction method and maintenance. A steel pipe of 600 mm is provided under column above the river water level.

f) Other Buildings

Security post is a small building. The structure is designed of RC post and beam structure with brick wall and the foundation is of direct mat foundation.

Fuel Station is a building without external walls and the roof is light. The structure is designed in the same manner as Terminal Gate.

Water Supply Facility, Power Supply Facility and Container Repair Shop are designed of steel construction taking to consideration long span, eave height, sloped roof and/or construction period. The foundation are designed as PHC pile foundation because of heavy equipment except Container Repair Shop foundation, which is a direct mat foundation because of small live load.

(3) Mechanical

1) General

This section of the report describes the scope of the mechanical works, design criteria and outline of each mechanical work to be utilized in this project.

2) Scope of Works

The scope of mechanical works for buildings includes the following works :

- Ventilation and Air-Conditioning System
- Plumbing System
- Fire Protection System
- Elevator

3) Ventilation and Air-Conditioning System

Air conditioning system will be provided for the various rooms in the terminal facilities in order to maintain proper working conditions to the terminal operating personnel. Basically split type air conditioner(s) or variable refrigerant volume (VRV) unit(s) will be utilized for the rooms or areas wherever air conditioning are required. Mechanical ventilations will be provided to supply fresh air to the occupied area, to remove heat and moisture and odors release from the equipment or excrement from the human bodies or other sources. Ventilation and air-conditioning will be designed in accordance with the recommendation of the ASHRAE Handbook and Uniform Building Codes.

a) Design Criteria for Air Conditioning

Outdoor Design Temperature : 38 ºC Dry Bulb (DB), 28 ºC Wet Bulb (WB)
Indoor Design Temperatures of each room are as follows;

Table 4.3-64 Indoor Design Temperatures

Building Name	Room Name	Temp. ºC DB	RH* (%)
Administration Bldg.	Entrance, Lift Lobby, Offices, Reception, Security & Monitor, Clinic, Meeting Rooms, Conference Rooms, Secretary, Director's Office, IT Room, Banquet/Observation, Electric Room	24	55
CFS	Operator's Offices, Customs Offices	24	55
Maintenance Shop (1)	Office (mezzanine floor)	24	55
Fuel Station	Rest Room	24	55
Marine Workers' Lounge	Canteen, Meeting Room, Office	24	55
Security Post	Guard Offices	24	55
Electrical Facility	Panel Room	30	55

Note : Relative humidity (RH) is not controlled and reference only for cooling load calculation.

Source : Study Team

b) Design Criteria for Ventilation

Fresh air changes and type of ventilating equipment are as follows :

Table 4.3-65 Fresh air changes and type of ventilating equipment

Building Name	Room Name	ACH*	Type	Fan
Administration Bldg.	Toilets	20	Exhaust	Axial
	Pantry	10	Exhaust	Axial
	Store	10	Exhaust	Axial
CFS	Domestic Cargo Store	NA	NA	Natural
	Bonded Cargo Warehouse	NA	NA	Natural
	Toilets	20	Exhaust	Axial
	Pantry	10	Exhaust	Axial
	Store	10	Exhaust	Propeller
Terminal Gate (1) (2)	Truck Booth, Clerk Booth	NA	NA	Natural
Maintenance Shop (1)	Working Area	NA	NA	Natural
	Paint Store, Mechanical Store, Comp. Store, Tool Store, Parts Store	10	Exhaust	Axial or Propeller
	Toilet (Mezzanine.)	20	Exhaust	Axial
	Pantry (Mezzanine.)	10	Exhaust	Axial
	Store (Mezzanine.)	10	Exhaust	Axial
Container Repair Shop	Repair Shop	NA	NA	Natural
Fuel Station	Toilet	10	Exhaust	Propeller
Electrical Facility	Generator Room	45 ºC	NA	Natural
Water Supply Facility	Pump Room	NA	NA	Natural
Marine Worker Lounge	Toilets	20	Exhaust	Axial
	Shower Room	20	Exhaust	Axial
	Kitchen	**	Exhaust	Axial
Security Post	Toilet	20	Exhaust	Propeller

Note * : FAC stands for Fresh Air Change per Hour ** : Face Air Velocity of Hood≧0.3 m/s

Source：Study Team

c) Outline of Air Conditioning System

Air-conditioning system, some of the major building are described hereunder :

i) Administration Building

Each room in the administration building will be provided with the split type air conditioning unit(s) or variable refrigerant volume (VRV) units. The split air conditioning unit consists of the direct expansion type fan-coil unit (indoor unit) and the air cooled condenser or condensing unit (outdoor unit), refrigerant piping, automatic temperature control devices, wiring and etc. VRV unit consists of the one outdoor unit and multi-split indoor units, each have a capacity to meet independent cooling requirements of the rooms. The fan coil unit will be either ceiling cassette type or ceiling concealed type. Where ceiling concealed type fan-coil units are selected, conditioned air will be supplied and returned by the air duct together with the appropriate air terminals. Air cooled condensing unit will be mainly installed at the balconies of each floor. The fan coil (indoor) unit and condensing (outdoor) unit will be interconnected by the refrigerant piping, cabling and control wirings.

Outdoor fresh air will be preconditioned by the two (2) dedicated fresh air conditioning units located at roof level, and conditioned air will be distributed into each room via air duct. The fresh air conditioning units will be of air cooled packaged roof top units consisting of compressor(s), indoor and outdoor fans, refrigerant coils, air filters, dampers, safety and control devices and enclosure casing. The preconditioning of the outdoor air will consisting filtering the air, cooling and dehumidifying the air and maintaining the positive pressure inside the building to protect invasion of outdoor air, dust and dirt, and supplying air at approximately 18 ºC to each room.

Introduced outside air supplied to each room by the fresh air conditioning units room will be exhausted by the ventilation fans for the toilets through corridors. Consequently, corridors and toilets can also be lowered the temperature.

ii) Marine Worker Lounge

Canteen, meeting room and office in the marine worker lounge will be provided with respective air conditioning units.

The unit will be air cooled split type consisting of the indoor unit and outdoor unit and connecting refrigerant piping. Indoor unit will be either ceiling cassette type or wall mounted type and room temperature will be controlled individually.

Outdoor condensing units will be located at the walkway corridor at the second floor.

iii) CFS and Maintenance Shop

All offices and the like will be provided with air conditioning units. The units will be air cooled split type consisting of the indoor unit and outdoor unit, and connecting refrigerant piping. Indoor unit will be either ceiling cassette type or wall mounted type. Each air conditioner will control the room temperature by the individual temperature controller.

d) Mechanical Ventilation

Mechanical ventilation equipment will be provided for various rooms and/or areas in order to give proper working environment to the terminal operational personnel and to eliminate heat, odors, moisture, chemical vapor and etc. Type of the ventilation equipment will be selected from axial flow fan, centrifugal fan, wall mounted propeller fan or ceiling fan to meet the required function of the respective room. Outline of the ventilation system for some specific rooms are described hereunder :

i) Generator Room

Ventilation capacity for the generator room will be determined based on the requirements of the combustion air and radiator cooing for the generator-sets and ventilation requirements of the heat generated from the generator-sets. Room temperature will be maintained at maximum temperature 45 ºC. Ventilation air will be introduced from the outside to the room through the air louvers installed on the exterior wall, and exhausted by the radiator fan of the engine and roof monitors.

ii) Toilets

The toilets will be provided with the mechanical exhaust ventilating equipment in order to maintain negative pressure inside the room, and to avoid diffusion of the odors and moisture. The tube axial flow fan or propeller fan will be utilized above the ceiling and exhaust air will be ducted to the outside. As for small size toilets, propeller fan will be provided on the exterior wall.

4) Plumbing Works

Following utilities will be provided for the buildings as appropriate :

- Water Supply System
- Hot water Supply System
- Sewage, Wastewater and Vent Piping
- Plumbing Fixtures and trims

a) Water Supply System

Potable water will be obtained from the site reticulation water main by a dedicated branch line(s) to each building. Water will be supplied to the sanitary fixtures, showers, pantries, kitchen and etc. wherever water is required. A minimum working pressure of 70 kPa (0.7bar) at the highest and/or remotest point will be maintained. Scope of the building work include the connection to the branched take-off located at the outside of the building under the utility work.

i) Water Demand for the Buildings

Water consumption for the building occupants and sanitary use has been estimated on the basis of the project population based on the international guidelines for water consumption. The adoptive water consumption rate of 100 liter/capita/day is applied for occupancy staff. As for water demand for the future facilities in the plot 26, it is estimated that 50 percent of the water demand is considered as the future demand to minimize construction of the unnecessary facility and save the construction cost in future.

Table 4.3-66 Preliminary Water Demand for Building

Name of Building	Occupants			Water Use Rate (L/person/day)	Water Consumption (m^3/day)
	No. of Occupant per Shift	No. of Shift or Night staff	Daily		
Administration Building	113	24 staff	137	100	13.7
Meal	113 meals		113	30	3.39
Container Freight Station	60	1 shift	60	100	6
Maintenance Shop	16	1 shift	16	100	1.6
Container Repair Shop	10	1 shift	10	100	1.0
Terminal Gate	12	2 shift	24	100	2.4
Second Gate	3	2 shift	6	100	0.6
Marine Worker Lounge	permanent	temporary	-	-	
	51	60	111	100	11.1
	51 meals x 2		102	30	3.06
Fuel Station	2	1 shift	2	100	0.2
Sub-Station	-	-	-	-	-
Water Pump House/Tank	-	-	-	-	-
X-ray Check Facility	10	1 shift	10	100	1.0
Security Post	4	2 shift	8	100	0.8
Subtotal					44.85
Future Water Demand (50% of the above)					23.0
Total					68

Source：Study Team

b) Hot Water Supply System

Hot water will be supplied only for showers in the marine worker lounge. Point-of-use system using instantaneous tank-less electric hot water heater is proposed and this system has more advantages than the central system using electric storage heater of the following reason :

- Low initial cost,
- Total system failure can be avoid, and
- Less maintenance cost

c) Sewage, Wastewater and Vent Piping System

Sewage and wastewater from the plumbing fixtures, kitchen equipment, pantries and etc. at the various areas in the buildings will be collected by the gravity piping system and connected to the site sanitary sewer main at the appropriate locations. Scope of the building work includes to provide service manhole which will be connected to the site sanitary main by the utility work.

A grease interceptor(s) will be provided within the kitchen area of the marine worker lounge to remove fat and oily content before connection to the sewage pipe.

5) Fire Protection System

Container terminal yard and buildings will be provided with a fire protection and detection systems. The objectives of the fire protection and detection systems to be provided are early detection and alarm of fire, safe and rapid evacuation for the building's occupant, notifying the firefighting brigade of the location of fire, as well as suppressing of the fire itself to maximize life safety and to protect building properties including equipment. Fire detection and alarm system is described somewhere in other Section of this report.

a) Scope of Work

The fire protection systems for the terminal yards and for the buildings will be provided as follows :

- Fire Water Supply and Fire Pumps
- Exterior Yard Hydrant
- Dry Riser and Hose System
- Fire Extinguishers

b) Design Requirements

Design of the fire protection installation will meet the requirements of the latest rules and regulations issued by the following authorities, institutes and organizations.

- Local Fire Service Department
- Code and Practice for Fire Extinguishing Installation and Equipment in Premises (BS5306-1 :2006)
- Code and Practice for Selection and Installation of Portable Fire Extinguishers (BS5308-8 :2000)
- Code of Practice for Fire Hydrant System and Hose Reels (CP29 :1998)
- Code of Practice for Use and Maintenance of Portable Fire Extinguisher (CP55 :1991)

c) Water Supply and Fire Pumps

Fire water will be stored in the water storage tank together with the potable water. Water storage requirement for fighting fire is determined based on the requirements of the fire hydrant and hose reel system for the buildings. Amount of the water storage is considered two yard hydrant operate simultaneously 38 L/sec for first hydrant and 19 L/sec for second hydrant, and 2.27 L/sec for hose reel system for the duration of 45 minutes. It is, therefore, storage requirement of firefighting water has been calculated as follow :

(38 L/sec + 19 L/sec + 2.27 L/sec) x 60 sec x 45 min = 160,029 liters = 160 m3

Fire pumps will be provided to deliver pressurized water to the fire hydrant and hose reel systems. The fire pump set consists of one main fire pump, one standby pump and one jockey pump. These pumps will be located at adjacent of the potable water supply pumps in the water tank house.

A main fire pump and a standby fire pump will have a supply capacity of 59.27 L/sec respectively. Fire water for each fire hydrant will be fed from the site reticulation fire water main

d) Fire Hydrant

Fire hydrant will be of pillar type and provided along the perimeter road around the development area in accordance with the Singapore Standard CP 29 :1998 which is one of the applicable codes and standards in Myanmar. The fire hydrant will be provide at accessible location within 100m from building entrance, and within 100m interval for each hydrant. The hydrant will be provided with two 65mm diameter outlets for the fire hose connection by the fire brigade. A normal close gate valve will be proved for each hydrant to control the hydrant.

Fire water will be fed from the fire water main pressurized by the fire water pump sets.

e) Dry-Riser System

Multi-story building is difficult to evacuate and can be extremely hazardous in the event of an outbreak of fire, unless fixed fire protection equipment has been installed. Dry riser system will be provided in the buildings the habitable height is more than 10m, but not exceed 10m. As administration building is 20.85m in height, dry riser system will be adopted to provide for the administration building. The dry riser does not normally contain water, but supplied with water by the fire brigade during an outbreak of fire. The fire brigade connects the suction side of the fire engine via yard hydrant and discharge side is connected to the breeching inlet of the dry riser system. A 100mm diameter riser main will be provided at the escape staircase and connect to a 65mm diameter landing valve provided at each floor. Two breeching inlets connections will be provided on external wall at not more than 12m from the riser and within 18m from the access road.

The dry riser system comprises of landing valves, riser main, automatic air relief, and breeching inlets. The landing valve comprise of a 65mm diameter instantaneous female coupling outlet fitted with removable plug secured by a chain and installed at a height of between 0.9m and 1.1m above the floor slab. The breeching inlets will be provide at ground level for dry riser and consists of two 65mm instantaneous male coupling protected cap secured with the chain.

f) Hose-Reel System

Hose reels are considered as a first-aid firefighting measure and are designed for use of the occupants of the building in fighting an outbreak of fire. To maximize the life safety and protect the property of the building, the basic design criteria has been based on the administration building which is the largest and highest building in the terminal.

Fire water will be fed from the dedicated fire water main pressurized by the fire pump sets.

Hose reel system will be provided for the administration, marine worker lounge, maintenance repair shop and CFS. Hose reel will be the double swivel type with 25mm diameter, 30m length rubber hose.

g) Portable Fire Extinguishers

Portable fire extinguishers will be provided in all the buildings. The selection of the fire extinguishers will be determined by the character of the fires anticipated and construction of the individual buildings. The portable fire extinguishers are classified for use on certain classes of fires and rated for relative extinguishing the effectiveness at ambient temperature. The classification and rating will be determined in accordance with the requirement of Singapore Standards CP 55 : Code of Practice for Use and Maintenance of Portable Fire Extinguishers.

- Class A : Woods and General Fire
- Class B : Flammable Liquid
- Class C : Electricity
- Class D : Metal

Table 4.3-67 Typical fire extinguishers commonly used are tabulated below

Description	Type	Capacity	Fire Rating
Dry Chemical Powder	ABC	2.3 kg 4.5 kg 9.1 kg	2A/10BC 4A/60BC 20A/120BC
Aqueous Film Forming Foam (AFFF)	AB	6 L 9.5L	2A/10B 3A/20B
Carbon Dioxide	BC	2.3 kg 4.5 kg	5BC 10BC
Clean Agent Gas	BC	1.1 kg 2.3 kg 5.0 kg	2BC 5BC 10BC

Source : Study Team

6) Elevator

Two passenger elevators will be provided in the administration building. The elevator will be traction machine room-less type located at center core of the building.

Rated speed and capacity of each elevator will be 90 m/s and 900 kg (13 passengers) respectively. The elevator is designed that rear side panel is made of clear glass, so that passenger will overlook the view of atrium court and cloister at each floor of the administration building.

(4) Electrical Works

1) Single Line Diagram

a) Dual Incoming

To realize the redundancy, two (2) incomings with respective transformer will be provided as a back-up for possible trouble on one of them. Each of the incomings is separated strictly to make them independent.

b) Back Up

For essential loads such as gantry cranes, reefer container and port security systems, diesel generators are provided respectively. Load shedding scheme is applied to minimize the generator capacity using magnetic contactors and timers.

c) Switchgears

The switchgears are provided with proper use as the following and specified based on the short circuit calculation and JIS standard strictly.

VCB for 33 KV, VCB for 6.6 KV, ACB for LV main and MCCB for LV branch.

d) Protection Relay

Such relays as over current, low voltage, over voltage to protect the electrical facilities are basically switchgear built-in or multi-function combined type. Coordination among the relays are considered.

e) Main Transformer Capacity

Two sets of main transformer’s capacity are able to supply power for both of Phase I and II. The capacity of phase I is decided to totalize individual loads with considering each category of demand facto and phase II follow the Phase I.

f) Generator Capacity

Generator capacities are calculated to with totalizing individual loads and their operation. Such factors as engine bearing and voltage drop at the starting time are not considered.

g) Power Factor Correction

Power factor of the 6.6KV BUS is controlled by static capacitor with serial reactor to keep it 0.95 and suppress the harmonic distortion with protecting the capacitor itself.

2) Short Circuit Current

a) The short circuit current at the power receiving point.

The following is described in the DF/R 1 as to the power supply to the site.

Electrical Power

- Outside infrastructure and circumstances around Thilawa SEZ
- Power receiving could be expected to obtain 100MVA from Tanglin S/S (230KV/33KV).

From this, the short circuit current at the point can be calculated as the following.

Tangling S/S :

- P1 :Capacity 100MVA
- Z1 :Impedance 10% (usual value on the similar size TR)

Thilawa Site :

- P1 :Capacity 10MVA (refer to the single line diagram)
- Z2 :Impedance calculated as below,
  overhead wire is neglected as safety factor
- V2 :Voltage 22KV
- Is2 :Short Circuit Current calculated as below

z2=z1 x p2 / p1 =10% x 10 MVA / 100MVA = 1.0%
Is2= 10 MVA / √3 / 33KV / z2 = 10MVA / √3 / 33KV / 1.0% = 17.5KA

As the result of the above, the short circuit current by possible fault on the 33 KV line is decided to 25 KA as the nearest higher class of 17.5 KA.

Short Circuit Current on 33 KV Incoming Line 25 KA

VCB, the sort circuit current is decided to 25 KA or a fault on the 33KV.

b) The short circuit current at the downstream from the main transformer

Out of two (2) main transformers shown on the single line diagram, always only one (1) transformer is allowed to connect to the incoming by mechanical and electrical interlock, absolutely no parallel operation.

From this, the short circuit current can be calculated as the following.

Incoming Line :

- P1 :Short Circuit Capacity calculated as below
- Z1 :Impedance 100%
- Is1 :Short Circuit Current 16KA
- V1 :Line Voltage 33KV
- Z11 :Concverted Impedance calculated as below

Main Transformer :

- P2 :Capacity 10MVA (shown on the single line diagram)
- Z2 :Impedance 7% (shown on the single line diagram)
- V2 :Secondary Voltage 6.6KV

- Is2 :Short Circuit Current calculated as below
- Zc : Combined Impedance calculated as below

P1= $\sqrt{3}$ x Is1 x V1 = $\sqrt{3}$ x 17.5KA x 33KV =1000MVA
Z11= Z1 x P2 / P1 = 100% x 10MVA / 1000MVA = 1.0%
Zc= Z11 + Zc =7% + 1.0% =8.0 %
Is2= P2 / $\sqrt{3}$ / V2 / Z11 = 10MVA / $\sqrt{3}$ / 6.6KV / 8.0 % =10.9KA

As the result of the above, the short circuit current caused by possible fault on the 6.6 KV line is decided to 16KA as the nearest higher class of 10.9KA KA.

Short Circuit Current on 6.6 KV Main Feeders 16 KA

3) Load Calculation

a) EF S/S

Table 4.3-68 Load of at EF Sub-station

1. Administration Building

Area	Load	m2	VA/m2	DF	KVA
Air conditioning	LTG, Receptacle, small power, AC	2400	140	0.9	310
No Air conditioning	LTG, Receptacle, small power	1100	30	0.8	30
Common	Elevator (15 KVA)				15
IT	Equipment for IT				82
Port Security	LAN (5KVA), Tel(5KVA), F/A (5KVA)				55
	External LTG (30KVA), CCTV (5KVA)				
	P/A(5KVA)				
Sub-total					492

2. CFS

Area	Load	m2	VA/m2	DF	KVA
Air conditioning	LTG, Receptacle, small power, AC	540	140	0.9	70
No Air conditioning	LTG, Receptacle, small power	4900	30	0.8	120
Building Facility	Shutter (0.5 KVA x 24)				24
	Dock Leveler(1KVA x 12)				
Sub-total					214

3. Terminal Gate

Area	Load	m2	VA/m2	DF	KVA
Booth	LTG, Receptacle, small power	9	1200	1.0	11
Gate	LTG (High Bay)	9	1500	1.0	14
Sub-total					25

4. X-Ray

Area	Load	m2	VA/m2	DF	KVA
Machine	2 Nos. X-ray machine (Maker's information, 40KVA x 2nos.)				80
Sub-total					80

5. Fuel Station

Area	Load	m2	VA/m2	DF	KVA
Air conditioning	LTG, Receptacle, IT, small power, AC	12.5	110	0.9	2
No Air conditioning	LTG, Receptacle, IT, small power	137	30	0.8	4
Auxiliary Facility					5
Sub-total					11

6. Water Facility

Area	Load	m2	VA/m2	DF	KVA
No Air conditioning	LTG, Receptacle, IT, small power	500	30	0.8	12
Machinery Power	Various Pumps				118
Sub-total					120

7. Electrical Facility

Area	Load	m2	VA/m2	DF	KVA
Air conditioning	LTG, Receptacle, IT, small power, AC	360	120	0.9	40
No Air conditioning	LTG, Receptacle, IT, small power	320	30	0.8	8
Auxiliary Facility					12
Sub-total					60

8. Security Post

Area	Load	m2	VA/m2	DF	KVA
Air conditioning	LTG, Receptacle, IT, small power, AC	66	140	0.9	9
Sub-total					9

Source : Study Team

b) Reefer S/S

Table 4.3-69 Load at Reefer Sub-Station

1. Reefer Container

Area	Load	Sets	A/set	V	√3	KVA
Reefer Container	Refrigerator	180	13	400	1.73	1619
	13A/20ft, 40ft, 230V					
Sub-total						1619

2. Maintenance Shop

Area	m2	m2	VA/m2	DF	KVA
Air conditioning	LTG, Receptacle, IT, small power, AC	84	110	0.9	10
No Air conditioning	LTG, Receptacle, IT, small power	1260	30	0.8	30
Common	Air Compressor(3.7 KW x 4)				50
	Welding Machine(5.5KW x 4)				
	Handy Tool (10KVA)				
Sub-total					90

3. 2nd Terminal Gate

Area	Load	Lane	VA/Lane	DF	KVA
Booth	LTG, Receptacle, IT, small power	4	1200	1.0	5
Gate	LTG (High Bay)	4	1500	1.0	6
Sub-total					11

4. Port Security

Area	Load	Nos.	VA/no	DF	KVA
Plotted area	External Lighting				30
Plotted area	CCTV				4
Sub-total					35

Source : Study Team

c) Jetty S/S

Table 4.3-70 Load at Jetty Sub-Station

1. Gantry Crane

Load	Sets ①	Acceleration KW ②	Acceleration DF ③	Auxiliary KVA ④	Auxiliary DF ⑤	⑥=((②x③)+(④x⑤))x① KVA
Hoisting	2	917	0.75			137.5
Trolley Traversing	2	331	0.75			496.5
Auxiliary & Lighting	2			110	0..75	165
Sub-total						2037

2. Marine Worker's Lounge

Area	Load	m2 ①	VA/m2 ②	DF ③	KVA ④ = ① x ②x③
Air Conditioning	LTG., Receptacle, IT, small power, AC	300	120	0.9	35
No, Air Conditioning	LTG, Receptacle, small Power	150	30	0.8	4
Auxiliary Facility	Kitchen Equipment and etc.				16
Sub-total					55

3. Port Security

Area	Load	Nos ①	VA/no ②	DF ③	KVA ④=①x②x③
Plotted area	External Lighting				30
Plotted area	CCTV				5
Sub-total					35

Source : Study Team

4) Main Transformer Capacity

The transformer capacity is calculated as the following based on the above

EF S/S	1011 KVA
Reefer S/S	1755 KVA
Jetty S/S	2127 KVA
Total	4893 KVA
Transformer Capacity Total	5000 KVA

Note;

The transformers are designed based on the following conditions.

- Type : Oil Immersed
- Cooling : ONAN
- Impedance 7%

5) Generator Capacity

The generator are designed based on the following conditions.

- Starting : Battery Cell Motor, Automatically
- Cooling : Radiator Self Cooling
- Fuel : Fuel Oil A

  Supplied directly from one oil storage tank as gravity feed
- Power Change Over : with ATS
- Running Time : 6 Hours

a) EF Building

Table 4.3-71 Generator Capacity for EF Sub-station

Generator Load	System	Capacity	Remarks
CCTV	3p4w 400-230V	5KVA	Port Security, via UPS (40KVA)
Public Address	3p4w 400-230V	3KVA	
Fire Detective and Alarm	3p4w 400-230V	1KVA	With battery
LAN	3p4w 400-230V	5KVA	Via UPS (40KVA)
Tel	3p4w 400-230V	2KVA	With battery
PC (LAN Outlet)	3p4w 400-230V	30KVA	Via UPS (40KVA)
Emergency Lighting	3p4w 400-230V	20KVA	Inside building
External Lighting	3p4w 400-230V	20KVA	Port Security
Fire Pump	3p4w 400-230V	100KVA	
Others	3p4w 400-230V	64KVA	
Total		250KVA	

Source：Study Team

b) Reefer S/S

Table 4.3-72 Generator Capacity for Reefer Sub-station

Generator Load	System	Capacity	Remarks
Reefer Container	3p4w 400-230V	660 KVA	1650 x 0.4
CCTV	3p4w 400-230V	5 KVA	Port Security
External Lighting	3p4w 400-230V	30 KVA	Port Security
Emergency Lighting	3p4w 400-230V	15 KVA	
Total		710 KVA	

Source：Study Team

c) Jetty S/S

Table 4.3-73 Generator Capacity for Jetty Sub-station

Generator Load	System	Capacity	Remarks
Gantry Crane	3p3w 6600V	1082KVA	Hoisting & Trolley Traversing is not operated at same time
CCTV	3p3w400-230V	5KVA	Port Security
External Lighting	3p3w400-230V	30KVA	Port Security
Emergency Lighting	3p3w400-230V	15KVA	
Total		1132KVA	

Source：Study Team

6) Main and Main Feeder Cable

Main and main feeder cable size and the related conduit size are calculated according to the following and summarize them on the tables below.

a) Cable Size

All the main and feeder cables shall be able to withstand the following two (2) category of current.

- Continuous load current including ordinary over load as allowable size.
- Possible short time fault current such as short circuit and / or grounding as minimum size.

The cable sizes shall be calculated as the table below with applying the following formulate to clear the above condition.

Capacity (KVA) :transfer from the section 4.6.3 (4) 3) Load Calculation
Voltage (V) :Nominal Circuit Voltage (V)

Load Current (Al)=(KVA) / √3 / (V)

Fault Current (Af)=Short Circuit Current ; quoted from the section 4.6.3 (4) 2) Short Circuit Current

Minimum size (mm2)=KA x √(sec) /134 ; constant "134" is only used for XLPE/PVC cable

Allowable size (mm2) :quoted from manufacture's allowable cable size table

Table 4.3-74 Main Cable Size

From	to	Load (KVA)	Voltage (V)	Current		Fault	XLPE/PVC Size (mm^2)	
				Load (Al)	Fault (Af)	(sec)	Minimum	Allowable
33KV DS	33KV VCB	4000	33000	70.0	25000	1	185	25
6.6KV VCB	Reefer S/S	700	6600	61.3	16000	1	120	25
6.6KV VCB	Jetty S/S	1160	6600	101.6	16000	1	120	25

Source：Study Team

b) Conduit Size

Conduit sizes shall be decided with referring to the cable size pulled in it.
According to the manufacture's recommendation, the following condition shall be satisfied.

- Conduit size ≥ Cable size x 1.5

Cable size was calculated as shown on the table in the above item A
Accordingly, the conduit sizes are obtained as the following table.
Where;

Conduit Size ID (inner diameter), Cable size OD (outer Diameter).

Table 4.3-75 Conduit Size

From	to	Cable Size	Overall Diameter (ID)	Conduit Size (OD)=(ID)x1.5
33KV DS	33 KV VCB	185 mm^2	50 mm	75mm->150mm
6.6KV VCB	Reefer S/S	120 m^2	41 mm	62 mm->100mm
6.6KV VCB	Jetty S/S	120 m^2	41 mm	62 mm-> 100mm

Source：Study Team

c) Voltage Drop Check

Voltage shall be kept within the allowable level 3% of supply voltage referring to the JECA-8001-2005.

The voltage drops can be calculated as the table below with applying the following formulate to check that they meet the criterion.

Cable Length (m) :quoted from overall layout drawing of the site.

Voltage drop e(V)=$\sqrt{}$3 x (A) x (m) x (R cos θ+ X sin θ)

R/X : Quoted from manufacture's cable table

Table 4.3-76 Voltage Drop Check

From	to	Cable Size	Cable Length	Load Current	R & X (Ω/km)		Voltage Drop		check
					R	X	(eV)	%	
33KV DS	33KV VCB	185sq	50m	70.0A	0.11	0.11	1V	0 %	OK
6.6KV VCB	Reefer S/S	25sq	750m	61.3A	1.0	0.12	71.3V	1 %	OK
6.6KV VCB	Jetty S/S	25sq	900m	101.6A	1.0	0.12	133.4V	2 %	OK

Source：Study Team

All the grounding wires for the main and main feeder cables shall not be damaged to secure safety on possible electrical accident with enough size for excess rising temperature.

The grounding wire size can be calculated as the table below with applying the following formula.

θ=0.008 x T x (I / A)^2

A(mm2)=$\sqrt{}$(0.008 x T(sec)) x I(A)

Where;

Temperature Rise (ºC) = 150ºC; below the temperature of PVC wire damage

Fault Time (sec) = 0.5 sec ; VCB tripping time

Short circuit Current (A) = 25000A (for 33KV) or 16000A (for 6.6KV); quoted from the section 4.6.3 (4) 2) Short Circuit Current

Table 4.3-77 Grounding Wire Size

		①	②	③	④=③/$\sqrt{}$(①/0.008/②)
From	to	Temperature Rise (ºC)	Fault Time (sec)	Short Circuit Current (A)	Grounding Wire Size (mm2)
33KV DS	33KV VCB	120 (150-30)	0.05	25000(25KA)	PVC 40mm2 -> 50mm2
6.6KV VCB	Reefer S/S	120 (150-30)	0.05	16000(16KA)	PVC 26mm2 -> 35mm2
6.6KV VCB	Jetty S/S	120 (150-30)	0.05	16000(16KA)	PVC 26mm2 -> 35mm2

Source：Study Team

7) Static Capacitor

The EF substation shall be equipped with static capacitors together with serial reactors not only to reduce energy loss on the lines but also to increase substantial capacity of the transformers with compensate the power factor (PF) from 0.8 to 0.95.

Necessary capacity of the static capacitor can be calculated as the following with applying the following formula.

$\cos\theta1=0.8$, $\sin\theta1=\sqrt{1-\cos^2\theta1}=0.6$

$\cos\theta2=0.95$, $\sin\theta1=\sqrt{1-\cos^2\theta1}=0.31$

$Q = P(\tan\theta1-\tan\theta2) = 4000KVA \times \cos\theta1 \times (\sin\theta2/\cos\theta2-\sin\theta1/\cos\theta1)$

$= 4000KVA \times 0.8 \times (0.31/0.95 - 0.6/0.8)=1500KVAR$

Table 4.3-78 Requirement of Static Capacitor

Static Capacitor (SC)	1500 KVAR
Serial Reactor	6 %
APFC	(150KVAR x 10 Sets)

Source：Study Team

8) Interior Building Lighting

The interior building lighting is designed according to the following.

Table 4.3-79 Estimated Myanmar Population by Region

Area	Lighting Level (lux)	UGRL	Lighting Fixture (Basis)	
			Mounting	Type of fixture
Office	500	19.8	Recess	Louver
Executive Room	500	16.8	Recess	Cover
First Aid	500	19.9	Recess	Cover
Kitchen	500	22.8	Surface	V-shape
Security Post	500	19.8	Recess	Louver
Monitoring Room	500	16.8	Recess	Louver
Conference Room	500	19.8	Recess	Louver
Reception Room	500	19.8	Recess	Open
Night Duty Room	300	19.8	Surface	V-shape
Canteen	300		Pendant	Reflector
Lounge	200		Recess	Down Light
Library	200		Recess	Open
Warehouse	100		Pendant	Reflector
Locker Room	200		Surface	V-shape
Rest Room	200		Surface	V-shape + Mirror
Mechanical & Electrical Room	200		Pendant	Reflector
Stairs	150		Surface	Reflector
Corridor	100		Surface	Reflector
Elevator Hole	300		Surface	V-shape
Entrance Hole	500		High Bay	Reflector
Marquee	100		High Bay	Reflector
Emergency and Exist	2		Wall Mount	W / Battery

Source：Study Team

Note;

1. The lighting levels are referred to the JIS Z9110 (2010)
2. The mounting and type of fixture are only basis of design, not the absolute concept.
3. 20% of normal lights can be used as Emergency lights if they are supplied power from generator.
4. Necessary numbers of the fixture are calculated using lumen method as the following.

$$N = E \times A / F / U / M$$

Where;

N : Required Average Intensity of illuminance (lux)

E : Lumen per one (1) set of fixture (Lumen)
N : Necessary Numbers of fixture (Set)
A : Floor Area (m2)
U : Utilization Factor
M : Maintenance Factor

4.3.6. Inspection Facility

In Yangon district, the terminals and ports which are handling the containers are provided with X-Ray Inspection Facility at their site. AWPT introduced the relocate-able type of product of the Smith in USA, and MIP is adopting the relocate-able type of product of the nucTECH in China. In Myanmar, the facilities are at first introduced by the terminal and port operators. After completion, actual management and operation of the facility shall be directly conducted by the Custom office in place of the introducer. At the Phase I of this project, the specification of the Inspection Facility, through careful hearing of requirements and recommendations from local custom office, was decided as described below. At the time of official introduction, however, the specification shall be submitted again from the introducer to the Custom office for it's final review and approval. It is common way that the detail specifications of the X-ray Inspection System i not be openly disclosed in sight of public security,

(1) General Technical Specification

X-ray Inspection System has two types, one is X-ray Tube type and the other one is a Particle Accelerator type. The latter is much better in performance, but the size and scale of it is too big to be installed inside the normal container terminal. Under the circumstances, it is popular for a normal size of container terminal to introduce a relocate-able X-ray Inspection System powered by X-ray tube, which needs less installation space. Some container terminals in Yangon are utilizing this type of the X-ray Inspection System. At phase l of this project, the relocate-able X-ray Inspection System with X-ray tube shall be adopted.

The X-ray Inspection System examines the contents of a container while the container is running between the X-ray irradiation device and X-ray sensor. During container inspection, the tractor-chassis with container shall be driven by a chassis driver as usual. As the X-ray irradiation starts soon after the driver's cabin of tractor pass through the X-ray irradiation device, the driver shall not be exposed to X-ray at all. At hazardous, high X-ray level zoon around X-ray irradiation equipment, the protection wall and safety guard shall be set to prevent the staffs and workers from staying at the area. The monitoring room of inspectors shall be located on the place apart from X-ray equipment for safety of inspector.

(2) Specific feature of X-ray Inspection System

- The equipment shall potentially have inspection performance to inspect 200 of 40ft container every one hour.

- As a result of above feature, the equipment shall guarantee the performance to inspect 30 to 40 containers per hour by skilled inspector.
- The energy of X-ray shall be strong enough to penetrate a steel plate of maximum 300mm thickness.
- IDE (Interlaced Dual Energy) system shall be incorporated in the equipment to examine wider range of materials and objects.

4.3.7. Security related Facilities

(1) Fence and Gate

1) Design Concept

a) Type of Fence and Gate

The fence classified in the following table will be provided according to its purpose of installation.

Table 4.3-80 Type of Fence

TYPEA	Net Fence (with barbed wire)
TYPEB	Net Fence
TYPEC	Concrete block wall (with barbed wire)

Source：Study Team

TYPE A : It is installed at the boundary in order to prevent the entry of suspicious persons.

TYPE B : It is installed in container terminal for the purpose of dividing administration area, CSF area and other areas.

TYPE C : It is installed along the existing road side in order to block outsider’s sight from outside.

The type for the gate installed in the container terminal will be swing type that does not require space. The swing gate will be installed with different widths as shown below,

Table 4.3-81 Type of Gate

TYPEA	Swing Net Gate (1m)
TYPEB	Swing Net Gate (2m)
TYPEC	Swing Net Gate (5m)
TYPED	Swing Net Gate (10m)
TYPEE	Swing Net Gate (11m) (with barbed wire)

Source：Study Team

The security fences (Type A) and Gate (Type E) are so designed to comply with SOLAS amendments and ISPS CODE.

b) Layout of Fence and Gate

General layout of fence and gate is shown in figure 4.3.118.

2) Clear Zone

Both widths of inside and outside clear zone are set at 3 m as a standard. The width of outside clear zone will be minimum 1.5 m if it is difficult to ensure 3m of clear zone.

Regarding to the boundary of Plot 24 side of the container terminal, the fence will be installed in a place at a distance of 0.75m from site boundary to ensure the width 1.5 m outside clear zone.

3) Description of Specification

Specifications of the fence are as follows referring to the standard in Japan.

- The fence shall be 2400mm high, and the outrigger shall be 600mm long.
- Three lines of barbed wire shall be installed on the outrigger
- The mesh of the fence shall be 50mm to make it difficult for anyone to climb up the fence
- The diameter of the fence wire shall be more than 3.2mm (exclude coating) to prevent easy cutting.

(2) CCTV and PA System

1) Design Concept

a) Monitoring Policy

CCTV and PA system will be installed in order to comply with SOLAS amendment and ISPS CODE. Basic design concepts are as follow.

- Since the container yard will have many blind spots as containers are piled, and all of the areas cannot be thoroughly monitored, CCTV cameras shall be installed along the fence to monitor suspicious persons and intrusion from the fence in order to secure the restricted area.
- A swing type CCTV camera will be installed along the fence. Fixed type CCTV cameras will be suitable to monitor vehicles and drivers at the entrance and exit gates.

- Loudspeakers shall be installed to announce emergency conditions to people inside the restricted area and ships moored in the port.

b) Layout of CCTV and PA system

Layout of CCTV and PA system are shown in figure 4.3-119.

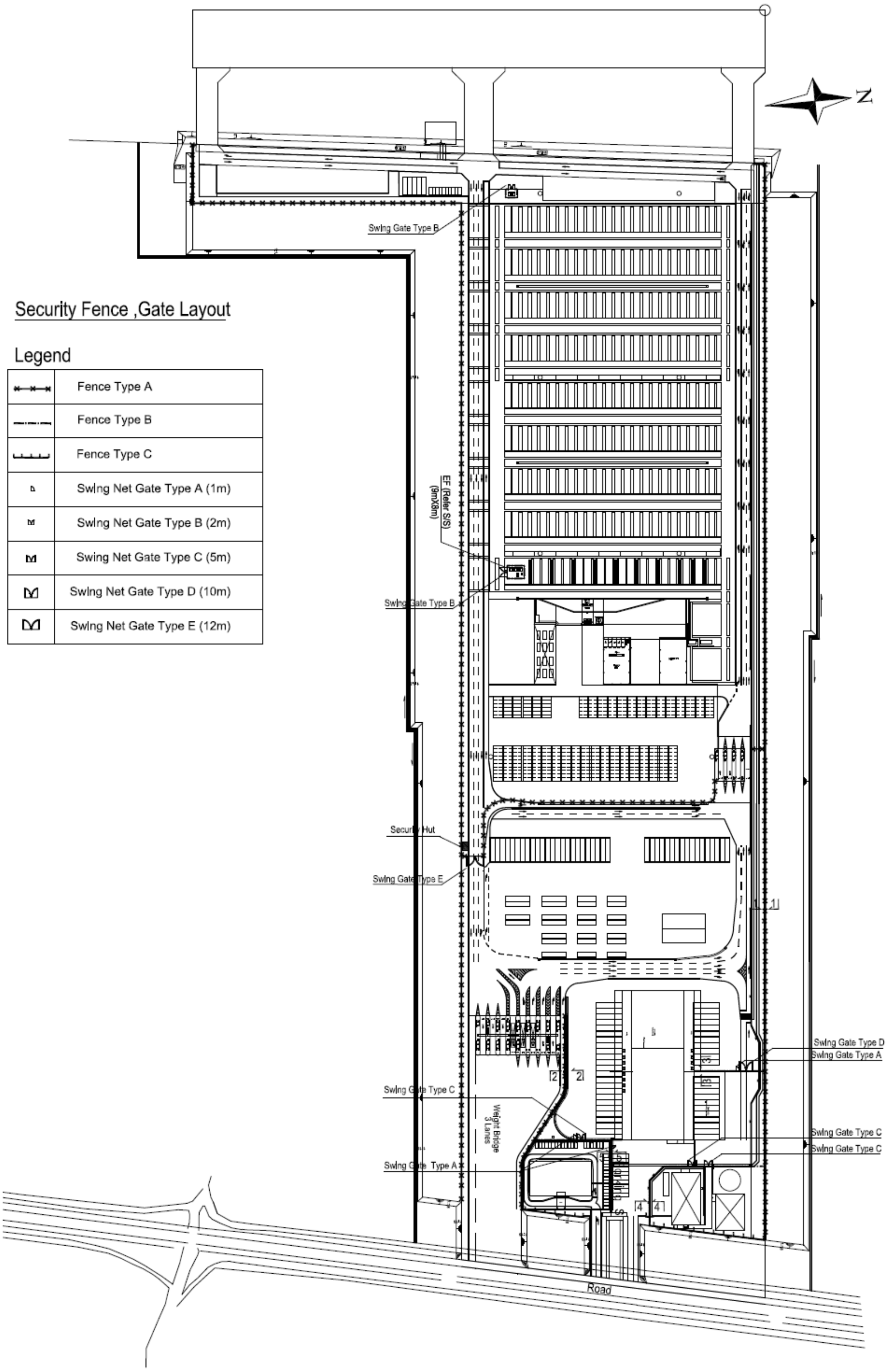
2) Description of Specification

a) CCTV

- Specification and layout of CCTV camera are designed to be able to monitor the motion of suspicious people under 3lx during the night time.
- Swing type CCTV cameras around fence will be installed on the pole inside the fence. The pole will be disposed in a place at a distance of 1.5m from security fence to secure the inside clear zone. Fixed type CCTV camera will be installed on the ceiling of the gate.
- Installation height of CCTV camera will be 8m to minimize blind spot with considering maintenance.

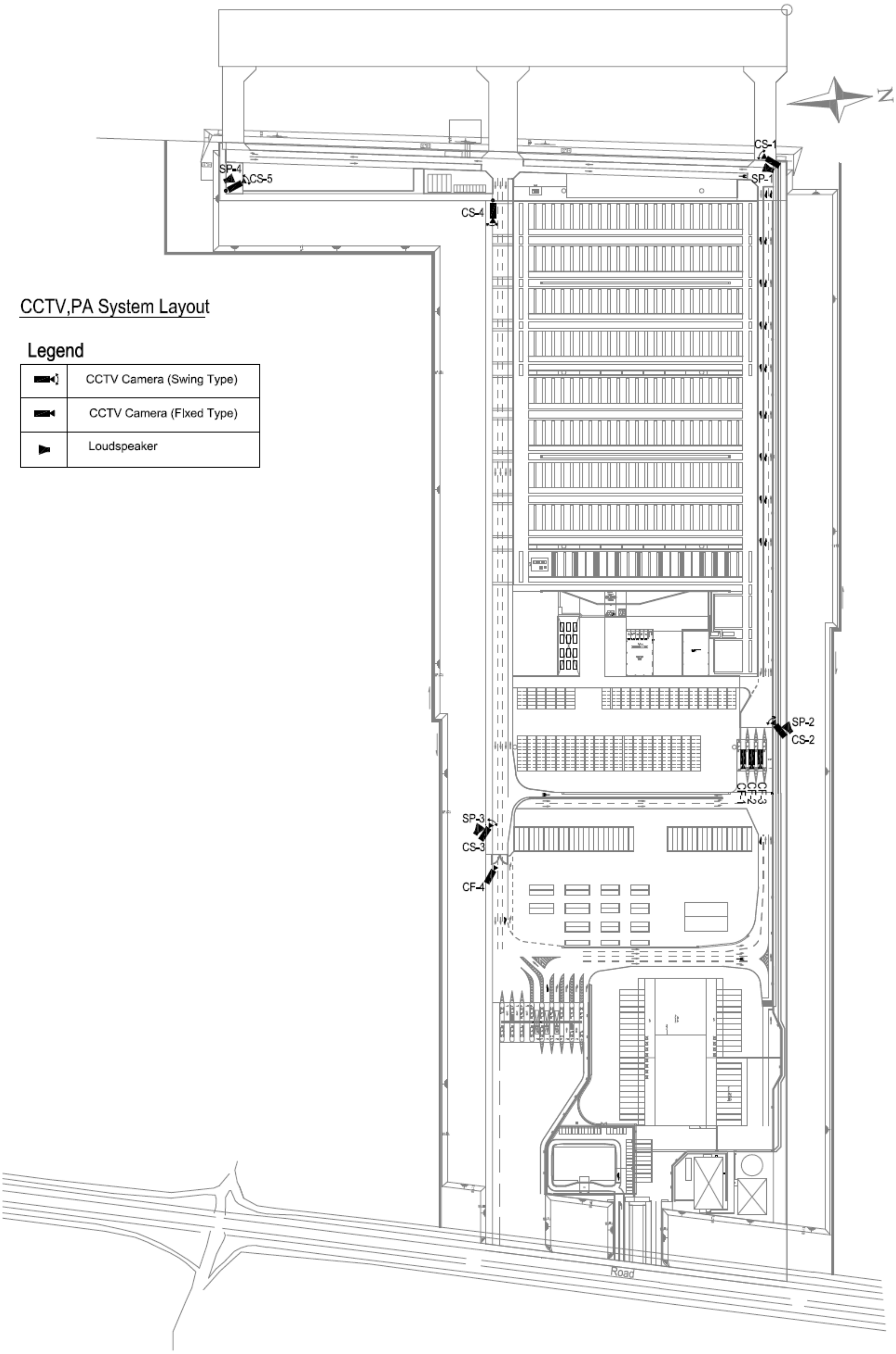
b) PA System

- Loudspeaker will be secured sound pressure levels of 75 db in the container terminal area and 80 db in JETTY area.
- The speaker will be installed on the CCTV camera pole to save the number of poles.



Source : Study Team

Figure 4.3-118 General Layout of Fence and Gate



Source : Study Team

Figure 4.3-119 General Layout for CCT and PA system

4.3.8. Area Lighting

(1) Design Concept

1) Applicable Standard Illumination Levels

Area lightings are designed for layout, installation method and lumps to satisfy minimum average illumination levels to be applied to each area.

Referring to the Japanese standards, a minimum average illumination level for each area is as follows;

Table 4.3-82 Standard Illumination Level

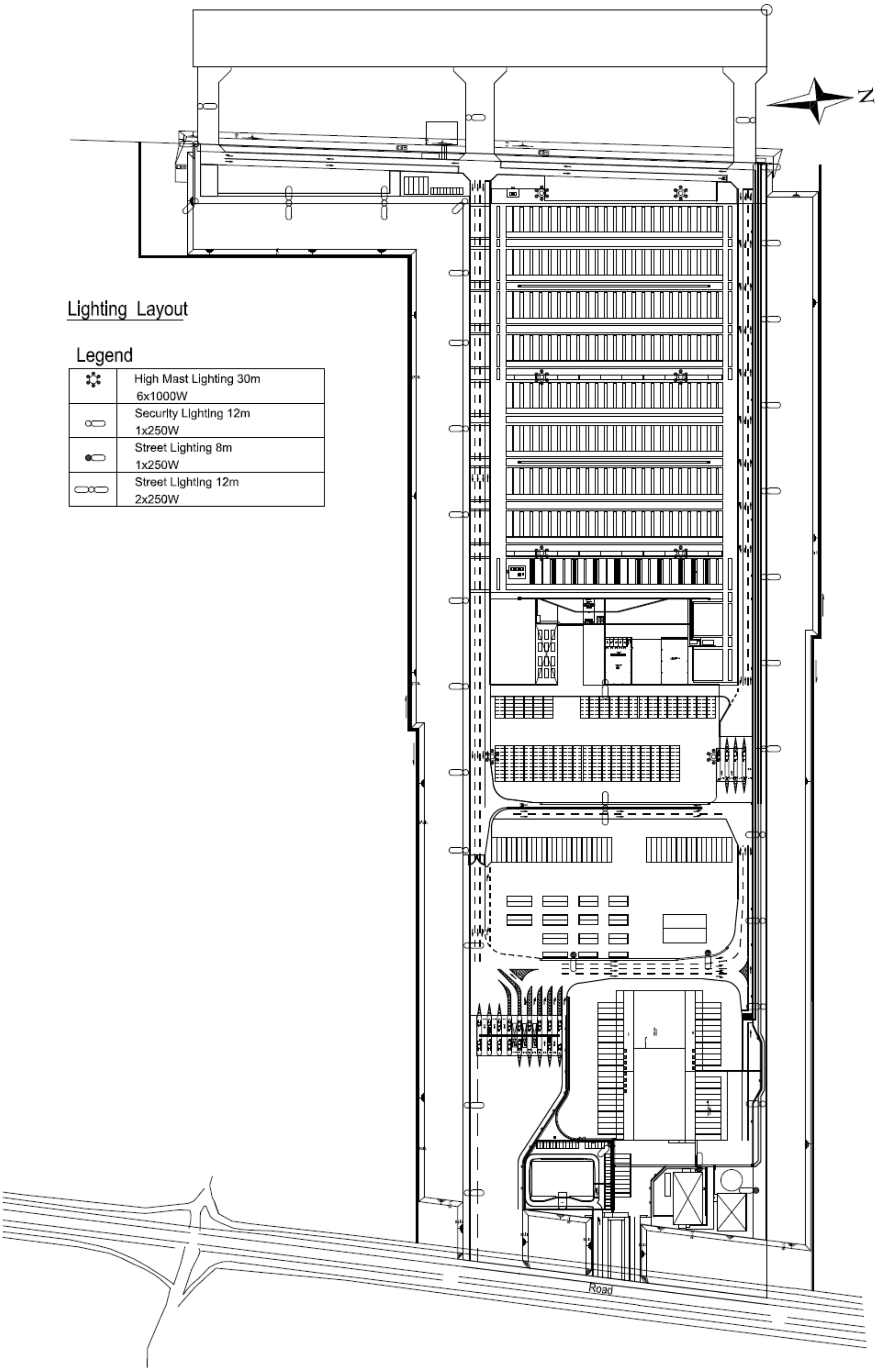
Container Yard	20lx
Internal Street	20lx
Around the security Fence	3lx

Source：Study Team

In Jetty area, a necessary illumination level for cargo handling will be provided by lights mounted on the gantry cranes.

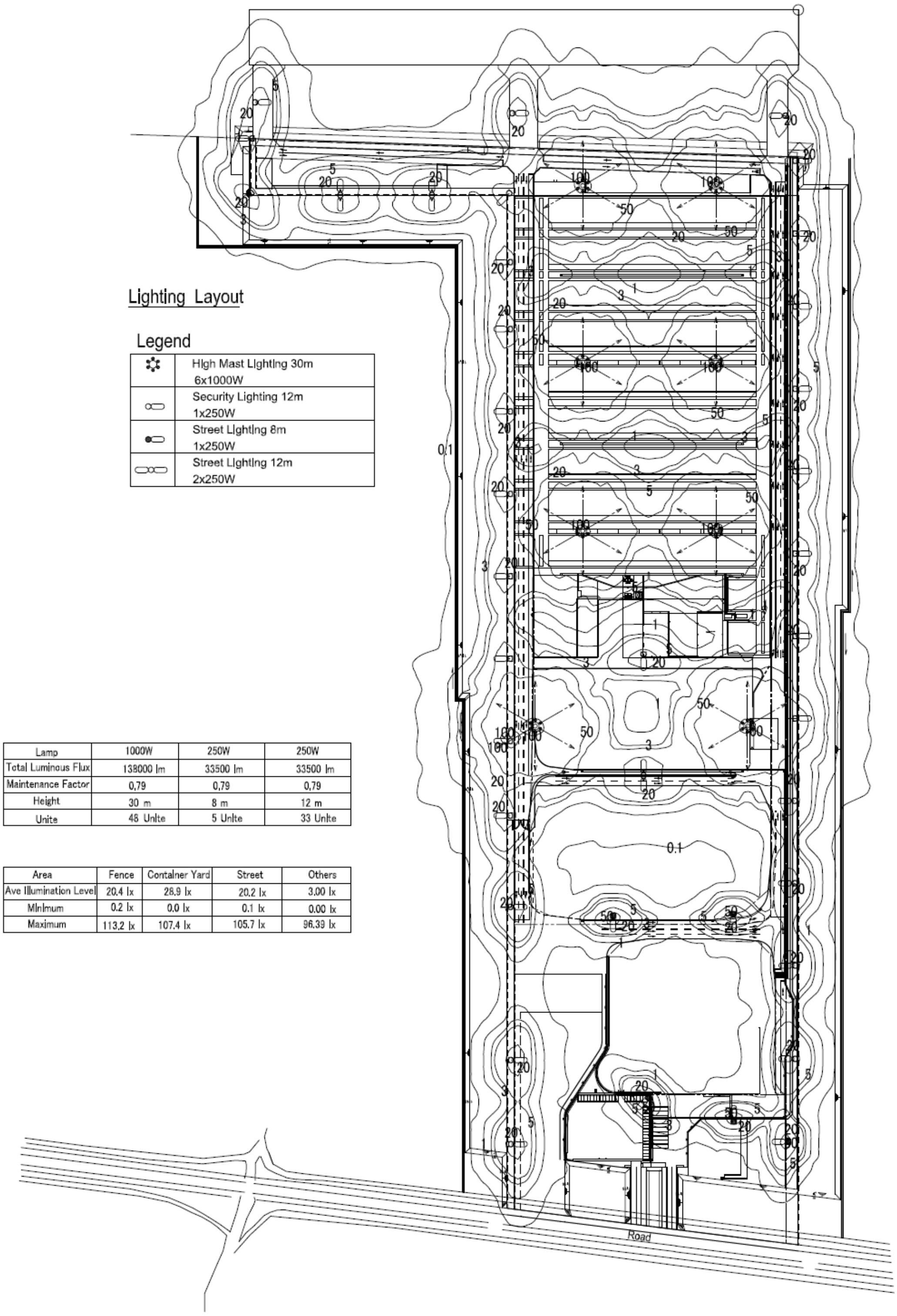
2) Layout of Area Lighting

Layout of Area lightings and illumination distribution map are shown in figure 4.3-120, 4.3-121.



Source : Study Team

Figure 4.3-120 Inland Water Network



Lamp	1000W	250W	250W
Total Luminous Flux	138000 lm	33500 lm	33500 lm
Maintenance Factor	0,79	0,79	0,79
Height	30 m	8 m	12 m
Unite	48 Unite	5 Unite	33 Unite

Area	Fence	Container Yard	Street	Others
Ave Illumination Level	20.4 lx	28.9 lx	20.2 lx	3.00 lx
Minimum	0.2 lx	0.0 lx	0.1 lx	0.00 lx
Maximum	113.2 lx	107.4 lx	105.7 lx	96.39 lx

Source : Study Team

Figure 4.3-121 Inland Water Network

(2) Description of Specification

1) Container Yard

- To avoid obstruction to cargo handling, Lighting will be provided by High mast pole that can illuminate a wide range area by small number.
- High mast pole will have a height of 30m. Installation location will be between RTG lanes, so height of pole should be higher than RTG.
- For the purpose of maintenance, the luminaries carriage will be provided on the pole.
- High pressure sodium lump (1000W x 6) will be used.

2) Internal Street

- Street light pole will have a height of 8m
- High pressure sodium lump (250W) will be used.

3) Around the security Fence

Security lighting will be installed along the security fence to provide enough illumination level for security guards to monitor action of suspicious person by his own eyes or CCTV camera.

- Security light pole will have a height of 12m
- Security lighting will be disposed to ensure the illumination level of 3 lx within 3m of outside and inside clear zone around the fence.
- Security lighting will be installed to illuminate the fence from inside container terminal.
- High pressure sodium lump (250W) will be used.

4.3.9. Drainage Facility

(1) Design Condition of Drainage System

1) The probability rainfall year

10-year return period.

2) Rainfall Intensity

Storm drain in the Project area is calculated based on the rainfall data. All drainage structures are designed using 10-year return period and the following intensity formula :

Table 4.3-83 Rainfall Intensity

min	Rainfall Intensity (mm/hr)	min	Rainfall Intensity (mm/hr)	min	Rainfall Intensity (mm/hr)
0～5	200	20～25	100	40～45	100
5～10	200	25～30	100	45～50	100
10～15	150	30～35	100	50～55	100
15～20	150	35～40	100	55～60	100

Source：Study Team

3) Inlet time (tc)

$$t_c = [(2/3) \times L \times (n/s)]^{0.467}$$

Where,

tc : inlet time (min)

L : distance from farthest area to inlet

n : coefficient of surface friction (pavement : 0.02, rubble : 0.07)

s : slope of drainage surface

4) Discharge Volume

The peak discharge is estimated with reference to a 10-year recurrence interval. The rational formula shown below is used for design calculation.

Q = 0.278 x C x I x A

Where,

Q : peak flow rate (m3/s)

C : coefficient of runoff (pavement : 0.80, Building; 0.70, Grass : 0.30)

I : average rainfall intensity (mm/hr)

A : catchment area (km2)

5) Water Velocity

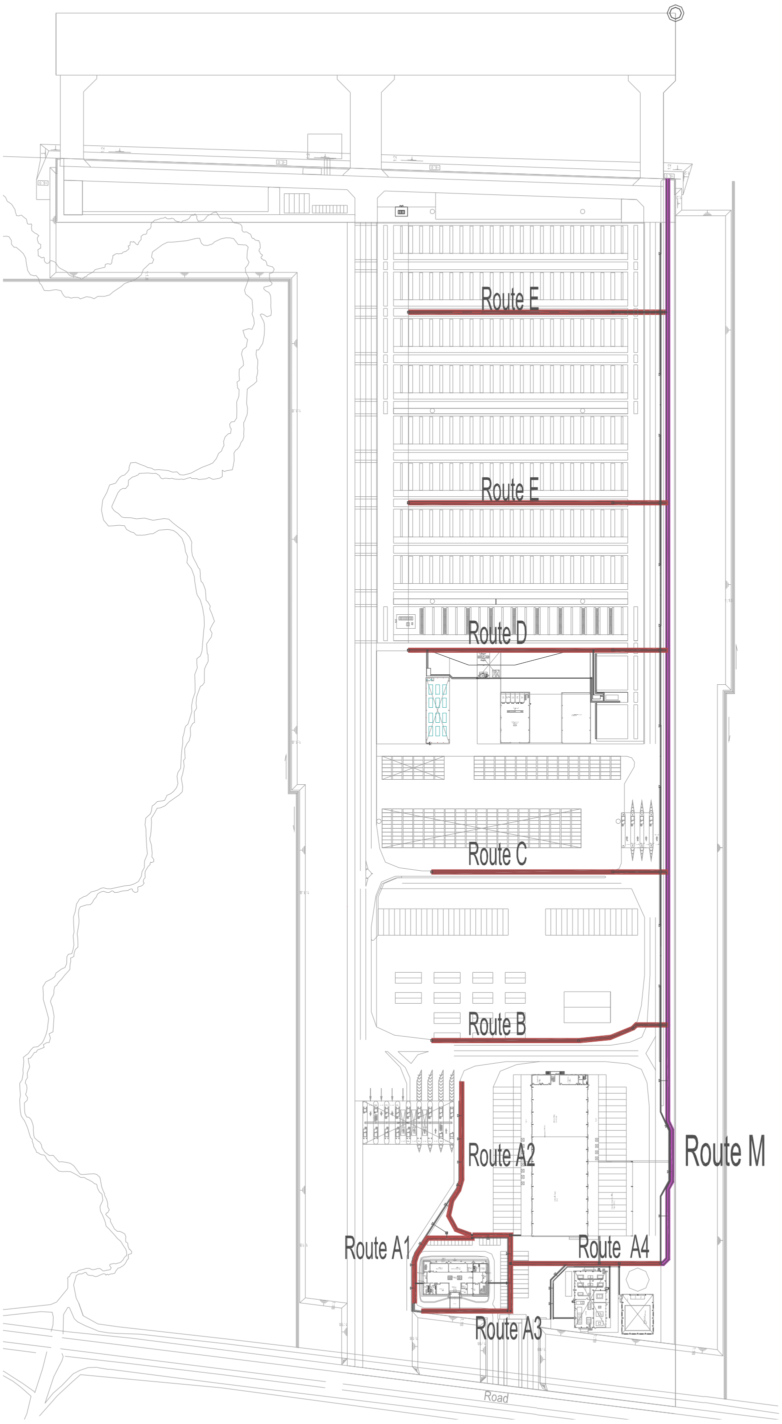
Maximum and minimum velocities of drainage water shall not be lower than 3.0 m/s and 0.6m/s, respectively.

6) Drainage Structure Slope

Drainage structure slope is not less than 0.15%.

(2) Drainage Route

Drainage Route is shown in Figure 4.3-122.

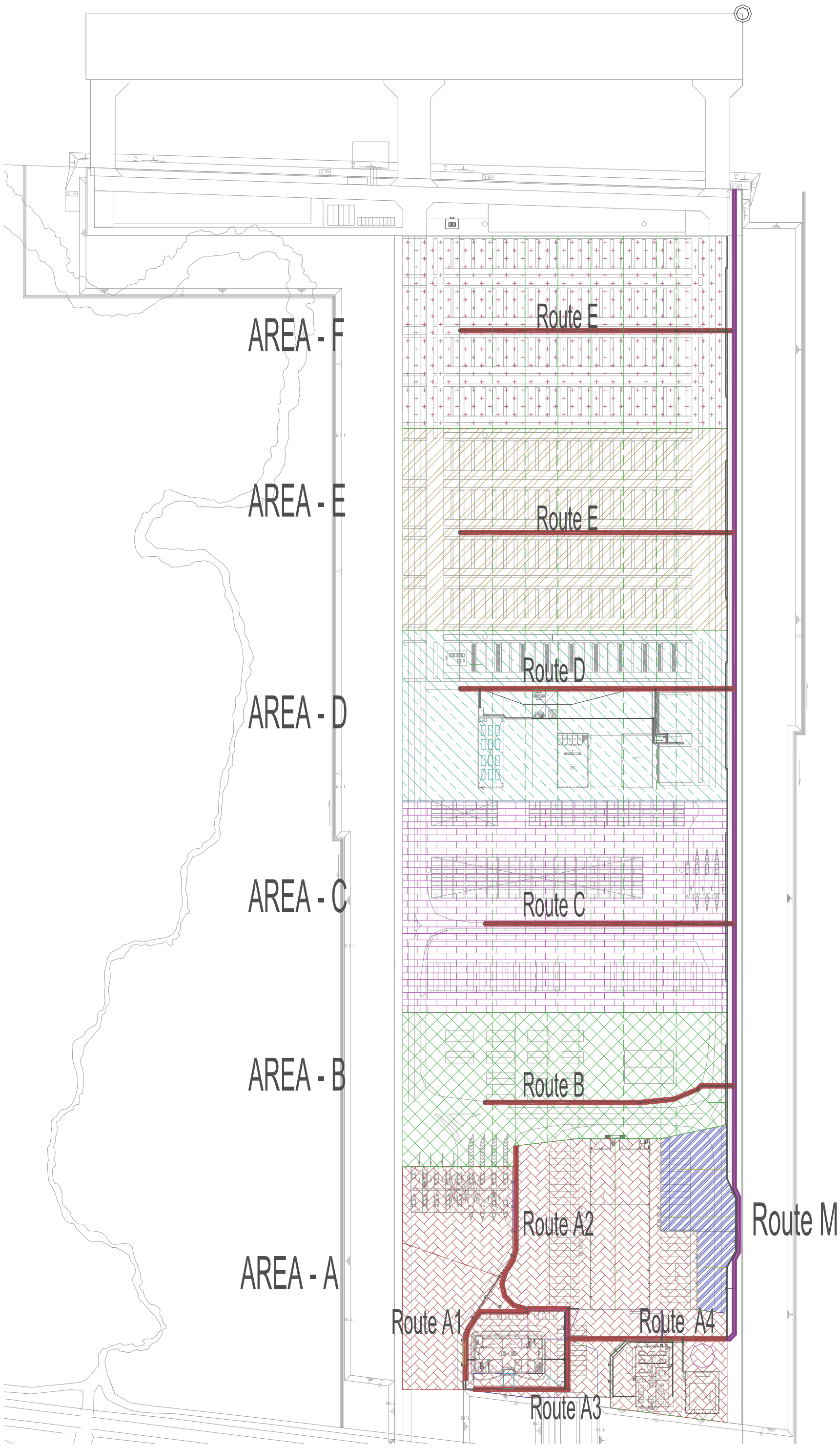


Source : Study Team

Figure 4.3-122 Drainage Route

(3) Catchment Area

Catchment Area of Container Yard is shown in Figure 4.3-123.

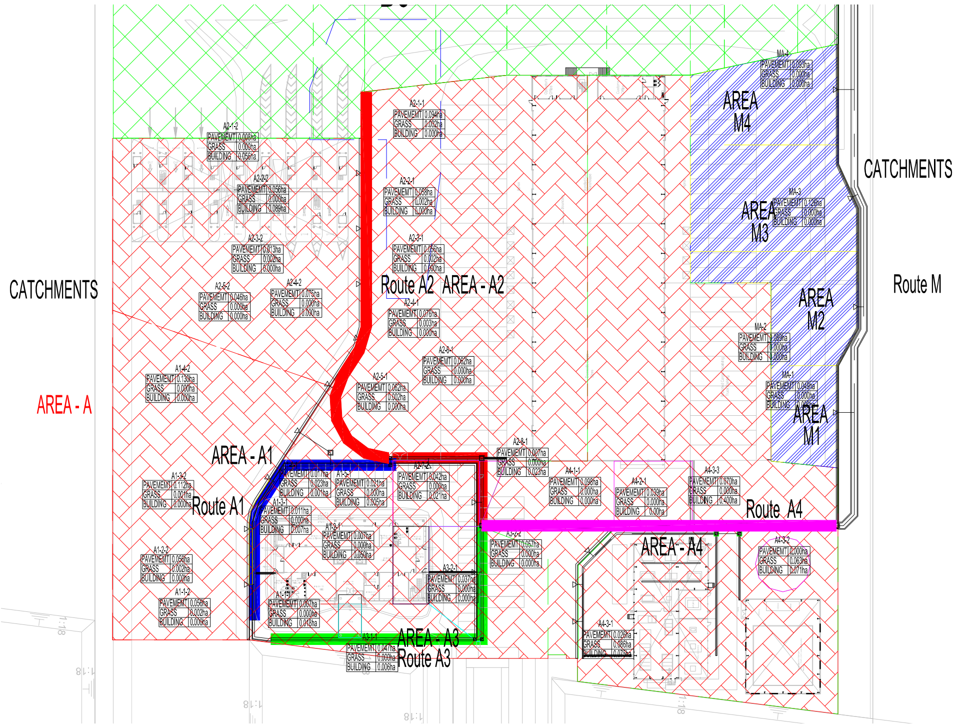


Source : Study Team

Figure 4.3-123 Catchment Area of Container Yard

1) Catchment Area A

Catchment Area A is shown in Figure 4.3-124, and Discharge Volume calculation is shown in Table 4.3-84.



Source : Study Team

Figure 4.3-124　Catchment Area A

Table 4.3-84　Discharge Volume Calculation

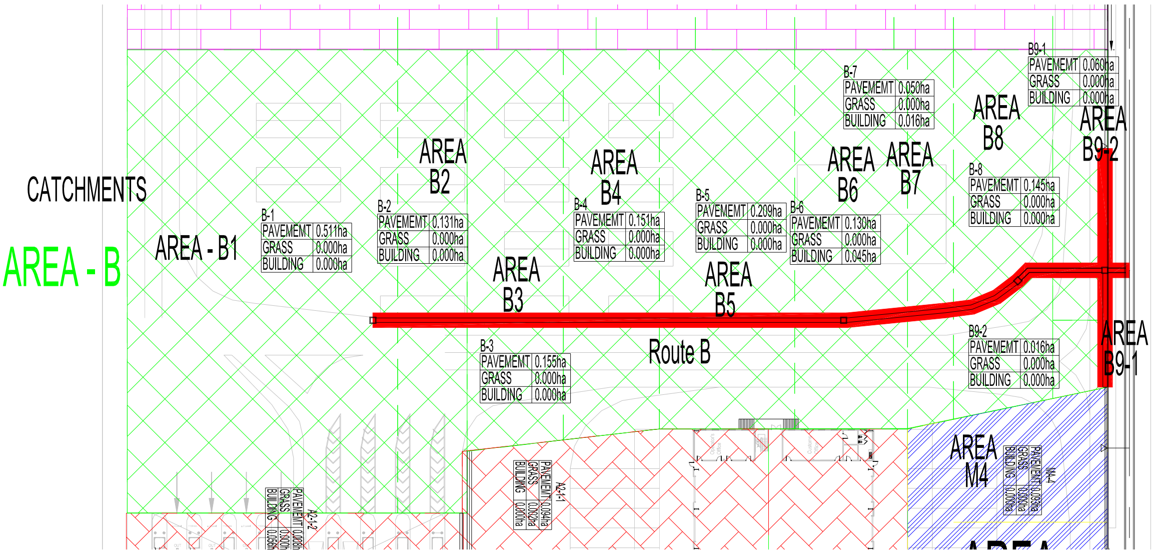
Discharge Volume 1/2

Catchment Area Number	Catchment Are: Pavment 0.8 (ha)	Grass 0.3 (ha)	Bulding 0.7 (ha)	Σ C·A	Distance from farthest area to inlet l	coneffici ent of surface friction n	slope of drainage surface s	Distance om remot points t1(min)	TiME: Length (m)	Velocity (m/s)	Time of flow t2(min)	Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Discharge Volume: Type of Drainage: Type	Width	Depth	Number of pipe	Pipe Diameter (cm)	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)	Discharge Volume (m3/s)
A1−1−1	0.007	0.000	0.018	0.018	30.00	0.050	0.881%	9.114	15.00	0.978	0.256	9.370	200.0	0.010	U−Ditch	0.600	0.400	1		0.978	0.235	0.010
A1−1−2 (→A1−S1)	0.056	0.002	0.000	0.045					1.45	1.143	0.021	9.391	200.0	0.025	Pipe			1	30	1.143	0.081	0.025
A1−2−1 (→A1−3−1)	0.007	0.000	0.050	0.041					15.00	0.978	0.256	9.647	200.0	0.058	U−Ditch	0.600	0.400	1		0.978	0.235	0.058
A1−2−2 (→A1−S2)	0.056	0.002	0.000	0.045					1.45	1.143	0.021	9.668	200.0	0.025	Pipe			1	30	1.143	0.081	0.025
A1−3−1 (→A1−4−1)	0.011	0.000	0.007	0.014					15.00	0.978	0.256	9.924	200.0	0.091	U−Ditch	0.600	0.400	1		0.978	0.235	0.091
A1−3−2 (→A1−S3)	0.112	0.001	0.000	0.090					1.45	1.143	0.021	9.945	200.0	0.050	Pipe			1	30	1.143	0.081	0.050
A1−4−1 (→A1−5−1)	0.017	0.023	0.001	0.021					15.00	0.978	0.256	10.201	150.0	0.114	U−Ditch	0.600	0.400	1		0.978	0.235	0.114
A1−4−2 (→A1−S4)	0.130	0.017	0.000	0.109					14.00	1.143	0.204	10.405	150.0	0.045	Pipe			1	30	1.143	0.081	0.045
A1−5−1 (→A1−6−1)	0.021	0.000	0.005	0.020					16.00	0.978	0.273	10.678	150.0	0.168	U−Ditch	0.600	0.400	1		0.978	0.235	0.168
PIPE (→A2−7−1)				0.000					1.90	2.770	0.011	10.689	150.0	0.168	Pipe			1	40	2.770	0.349	0.168
A2−1−1 (→A2−2−1)	0.094	0.002	0.000	0.076	39.00	0.050	0.881%	10.302	21.91	0.978	0.373	10.675	150.0	0.032	U−Ditch	0.600	0.400	1		0.978	0.235	0.032
A2−1−2 (→A2−S1)	0.008	0.000	0.056	0.046					1.45	1.143	0.021	10.696	150.0	0.019	Pipe			1	30	1.143	0.081	0.019
A2−2−1 (→A2−3−1)	0.058	0.002	0.000	0.047					15.00	0.978	0.256	10.931	150.0	0.070	U−Ditch	0.600	0.400	1		0.978	0.235	0.070
A2−2−2 (→A2−S2)	0.056	0.000	0.089	0.107					1.00	1.143	0.015	10.946	150.0	0.045	Pipe			1	30	1.143	0.081	0.045
A2−3−1 (→A2−4−1)	0.056	0.002	0.000	0.045					15.00	0.978	0.256	11.187	150.0	0.134	U−Ditch	0.600	0.400	1		0.978	0.235	0.134
A2−3−2 (→A2−S3)	0.013	0.002	0.000	0.011					1.00	1.143	0.015	11.202	150.0	0.005	Pipe			1	30	1.143	0.081	0.005
A2−4−1 (→A2−5−1)	0.076	0.003	0.000	0.062					15.91	0.978	0.271	11.458	150.0	0.164	U−Ditch	0.600	0.400	1		0.978	0.235	0.164
A2−4−2 (→A2−S4)	0.750	0.000	0.000	0.600					1.00	1.607	0.010	10.312	150.0	0.250	Pipe			1	50	1.607	0.315	0.250
A2−5−1 (→A2−6−1)	0.062	0.002	0.000	0.050					15.91	1.135	0.234	11.692	150.0	0.435	U−Ditch	0.600	0.700	1		1.135	0.477	0.435
A2−5−2 (→A2−S5)	0.046	0.000	0.000	0.037					1.00	0.723	0.023	10.325	150.0	0.015	Pipe			1	30	0.723	0.051	0.015
A2−6−1 (→A2−7−1)	0.062	0.002	0.000	0.050					28.27	1.135	0.415	10.740	150.0	0.471	U−Ditch	0.600	0.700	1		1.135	0.477	0.471
A2−7−1 (A2−8−1)	0.000	0.000	0.000	0.000					24.91	1.279	0.325	11.065	150.0	0.639	U−Ditch	0.800	0.700	1		1.279	0.716	0.639
A2−7−2 (→A2−8−1)	0.042	0.000	0.021	0.048					1.45	0.723	0.033	10.335	150.0	0.020	Pipe			1	30	0.723	0.051	0.020
A2−8−1 (→A4−1−1)	0.007	0.000	0.023	0.022					18.50	1.279	0.241	11.306	150.0	0.669	U−Ditch	0.800	0.700	1		1.279	0.716	0.669
from Building	0.000	0.000	0.023	0.016					6.10	1.089	0.093	0.093	200.0	0.009	U−Ditch	0.300	0.300	1		1.089	0.098	0.009
A3−1−1 (→PIPE)	0.047	0.000	0.006	0.042	15.00	0.050	0.300%	10.904	55.55	0.978	0.947	11.851	150.0	0.017	U−Ditch	0.600	0.400	1		0.978	0.235	0.017
PIPE (→A3−2−2)	0.000	0.000	0.000	0.000					1.45	0.723	0.033	11.884	150.0	0.017	Pipe			1	30	0.723	0.051	0.017
A3−2−1 (→PIPE)	0.037	0.000	0.000	0.030					1.45	0.723	0.033	11.339	150.0	0.012	Pipe			1	30	0.723	0.051	0.012
A3−2−2 (→A4−1−1)	0.062	0.002	0.000	0.050					30.50	0.978	0.520	11.859	150.0	0.051	U−Ditch	0.600	0.400	1		0.978	0.235	0.051
A4−1−1 (→A4−1−1)	0.098	0.000	0.000	0.078					36.05	1.324	0.454	12.313	150.0	0.752	U−Ditch	0.800	0.800	1		1.324	0.847	0.752
A4−2−1 (→A4−3−3)	0.039	0.000	0.000	0.031					21.25	1.324	0.267	12.580	150.0	0.765	U−Ditch	0.800	0.800	1		1.324	0.847	0.765
A4−3−1 (→PIPE)	0.026	0.086	0.075	0.099	30.00	0.050	0.300%	15.072	64.76	0.689	1.566	16.638	150.0	0.041	U−Ditch	0.300	0.300	1		0.689	0.062	0.041
PIPE (→A4−3−2)	0.000	0.000	0.000	0.000					6.30	0.723	0.145	16.783	150.0	0.041	Pipe			1	30	0.723	0.051	0.041
A4−3−2 (→PIPE)	0.000	0.063	0.071	0.069	50.00	0.050	0.300%	19.133	18.01	0.689	0.436	19.569	150.0	0.029	U−Ditch	0.300	0.300	1		0.689	0.062	0.029
PIPE (→A4−3−3)	0.000	0.000	0.000	0.000					2.00	0.876	0.038	19.607	150.0	0.070	Pipe			1	40	0.876	0.110	0.070
A4−3−3 (→A5−1−1)	0.070	0.000	0.400	0.336					39.30	1.363	0.481	20.088	150.0	0.975	U−Ditch	0.800	0.900	1		1.363	0.981	0.975
from Building	0.000	0.000	0.400	0.280					17.69	1.377	0.214	10.000	150.0	0.117	U−Ditch	0.300	0.300	1		1.377	0.124	0.117

Source：Study Team

2) Catchment Area B

Catchment Area B is shown in Figure 4.3-125, and Discharge Volume calculation is shown in Table 4.3-85.



Source : Study Team

Figure 4.3-125 Catchment Area B

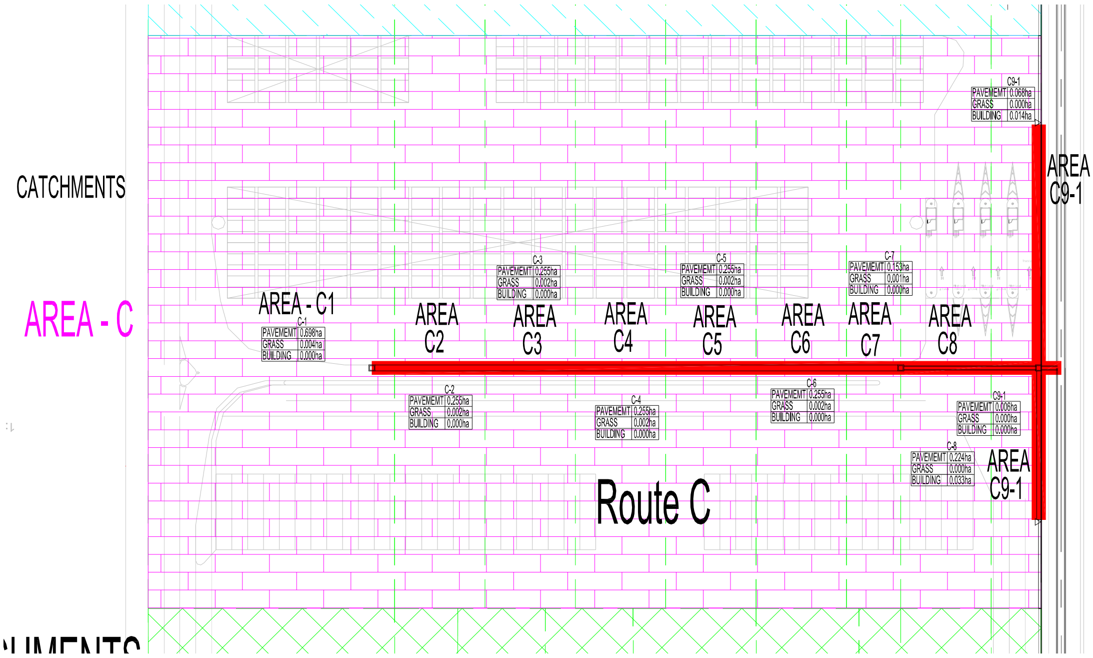
Table 4.3-85 Discharge Volume Calculation

Catchment Area Number	Catchment Are			ΣC·A	Distance from farthest area to inlet	coneffiecient of surface friction	slope of drainage surface	Distance from remote points	TiME			Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Discharge Volume								
	Pavment 0.8 (ha)	Grass 0.3 (ha)	Bulding 0.7 (ha)		l	n	s	t1(min)	Length (m)	Velocity (m/s)	Time of flow t2(min)				Type of Drainage: Type	Width	Depth	Number of pipe	Pipe Diameter (cm)	Slope i ‰	Coefficient of roughness n	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)
B-1	0.511	0.000		0.409	65.00	0.050	0.685%	14.708	5.00	0.978	0.085	14.708	150.0	0.170	U-Ditch	0.600	0.400	1		2.000	0.015	0.978	0.235
B-2 (→B-3)	0.131	0.000		0.105					14.00	0.978	0.239	14.947	150.0	0.214	U-Ditch	0.600	0.400	1		2.000	0.015	0.978	0.235
B-3 (→B-4)	0.155	0.000		0.124					19.38	1.043	0.310	15.257	150.0	0.266	U-Ditch	0.600	0.500	1		2.000	0.015	1.043	0.313
B-4 (→B-5)	0.151	0.000		0.121					19.38	1.093	0.296	15.553	150.0	0.316	U-Ditch	0.600	0.600	1		2.000	0.015	1.093	0.393
B-5 (→B-6)	0.209	0.000		0.167					27.25	1.093	0.416	15.969	150.0	0.386	U-Ditch	0.600	0.600	1		2.000	0.015	1.093	0.393
B-6 (→B-7)	0.130	0.000	0.045	0.136					22.75	1.135	0.334	16.303	150.0	0.442	U-Ditch	0.600	0.700	1		2.000	0.015	1.135	0.477
B-7 (→B-8)	0.050	0.000	0.016	0.051					9.25	1.135	0.136	16.439	150.0	0.463	U-Ditch	0.600	0.700	1		2.000	0.015	1.135	0.477
B-8 (→B-9)	0.145	0.000		0.116					18.47	1.176	0.262	16.701	150.0	0.512	Pipe			1	80	2.000	0.013	1.176	0.592
B9-2 (→B-9)	0.076	0.000		0.061	10.00	0.050	0.500%	7.108	23.66	0.978	0.403	7.511	200.0	0.034	U-Ditch	0.600	0.400	1		2.000	0.015	0.978	0.235
B9-1 (→B-9)	0.145	0.000		0.116	10.00	0.050	0.500%	7.108	44.62	0.978	0.760	7.868	200.0	0.064	U-Ditch	0.600	0.400	1		2.000	0.015	0.978	0.235
(→MB)				0.000	10.00	0.050	0.500%	7.108	4.90	1.176	0.069	16.770	150.0	0.585	Pipe			1	80	2.000	0.013	1.176	0.592

Source：Study Team

3) Catchment Area C

Catchment Area C is shown in Figure 4.3-126, and Discharge Volume calculation is shown in Table 4.3-86.



Source : Study Team

Figure 4.3-126 Catchment Area C

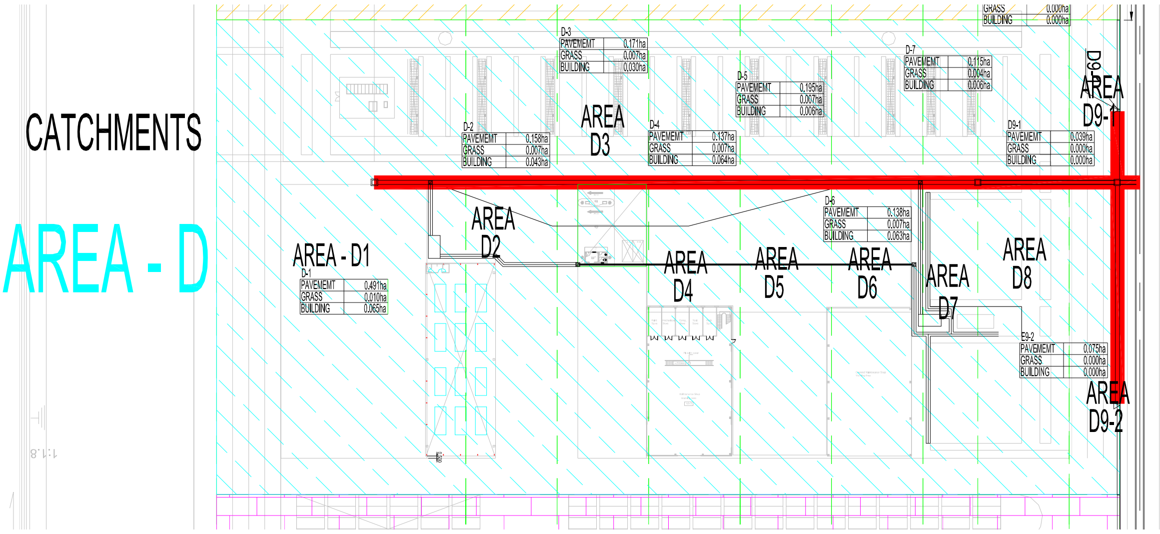
Table 4.3-86 Discharge Volume Calculation

Catchment Area Number	Catchment Are: Pavment 0.8 (ha)	Catchment Are: Grass 0.3 (ha)	Catchment Are: Bulding 0.7 (ha)	ΣC・A	Distance from farthest area to inlet l	conefficient of surface friction n	slope of drainage surface s	Distance om remot points t1(min)	TiME: Length (m)	TiME: Velocity (m/s)	TiME: Time of flow t2(min)	Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Discharge Volume: Type of Drainage: Type	Width	Depth	Number of pipe	Pipe Diameter (cm)	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)	Discharge Volume (m3/s)
C−1	0.698	0.004		0.560	82.48	0.050	0.685%	16.438	5.00	1.315	0.063	16.501	150.0	0.233	U−Ditch	0.800	0.400	1		1.315	0.421	0.233
C−2 (→C−3)	0.255	0.002		0.205					20.00	1.315	0.253	16.754	150.0	0.318	U−Ditch	0.800	0.400	1		1.315	0.421	0.318
C−3 (→C−4)	0.255	0.002		0.205					20.00	1.418	0.235	16.989	150.0	0.404	U−Ditch	0.800	0.500	1		1.418	0.567	0.404
C−4 (→C−5)	0.255	0.002		0.205					20.00	1.503	0.222	17.211	150.0	0.489	U−Ditch	0.800	0.600	1		1.503	0.721	0.489
C−5 (→C−6)	0.255	0.002		0.205					20.00	1.503	0.222	17.433	150.0	0.574	U−Ditch	0.800	0.600	1		1.503	0.721	0.574
C−6 (→C−7)	0.255	0.002		0.205					20.00	1.503	0.222	17.655	150.0	0.659	U−Ditch	0.800	0.600	1		1.503	0.721	0.659
C−7 (→C−8)	0.153	0.001		0.123					12.00	1.503	0.133	17.788	150.0	0.711	U−Ditch	0.800	0.600	1		1.503	0.721	0.711
C−8 (→C−9)	0.224	0.000	0.033	0.202					30.55	1.664	0.306	18.094	150.0	0.795	Pipe			1	80	1.664	0.837	0.795
C9−1 (→C−9)	0.068	0.000	0.014	0.064	10.00	0.050	0.500%	7.108	74.45	0.978	1.269	8.377	150.0	0.027	U−Ditch	0.600	0.400	1		0.978	0.235	0.027
C9−2 (→C−9)	0.006	0.000		0.005	10.00	0.050	0.500%	7.108	54.28	0.978	0.925	8.033	150.0	0.002	U−Ditch	0.600	0.400	1		0.978	0.235	0.002
(→M−C)				0.000					4.90	1.664	0.049	18.143	150.0	0.824	Pipe			1	80	1.664	0.837	0.824

Source：Study Team

4) Catchment Area D

Catchment Area D is shown in Figure 4.3-127, and Discharge Volume calculation is shown in Table 4.3-87.



Source : Study Team

Figure 4.3-127　Catchment Area D

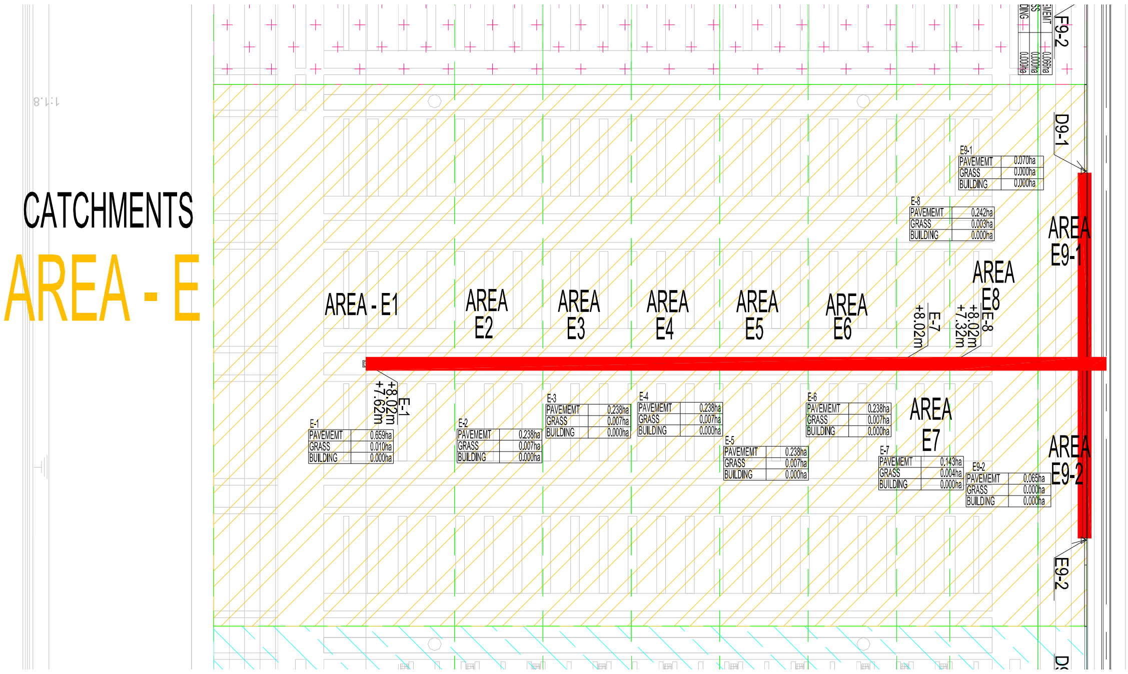
Table 4.3-87　Discharge Volume Calculation

Catchment Area Number	Catchment Are			ΣC·A	Distance from farthest area to inlet	conefficient of surface friction	slope of drainage surface	Distance om remot points	TiME			Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Discharge Volume						
	Pavment 0.8 (ha)	Grass 0.3 (ha)	Bulding 0.7 (ha)		l	n	s	t1(min)	Length (m)	Velocity (m/s)	Time of flow t2(min)				Type of Drainage: Type	Width	Depth	Number of pipe	Pipe Diameter (cm)	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)
D-1	0.491	0.010	0.065	0.441	76.65	0.050	0.646%	16.326	20.00	1.198	0.278	16.604	150.0	0.184	U-Ditch	0.600	0.400	1		1.198	0.288
D-2 (→D-3)	0.158	0.007	0.043	0.159					20.00	1.278	0.261	16.865	150.0	0.250	U-Ditch	0.600	0.500	1		1.278	0.383
D-3 (→D-4)	0.171	0.007	0.030	0.160					20.00	1.339	0.249	17.114	150.0	0.317	U-Ditch	0.600	0.600	1		1.339	0.482
D-4 (→D-5)	0.137	0.007	0.064	0.157					20.00	1.339	0.249	17.363	150.0	0.382	U-Ditch	0.600	0.600	1		1.339	0.482
D-5 (→D-6)	0.195	0.007	0.006	0.162					20.00	1.391	0.240	17.603	150.0	0.449	U-Ditch	0.600	0.700	1		1.391	0.584
D-6 (→D-7)	0.138	0.007	0.006	0.117					20.00	1.430	0.233	17.836	150.0	0.498	U-Ditch	0.600	0.800	1		1.430	0.686
D-7 (→D-8)	0.115	0.004	0.006	0.097					12.00	1.430	0.140	17.976	150.0	0.539	U-Ditch	0.600	0.800	1		1.430	0.686
D-8 (→D-9)	0.208	0.000	0.000	0.166					30.55	1.664	0.306	18.282	150.0	0.608	Pipe			1	80	1.664	0.837
D9-1 (→D-9)	0.039	0.000	0.014	0.041	10.00	0.050	0.500%	7.108	35.55	0.978	0.606	7.714	200.0	0.023	U-Ditch	0.600	0.400	1		0.978	0.235
D9-2 (→D-9)	0.075	0.000		0.060	10.00	0.050	0.500%	7.108	68.45	0.978	1.166	8.274	200.0	0.033	U-Ditch	0.600	0.400	1		0.978	0.235
M-D				0.000					4.90	1.664	0.049	18.331	150.0	0.650	Pipe			1	80	1.664	0.837

Source：Study Team

5)　Catchment Area E

Catchment Area E is shown in Figure 4.3-128, and Discharge Volume calculation is shown in Table 4.3-88.



Source : Study Team

Figure 4.3-128 Catchment Area E

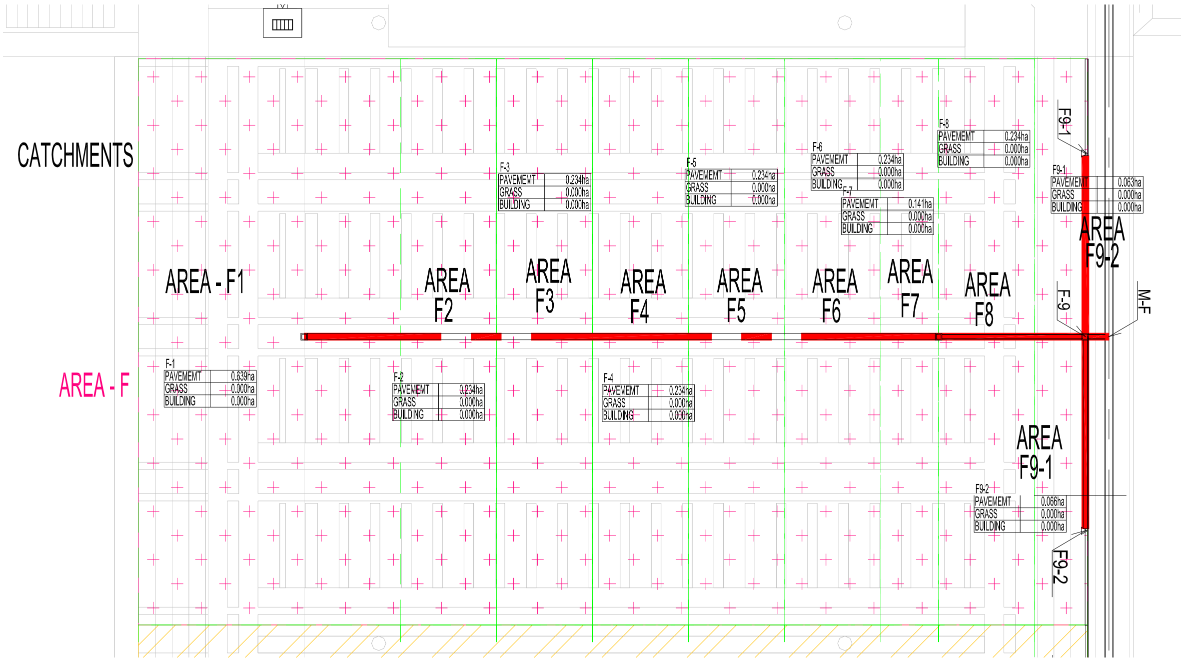
Table 4.3-88 Discharge Volume calculation

Catchment Area Number	Catchment Are: Pavment 0.8 (ha)	Grass 0.3 (ha)	Bulding 0.7 (ha)	ΣC・A	Distance from farthest area to inlet l	conefficient of surface friction n	slope of drainage surface s	Distance from remot points t1(min)	TiME: Length (m)	Velocity (m/s)	Time of flow t2(min)	Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Discharge Volume: Type of Drainage: Type	Width	Depth	Number of pipe	Pipe Diameter (cm)	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)
E-1	0.666	0.003		0.534	72.05	0.050	0.680%	15.485	20.00	1.315	0.253	15.738	150.0	0.222	U-Ditch	0.800	0.400	1		1.315	0.421
E-2 (→E-3)	0.238	0.007		0.193					20.00	1.315	0.253	15.991	150.0	0.303	U-Ditch	0.800	0.400	1		1.315	0.421
E-3 (→E-4)	0.238	0.007		0.193					20.00	1.315	0.253	16.244	150.0	0.383	U-Ditch	0.800	0.400	1		1.315	0.421
E-4 (→E-5)	0.238	0.007		0.193					20.00	1.418	0.235	16.479	150.0	0.463	U-Ditch	0.800	0.500	1		1.418	0.567
E-5 (→E-6)	0.238	0.007		0.193					20.00	1.418	0.235	16.714	150.0	0.543	U-Ditch	0.800	0.500	1		1.418	0.567
E-6 (→E-7)	0.238	0.007		0.193					20.00	1.503	0.222	16.936	150.0	0.623	U-Ditch	0.800	0.600	1		1.503	0.721
E-7 (→E-8)	0.143	0.004		0.116					12.00	1.567	0.128	17.064	150.0	0.672	U-Ditch	0.800	0.700	1		1.567	0.878
E-9 (→E-10)	0.241	0.003		0.194					30.55	1.664	0.306	17.370	150.0	0.752	Pipe			1	80	1.664	0.837
E-1 (→D-9)	0.070	0.000	0.014	0.066	10.00	0.050	0.500%	7.108	30.55	0.978	0.521	7.629	200.0	0.037	U-Ditch	0.600	0.400	1		0.978	0.235
E9-2 (→E-9)	0.065	0.000		0.052	10.00	0.050	0.500%	7.108	68.45	0.978	1.166	8.274	200.0	0.029	U-Ditch	0.600	0.400	1		0.978	0.235
E-10 (→M-E)				0.000					4.90	1.664	0.049	17.419	150.0	0.801	Pipe			1	80	1.664	0.837

Source：Study Team

6) Catchment Area F

Catchment Area F is shown in Figure 4.3-129, and Discharge Volume calculation is shown in Table 4.3-89.



Source : Study Team

Figure 4.3-129 Catchment Area F

Table 4.3-89 Discharge Volume calculation

Catchment Area Number	Catchment Are: Pavment 0.8 (ha)	Catchment Are: Grass 0.3 (ha)	Catchment Are: Bulding 0.7 (ha)	Σ C・A	Distance from farthest area to inlet l	conefficient of surface friction n	slope of drainage surface s	Distance om remot points t1(min)	TiME: Length (m)	TiME: Velocity (m/s)	TiME: Time of flow t2(min)	Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Type of Drainage: Type	Type of Drainage: Width	Type of Drainage: Depth	Type of Drainage: Number of pipe	Type of Drainage: Pipe Diameter (cm)	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)
F-1	0.639			0.511	69.00	0.050	0.710%	14.873	20.00	1.315	0.253	15.126	150.0	0.213	U-Ditch	0.800	0.400	1		1.315	0.421
F-2 (→F-3)	0.234			0.187					20.00	1.315	0.253	15.379	150.0	0.291	U-Ditch	0.800	0.400	1		1.315	0.421
F-3 (→F-4)	0.234			0.187					20.00	1.418	0.235	15.614	150.0	0.369	U-Ditch	0.800	0.500	1		1.418	0.567
F-4 (→F-5)	0.234			0.187					20.00	1.418	0.235	15.849	150.0	0.447	U-Ditch	0.800	0.500	1		1.418	0.567
F-5 (→F-6)	0.234			0.187					20.00	1.503	0.222	16.071	150.0	0.525	U-Ditch	0.800	0.600	1		1.503	0.721
F-6 (→F-7)	0.234			0.187					20.00	1.567	0.213	16.284	150.0	0.603	U-Ditch	0.800	0.700	1		1.567	0.878
F-7 (→F-8)	0.141			0.113					12.00	1.567	0.128	16.412	150.0	0.650	U-Ditch	0.800	0.700	1		1.567	0.878
F-9 (→F-10)	0.234			0.187					30.55	1.664	0.306	16.718	150.0	0.728	Pipe			1	80	1.664	0.837
E-1 (→D-9)	0.063	0.000		0.050	10.00	0.050	0.500%	7.108	35.55	0.978	0.606	7.714	200.0	0.028	U-Ditch	0.600	0.400	1		0.978	0.235
E9-2 (→E-9)	0.066	0.000		0.053	10.00	0.050	0.500%	7.108	68.45	0.978	1.166	8.274	200.0	0.029	U-Ditch	0.600	0.400	1		0.978	0.235
→M-F				0.000					4.90	1.664	0.049	16.767	150.0	0.771	Pipe			1	80	1.664	0.837

Source：Study Team

7) Discharge Volume calculation of Main Route

Discharge Volume calculation of Main Route is shown in Table 4.3-90.

Table 4.3-90 Discharge Volume calculation of Main Route

Catchment Area Number	Catchment Are Pavment 0.8 (ha)	Catchment Are Grass 0.3 (ha)	Catchment Are Bulding 0.7 (ha)	Σ C・A	Distance from farthest area to inlet l	coneffici ent of surface friction n	slope of drainage surface s	Distance om remot points t1(min)	TiME Length (m)	TiME Velocity (m/s)	TiME Time of flow t2(min)	Time to reach (min)	Rainfall Intensity (mm/hr)	Discharge Volume (m3/s)	Discharge Volume Type of Drainage Type	Type of Drainage Width	Type of Drainage Depth	Type of Drainage Number of pipe	Type of Drainage Pipe Diameter (cm)	Velocity V (m/s)	Allowable Discharge Volume Q(m3/s)
M-A				0.000					163.00	1.352	2.009	22.097	100.0	0.701	U-Ditch	1.500	0.900	1		1.352	1.551
M-B				0.000					124.00	1.352	1.529	23.626	100.0	1.092	U-Ditch	1.500	0.900	1		1.352	1.551
M-C				0.000					125.75	1.397	1.500	25.126	100.0	1.641	U-Ditch	1.500	1.000	1		1.397	1.781
M-D				0.000					114.00	1.476	1.287	26.413	100.0	2.074	U-Ditch	1.500	1.200	1		1.476	2.258
M-E				0.000					85.75	1.565	0.913	27.326	100.0	2.608	U-Ditch	1.500	1.500	1		1.565	2.993
M-F				0.000					26.00	1.614	0.268	27.594	100.0	3.122	U-Ditch	1.500	1.700	1		1.614	3.498

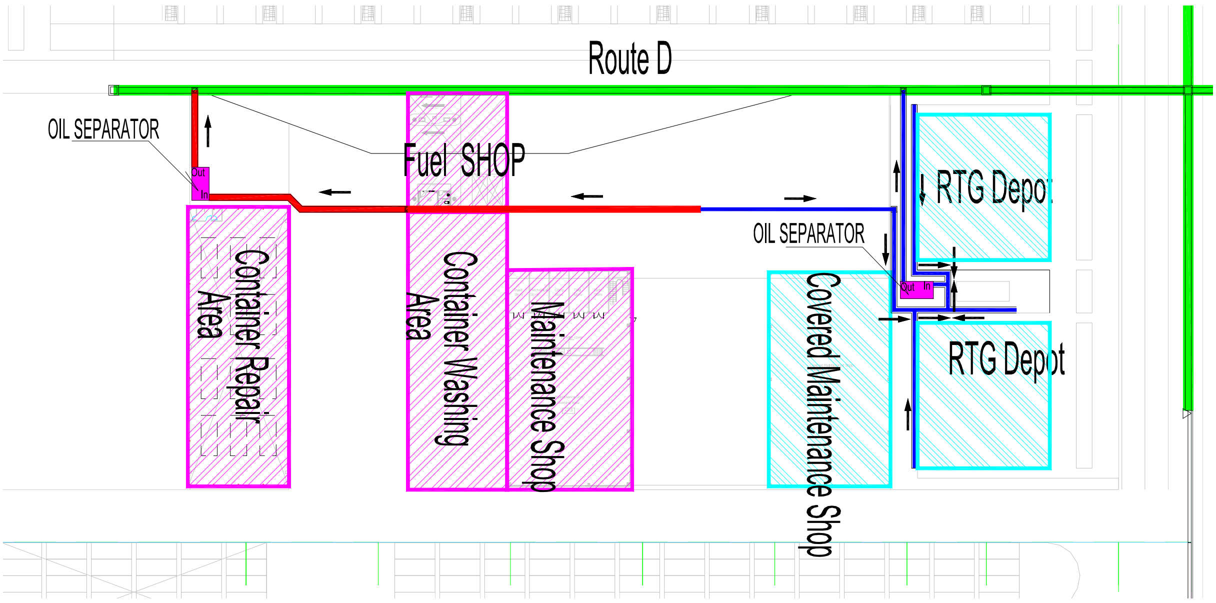
Source：Study Team

(4) Oil/water Separator

Oil/ Water Separator Area is directed to a facility below.

- Container Washing Are
- Container Repair Area
- Fuel Shop
- RTG Depot
- Maintenance Shop Area

Oil/ Water Separator Area and Route are shown in Figure 4.3-130



Source : Study Team

Figure 4.3-130 Oil/ Water Separator Area and Route

4.4. Execution Plan

Construction plan is assumed as mentioned in this chapter. This plan is a reasonable and realistic but the actual construction will be carried out by the method of the contractor's proposal with approval by supervision consultant.

4.4.1. Temporary Yard

Temporary yard is planned at Plot No.24 of beside of the Project site. Main temporary facilities are as below.

- Temporary site office (contractor, consultant and owner) and laboratory for concrete
- Storing and fabricating for reinforcement, fabricating of formwork, store for materials
- Fabrication of Precast concrete slabs and curb, etc.
- Concrete Batcher Plant (option by contractor)
- Temporary Jetty (less than 50m length) for loading and unloading for steel pipe pile, stone materials, etc.
- Yard for extension of Steel Pipe Pile

There is a plan to pull from existing electricity and water supply to the site but it is not confirmed. Standby generators and wells/water tank lorry are planned in this study.

4.4.2. Civil Work

(1) Procurement Country for Main Materials

Procurement of main materials is assumed as shown in the table below.

Table 4.4-1 List of Materials Procurement

Item	Description	Procurement Country
Steel materials	Steel Pipe Pile, Sheet Pile, Jacket Structure, Steel-bar, H-beam, etc.	Thailand, Singapore, Indonesia, Japan
Cement	Concrete, building works	Thailand
Fine sand for concrete	Sand	Yangon
Aggregate for concrete	Crushed stone	Mon state
Stone for slope protection	Rubble stone for Gabion & Armor stone	Mon state
PVD for Soil Improvement	Plastic drain	Thailand
Sand for filling and Soil Improvement	Sand for sand mat and filling for surcharge	Yangon
Accessory materials	Fender, Bollard, Crane rail, etc.	Thailand, Singapore
Gabion		Japan

Source：Study Team

(2) Procurement Country for Main Equipment

Procurement of Main Construction Equipment are assumed as following

Table 4.4-2 List of Equipment

Equipment	**note**	**Procurement Country**
General Machinery	Bulldozer, Backhoe, Dump track etc.	Yangon
Machinery for Pavement	Grader, Compaction machines, etc.	Yangon
Piling barge Leader 60m	With 15ton class Hydraulic Hammer	Singapore
Vibro-hammer	80E class	Singapore
Soil improvement machinery	Prefabricated Vertical drain Method	Thailand, Vietnam
Self-elevating barge	1000ton class	Singapore
Crane Barge	Crane 300ton class	Singapore
Grab dredger	10cu.m<	Singapore
Tug boat, Barge, Transportation boat	Tug 600PS<, Barge300 to 3000ton Hopper barge 1000cu.m	Singapore
Land piling machine	Diesel hammer 4ton class	Yangon
Anchor Boat	Lifting capacity15ton class	Singapore
Backhoe Barge	Backhoe 2cu.m class	Singapore

Source：Study Team

(3) Quantity of Main Construction

Table 4.4-3 Quantity of Marine Works

description	detail
Jetty W=40m, L=400m	Dredging : 155.000m3, gabion of slope protection : 24,000m2 Pipe pile dia1300mm, L=46.5m : 120nos. (3,729ton) Jacket Structure : 4,420ton (L20m x 20 Span) Precast Concrete slab 800nos. (concrete5,890m3, steel bar1374ton) In-situ concrete : 3,901m3 Accessory : fender 40nos, Bollard 20nos, Becon 2nos. Crane rail 791m, Cathodic protection1320nos.
Trestle L=60m 3-places	Steel Pipe pile : Dia600mm : 125No Top concrete : 2,400m3, steel bar 450ton Gabion of Slope protection : 5,003m2 Accessory : hand rail, curb, corner protection etc.

Source：Study Team

Table 4.4-4 Quantity of Land Civil Works

description	detail
Land Filling	340,000m3
Soil Improvement of PVD Method 213,000 m2	Driving of PVD : 3,990,000m Filling for Surcharge : 1,040,000m3 Removal of Surcharge Sand : 675,000m3
Revetment L=400m	Sheet Pile L=13.5m : 697sheets, type III-w Steel Pipe Pile dia600mm :44Nos. Coping Concrete : 545m3 Gabion of Slope Protection :5,003m2
Pavement Works	Interlocking Block Pavement :77,732m2 Concrete Pavement :33,000m2 Concrete Pavement for RTG Rane :10,161m2, Drainage :2,558m

Source：Study Team

(4) Jetty Construction

Dredging work will be started before piling work. Steel pipe pile will be driven by piling barge with 15ton class hydraulic hammer and vibro hammer. PC slabs is manufactured at the temporary yard and is installed crane barge from river site. Jacket will be fabricated at a steel factory which has jetty for loading of it. It will be transport from the factory to the Project site for installation. One span of it is 20m and there is 20 spans in total.

Construction flow of Jetty is shown as below.

1. Preparation	Start of manufacturing of Jacket, Transportation of Pipe Pile and Extension of the Pile on land
2. Dredging	Grab dredger, Hopper barge, Anchor boat, Tug boat, Backhoe Barge
3. Driving of pipe pile	Piling barge with hydraulic hammer and vibro Hammer, Barge, Anchor boat, Tug boat, Crane barge
4. Slope protection under Jetty	Backhoe barge, Crane barge, Barge, Anchor boat, Tug boat
5. Installation of Jacket	Self-elevating Barge, Crane barge, Anchor boat, Tug boat
6. Welding, Grouting, Cathodic protection	Crane Barge, Grouting machine, Welding Machine, Anchor boat, Tug boat
7. Installation PC slab, In-situ concrete	Crane barge, Barge, Anchor boat, Tug boat
8. Concrete work of superstructure of Jetty, Accessory works	Concrete pump truck, Crane truck

Extension of pipe pile will be welded at temporary yard before carrying to the piling site. In-situ concrete works of upper structure will be casted by concrete pump truck. Gabion works under the Jetty for slope protection will be installed by marine equipment from river site. Jetty Construction will be started and completed from north side.

(5) Trestle construction

50% of steel pipe pile will be driven by piling barge from river side. Another 50% will be by three point crawler piling machine from land side. The pile of marine driving will be welded for extension at the temporary yard before carrying to the piling site. Marine piling work is necessary to wait by high tide water level. Extension of the pile for land piling is planned at the piling site.

North Trestle “T-1” is planned to complete for handing over to owner by the end of 17th month from the construction commencement. Placing concrete for super-structure is planned to use concrete pump truck. Formwork for super-structure is planned bracket type and supporting system.

(6) Revetment construction

After soil improvement work will be completed 100m area, sheet piling of revetment will be started. The sheet pile is type III-wide. The sheet pile will be transported from Japan. The pile will be driven by 3 point crawler piling machine. Slope protection as of installation of filling sand, stone and armor block can be started after sheet piling completion. Placing concrete will be cast by concrete hopper. All of revetment works are planned as land work. Construction will be started from North side.

(7) Soil Improvement Construction

PVD driving machine will be needed at least4 sets. Sand filling will be installed for sand mat. The sand will be dredged from Yangon river by local pumping boat. Soil improvement will be completed at the location of both 200m length from revetment line and main building in advance. Term of surcharge is scheduled for six (6) months. Surcharge sand will be removed to temporary yard or Plot No.26 by dump trucks after completion of surcharge.

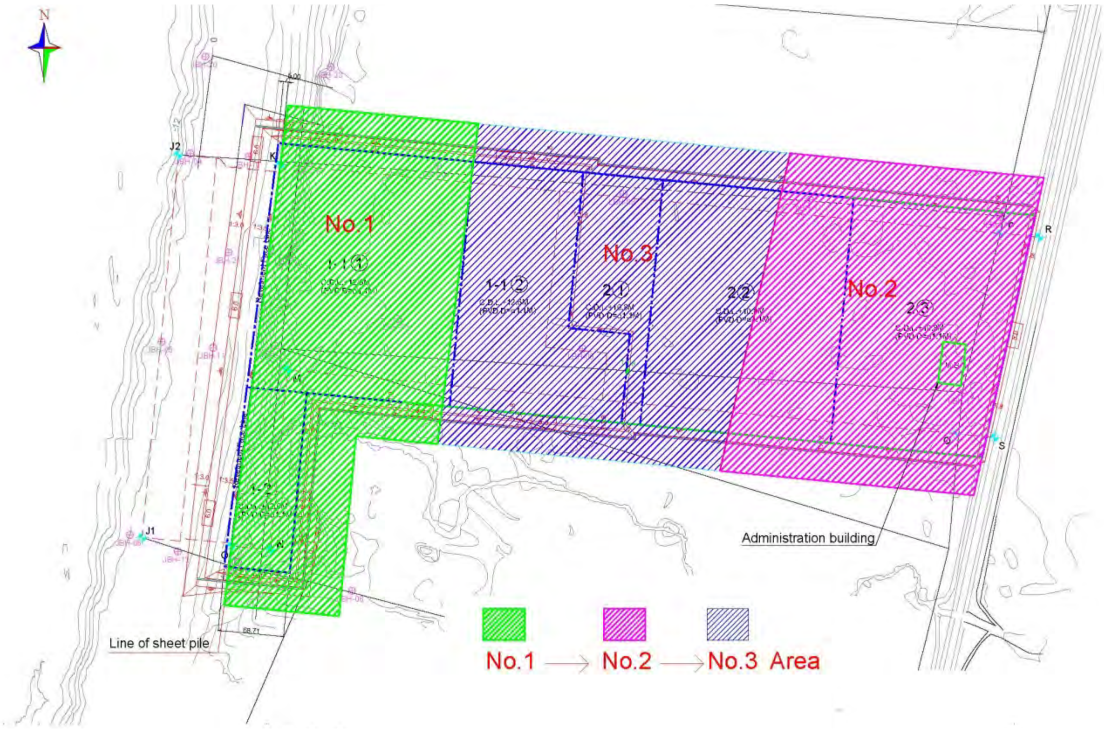


Figure 4.4-1 Construction Order of Soil Improvement

Source : Study Team

Construction flow is shown as below.

1. Site clearance and removal of obstruction	Bulldozer, Backhoe, Dump truck
2. Land filling & sand mat 340,720m3	Sand dredger (100m3/ship x 10ships), Backhoe, Bulldozer
3. Driving PVD 3,996,998m	Soil improvement machine 4nos, Backhoe
4. Sand filling for surcharge 1,042,846m3	Sand dredger (100m3/ship x 10ships), Backhoe, Bulldozer
6 Month	
5. During surcharge of loading, monitoring and quality control	a) Settlement Plate b) Magnet extensometer c) Inclinometer d) Stand pipe for water level e) Piezometer for water pressure f) well for pumping water
6. Removal of surcharge sand 675,156m3	Backhoe 2nos, Dump Truck 10nos.
7. Starting of land works	

(8) Pavement work

Pavement work has construction work of interlocking concrete block, concrete pavement, drainage and curb. Construction method is as below.

- Crushed stone for base course and sub-base course is installed in direct to the Project site from quarry (Mon state) by 3000ton class barge
- Interlocking block and curb is manufactured in a factory or temporary yard

- Concrete drainage and pit is cast in place
- Stockpile of crushed stone is in temporary yard for pavement work

List of machines are as below

- Bulldozer 5ton to 15ton, Grader L=3m, Macadam roller 10ton, Tire roller 10ton,
- Rammer50kg, Plate compactor 40kg, Dump truck 10ton,
- Concrete Spreader and Cutter for concrete pavement

(9) Construction Schedule

At the Feasibility Study, construction schedule was planed that Phase I-1 in this Project of Jetty 200m from north point and Trestle T1 will be completed within 17 months from the construction commencement, will be handover to the owner and will use for temporary loading and unloading services. Phase I-2 except the work of Phase I-1 will be completed within 30 months from the construction commencement.

By the additional study of the construction period in detail, it is confirmed that the construction period of both 17 months for Phase I-1 and 30 months for Phase I-1and I-2 is very tight and shortest.

Work Completed Quantity per month is as below. Working day per month is assumed for 25days.

Table 4.4-5 Work Quantity for a Month

Description	Quantity Per Month	Description	Quantity Per Month
Dredging	75,000m3	Sand Filling	130,000m3
Driving P-Pile Ø1300	36 nos.	Filling Surcharge Sand	150,000m3
Fabrication Jacket	1.7 sets	Driving PVC drain	700,000m
Installation Jacket	2 sets	Removal Sand	100,000m3
Installation PC-slab	55 nos.	IBC Pavement	10,000m2
Concrete of Jetty	500m3	Concrete pavement	6,000m2
Driving P-Pile Ø600	40 nos.	Drainage	600m
Concrete of Trestle	200m3	RTG-Con Pavement	3,000m

Source：Study Team

4.4.3. Cargo Handling Equipment

Implementation plan including Normal terms of each procedure is as below for cargo handling equipment. Gantry Crane, RTG, Reach Stacker, Forklift, Truck and Chassis are one procurement package. Overall cargo handling equipment will be imported from abroad.

- Term of PQ : Three (3) Month

- Term of Tender : Five (5) Month
- Term of Supply and Assembly for Gantry Crane : 16 months (including design)
- Term of Supply and Assembly for RTG : 13 months (including design)
- Term of Supply and Assembly for Reach Stacker : 13 months (including design)
- Term of Transportation are 1.5 to 2.0 months (different belong country)
- Installation and Inspection of Delivery are 1.5 months

It is need for 27 months from the starting of PQ to operation

4.4.4. Construction Planning for Buildings and Miscellaneous Facilities

(1) Temporary work

Materials for temporary work except scaffold will be local procurement. Materials of scaffold will be purchased from neighboring countries.

(2) Piling work

PHC pile will be procured from neighboring countries. Steel pipe pile will be procured from Japan. Constructional machinery will be local procurement.

To proceed while checking the vertical when placing concrete.

(3) Earth work

Constructional machinery will be local procurement.

Secure operating space by over break, at the same time, check level of excavation bottom. The angle of the slope is needed to plan properly by considering the soil.

Use specified soil and sand for backfill. Repeat the rolling compaction at the predetermined height of the backfill. Prevent plain subsidence at the end of work.

(4) Concrete work

Concrete and concrete pump car will be local procurement.

The tip of the pipe is needed to give attention not go over the specified height by using concrete pump and prevent honeycombing when pouring concrete. Also pay attention when pouring concrete to the narrow space like wall, use vibrator to pour concrete through each section. However the excessive use of vibrator could cause segregation of concrete.

(5) Form work

Materials will be local procurement.

When installation of formwork, placing separator properly, tightening form tie closely to prevent to occur swelling. When using a donut to the spacer for securing protective concrete covering depth, pay attention to the position and direction of installation and pouring concrete properly.

(6) Steel Reinforcement work

Materials will be purchased from neighboring countries.

Determining storage location of materials with due consideration of humidity and dirt. When bring materials into the job site, check each mill sheets. Upon construction, install splice of main reinforcement bars to specified place. Corresponding by increasing number of stages, if the interval of the main reinforcement bar is narrow. Make coarse aggregate of concrete can pass through it. Prevent not to drop rebar of lower stage when placing more than two stages vertical main reinforcement bars.

(7) Structural Steel work

Materials will be purchased from neighboring countries. Constructional machinery will be local procurement.

As checking accuracy of factory weld, run ultrasonic testing. Equipment and engineer of ultrasonic testing will be arranged from neighboring countries. Complying with the provisions of the specifications for enforcement rate of the test. If you do the construction of internal diaphragm by the size difference of posts, check accuracy of welding of internal diaphragm before welding external diaphragm as necessary.

When placing HTB, do additional tightening by using equipment like torque wrench after temporary tightening in order to make sure of appropriate torque. If there is a need to have sleeves of duct for ventilation fan, it has to be reinforced at factory in advance because welding to the structure at the job site is unacceptable.

(8) Masonry work

Materials will be local procurement.

Height of a masonry construction for one day will be within prescribed height of the specification.

(9) Waterproofing work

Materials will be purchased from neighboring countries.

When constructing of membrane waterproofing, make sure that under bed is dry to prevent swollen sheet. Cure the place to avoid dust and dirt for 24 hours immediate after caulking.

(10) Tile work

Materials will be purchased from neighboring countries.

(11) Carpentry work

Materials will be local procurement.

(12) Steel roofing work

Steel roof and wall materials will be shipped from Japan.

In order to minimize of damage of products during transportation, carry in roll products to the job site. Use mold products which made by molding machine.

Crane will be local procurement. Pay careful attention to humidity of storage of product. Plan the storage to have no risk to occur corrosion to product. Also to plan storage condition without risk to occur distortion of tight frame by damaging accessories like spacer.

(13) Metal work

Metal will be local procurement except Stainless steel curtain wall. Stainless steel will be purchased from neighboring countries. Curtain wall will be shipped from Japan.

(14) Plaster work

Materials will be local procurement.

Confirmation of mix proportion of cement, sand and water, also humidity regulation of plaster base are required.

Process is different depending on thickness of coating, thickness of one coating will be limited to 7mm.　It is necessary to move to the next process, after cracking is confirmed.

(15) Doors and Windows

Electric shutters will be purchased from neighboring countries. Materials except electric shutters will be local procurement.

All windows and doors need to be considered how to place them according to shop drawings. Installation method, and the clearance between windows/doors and frame are needed to adjust. Check that distortion didn't occur to panel or frame during transportation. Check the damage on the glazing if glazing is done at factory.

(16) Glazing work

All glazing except wired glass and Low-E glass will be local procurement. Wired glass and Low-E glass will be purchased from neighboring countries.

(17) Painting work

Materials will be local procurement.

(18) Interior finishing work

Interior materials will be local procurement.

(19) Miscellaneous work

Materials will be local procurement.

Table 4.4-6 Construction Schedule

		Description	Qty	Unit	Qty/M	Term	
A		**Preparation**	1	sum	1	1.0	
B		**Temporary Works, Mobilization&Demo.**	1	sum	0	4.0	
C		**Environment Monitoring & HIV Prevention Program**	12	Mon			
D		**Civil Works**					
	1	**Jetty**	400	m			
		Dredging	155,000	cu.m	75,000	2.5	
		Gabion for Slope protection	12,000	sq.m	4,000	3.8	
		Piling Works	120	No	36	4.2	
		Manufacture of Jacket L=20m	20	set	2	12.0	
		Installation of Jacket	20	set	2	12.0	
		Installation of PC-Slab	360	No	30	14.0	
		Upper Structure concrete works	3,324	cu.m	300	12.0	
		Cthodic Protection	800	No	250	4.0	
		Crane rail	800	m	300	2.5	
		Accessory Works(fender,corner,etr.)	1	sum	0	4.0	
	2	**Trestle**	3	unit			
		Piling Works(from river & land site)	125	No	2	2.5	
		Upper Structure works(beam&slab)T1	2,410	cu.m	500	5.8	
		Upper Structure works(beam&slab)T2	2,836	cu.m	500	6.5	
		Upper Structure works(beam&slab)T3	1,873	cu.m	500	4.5	
	3	**Reclamation & Soil Improvement**					
		Site Clearance	160,000	sq.m	200,000	1.0	
		Reclamation of Sand Mat	310,000	cu.m	130,000	2.9	5,000/day
		Driving of PVD for soil improvement	4,000,000	m	28000/day	5.7	4team, 7,000m/day/team
		Sand Filling of Surcharge	1,100,000	cu.m	150,000	7.3	5,000/day
		Removal of Surcharged sand	800,000	cu.m	100,000	8.0	1000/day*4teams
	4	**Revetment**					
		Steel Sheet Piling	697	pic	24/day	1.4	
		Steel Pipe Piling	44	No	2no/day	1.0	
		Coping Beam	545	cu.m	82	7.9	1span=10m, 6span/day (total 40span)
		Slope Protection	4,822	sq.m	1,000	5.8	
	5	**Pavement & Drainage**					
		Interlocking pavement	150,000	sq.m	20,000	8.0	
		Concrete pavement	1	sum			
		Drainage works	1,500	m	300	5.0	
		Concrete Curb	1,000	m	500	2.0	
E	6	**Building Works**					
	1	Administration Building	3,436	sq.m			
	2	Container Freight Station	5,000	sq.m			
	3	Workshops	600	sq.m			
	4	X-ray building	200	sq.m			
	5	Gate house	1	sq.m			
	6	Marine House	836	sq.m			piling
	7	Fuel Station	400	sq.m			
	8	Power house (Sub-Station)	600	sq.m			
	9	Water Facility(tank, reservoir)	1	sq.m			
F		**Utility**					
		Fence and gate	1,600	m			
		Water Supply system	1	sum			
	1	Power generation Equipment	1	sum			
	2	Landscape(sodding, planting)	1	sum			
	3	Septic tank(waste water system)	1	sum			
	4	Truck Scale Station	1	sum			
	5	Power High pole Lighting	8	Unit			
	6	Fire Fighting	30	No			
	7	X-ray Scan Station	1	sum			
	8	Communication System	1	sum			
	9	Washing Station	1	sum			
	10	CCTV System	1	sum			
	11	The other facility					
G		Cargo Handling Equipment	1	sum			

Source：Study Team

4.4.5. Safety Control

(1) General

1) Background

Safety in any Construction Work is the most important and serious matter for all of the concerned organizations and individuals involved. To this end, a key phrase of “Safety First” is, in most of construction officers. Always used to remind that Safety has the utmost priority than any other things in any kind of work.

In spite of such wishes to complete a construction project with “No Accident”, this has not been yet completely achieved as some serious accidents in construction projects were annually reported somewhere in a country. This may reveal that it is not easy to perfectly eliminate from the construction projects any violations/negligence of the basic requirements of Laws and Regulations related to the Construction Safety and/or insufficient Safety Arrangement & Management due to an attempt to complete a project in a more economical of hurried manner.

2) Purpose of the Safety Control

In this Section, an effective safety plan for the construction works will be discussed and recommended, using “Safety Risk Analysis Method”, with due consideration of Project Component, respective Work Plans, Site conditions as well as Related Laws/ regulations in the Country for targeting to achieve a None-Accident Project.

(2) Safety Risk Analysis

1) Method of Safety Risk Analysis

Risk Analysis Method is one of the mathematical methods to find out significant safety risk in the construction project. We can find significant safety risk through this method so that effective safety control plan and counter measures can be established.

In this method, Safety Risk is obtained by “probability of occurrence” times “severity of damage if it was happened”. Probability and severity is indicated as grade 1 to grade 5 with following meanings shown in Table 4.4-7 and Table 4.4-8.

Table 4.4-7 Grade of the “Probability of occurrence”

Grade	Explanation
1	Very difficult to be happened such as unexpected serious natural disaster and violent attack from other country.
2	Difficult to be happened such as collapse of facility. This grade does not include human errors.
3	Easy to be happened when some special conditions are satisfied.
4	Easy to be happened when special condition is satisfied.
5	Easy to be happened with human error and/or necessary condition.

Source：Study Team

Table 4.4-8 Grade of the “Probability of occurrence”

Grade	Explanation
1	A people will be injured.
2	A people will be injured seriously or some people will be injured.
3	A people will be died or some people will be injured seriously.
4	Some people will be died or many people will be injured seriously.
5	Many people will be died. Third party’s person will be died or injured seriously.

The grade will be determined according to the actual work conditions shown in the next section.

Source : Study Team

2) Input Data

a) Work item

Following work items are expected for the construction works.

- Work Item-01 : Piling Work (marine work)
- Work Item-02 : Fabrication of Steel Jacket
- Work Item-03 : Installation of Steel Jacket (marine work)
- Work Item-04 : Superstructure Concrete works
- Work Item-05 : Dredging and Disposal works
- Work Item-06 : Reclamation Work
- Work Item-07 : Revetment Work (Steel Sheet Piling and Stone Works)
- Work Item-08 : Installation of PVD
- Work Item-09 : Earth Works
- Work Item-10 : Drainage Works

- Work Item-11 : Pavement Works (Concrete and ICB Pavement)
- Work Item-12 : Building Works
- Work Item-13 : Power Supply and Utility Works

b) Work Methods

Detailed work method of the construction works are described in the Section 4. Notable methods of each work item are shown in Table 4.4-9.

Table 4.4-9 Notable Work Methods

No.	Work Item	Notable Work Methods
1	Piling	Lift up of the SPP by piling barge Pile driving by Piling barge
2	Fabrication of Steel Jacket	Welding of steel parts
3	Installation of Steel Jacket	Lift up of Steel Jacket by crane barge Installation of Steel Jacket by crane barge
4	Superstructure Concrete Works	Form work and Re-bar work on the Jacket Placing concrete by concrete pump
5	Dredging and Disposal works	Dredging work by grab dredger Transportation of the disposal barge
6	Reclamation Work	Transportation of the sand by sand barge Pump up sand to the site by sand pump
7	Revetment Work	Installation of SSP by Vibro-Hammer Installation of the stone by Backhoe
8	Installation of PVD	Installation of PVD by PVD machine Cutting PVD by worker
9	Earth Works	Compaction of sand by compaction roller Shifting sand by bulldozer
10	Drainage Works	Excavation by Backhoe Installation of drainage pipe by crane
11	Pavement Works	Compaction of base material by compaction roller Cutting ICB by concrete cutter
12	Building Works	Casting concrete for slab Mason work on the temporary stage
13	Utility Works	Excavation of the trench Installation of the power cable and sub-station

Source：Study Team

c) Used Equipment

Most of the safety risk of construction work is closely related with used equipment. Notable used equipment of each work item are shown in Table 4.4-10.

Table 4.4-10 Notable used equipment of each work item

No.	Work Item	Notable Used Equipment
1	Piling Work	Piling Barge, Material Barge
2	Fabrication of Steel Jacket	Mobile crane, Welding machine
3	Installation of Steel Jacket	Crane Barge
4	Superstructure Concrete works	Concrete pump, Crane Barge
5	Dredging and Disposal works	Grab Dredger, Tug Boat, Disposal Barge
6	Reclamation Work	Sand Barge, Sand Pump, Bulldozer
7	Revetment Work	Compaction Roller, Mobile crane
8	Installation of PVD	PVD machine
9	Earth Works	Backhoe
10	Drainage Works	Backhoe, Mobile crane
11	Pavement Works	Compaction Roller, Concrete cutter
12	Building Works	Mobile crane
13	Utility Works	Backhoe Mobile crane

Source：Study Team

d) Characteristics of Working Area

When safety risk is evaluated, characteristics of working area should be considered, Construction work of this project will be carried out at riverside in Myanmar and main characteristics of this working area are shown below.

- Working area has rainy season
- Highest temperature of working area is nearly 40 degree at the hot season
- Maximum Tide range is nearly 6m.
- Maximum Water current is about 3.0 m/s
- Third party person (local resident) can approach the working area
- Vessel traffic is crowed at the river in front of the site
- Local workers are not well trained in view of safety

3) Risk Analysis Table

Considering the risk factors mentioned above, major possible risk and its grade are determined and shown as “Risk Analysis Table”.

Risk Analysis Table is shown in Table 4.4-11. In this table, “A” shows grade of “Probability” of occurrence”, “B” shows grade of “severity of damage”, and “C” shows “Total Grade” which is calculated by A times B.

Table 4.4-11 Risk Analysis Table

No.	Possible Safety Risk	A	B	C
1	**Piling Work**			
1-1	When a SPP is lifted up, SPP drops down on workers.	4	4	16
1-2	When a barge is shifted, tie lope is cut and hit workers.	3	3	9
1-3	A worker falls down into the sea and gets in between barges.	3	3	9
1-4	Workers go up piling leader and fall down from high position.	3	3	9
1-5	Fishing boat hits the piling barge.	2	2	4
2	**Fabrication of Steel Jacket**			
2-1	When welders are welding parts, welders are struck by an electric shock.	4	4	16
2-2	Lifted steel parts drop down on workers.	3	3	9
2-3	Invaded children are hit by mobile crane at the fabrication yard.	2	5	10
2-4	Truck makes traffic accident with motor bike at the gate of fabrication yard.	3	2	6
3	**Installation of Steel Jacket**			
3-1	When a jacket is lifted up, jacket drops down on workers.	2	5	10
3-2	A worker gets in between jacket and SPP.	3	3	9
3-3	Workers fall down into the sea by the movement of lifted jacket.	3	2	6
4	**Superstructure Concrete works**			
4-1	Concrete hose of the pump truck bursts and fresh concrete hit workers.	4	2	8
4-2	Outrigger is broken and pump truck falls down on workers.	2	3	6
4-3	Temporary stage is broken and workers fall down into the sea.	2	3	6
4-4	Agitator truck hits a worker.	3	3	9
5	**Dredging and Disposal works**			
5-1	Dredger hits a fishing boat.	2	3	6
5-2	Tug boat hits a fishing boat.	3	4	12
5-3	A worker falls down into the sea.	4	2	8
5-4	Tie lope is broken and hits workers	4	2	8
5-5	Grab bucket hits worker on the barge	2	3	6
6	**Reclamation Work**			

6-1	A bulldozer hits a worker.	3	3	9
6-2	Temporary sand stock-pile is collapsed and worker is buried.	3	3	9
6-3	Temporary sand stock-pile is collapsed and invaded child is buried.	2	5	10
6-4	Sand barge hits other vessel.	4	4	16
6-5	Worker falls down into the sea from sand barge.	4	2	8
7	**Revetment Work**			
7-1	Ground sliding is happened and workers are involved.	3	4	12
7-2	Lifted gabion drops down on divers.	3	3	9
7-3	A diver is drowned.	3	3	9
7-4	Vibro-hammer drops down on a worker.	3	3	9
7-5	Lifted SSP drops down on workers.	3	4	12
8	**Installation of PVD**			
8-1	PVD machine overturns on workers.	3	4	12
8-2	PVD machine hits a worker.	3	3	9
8-3	Workers went up piling leader and falls down from high position.	2	3	6
9	**Earth Works**			
9-1	Backhoe hits a worker.	5	3	15
9-2	A dump truck hits a worker at site.	5	3	15
9-3	A dump truck makes traffic accident on the public road.	4	3	12
10	**Drainage Works**			
10-1	A worker falls down into the excavated trench.	5	2	10
10-2	A dump truck falls into the excavated trench and hits workers.	3	4	12
10-3	Invaded children are drowned in the excavated trench.	2	5	10
10-4	A lifted drainage pipe drops down on a worker.	3	3	9
10-5	Excavated slope collapse and workers are buried.	4	4	16
11	**Pavement Works**			
11-1	A compaction roller hits a worker.	3	3	9
11-2	A worker is injured by concrete cutter when he is cutting ICB.	4	1	4
11-3	A worker gets sunstroke.	5	1	5
11-4	A worker is struck by lightning.	2	3	6
12	**Building Works**			
12-1	A worker falls down from high position.	3	3	9
12-2	Lifted material drops down on workers.	3	4	12
12-3	A worker using electric machine is struck by an electric shock.	3	3	9
12-4	A tool or material drops down on workers from high position.	4	3	12
12-5	Supported stage is broken and workers fall down from high position.	3	5	15

12-6	Piled materials drop on a worker.	4	2	8
13	**Power Supply and Utility Works**			
13-1	A worker is struck by an electric shock at the sub-station.	4	3	12
13-2	A worker falls down into the manhole.	4	2	8

More detailed safety risk should be analyzed by the contractor based on the actual work method.

Source : Study Team

(3) Significant Safety Risk

There are many safety risks on the project. It is difficult to consider all risk and take counter measures for all of them. In this study, the Significant Safety Risks are selected from the Risk Analysis Table and recommended counter measures for these Significant Safety Risks are presented. According to the Risk Analysis mentioned in the Section 2, the Significant Safety Risk on the Project can be selected as below.

1) Selection of the Significant Safety Risk

Safety Risks with total grade of higher than 12 points are defined as the Significant Safety Risk and Safety Risks with total grade of higher than 15 points are defined as the Special Significant Safety Risks in this study and will be analyzed.

2) List of the Significant Safety Risk

Total grade with higher than 12 points are shown in Table 4.4-12.

Table 4.4-12 List of the Significant Safety Risk

No.	Possible Safety Risk	A	B	C
1	**Piling Work**			
1-1	When a SPP is lifted up, SPP drops down on workers.	4	4	**16**
2	**Fabrication of Steel Jacket**			
2-1	When welders are welding parts, welders are struck by an electric shock.	4	4	**16**
5	**Dredging and Disposal works**			
5-2	Tug boat hits a fishing boat.	3	4	12
6	**Reclamation Work**			
6-4	Sand barge hits other vessel.	4	4	**16**
7	**Revetment Work**			
7-1	Ground sliding is happened and workers are involved.	3	4	12
7-5	Lifted SSP drops down on workers.	3	4	12
8	**Installation of PVD**			
8-1	PVD machine overturns on workers.	3	4	12
9	**Earth Works**			
9-1	Backhoe hits a worker.	5	3	**15**
9-2	A dump truck hits a worker at site.	5	3	**15**
9-3	A dump truck makes traffic accident on the public road.	4	3	12
10	**Drainage Works**			
10-2	A dump truck falls into the excavated trench and hits workers.	3	4	12
10-5	Excavated slope collapse and workers are buried.	4	4	**16**
12	**Building Works**			
12-2	Lifted material drops down on workers.	3	4	12
12-4	A tool or material drops down on workers from high position.	4	3	12
12-5	Supported stage is broken and workers fall down from high position.	3	5	**15**
13	**Power Supply and Utility Works**			
13-1	A worker is struck by an electric shock at the sub-station.	4	3	12

* Total grade with bold types show the Special Significant Safety Risks.

Source : Study Team

3) Classification of the Significant Safety Risk

Significant Safety Risk can be classified into the following seven Risk types as shown in Table 4.4-13.

Table 4.4-13 Classification of the Significant Safety Risk

No.	Risk Type	Significant Risk No.
1	Lifted material falls down	**1-1**, 7-5, 12-2, 12-4
2	Electric shock	**2-1**, 13-1
3	Third party is involved	5-2
4	Accident by ground condition	7-1, **10-5**
5	Heavy equipment accident	8-1, **9-1**
6	Traffic Accident	**9-2**, 9-3, 10-2
7	Water Traffic Accident	**6-4**
8	Temporary facility collapse	**12-5**

* Risk No. with bold types show the Special Significant Safety Risks.

Source : Study Team

(4) Recommended Counter Measures

Counter measurements should be considered basically against the whole safety risks. Adding to that, seven Risk Types of the Significant Safety Risk shown in Table 4.4-13 should be fully covered. In this study, counter measures against the whole safety risks are recommended.

Recommended counter measures against the safety risks are divided into six groups such as;

- Safety Management System
- Important facilities required special attention
- Necessity of Safety Facilities
- Prevention of Human Errors
- Retention of Safety Risks
- Removal of Safety Risks

1) Safety Management System

It is very important to establish a Safety Management System to prevent the actualizing of safety risks. This system can act effectively on the whole safety risk. Main activities of the Safety Management System and its effectiveness are summarized in Table 4.4-14. It is recommended to establish Safety Management System and follow prescribed activities.

Table 4.4-14 Activities of the Safety Management System

No	Activities	Effectiveness
1	To determine the responsible person	All works, activities and facilities will be checked by the responsible staff.
2	To determine the safety organization	Not only the staff but also the project team will take care of the safety activity.
3	To determine the safety rules	Most of human errors and facility faults will be prevented by the rules.
4	To check the work procedure of dangerous works	Accidents caused by the fault work procedure will be prevented.
5	To check the design of temporary facilities	Serious accidents caused by collapse of the facilities such as ground sliding and stage collapse will be prevented.
6	To hold safety meeting	All staff and workers will have consciousness to prevent accident.
7	To determine the emergency contact network	Quick and effective action will be able to be taken when accident happens.
8	To carry out the safety patrol	Faulty facility, action or work procedure can be found before accident happens.
9	To carry out the safety training	All workers will have knowledge and skill to prevent accident and to take effective action when accident happens.

Source：Study Team

2) Important Facilities Required Special Attention

According to the List of Significant Safety Risks, some facilities need to be taken care of especially. Important facilities to be taken care of and necessary actions to be taken are mentioned in Table 4.4-15. It is recommended to take these necessary actions to prevent serious accident.

Table 4.4-15 Important Facilities

No.	Important Facilities	Necessary Actions
1	Lifting wire	To conduct routine check and replacing damaged one (if any). Damaged wire is not allowed to be recycled. Lifting parts should be checked, too.
2	Lifting hook	To conduct routine check to confirm the wire stopper is attached and it works effectively.
3	Anchor and winch of the barge	To conduct routine check and replacing damaged one (if any). Wire rope of winches should be checked, too. Indication buoy should be attached for each anchor.
4	Tie rope and tie wire	To conduct routine check and replacing damaged one (if one). All tie rope and tie wire should be replaced before its lifetime.
5	Ground condition of heavy equipment	To check whether the ground has enough strength against heavy equipment prior to mobilize them.
6	General condition of heavy equipment	To conduct routine check of fuse and breaker to prevent a short circuit accident.
7	Brakes of equipment and truck	To conduct routine check and replacing damaged one (if any). All brake pads should be replaced before its lifetime. Brake of winch attached on the crane needs to be checked too.

It is also important to make check list and keep check result. It is recommended to assign the Safety responsible person of each important facility.

Source：Study Team

3) Necessity of Safety Facilities

According to the list of the Risk Analysis Table and the List of Significant Safety Risks, Safety Facilities are necessary to be prepared in the site to prevent serious accident. Necessary Safety Facilities to be prepared and its explanations are mentioned in Table 4.4-16. It is recommended to prepare these necessary Safety Facilities to prevent serious accident.

Table 4.4-16 Safety Facilities

No.	Safety Facilities	Explanation
1	PPG (Personnel Protection Gear)	PPG means protection gears for the workers which put on the workers directly such as safety wear, safety shoes, helmet, safety glass, life jacket, safety glove, etc. It is important to establish rule that PPE should be put on when workers carry out related activities.

2	Watching Boat	Watching Boat is effective to prevent water traffic accident and rescues person who falls into the water.
3	Security Fence and Gate	Security fence and gate is necessary to prevent third party person from invading the working site. Safety fence should be high, strong and dense enough to block children and residents. Safety Gate should be strictly controlled to prevent the person and vehicle unconcerned with the project from entering the project site.
4	Safety barricade and signboard	Safety barricade and signboard shall be installed and indicate following area. - Heavy equipment working area - Hole, slope and excavated area - Lifting work area (area under the lifted material) - Dangerous material stock area (gas, fuel, etc) - High position work area - Electrical power control area (sub-station, switch box) - High position work area - Electrical power control area (sub-station, switch box) - Other dangerous area and restricted area
5	Handrail, safety rope and safety net	Where working position is higher than 2.0m, safety working stage with handrail and safety rope is required to prevent falling down accident. Safety net may be required to prevent dropped material or tool from fitting workers working under the high position working area.
6	Worker’s rest house	Worker’s rest house may be required to prevent sunstroke and/or struck by lightning. Smoking area should be located outside the working area to prevent fire accident.
7	Emergency Road in site and Safety path	There should be a good road in the site which can access any location of the site by vehicle in case of emergency. A safety path should be prepared to allow person to access anywhere without any dangerous factor. Workers shall use this path when they go to their working area. No material and equipment is allowed to be kept on the emergency road and safety path.

Source：Study Team

4) Prevention of Human Error

According to the accident record, most of the accidents are caused by human error. They include traffic accident and heavy equipment accident caused by faulty work procedure. These accidents may be prevented if no error has happened in the whole procedure.

Following countermeasures are recommended to prevent human error in this study.

a) Daily Group Meeting before the commencement of works

Prior to commencement of each work, group meeting is recommended to be hold. Work procedure, physical condition of the group member and safety instructions should be discussed and shared among the group.

b) Sharing the "Hiyari-Hatto (near-accidents event)" experiences

Most of the accidents are happened through the "Hiyari-Hatto" situations. Many staff and workers have these "Hiyari-Hatto" experiences. To share these experiences is very important to prevent the occurrence of similar experience.

It is recommended to collect the "Hiyari-Hatto" experiences to share staff and workers.

c) Case Study Training

Most of the accidents are caused by similar causes. Case studies of actual accident are effective to prevent the occurrence of similar accidents.

It is recommended to conduct Case Study Training and take counter measures to prevent the occurrence of similar accidents.

"Case Studies on Accidents and Near Misses in construction" by MOC in Vietnam and JICA is usable as the text for training.

d) Placing of "Warning Signboards"

Even trained, studied and join meeting, people may forget safety instructions sometimes. Therefore, "Warning Signboards" are recommended to be set up in the site. These signboards can remind staff and workers to be cautious about safety instructions.

Followings are the example contents of the "Warning Signboards".

- Don't enter under the lifted material!
- Be careful of floor condition!
- Don't run on the stage!
- Watch around your equipment before move!
- Check lifting wire before using!
- Don't approach Backhoe!

5) Removal of Safety Risks

When counter measures against the serious safety risks such as abnormal natural disaster or violent attack form other country are considered, it needs to take huge amount of cost and time, both of which will impact on the project feasibility.

These Safety Risks occur in very rare case and project staff cannot prevent the occurrence of these events by themselves. Therefore, it is recommended to leave these very rare safety risks to the insurance.

(5) Particular care for the Special Significant Safety Risks

The Special Significant Safety Risks require the particular cares. Recommended particular cares are studied in this section.

1) Particular cares for the risk of "Accident of lifted material drops down"

Lifting work is one of the most dangerous works in the construction activity. Accident can happen with two factors such as "Lifted load is dropped" and "people stay under the lifted load" are happening.

There are some reasons of drop of lifted load such as "broken of lifting wire or lifting gears", "break down of winch brake" and "getting loose of tie rope".

Lifting wire or lifting gears may be broken caused by lack of checking, overload or wrong lifting procedure. They can be called "Human error".

Break down of winch break may happen by the lack of checking or the mechanical trouble. It is difficult to find out such cause of trouble sometimes. Routine checking and keeping repairing records are important.

Counter measures to prevent accident consist of generally two factors such as "no load is dropped down" and "no workers stay under the lifted load in case load is dropped down".

Necessary cares to prevent drop accident based on the above analyses are;

- To check lifting wire and lifting gears with certainty.
- To check crane winch with certainty.
- Tying shall be carried out by skilled worker.
- Using guide rope to stabilize the lifted loads.
- To warn workers not to enter position under the lifted loads.
- Dangerous area under the lifted loads shall be restricted by barricade and signal person who take care the safety of the working area.
- To train all workers including welders regarding the drop accident by using the Case Study.

- To train all workers including welders regarding the drop accident by using the Case Study.

2) Particular cares for the risk of "Electric shock accident"

Most of the electric shock accidents are caused by short circuit. Short circuit can happen due to mechanical problem or wet condition.

Necessary cares to prevent electric shock accident are;

- To check short circuit breaker of the welding machine and generator.
- To stop welding work in wet condition and at the rainy day.
- Do not put welding machine, generator and power cable on wet floor.
- Welders need to wear PPG.
- Sub-station and power house shall be restricted to enter.

Adding to above, training of workers including welders regarding the electric shock accident by using the Case Study is important and effective.

3) Particular cares for the risk of "Accident by ground condition"

The most important thing to prevent accident due to the ground condition is to make a good "planning of work procedure". Slant of excavation should be planned based on the ground conditions and excavation depth. Heavy equipment need to be restricted to enter the shoulder area of excavation by barricade. And conditions of excavated slope shall be checked every day especially at the rainy day and when workers are working in the excavated trench.

4) Particular cares for the risk of "Heavy equipment accident"

Most of the heavy equipment accident happened by human errors. To prevent the heavy equipment accidents, assign of the signal person who take care the safety of the working area is effective. Duties of the signal person are;

- To restrict the entering of the workers behind the equipment
- To install barricade of safety tape around the equipment working area
- To confirm operator wheel stopper when operator get out of the equipment
- To notify operator when the equipment is approaching slope, hole or people
- To confirm equipment has been checked everyday
- To check operator's physical conditions and his skill

Adding to above, training of workers including operators regarding the heavy equipment accident by using the Hiyari-Hatto experiences and the Case Study are important and effective.

5) Particular cares for the risk of “Traffic Accident”

Many vehicles including material supply and material removal will come to the site. Most of the traffic accidents in the working site happened by the human errors which is same as at the public road. However, it is difficult to train the whole driver at the project. Therefore, facility arrangement and determination of traffic rules become very important.

Arrangement of facility and determination of traffic rules include;

- To maintain good road surface conditions (remove hole, mud or obstacles)
- To limit the maximum speed of vehicles
- To provide the traffic signboards (stop, speed limit, intersection, etc)
- To remove unnecessary materials, tools and equipment from the road
- To provide safety path for workers

6) Particular cares for the risk of “Water Traffic Accident”

In this project, many work barges like sand barge for the reclamation work are planned to cross the existing channel.

This may cause near misses between work barges and vessels in operation. Basically, working vessels shall not disturb operations of other vessel, therefore it is necessary to provide a watching boat. Duties of the watching boat are;

- To restrict working vessels entering the existing channel.
- To restrict fishing boat and other unconcerned boat entering working area
- To notify the dangerous situation to vessels passing by in case any dangerous situation is likely to happen
- To rescue persons in case the accident is happened

7) Particular cares for the risk of “Accident of temporary facility collapse”

Temporary facility collapse may be happened due to the wrong designing, wrong construction works or wrong work plan. Important matters to prevent collapse accidents are to check design and construction works in the same manner as permanent works.

Especially, at the temporary stage for casting concrete when many workers and tools may work, design and construction works shall be checked and inspected prior to the commencement of the work. Adding to that, overload is one of the causes of the accident therefore designer of the temporary facilities shall strictly check the work plan and the actual work conditions.

(6) Emergency Plan

In the case that any accident happens, quick and effective response is necessary to protect human resources and prevent secondary accident. It is recommended to prepare the Emergency Plan prior to the commencement of the works.

Emergency Plan consists of following action plan.

- First aid
- Action for prevention secondary accident by such as power cut, installation of barricade, suspending of surround activities
- Contact safety officer (safety responsible person)
- Contact ambulance, hospital, police or fire service
- Contact the Client and the Engineer
- Report to the related authorities, the Client and the Engineer

It is necessary to understand that main purpose of the Emergency Plan is to protect human resources and prevent secondary accident in preparing the Emergency Plan.

(7) Related Local Law and Regulations

There is no related local law or regulation with concrete manual or guidance for construction safety. However, there are some Safety Manuals which can be applied to the project. Safety Manual provided by government of Vietnam and Japan is usable such as;

- Construction Safety Manual by MLIT in Japan
- Safety and Health Manual in Construction by MOC in Vietnam and JICA
- Safety Manual of Construction Equipment by MLIT in Japan

Above manuals are prepared for general works with general site condition and, each construction project should establish his own construction safety plan based on its specific site condition. The contractor should consider his actual construction work methods, equipment and conditions for the preparation of the Construction Safety Plan by referring the above manuals.

(8) Conclusion

Human life is definitely more important than any other factors of the project such as cost, schedule or quality. When accident is happened, every related party should have penalty in view of financial and/or social status. Consideration these meanings, “Safety” should be taken care of extremely.

However, many accidents including several serious accidents are happened in the construction project all over the world.

Every related person should understand that most of the accidents have clear cause(s) and there should be a chance or chances for somebody to aware of these cause(s).

Important related person should understand that most of the accidents have clear cause(s) and there should be a chance or chances for somebody to aware of these cause(s).

Important thing is to take good care of these chances and to take necessary counter measure(s). For this purpose, every related persons need to have interest of safety itself and courage to take action when he is aware of safety risk factor at any stage.

4.5. Procurement Packaging

To procure the works and plant concluded in the additional detailed study, two procurement packages have been proposed :

- Package 1 : Civil Work and Buildings
- Package 2 : Procurement of Cargo Handling Equipment (Design, Manufacture, Supply and Installation)

The bidding documents have been prepared in this study in accordance with JICA’s guidelines and Standard Bidding Documents for Works (Package 1) and Plant (Package 2), respectively. The major scopes of the two packages are summarized in the following tables :

Table 4.5-1 Major Scope (Package 1)

	Item	Q'ty	Specification
A. Civil work			
1	Soil Improvement PVD method	240,000 m	・L=30m
2	Ditto Filling sand for loading	730,000 cu.m	・H=6m
3	Jetty 40×400m	16,000 sq.m	・Steel pipe pile, Jacket type deck
4	Trestle w=20m and 15m, L= about 62m	3Nr	・Steel pipe pile, Concrete structure
5	Revetment	400 m	・Sheet Pile & PHC pile
6	Access Road	800 m	・Asphalt Pavement
7	Pavement for Container	150,000 sq.m	・Interlocking, Concrete pavement
8	Dredging works	15,500 cu.m	・In the vicinity of jetty
B. Building work			
1	Administration Building	3,436 sq.m	・4 stories RC building, Curtain wall ・PHC piles ・2 elevators
2	Container freight station/ Warehouse	5,000 sq.m	・1 story steel structure building ・PHC piles
3	Maintenance Shop 1	720 sq.m	・1 story steel structure building ・PHC piles ・15 t crane
4	Maintenance Shop 2	576 sq.m	・1 story steel structure building ・PHC piles
5	Terminal Gate	5 for In 3 for Out	・1 story steel structure building
6	Marine House	836 sq.m	・2 stories RC building ・Steel Piles
7	Fuel Station	400 sq.m	・1 story steel structure & roof
8	X-ray Building	200 sq.m	・1 story
9	Sub-station A Main Sub-Station	600 sq.m	・1 story steel structure building ・Generator
10	Sub-station B Sub-station for Jetty	35 sq.m	・1 story steel structure building
11	Sub-station C Sub-station for Refer	4 sq.m	・1 story steel structure building without exterior wall
12	Sub-station D Sub-station for Marine power	4 sq.m	・1 story steel structure building without exterior wall
13	Water Reservoir pump House	800 sq.m	・1 story steel structure building ・2,000 cubic m tank

14	Elevated Water Tank	40 m hegit	・200 cu.m tank
15	Guard House A	20 sq.m	・1 story RC structure building
16	Guard House B	20 sq.m	・1 story RC structure building
17	Wastewater Treatment Plant A	100 sq.m	・RC structure concealed underground
18	Wastewater Treatment Plant B	100 sq.m	・RC structure concealed underground
19	Outside Lighting A	8 poles	・30 m height pole with 6 lighting fixture
20	Outside Lighting B	2 poles	・12 m height pole with 2 lighting fixture
21	Outside Lighting C	41 poles	・12 m height pole with 1 lighting fixture

Source：Study Team

Table 4.5-2 Major Scope (Package 2)

	Item	Q' ty	Specification
1	STS Gantry Crane	2 units	Hinged boom, rigid box portal construction with mono-box girder, rope trolley and self traveling gantry crane Cargo and load handled : ISO 20/40/45Ft Container Spreader 20/40Ft telescopic type Seismic isolation system
2	Rubber Tyre Gantry Crane	6 units	Crab trolley type, diesel-electric powered, self traveling rubber tyred gantry crane. Cargo handled : ISO 20/40/45Ft container Spreader 20/40Ft telescopic type
3	Reach stacker	3 units	Retractable and luffing boom type, diesel driven, self traveling rough terrain container handling and stacking vehicle.
4	3.5t Forklift	2 units	To be used for loading/retrieving LCL load to/from ISO container at CFS , and occasionally general cargo handling at in- door/ out-door. To be Diesel engine driven, counter balance type fork lift. Lifting capacity 3.5t
5	Terminal tractor	6 units	Diesel driven tractor head for towing container chassis with load up to 40.6t
6	Terminal chassis	6 units	The Terminal Chassis to be used for transporting a laden and empty container by towed by Terminal Tractor. The terminal chassis shall have space and load capacity to carry 1x20ft container (24 metric tons),or 2 x 20ft container (20 metric tons each), or 1 x 40/45Ft container.

Source：Study Team

4.6. Cost Estimation of Project

4.6.1. General of the Project Cost

- The Project cost is divided into two components of construction cost and general expense.
- Direct cost of construction is considering cost of labor, machinery and material.
- Total of general expenses is added 15% to unit price that is comprised 5% are site

expenses and 10% are overhead and general administration for contractor. Package2 is not consisted above general expenses.

- Bill No.1 of general requirement is In-direct cost for the project which is consisted site office common temporary work, transportation cost for machinery and marine equipment, safety control, environment monitoring, quality control and HIV program, etc.
- Cost estimation of Package 1 is divided general requirement, Jetty and Trestle, land filling and Soil improvement, Pavement and Drainage, Building work, and Utility work.
- Total period of construction is 30 month.

(1) Survey term and determination of price

- Unit price of labor, materials and equipment was surveyed from June to November 2013.
- Unit price of the Project cost estimation is on November 2013.
- Local price for labor, equipment and material is received by local currency Kyat which is using exchange to US$
- Exchanging rate for Kyat and yen is US$1=JPY100.00, US$1=Kyat970.00.

(2) Contingency cost

Calculating of Contingency is 6% of direct cost against physical contingency and 2.1% of foreign currency and 6.1% of local currency against price escalation.

4.6.2. Estimation of Civil Works

(1) Currency of Estimation

1) Local currency “Kyat”

Quotation and investigation price by local currency Kyat is using exchange to US$ as below.

- Labor rate, diesel and gasoline, ready-mix concrete, aggregate, filling sand, reinforcement, stone materials, interlocking block, fence, water pipe and others.
- Small size of steel (angle, channel) general construction equipment (bulldozer, backhoe, dump truck and others).

2) Foreign currency “US$”

Quotation and investigation price by foreign currency US$ and Japanese yen is exchanged to US$ as below.

- Steel pipe pile, sheet pile, Jacket structure, cathodic protection, piling barge , Marine ship equipment
- Soil improvement machine, fender, bollard, be-con
- Cost of mobilization and demobilization of marine equipment, X-ray facility

(2) Taxes and Duties

Labor rate is including personal income tax. The Customs duty will be exempted that contractor import materials and equipment from third country

(3) Survey of Unit Pric

- Local labor rate is surveyed hiring investigation and quotation to local several contractors, Rate is decided average of several rates. General construction equipment is surveyed hiring investigation and quotation to local several contractors.
- Special construction marine equipment which is Grab dredger, Piling barge, Self-elevating barge, Tug-boat, Soil improvement machine were quoted by contractor from Singapore, Thailand and Indonesia
- Fabrication and installation of Jacket structure, sheet pile, and steel pipe pile were quoted by Japanese steel company.
- Materials and machinery for soil improvement were quoted into professional company from Thailand.
- Cargo handling equipment and X-ray equipment were quoted by Japanese company.

Table 4.6-1   Rate of Main Materials

No	Material	unit	rate kyats	Exchange to U$
1	ready mix concrete 24N	m3	90,000	92.80
2	ready mix concrete 30N	m3	100,000	103.10
3	Portland cement	kg	90	0.10
4	Aggregate dia25mm for concrete	m3	42,000	43.30
5	sand for concrete	m3	25,000	25.80
6	Flesh water for concrete	ton	1,000	1.00
7	Deform bar 9 to 12mmDia	ton	540,000	556.70
8	Deform bar 12 to 19mmDia	ton	560,000	577.30
9	Deform bar 25 to 32mmDia	ton	580,000	597.90
10	Round bar dia 25mm<	ton	590,000	608.20
11	Connection wire for Re-bar	kg	3,800	3.90
12	H-beam 300*300	ton	750,000	773.20
13	H-beam 250*250	ton	680,000	701.00
14	Channel W=100mm	ton	780,000	804.10
15	Angle 100*100mm	ton	780,000	804.10
16	Plate t12mm	ton	690,000	711.30
17	Plate t25mm	ton	710,000	732.00
18	Bolt dia25mm	No	900	0.90
19	Steel pipe pile dia1100mm t22mm	ton		1200
20	Steel pipe pile dia1100mm t17mm	ton		1200
21	Steel pipe pile dia1100mm t13mm	ton		1200
25	Steel sheet pile	ton		1200
26	plywood t12mm for formwork	pc	9,500	9.80
27	plywood t25mm for formwork	pc	31,000	32.00
28	mound stone <200kg	m3	21,000	21.60
29	Armor stone >500kg	m3	22,000	22.70
30	Armor stone >1000kg	m3	24,000	24.70
31	Armor stone >2000kg	m3	25,000	25.80
32	Gasoline	L	900	0.90
33	Diesel	L	920	0.90
34	Oil	L	9,800	10.10
38	Welding rod	5kg	4,600	4.70
39	Interlocking block	no	600	0.60
40	Oxygen	bottle	90,000	92.80
41	Acetylene	bottle	45,000	46.40
42	PVC pipe dia100	m	800	0.80

43	PVC pipe dia200	m	1,200	1.20
44	Granite stone 150<225	m3	21,000	21.60
45	Granite stone 50<100	m3	23,000	23.70
46	Granite stone 25<50	m3	25,000	25.80
47	chipping <10	m3	28,000	28.90
50	Asphalt	ton		13,170
51	Prime coat asphalt	liter	750	0.80
52	Filter Cloth (sheet for Gabion)	sq.m		15
53	Gabion 1000*2000*t500mm	set		116
54	Blinding Concrete	m3		70
55	Street light straight h=12m	No	903,000	930.90
56	Street light single arm h=8m	No	910,000	938.10
57	Street light double arm h=12m	No	1,010,000	1,041.20

Source：Study Team

(4) Working production and operating cost of land equipment and marine equipment

- Based estimations follow “Port and Harbor Contract Construction Estimation Basis” by editorial Japan Ministry of Land, Infrastructure, Transport and Tourism
- Working production for general labor changed one-and-a-half to double because above based is Japanese worker
- Special worker changed one-and-a-half to double also

Table 4.6-2   Rate of Land Worker

No	type of labor	unit	rate kyats	Exchange to U$
1	unskilled worker	day	4,500	4.60
2	skilled worker	day	7,500	7.70
3	steel bender	day	6,500	6.70
4	carpenter	day	7,500	7.70
5	operator of land equipment A	day	24,000	24.70
6	operator of land equipment B	day	16,000	16.50
7	driver A	day	8,000	8.20
8	driver B	day	10,000	10.30
9	driver C	day	16,000	16.50
10	Forman	day	30,000	30.90
11	foreman of concrete plant	day	12,000	12.40
12	welder	day	8,000	8.20
13	watchman	month	150,000	154.60
14	store keeper	month	200,000	206.20
15	Field engineer	month	400,000	412.40
16	chief surveyor	month	400,000	412.40
17	assistant of survey	month	300,000	309.30

Source：Study Team

Table 4.6-3   Rate of Marine Worker

No	type of labor	unit	rate kyats	Exchange to U$
18	captain of dredger	day	55,000	56.70
19	captain of piling barge	day	55,000	56.70
20	captain of tug boat	day	100,000	103.10
21	captain of crane barge	day	60,000	61.90
22	captain of anchor boat	day	40,000	41.20
23	special crew for dredger & piling	day	30,000	30.90
24	crew of dredger	day	30,000	30.90
25	technical crew of piling barge	day	50,000	51.50
26	driver of transport boat	month	250,000	257.70
27	normal crew of marine equipment	day	20,000	20.60
28	chief diver	day	50,000	51.50
29	normal diver	day	30,000	30.90
30	foreman for armoring	day	45,000	46.40

Source：Study Team

Table 4.6-4 Rate of Equipment

No	type of equipment	unit	rate kyats	EXC. US$
1	Back hoe 0.7 m3	day	350,000	360.80
2	Bulldozer 15 ton class	day	350,000	360.80
3	Crawler crane 40ton type	day	700,000	721.60
4	Crawler crane 80ton type	day	1,500,000	1,546.40
5	Truck crane 25ton	day	320,000	329.90
6	Dump truck 10ton	day	170,000	175.30
7	Macadam roller 12ton	day	350,000	360.80
8	Motor grader 3m	day	380,000	391.80
9	Generator 200 KVA	day		120
10	Flat barge 400 ton	day	200,000	206.20
11	Tug boat 1200 or 1000HP	day	1,200,000	1,237.10
12	Crawler crane 300ton class	day		4,200
13	Crane barge with 200ton crane	day		4,800.00
14	Grab dredging barge 10 m3	day		8,000

Source：Study Team

4.6.3. Estimation of Building Work

Cost of building work is estimated based on the below concept.

- This project is financed by JICA loan.
- Cost estimations are calculated according to the JICA guideline 2007.
- Cost estimations are expressed by US dollars exchanged from local kyats used for calculations.
- Direct cost includes material cost, labor cost, and machines cost.
- In case of import from other country, material cost includes cost necessary for import such as overseas transportation fee.
- Labor cost includes social insurance fee.
- In case, no adequate machine available in this country, machine cost includes overseas transportation fee.

The each construction cost for the building work is estimated as below. The total construction cost without contingency is estimated at 33.5 million US$.

Table 4.6-5 Construction Cost of Building Work

Name of Work for Building	Construction Cost ($)
Temporary Works	66,931
Pile and Gravel Works	1,940,649
Earth Works	229,233
Concrete Works	1,101,437
Concrete Formworks	1,209,766
Steel Reinforcement Works	1,852,565
Structural Steel Works	5,035,179
Masonry Works	57,832
Waterproofing Works	21,838
Tile Works	67,196
Carpentry Works	4,460
Metal Roofing Works	2,138,067
Metal Works	5,100,511
Plastering Works	82,696
Doors and Windows	486,468
Glazing Works	627,115
Painting Works	244,255
Interior Finish Works	264,817
Miscellaneous Works	75,884
Electrical Works	3,737,058
Mechanical Works	3,607,919

Source：Study Team

4.6.4. Estimation of Cargo Handling Equipment

- Because there are no factories for cargo handling equipment for the Project in Myanmar, the Study team got the quotation for the cargo handling equipment from Makers in Japan.
- The price and exchange rate of quotation is based on November 2013.
- Transportation fee is assumed it from Japan to Myanmar.
- Total cost without contingency is estimated at 32.5 million US$ as below table.

Table 4.6-6 Cost of Cargo Handling Equipment

Equipment	Nos.	Amount
Gantry Crane	2	17,820,000
Rubber Tyre Gantry Crane	6	10,098,000
Reach Stacker	3	3,660,000
Forklift	2	90,000
Terminal Trailer	6	540,000
Terminal Chassis	6	270,000
TOTAL	25	32,478,000

Source：Study Team

4.6.5. Cost of the Project

- Total Amount of Package 1 is estimated at US$165,829,000 (not including contingency)
- Total amount of Package2 is estimated at US$32,478,000 (not including contingency)
- Cost of Consultants, Cost Management of the Project ,TAX and Interest follow as amount of F/S
- Cost Management of the Project and TAX follow as F/S including amount of project, but not including in Loan of JICA
- Total Construction amount is U$222million including contingency, Total Project Cost is US$239million

Table 4.6-7 Total Project Cost

Item	Content		Total (1,000 US$)
1	Construction and Procurement		222,325
	(1)	Civil and Building	165,829
	(1-1)	General Requirement	6,949
	(1-2)	Jetty (400m) & Trestle	72,308
	(1-3)	Land Fill & Soil Improvement	27,006
	(1-4)	Pavement & Drainage	11,695
	(1-5)	Buildings	33,542
	(1-6)	Utility	14,329
	(2)	Cargo Handling Equip.	32,478
	(3)	Inflation contingency	11,434
	(4)	Physical contingency	12,584
2	Consultant Cost		12,329
	(1)	Design	0
	(2)	Supervision	11,009
	(2)	Inflation contingency	733
	(3)	Physical contingency	587
3	Project Administration Cost		2,031
4	Preparation Cost		0
	(1)	Compensation	0
	(2)	EIA Cost	0
5	Tax		2,343
6	Interest		42
	(1)	Interest	42
	(2)	Commitment charge	0
7	Total	Project Cost	239,028
	Total	JICA Portion	234,654

Source：Study Team

4.7. Project Evaluation

Regarding the effect of this Project, it has been once evaluated already in the 1st stage study, in which both economic and financial analysis has been conducted, however, it was re-evaluated using the re-estimated cost as presented in the previous chapter **4.6**, and also reflecting the progress of the project.

The detailed cost re-estimation was done for the area of the Urgent Development Plan (Phase I-1 and I-2) only, out of the whole Thilawa Area Development Plan shown in **Fig 4.7-1**, and so as the re-evaluation. However, as explained in detail in **4.7.2 (1)**, the scope of evaluation in financial analysis was set for the area of the Phase I excluding Phase I-2 portion only (1 berth 1 yard plot), or Phases I and II (2 berths and 2 yard plots).

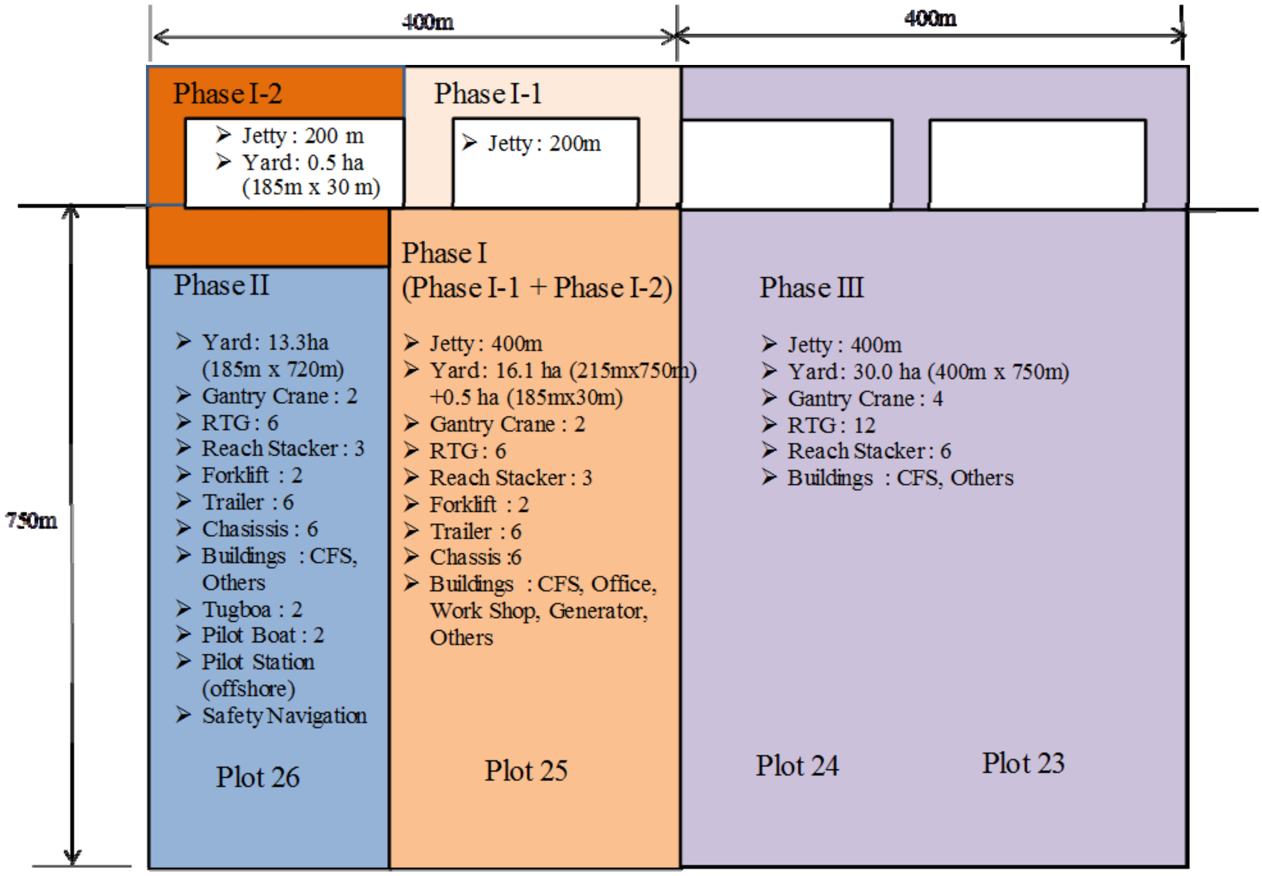


Figure 4.7-1 Thilawa Area Development Plan

Source：Study Team

4.7.1. Economic Analysis

(1) Method of Economic Analysis in the 1st stage study, and Difference with this Analysis

In the 1st stage study, the Economic Analysis was conducted for the period of 30 years, taking 'Added value to the economy of Myanmar by the export containers' as the Project benefit, and taking 'Construction, Maintenance, Repair cost of the Port facilities; Purchasing, Maintenance, Repair and Renewal cost of Cargo Handling Equipment, Yard Vehicles and Tug Boats; Management and Operation cost of the Terminal' as the Project cost. The same settings were employed at the analysis this time.

(Please note that detailed contents of the construction and purchasing differ, according to the result of detailed consideration, such as X-ray inspection machine added, number of buildings increased, specification of buildings changed, while Tug boats removed.)

The different points from the 1st stage study are as follows;

- **Project cost**: As the result of the detailed consideration, and also because of the different exchange rate, the Project cost for the Economic Analysis has increased from about US $191 million to about US $224 million.

- **Exchange rate**: This has changed from 1 US $=83.64 JP yen ＝868 kyats to 1 US $＝100.00 JP yen ＝970 Kyats.

- **Implementation Schedule**: Originally, a construction supervision consultant was to be engaged within 2013, and after the bidding for the constructor, the construction was to be started in July 2014, and the terminal partially using by December 2015, and fully opening by January 2017, however, the contract with the construction supervision consultant is not done yet at this moment (March 2014). So, meantime for the analysis only, the implementation schedule is delayed by 12 months.

- **Container handling throughput during the 1st year of operation (Partial use)**: During the partial using period, 1 berth can be used, however, the soil improvement of the yard area will not be completed hence there will be no yard in use, no electricity or water supply in place, no fence will be set up to comply to SOLAS convention, and no X ray machine installed for container cargo inspection, so handling of international containers will be very difficult compared with the full opening terminal. Hence, to be on the safe side in the analysis, during the partial use period, cost for staffs will be considered for the daytime, but the benefit from handling export containers will be counted 0 until the full opening of the terminal.

- **Planned number of containers handled in the terminal (Maximum)**: In the 1st stage study, the maximum capacity of the Phase I area was set at 160,000 TEUs; however, after the detailed consideration of the yard operation, this was set to 200,000 TEUs per year maximum.

- **Terminal operation cost (Staffs, Electricity, Fuel)**: In the 1st stage study, the cost estimation of the terminal operation was set referring to the numbers of neighboring countries’ international container terminal (Laem Chabang, Thailand), however, in this 2nd stage study, this cost was reviewed through interview and information collection of other container terminals in Yangon port. Compared with the 1st stage study, the cost per unit price became 4 times higher.

Table 4.7-1 shows the estimated container handling throughput which is used in the Economic Analysis (With and without cases).

Table 4.7-1 Estimated Container Throughput for 'with' and 'without' cases

Year	Years from the start of operation	Estimated amount of International trade containers handled		Total handling amount (With Case)	Total Demand
		At existing terminals (Without Case)	At the new terminal in Thilawa		
2012		509,000	−	509,000	509,000
2013		615,000	−	615,000	615,000
2014		727,000	−	727,000	727,000
2015		781,000	−	781,000	853,000
2016	1	898,000	−	898,000	990,000
2017	2	1,063,000	−	1,063,000	1,142,000
2018	3	1,277,000	33,000	1,310,000	1,310,000
2019	4	1,491,000	4,000	1,495,000	1,495,000
2020	5	1,540,000	160,000	1,700,000	1,700,000
2021	6	1,540,000	200,000	1,740,000	1,923,000
2022	7	1,540,000	200,000	1,740,000	2,170,000
2023	8	1,540,000	200,000	1,740,000	2,441,000
2024	9	1,540,000	200,000	1,740,000	2,738,000
2025	10	1,540,000	200,000	1,740,000	3,064,000
2026	11	1,540,000	200,000	1,740,000	
2027	12	1,540,000	200,000	1,740,000	
2028	13	1,540,000	200,000	1,740,000	
2029	14	1,540,000	200,000	1,740,000	
2030	15	1,540,000	200,000	1,740,000	
2031	16	1,540,000	200,000	1,740,000	
2032	17	1,540,000	200,000	1,740,000	
2033	18	1,540,000	200,000	1,740,000	
2034	19	1,540,000	200,000	1,740,000	
2035	20	1,540,000	200,000	1,740,000	
2036	21	1,540,000	200,000	1,740,000	
2037	22	1,540,000	200,000	1,740,000	
2038	23	1,540,000	200,000	1,740,000	
2039	24	1,540,000	200,000	1,740,000	
2040	25	1,540,000	200,000	1,740,000	
2041	26	1,540,000	200,000	1,740,000	
2042	27	1,540,000	200,000	1,740,000	
2043	28	1,540,000	200,000	1,740,000	
2044	29	1,540,000	200,000	1,740,000	
2045	30	1,540,000	200,000	1,740,000	

Source：Study Team

(2) EIRR and the evaluation of the Project

Based on the revised settings as explained, the Project cash flow was recalculated and EIRR turned out to be at 12.9% for the new container terminal of this Project, as shown in **Table 4.7-2**.

Sensitivity analysis was done to check whether the project would be still feasible even when some conditions change. When the cost increases 10% and the benefit decreases 10%, the EIRR was calculated to be 10.5%.

The EIRR of the project is compared with the opportunity cost of the country's capital and if the EIRR is considered higher, then the project is evaluated as economically feasible. There is no published data available for the opportunity cost of the capital in Myanmar, so by applying the World Bank's benchmark for project approval of 12%, this project's EIRR is higher than the opportunity cost, and it is similar for the sensitivity analysis case.

Therefore, the proposed project is considered to be economically feasible.

Table 4.7-2 EIRR of the Thilawa Area Urgent Development Plan Project (30 years)

Unit: '000 USD/Yr

Year		Cost				Benefit		Total	Cost+10% Revenue-10% Total
		Const-ruction	Mainte-nance	Terminal Operation	Tug	Container (TEU)	Value		
unit price				2325.773	0.001044		0.2625		
2014		1,618	0	0	0	0	0	-1,618	-1,779
2015		78,893	101	0	0	0	0	-78,994	-86,893
2016		97,130	329	0	0	0	0	-97,459	-107,205
2017	1	61,387	554	1,163	0	0	0	-63,104	-69,414
2018	2	0	813	2,326	34	33,000	8,663	5,489	4,306
2019	3	0	668	2,326	4	4,000	1,050	-1,948	-2,353
2020	4	0	1,448	2,326	167	160,000	42,000	38,059	33,465
2021	5	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2022	6	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2023	7	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2024	8	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2025	9	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2026	10	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2027	11	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2028	12	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2029	13	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2030	14	0	6,883	2,326	209	200,000	52,500	43,082	36,891
2031	15	0	11,071	2,326	209	200,000	52,500	38,894	32,284
2032	16	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2033	17	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2034	18	0	10,558	2,326	209	200,000	52,500	39,407	32,848
2035	19	0	10,558	2,326	209	200,000	52,500	39,407	32,848
2036	20	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2037	21	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2038	22	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2039	23	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2040	24	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2041	25	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2042	26	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2043	27	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2044	28	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2045	29	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2046	30	0	1,648	2,326	209	200,000	52,500	48,317	42,649
Total		239,028	77,591	66,285	5,428	5,197,000	1,364,213	1,024,198	806,597

EIRR	12.9%	10.5%

Source：Study Team

4.7.2. Financial Analysis

(1) Scope of the Financial Analysis – Physical Area

The Project for Expansion of Yangon Port in Thilawa Area will be developed in 3 phases, as indicated in **Figure 4.7-1**.

Firstly, the Phase I will be implemented and will be partially in use in 2016, and become fully operational in 2017. In Phase I, to cater for the strong needs of providing more berthing windows for the vessels calling at Yangon Port, which requires long waiting hours due to the tide and prohibition of the nighttime navigation, 2 berths at Plots 25 and 26 will be developed, for the one yard plot at Plot 25, packaged as 'Thilawa Area Urgent Development Plan'. And following the increase of the cargo handling throughput, the second yard plot at Plot 26 will be developed as Phase II. (The schedule for the development of Phase III, which covers the Plots 23 and 24, is to be decided later.) And in the original plan, the opening of the Phase II is assumed at only two years later after the full opening of Phase I, reflecting the estimated strong growth of the container handling throughput of Yangon Port.

When planning the participation of private companies as the terminal operator of this Project, the scope of the Urgent Development Plan, which is the area of Phase I, is not necessarily the scope of the private terminal operator's business area. This is because it is not realistic to assume that the operator of the berth at Plot 26, and that of the yard at Plot 26 would be different, nor the operator of the berth at Plot 25, and that of the berth at Plot 26. And also, if the container handling throughput grows as assumed, the yard at Plot 26 (the Phase II) will be in operation within 2 years after the full opening of the Phase I, so it is realistic that the private parties who are interested in participating as the operator would consider the scope of their business at both Plots 25 and 26, which is both Phase I and II.

Also, if we look at the cost revenue structure of the container terminal, which the revenue depends on the maximum container handling capacity of the terminal, and the capacity depends on the size of the yard area, a financial analysis taking the scope of L-shaped Urgent Development Plan area only, will analyze the operation of a terminal paying back the cost of construction of 2 jetties with the revenue of 1 yard plot, which is a too difficult temporary situation to analyze.

However, in this 2nd stage study, the scope of the detailed consideration and the cost re-estimation is on the Urgent Development Plan area only, and the cost estimation for the excluded yard area of Plot 26 cannot be done using the result of Plot 25, since there is a creek running in the middle of Plot 26 which needs to be re-routed for the development of the container terminal yard. So it is not possible to conduct a feasibility study for the area of the whole Plots 25 and 26 using the output of this 2nd stage study. However, it is possible to conduct a feasibility study for the area of the Plot 25 only, by removing half of the cost of the jetty from the output of this 2nd stage study's cost re-estimation.

(2) FIRR and Financial Feasibility

As discussed in the previous section, FIRR was calculated for the scope of 1 berth 1 yard of Plot 25, by removing the construction cost of the berth of Plot 26 from the total cost of Urgent Development Plan. This is meant to be making the feasibility study more real to the situation. To explain more in details, according to **Table 4.6-7 Total Project Cost**, total construction cost for the jetty and the trestle, which is for the two berths, is estimated as 72,308,000 USD, so a half of this was removed from the total construction cost. If discussed more precisely, there could be other related costs which also decreases, however, these decreasing factors were not considered for following two reasons; firstly, it is difficult to quantify it, and secondly, there might be also some loss in the revenue which counters this cost decrease **-** as in theory it is possible to serve all the vessels calling by 1 berth only, however, in the real situation, it will make the vessels wait more, and that might lead to some loss of vessel calls to the other terminals in competition.

Also, as same as the economic analysis, changes listed in **4.7.1 (1)** were also reflected in this financial analysis.

The financial analysis was done taking the tariff based income as the project revenue and construction, maintenance and operation cost as the project cost, as same with the 1st stage study. As shown in **4.7.1(1)**, the construction cost was re-estimated based on the outcome of the detailed study and the change in exchange rate, so as the tariff based income and the operation cost, based on the interview to other container terminals in Yangon.

As for the time length of the financial analysis, it was set to 30 years at the 1st stage study, but this time, 40 years was chosen to streamline with the terms of the Japanese ODA loan which this Project is going to use. This is because the detailed financial analysis for public and private entities which will follow this financial analysis will not become meaningful unless it covers the whole period of the loan repayment.

As the result, as shown in **Table 4.7-3**, FIRR for the whole project was calculated to be 5.4%. The result of the sensitivity analysis of revenue 10% decrease, cost 10% increase was 3.5%.

Table 4.7-3 FIRR for the Thilawa Area Urgent Development Plan (40years.)

Unit: '000 USD/Yr

Year		Cost			Revenue				Project Total	Cost+10% Revenue-10%
		Const-ruction	Main-tenance	Terminal Opera-tion	Container (TEU)	Container Handling	Port Entry charges	Revenue Total		
2014		1,622	0	0	0	0	0	0	-1,622	-1,784
2015		55,582	101	0	0	0	0	0	-55,683	-61,251
2016		84,119	282	0	0	0	0	0	-84,401	-92,841
2017	1	57,449	481	1,491	0	0	0	0	-59,421	-65,364
2018	2	0	730	2,981	33,000	3,168	320	3,488	-223	-943
2019	3	0	585	2,981	4,000	384	39	423	-3,143	-3,542
2020	4	0	1,365	2,981	160,000	15,360	1,553	16,913	12,567	10,441
2021	5	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2022	6	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2023	7	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2024	8	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2025	9	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2026	10	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2027	11	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2028	12	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2029	13	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2030	14	0	6,800	2,981	200,000	19,200	1,941	21,141	11,360	8,268
2031	15	0	10,988	2,981	200,000	19,200	1,941	21,141	7,172	3,661
2032	16	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2033	17	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2034	18	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2035	19	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
2036	20	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
2037	21	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2038	22	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2039	23	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2040	24	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2041	25	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2042	26	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2043	27	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2044	28	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2045	29	0	6,800	2,981	200,000	19,200	1,941	21,141	11,360	8,268
2046	30	0	10,988	2,981	200,000	19,200	1,941	21,141	7,172	3,661
2047	31	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2048	32	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2049	33	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2050	34	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2051	35	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2052	36	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2053	37	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2054	38	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2055	39	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
2056	40	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
Total(40)		**198,773**	**124,827**	**117,767**	**7,397,000**	**710,112**	**71,792**	**781,904**	**340,537**	**218,210**

40years	FIRR	5.4%	3.5%

Source：Study Team

(3) Public Private Partnership pattern for Thilawa Area Urgent Development Plan

The implementation scheme for this Urgent Development plan has not yet been finalized, but possibilities would be, firstly, as analyzed in the previous section, Myamma Port Authority (MPA) could be both the developer and the operator. This is the conventional way of Public-developed Public-operated terminal.

Having private parties participate to the management and operation of ports has many benefits compared with the conventional way. For this project, it is already decided that the development will be by using Japanese ODA loan so it will be publicly developed, but the management and operation can be done by private parties. In other terminals in Yangon, privatization of the terminal operation is gradually spreading, and it is quite appropriate and reasonable to choose a scheme that can utilize the fund and the expertise of the private parties in order to fulfill both a rapid infrastructure development and efficient and effective terminal operation.

As discussed in the 1st stage study, following scheme is proposed for the Thilawa area development.

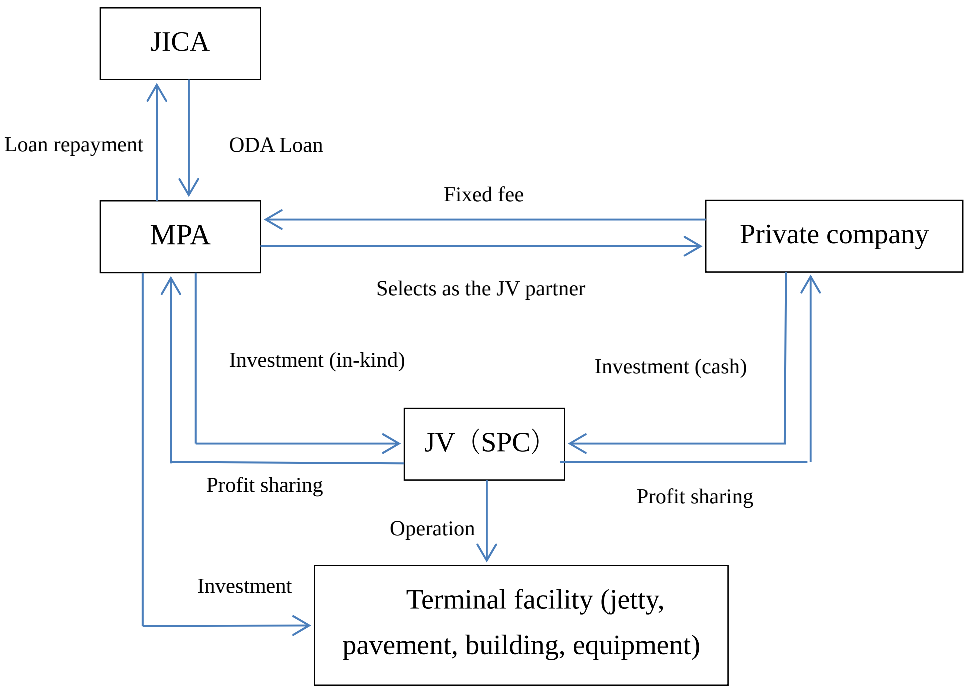


Figure 4.7-2 PPP scheme for Urgent Development Plan of Thilawa Area (JV scheme)

Source：Study Team

Outline of the proposed scheme can be described mainly in following two points;

- a) Contract period of the Joint Venture should be set to 40 years, taking the same period as the repayment period of the Japanese ODA loan (30 years repayment with 10 years grace period.)
- b) Concession fee should be comprised of 'Fixed fee' and 'Variable fee', and the 'Fixed fee' should be set to a sufficient amount for the repayment of the Japanese ODA loan, and should be

made as a given condition in the selection of the terminal operator. It should be noted that there should be some consideration on fee settings to make it lower during the construction period and the early years of operation when the demand is generally low. 'Variable fee' is proposed to be a profit share based on the percentage of the capital subscription, in order to give an incentive of profit making to the management effort of the Joint Venture. Payment of the fixed fee can be from the Joint Venture (The Special Purpose Company); however, it is less risky to MPA when the payment is made from the Joint Venture partner private company, as same in the case at the Sule Pagoda Terminal.

In this analysis, we assumed a scheme that a private company sets up a Joint Venture contract with MPA, and participate as the terminal operator for 40 years, while paying a concession fee to MPA comprised of 'Fixed fee' and 'Variable fee'. The 'Fixed fee' of the concession fee is set to a fixed annual rate dividing the total amount of the Japanese ODA loan (including the interest) by 40. The 'Variable fee' is a profit share, dividing the annual profit according to the percentage of capital subscription. The percentage of capital subscription is not fixed yet, so for this analysis purpose only, we have set 3 cases that MPA subscribes 51%, 40% and 20% of the Joint Venture's capital respectively. Also, the annual profit is set to be not reserved in the Joint Venture, but the entire amount is divided and paid to the capital subscribers.

As similar to the financial analysis of the whole project, the scope of the analysis was set to the 1 berth and 1 yard of Plot 25 only, and set to handle maximum 200,000 TEUs of containers based on the demand forecast. The operator will pay the operational fee, and also, the maintenance and renewal fee of the facilities and equipment. Also, the operator will earn an income through handling the containers, based on the tariff but discounted for 40% (the discount rate reflects the current market trend based on the interview to other terminal operators in Yangon.), and pay the concession fee explained in the previous paragraph.

The result of the financial analysis under above conditions is shown in the following **Table 4.7-4**. In the case which MPA subscribes more than a half of the capital at 51%, the private entity's FIRR for the 40 years will be 20.5%, and in the case which the private entity subscribes 80% of the capital, then the FIRR will be 26.7%, both of which are at sufficient level to invite private party's participation. So it can be concluded that it is feasible to implement this Project according to a PPP scheme.

Table 4.7-4 FIRR for the Thilawa Area Urgent Development Plan (Private Entity)

('000 USD)

Year		Cost		CF(Fix)	Revenue		Operator	Operator	CF(Variable):MPA Share			Private Total		
		Main-tenance	Terminal Opera-tion		Container (TEU)	Container Handling	Profit	Profit after tax	51%	40%	20%	(49% Share)	(60% Share)	(80% Share)
2014		0	0		0	0	0	0	0	0	0	0	0	0
2015		101	0		0	0	-101	-101	0	0	0	-101	-101	-101
2016		282	0		0	0	-282	-282	0	0	0	-282	-282	-282
2017	1	481	1,491	4,982	0	0	-6,954	-6,954	0	0	0	-6,954	-6,954	-6,954
2018	2	730	2,981	4,982	33,000	3,168	-5,525	-5,525	0	0	0	-5,525	-5,525	-5,525
2019	3	585	2,981	4,982	4,000	384	-8,164	-8,164	0	0	0	-8,164	-8,164	-8,164
2020	4	1,365	2,981	4,982	160,000	15,360	6,032	4,524	2,307	1,810	905	3,725	4,222	5,127
2021	5	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2022	6	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2023	7	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2024	8	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2025	9	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2026	10	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2027	11	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2028	12	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2029	13	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2030	14	6,800	2,981	4,982	200,000	19,200	4,437	3,328	1,697	1,331	666	2,740	3,106	3,771
2031	15	10,988	2,981	4,982	200,000	19,200	249	187	95	75	37	154	174	212
2032	16	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2033	17	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2034	18	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2035	19	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
2036	20	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
2037	21	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2038	22	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2039	23	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2040	24	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2041	25	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2042	26	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2043	27	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2044	28	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2045	29	6,800	2,981	4,982	200,000	19,200	4,437	3,328	1,697	1,331	666	2,740	3,106	3,771
2046	30	10,988	2,981	4,982	200,000	19,200	249	187	95	75	37	154	174	212
2047	31	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2048	32	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2049	33	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2050	34	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2051	35	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2052	36	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2053	37	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2054	38	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2055	39	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
2056	40	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
Total(40)		**124,827**	**117,767**	**199,280**	**7,397,000**	**710,112**	**268,238**	**195,922**	**110,643**	**86,779**	**43,390**	**157,594**	**181,459**	**224,848**
										FIRR	**40years**	**20.5%**	**22.8%**	**26.7%**

Source：Study Team

Please note that this analysis does not include any extra investment by the private entity.

In reality, the private entity will make some extra investment and provide more value added service, which will result in more cargo attracted, (If invested in Inland Container Depot, it will be possible to handle more than 200,000 TEUs per a berth), or less promotional cost required, both of which will possibly make the Project more feasible.

However, when interpreting the result of this analysis, it should also be noted that the scope of the analysis is set to Plot 25 only; taking into account that the implementation of Phase II will immediately follow, therefore, actual investment of the Plot 26 jetty is excluded. So one of the conclusion of the financial analysis is, to keep this project feasible for the private entities to participate, it is important that Phase II is completed and opened following the planned schedule.