CHAPTER 10　AIRPORT FACILITY PLANNING

（SUMMARY OF AIRPORT FACILITY DESIGN）

(Intentionally Blank)

Chapter 10 AIRPORT FACILITY PLANNING（SUMMARY OF AIRPORT FACILITY DESIGN）

Facilities and equipment based on the earlier design condition are to be summarized by making questionnaire and clarifying unresolved issues.The summarized design is aimed to calculate the cost of this project. The required drawings for the above are to be minimal and based on the earlier design and conditions.

In addition to the above, the summarized design is to be reviewed and developed to reduce cost and shorten construction schedule while maintaining quality. It shall also review applicable Japanese technologies and standards. Moreover, the airport security equipment shall consider the situation in Bangladesh and related international standards.

10.1 Passenger Terminal Building（T3）

Meetings with Civil Aviation Authority, Bangladesh (CAAB), were held to confirm the scope of Phase-1 and requirements. The confirmed issues and conditions will form the basis for the airport facilities design.

(1) Results of Interview with CAAB

- There was no explanation by consultants (CPG and Yooshin) of final drawings and function of the Master Plan.
- The VIP arrival flow through the boarding bridge is mixed with ordinary passenger flow in the original design. The VIP arrival flow should be reconsidered.
- BHS design, especially VIP BHS circulation, in the original design is not clear.
- The mosque indicated in the original layout plan is independent from the terminal structure. It is not a prayer room and whether to include it in the scope of the project should be confirmed.
- After the meeting, JICA confirmed the mosque is part of the scope of this project, since the mosque is considered as one of the facilities in this airport.
- The required rooms of CIQ were verbally instructed by CAAB to CPG; however, the final drawings are not adequate. This issue shall be clarified.
- CAAB recognizes the need to confirm functions and the design intent in the original design for the Master Plan with the M/P consultant.

(2) Definate Design Requirement

JICA Study Team presented about the following matters at the 2nd CAAB meeting and confirmed that further re-check and re-arrangement shall be continued in the next stage.

- The Functional Occupation List to confirm the requirement of each room.
- The colored layout plans which show the function of airport facilities.

(3) Elevation and Section

- Elevation and section design is basically not changed from the original design.

10.2 Cargo Complex Terminal

In cargo buildings, it is necessary not only to improve the processing capacity but also to design facilities and equipment for smooth operations and eliminate lost cargo, as well as improve cargo flow.

There are various approaches to layout in the basic design, and JICA Study Team inquired about the possiblity for changes to facility layout after study of the local operation situation. CAAB responded by requesting proposals for improvement of operations, including facility layout, operational support facility and systems etc.

Also, CAAB requested for the introduction of a fully automated system.

Against this background, JICA Study Team decided to organize the issues and concepts of existing facilities shown in the next section and propose a new layout proposal.

In the second meeting, the following comments were received from CAAB.

- A report on the integration the import and export in one building is requested.
- The export cargo terminal is designed in the north side, but existing export cargo terminal building is located in the south. The possible of extension of the existing export cargo terminal building should be explored.
- 24 hour operation custom inspection is expected in the future and this should be reflected in future plans.
- Conversion and reuse of existing semiautomatic equipment should be attempted whenever possible.
- A medium-sized inspection machine (tunnel size = 1.8m) should be installed.
- The large-sized inspection machine is unnecessary.

Based on the above request, JICA Study Team developed concepts, equipment and layout of the cargo terminal building as described below.

(1) Condition of existing cargo terminal building

On-site inspections of operations at the existing cargo terminal buildings revealed the following problems.

- Smoke detectors and smoke evacuation windows are installed in the building, but fire extinguishing facilities (sprinkler, drainer, indoor fire extinguishing facility, etc.) are also necessary. Lack of firefighting equipment is confirmed with only fire extinguishers provided.
- Maintenance of existing fire-fighting equipment has not been carried out and damage was confirmed.
- The drive deck cannot be used, and the control panel is also deteriorated. Restarting will require extensive maintenance .
- The security inspection machine is an old single view inspection device and inspection of individual pieces of cargo is required.

Source: JICA Study Team

Figure 10-1 Smoke Detector

Source: JICA Study Team

Figure 10-2 Existing Drive Deck

Source: JICA Study Team

Figure 10-3 Fire Fighting Facility

Source: JICA Study Team

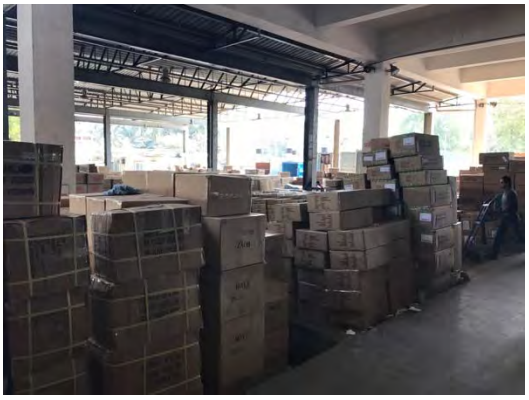
Figure 10-4 Present Cargo Inspections

(2) Issues during the construction for expansion

In planning for expansion, it is important to install new equipment and facilities without stopping the operation of existing cargo terminal buildings, but assuming a migration plan, the following issues were confirmed。

- With the expansion of the apron of phase 2, about 50 m from the building on the airside side of the cargo terminal building is planned to be demolished.
- In the existing cargo terminal building, the drive deck and racks are not used, while the process before the build-up is congested.
- Therefore, there is concern that construction work for expansion in the existing export cargo terminal building or adjacent site will cause major disruption on operations, resulting in increased cargo delays and confusion.
- Introduction of automated equipment will require sufficient training, but there is not enough space to carry out training activities.

Based on the above, the new export cargo terminal building should be planned in a different location to allow single day transfer of operations that does not stop cargo processing.

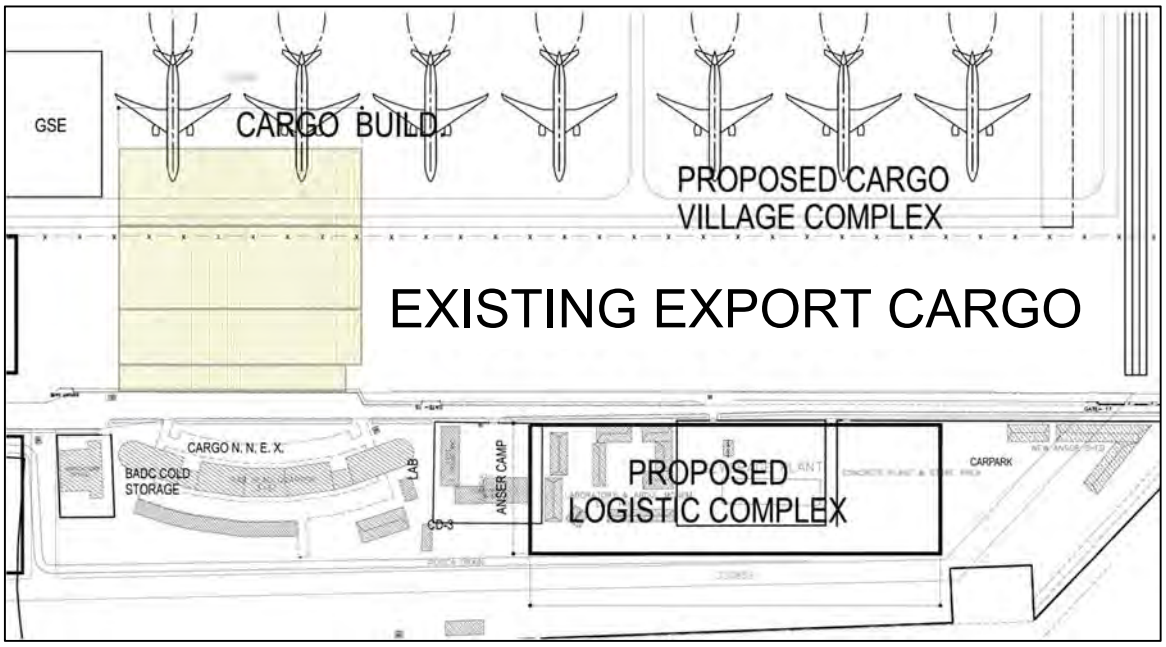


Source: JICA Study Team

Figure 10-5 Truck Yard

Source: JICA Study Team

Figure 10-6 Truck Yard



Source: JICA Study Team

Figure 10-7 Existing Cargo Terminal and Apron Expansion Plan

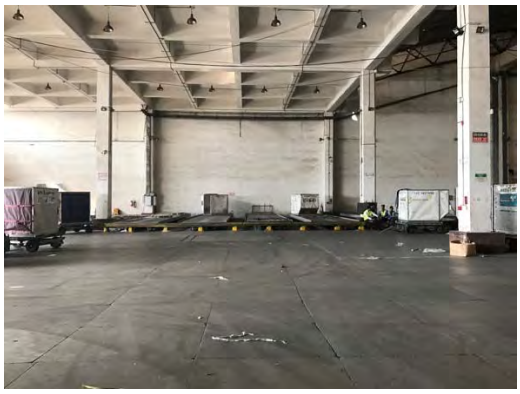
(3) Countermeasures to Issues During Operation

Both export and import operations are divided between separate companies (cargo terminal building, Biman Cargo, ground handling, Biman Bangladesh Airline). The communication between the two sides is insufficient, resulting in defective cargo operations.

For this reason, both sides attend only to their own responsibilities, moving cargo to handover zone without considerations for the next process was observed sporadically. In a remarkable example, export cargo scheduled for nighttime loading was immediately transported to the apron after completion of build-up so that they had already been taken outdoors at 2 p.m. Perishable goods are included in these cargo and damage to cargo due to sunshine, rain etc. is serious.

To solve this problem it is necessary for the sending side to promptly accommodate the cargo in the storage facility and secure the work area upon completion of preparation. Meanwhile, on the receiving side, timely receipt of cargo according to the flight situation of the aircraft must be made available.

Therefore, equipment for cargo storage are required for both import and export.



Source: JICA Study Team

Figure 10-8 Cargo Storage

Source: JICA Study Team

Figure 10-9 Cargo are Waiting Longtime

(4) Separate and Integrated lans

Cargo terminal buildings can be constructed as separate export and import structures as at present or by combining into an integrated structure.

In this project, we recommend to provide temporary storage facilties for both export and import cargo. In this case, in general, the processes for both export and import are divided with the arrival of the aircraft as the boundary. For this reason, in the case of separation, there is concern that the capacity of the equipment will overlap and the cost will increase.

It is expected that in the future, a large volume of export cargo will be built up outside the airport along with security inspection and customs clearance. In such cases, it is assumed that the cargo terminal building to be constructed in this project will be operated as an import cargo terminal building. In order to minimize the necessary renovation work at such a time, we recommend integrated construction

Based on the above demands and background, the following policy will be observed for the design of the facilities.

- ✈ Integrate exports and imports, layout functions for flexible operations and design to be responsive to future changes in operations.
- ✈ For MHS and ASRS will be installed for both import and export.
- ✈ Built-up Unit Load Device (ULD) and pallets are to be stored until ground handler is ready for pick up. Material Handling System (MHS) etc. will also be arranged to allow cargo pick up in accordance with breakdown progress.
- ✈ If automatic system is chosen, Automatic Storage Rack System (ASRS) for daytime storage of cargo after customs inspection completion during the period large vehicles cannot enter should be provided.
- ✈ In an automated system, ASRS for cargo after completion of breakdown should automatically manage and transport cargo according to the situation at customs inspection and cargo pick up.
- ✈ ASRS is rarely used for export cargo in an automated system. However, in order to cope with the adverse flight conditions and accidents, the system should be capable of separate management of export cargo.

- ✈ Install inspection machine with higher performance equivalent to multi-view or better for efficient inspection.
- ✈ Space for installation of large inspection machine in the future will be reserved.

In the existing plan, neither the facilities listed above nor CAAB requests are satisfied. Therefore, the JICA Study Team conducted a study on a new layout in this Preparatory Study.

It was confirmed with CAAB, that the final concepts, functions and layouts will be discussed in the next stage to determine the layout and necessary equipment for detailed design.

(5) Semi-automated, Full-automated

CAAB is requesting for the installation of fully automated equipment.

On the other hand, installation of fully automatic equipment increases not only installation cost but also maintenance cost. Also, unless efficient maintenance of the equipment is carried out, breakdowns will occur, causing major disruption in services.

Accordingly, two layouts were prepared, one with fully automated equipment and the other with semi-automatic equipment.

In the next stage, CAAB will be engaged to finalize the operation method and equipment specification after cost estimates are reviewed.

(6) Setimation of the Cargo Terminal Building Handling Volume

The cargo volume is set according to Table 10-1.

Table 10-1 Cargo Volume

Year	2025
Cargo volume per year (ton)	601,172
Daily cargo volume (ton) (1/330)	1,822
Import cargo volume per year (ton)	200,395
Import daily cargo volume (ton) (1/330)	607
Export cargo volume per year (ton)	400,781
Export daily cargo volume (ton) (1/330)	1,214

Source: JICA Study Team

(7) Required Area of the Cargo Terminal Building

The required area of the cargo terminal building for the estimated cargo volume is set according to Table 10-2 and Table 10-3.

Table 10-2 Area of Cargo Terminal (Import)

Import Area	Area (m^2)	Remarks
ULD storage	4,500	477 ULD
Breakdown	3,650	
Storage, Custom, Dispatching	12,250	
Delivery	2,100	
Truck yard	6,150	
Total	28,650	Unit rate 7 tons / m^2

Source: JICA Study Team

Table 10-3 Area of Cargo Terminal (Export)

Export Area	Area(m2)	Remarks
Truck yard	6,150	
Unloading	3,300	
Ramp	2,700	
Security inspection	1,250	
Buildup	3,400	
ULD storage	1,900	
Total	18,700	Unit rate 21.4 tons/m2

Source: JICA Study Team

(8) Cargo Terminal Building Equipment

Two cases are presented for the cargo terminal, fully automated case and semi-automated case, the respective facilities.

It was decided to arrange MHS and ASRS (Full automated) as single systems for both import and export for the purpose of planning efficiency.

Table 10-4 Cargo Terminal Equipment (Full automated)

Equipment	Qty	Remarks
MHS (Material Handling System)	1	4 level
ETV (Elevating Transfer Vehicles)	3	600 ULD/Pallet
ASRS (Automatic Storage Rack System)	1	6,000 rack
X-ray (for small packages)	3	
X-ray (for large packages)	1	Pre-packed upto 4.5 m height
X-ray (for custom)	3	
X-ray (for staff)	2	
Freezer	6	Import=3, Export=3
Refrigerator	2	Import=1, Export=1
Elevating Workstations	8	
Dock-leveler	1	
Dock-lift table	1	
Floor scale	2	
CMS (Cargo Management System)	1	
RMS (Rack Management System)	1	
TRS (Truck Control System)	1	
Forklift	25	Spare: 3
Tag and dolly	13	Spare: 2
Hand fork	22	

Source: JICA Study Team

Table 10-5 Cargo Terminal Equipment (Semi automated)

Equipment	Qt	Remarks
MHS (Matrial Handling System)	1	4 level
ETV (Elevating Transfer Vehicles)	3	600 ULD/Parett
Rack	1	6,000 Rack
X-ray (for small packages)	3	
X-ray (for large packages)	1	Pre-packed upto 4.5 meters' height.
X-ray (for custom)	3	
X-ray (for staff)	2	
Freezer	6	Import=3, Export=3
Refrigerator	2	Import=1, Export=1
Elevating Workstations	8	
Dock-leveler	1	
Dock-lift table	1	
Floor Scale	2	
CMS (Cargo Management System)	1	
RMS (Rack Management System)	1	
TRS (Truck Control System)	1	
Forklift	35	Spare 4
Tag and dolly	13	Spare 2
Hand Fork	22	

Source: JICA Study Team

Source: JICA Study Team

Figure 10-10 Example of MHS (other airport)

Source: JICA Study Team

Figure 10-11 Example of ETV (other airport)

Source: JICA Study Team

Figure 10-12 Example of ASRS (other airport)

Source: JICA Study Team

Figure 10-13 Example of large inspection machine (other airport)

The layout for the detailed design and the confirmation of necessary equipment for both cases (Full automated and semi automated) will be carried out in the future.

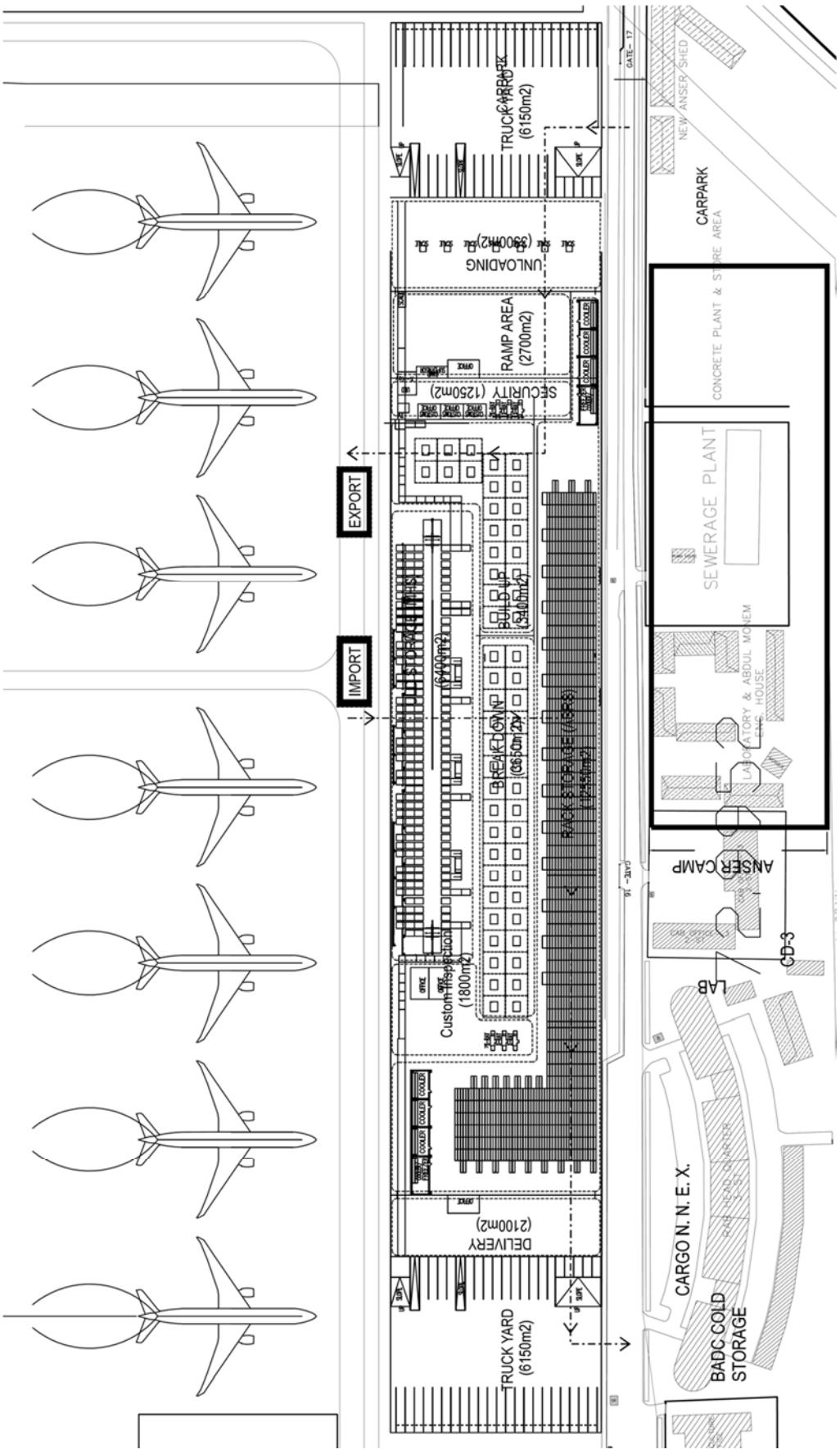
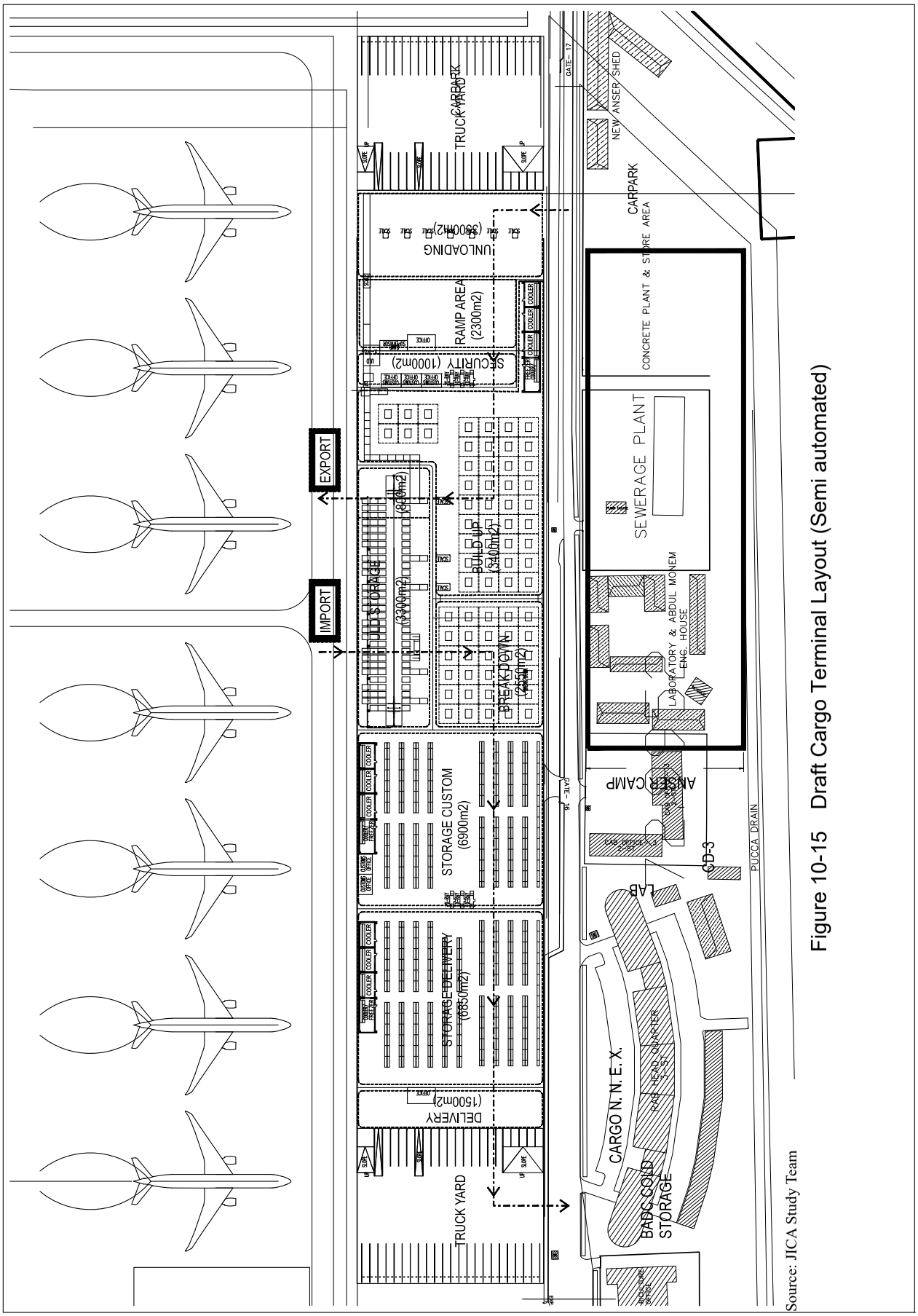


Figure 10-14 Draft Cargo Terminal Layout (Full automated)

Source: JICA Study Team



Source: JICA Study Team

Figure 10-15 Draft Cargo Terminal Layout (Semi automated)

10.3 VVIPTerminal

The survey and interview about existing VVIP Terminal were implemented during the first meeting with CAAB. The new VVIP Terminal shall be designed as suitable for the VVIP based on the functions of the existing facility. CAAB will continue to be consulted on future development of proposed facilities.

In the meeting with CAAB held on 6th February, CAAB requested that barrier free design for handicapped or elderly passenger flow to be considered. Further discussion and study will be continued in the next stage.

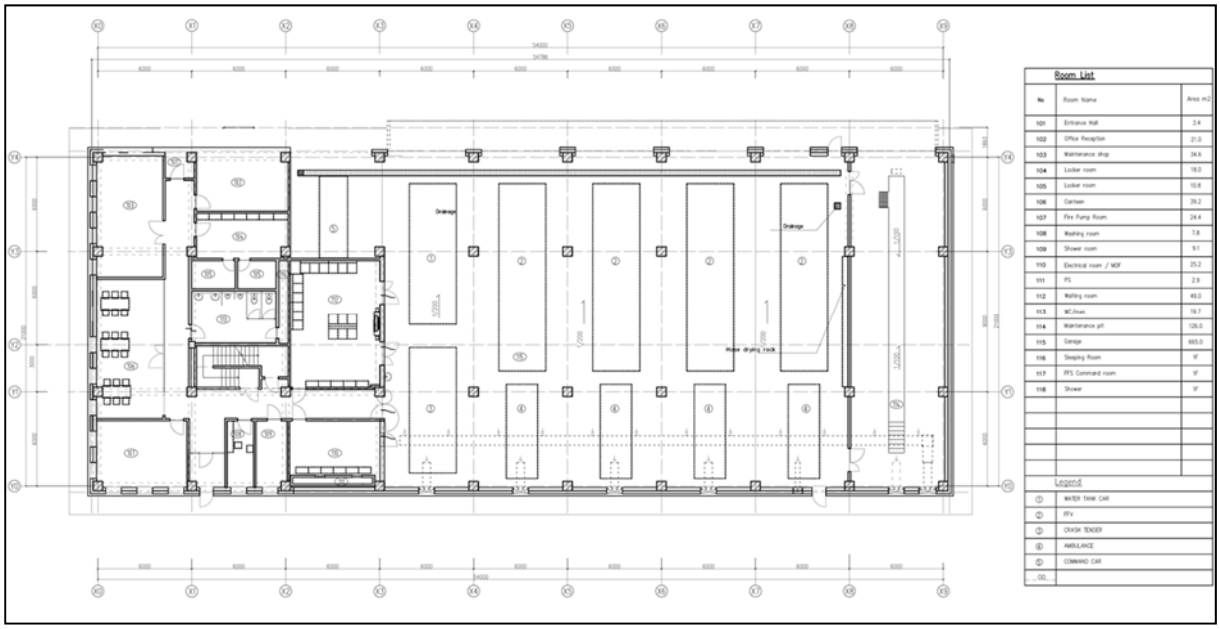
10.4 Fire Station

Based on the result of on-site confirmation, the facilities for the fire station with maximum numbers of with vehicle/equipment were set as shown below.

Table 10-6 Plan of Fire Station

Item	Standard	Qty	Remark
FFV	9,000 L	1	
FFV	11,200 L	1	
FFV	9,000 L	2	Install in Feb 2017
Ambulance		4	
Command car		1	
Water tank car		1	
Crash tender		1	
Maintenance pit	Underground type	1	
Water hydrant		5	
Waiting room		1	
Control room		1	

Source: JICA Study Team



Source: JICA Study Team

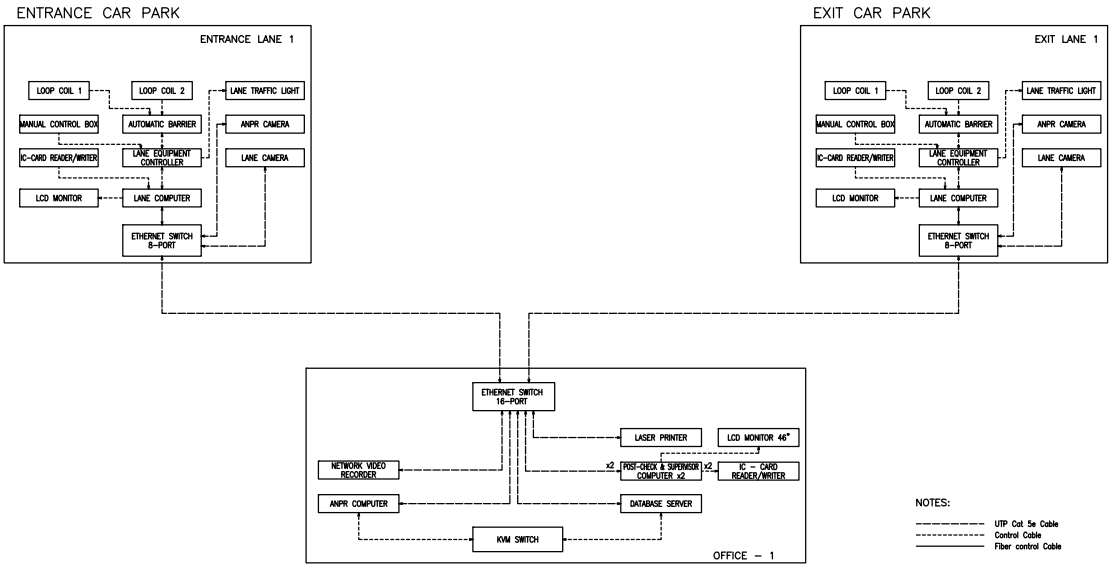
Figure 10-16 FFS Layout

10.5 Multi-level Car Parking

There are no indications of car parking system and details in original drawings. The design conditions and requirement shall be clarified as following items. In the meeting held on 6th Feburuary 2017, JICA survey team explained about the summary of Car Parking Control System. The design will be developed further in the next stage.

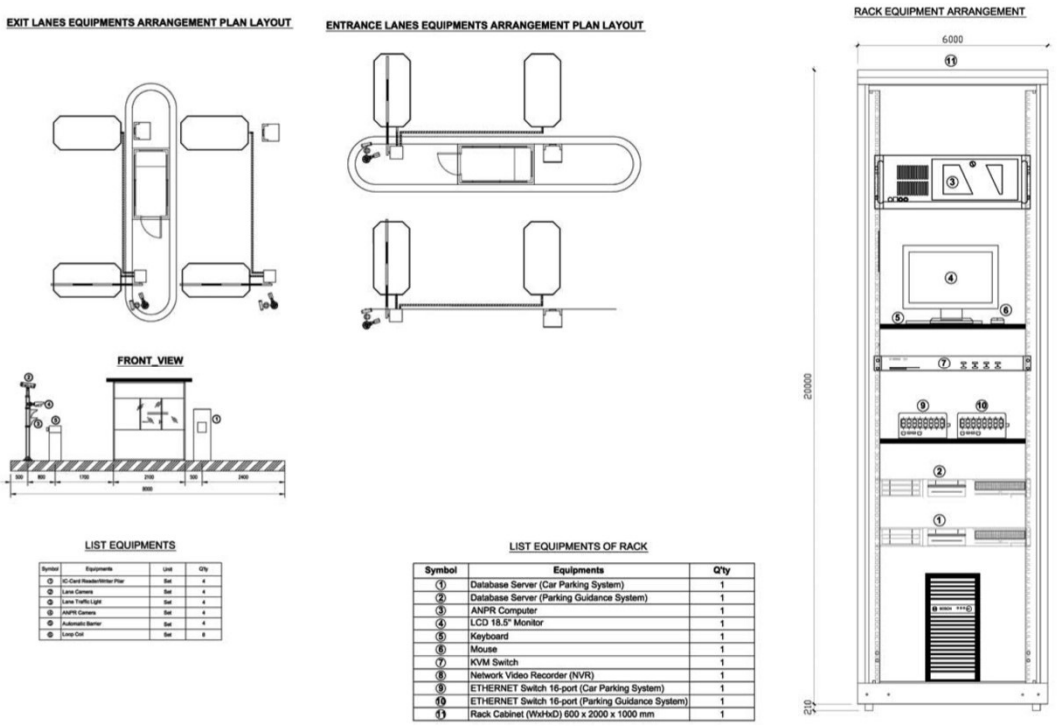
(1) Car Parking Control System

The basic design conditions for car parking are shown in the following figures. Control room is located at an office on the first floor.



Source: JICA Study Team

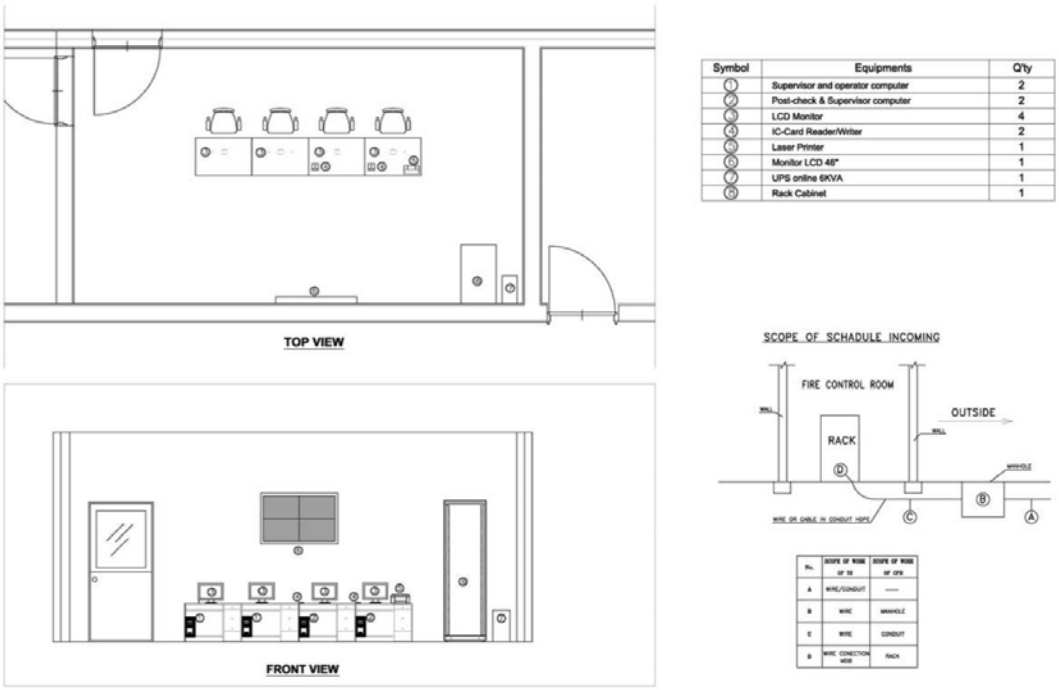
Figure 10-17 Parking Control System



Symbol	Equipments	Q'ty
①	Database Server (Car Parking System)	1
②	Database Server (Parking Guidance System)	1
③	ANPR Computer	1
④	LCD 18.5" Monitor	1
⑤	Keyboard	1
⑥	Mouse	1
⑦	KVM Switch	1
⑧	Network Video Recorder (NVR)	1
⑨	ETHERNET Switch 16-port (Car Parking System)	1
⑩	ETHERNET Switch 16-port (Parking Guidance System)	1
⑪	Rack Cabinet (WxHxD) 600 x 2000 x 1000 mm	1

Source: JICA Study Team

Figure 10-18 Toll Booth



Symbol	Equipments	Q'ty
①	Supervisor and operator computer	2
②	Post-check & Supervisor computer	2
③	LCD Monitor	4
④	IC-Card Reader/Writer	2
⑤	Laser Printer	1
⑥	Monitor LCD 46"	1
⑦	UPS online 6KVA	1
⑧	Rack Cabinet	1

Source: JICA Study Team

Figure 10-19 Control Room Layout

(2) Security System in Car Parking

The security system consists of surveillance cameras that can be checked in the car parking control room. The monitoring will be improved if the system is shared with Terminal 3 CCR. The requirement and operation shall be confirmed with CAAB.

(3) Security Zoning as Airport Facility

The car parking is connected with the terminal building on the ground floor, first floor, and second floor. Security planning shall be clarified at the next stage as part of the airport facility security plan.

(4) Demarcation of Scope of Work

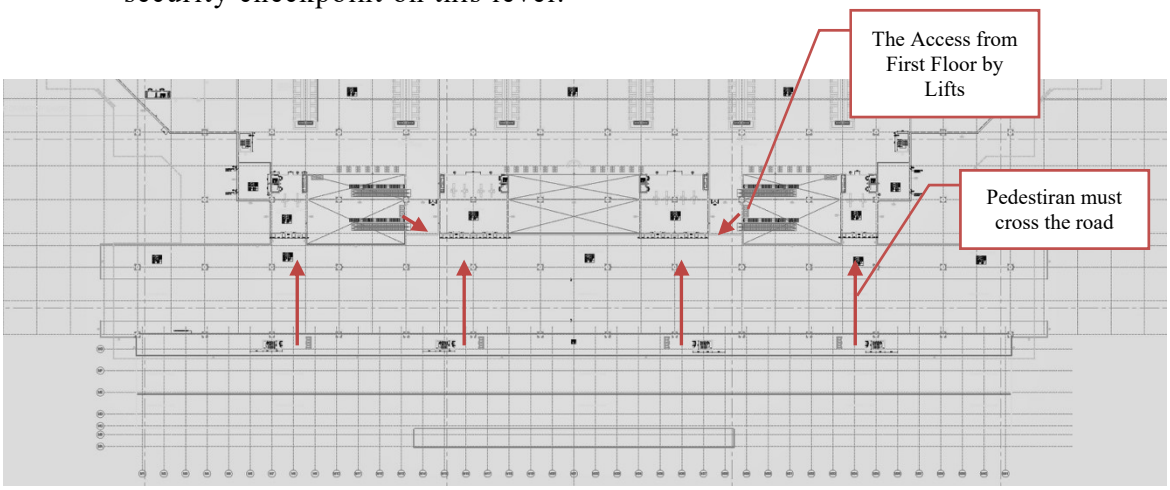
The demarcation of scope of work between car parking, elevated roadway, and terminal building is not clear in the original design. The demarcation of scope shall be clarified for terminal roof support columns, concourse connecting the terminal building and car parking, and the design of expansion joints.

(5) Room functions

Offices and toilets are located only on the first floor in the original design. Through the interview and discussion with CAAB, the requirement of rooms and operation shall be clarified.

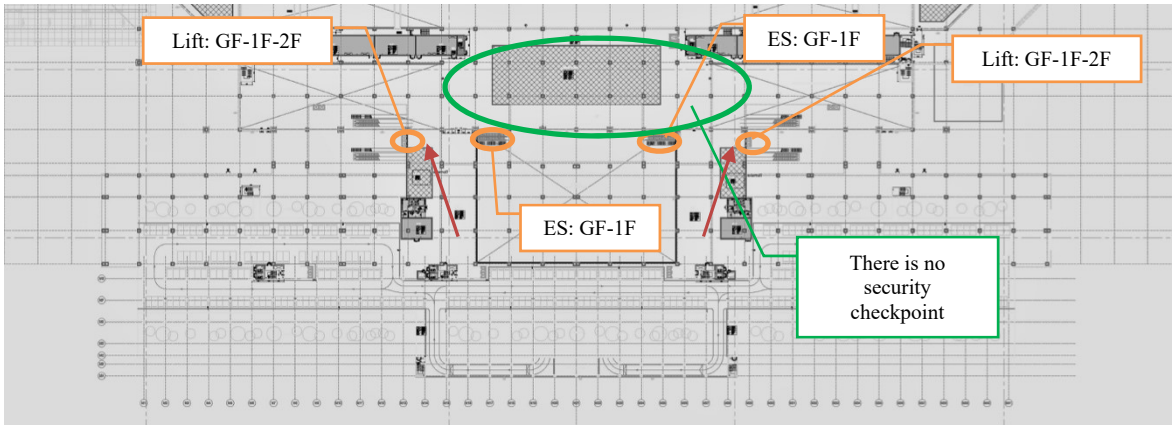
(6) Access and Security

- The main access from car park to the terminal building is designed to cross the roads on the ground floor and second floor. Safety and convenience issues should be addressed.
- The first floor connection is by a concourse to the concession area. There are lifts and escalators to the ground floor and second floor. However, there is no security checkpoint on this level.



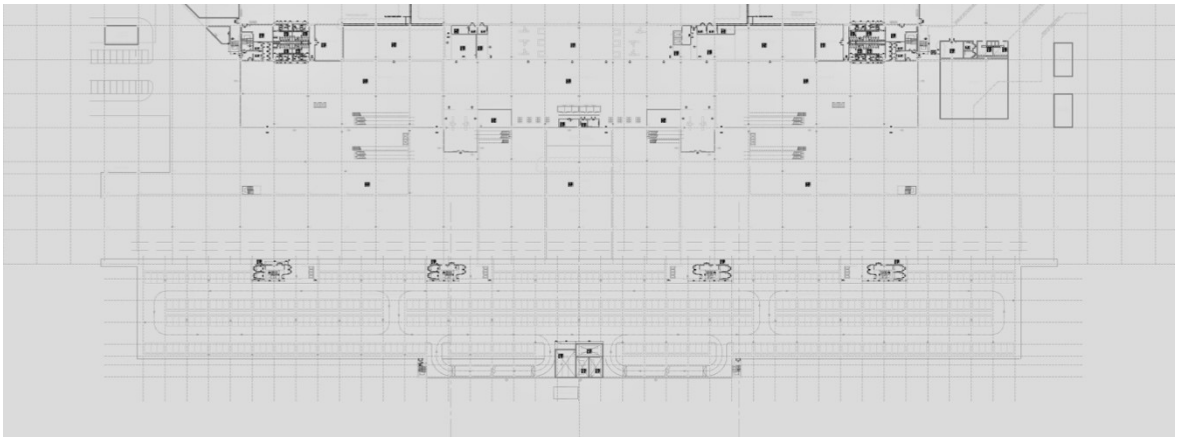
Source: CAAB Master Plan

Figure 10-20 Second Floor Plan



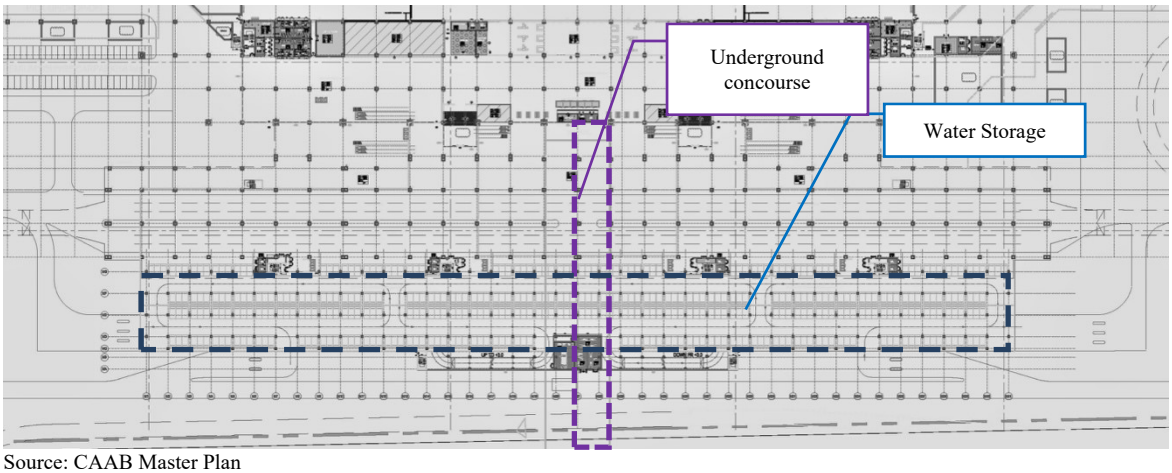
Source: CAAB Master Plan

Figure 10-21 First Floor



Source: CAAB Master Plan

Figure 10-22 Mezzanine Floor



Source: CAAB Master Plan

Figure10-23 Floor

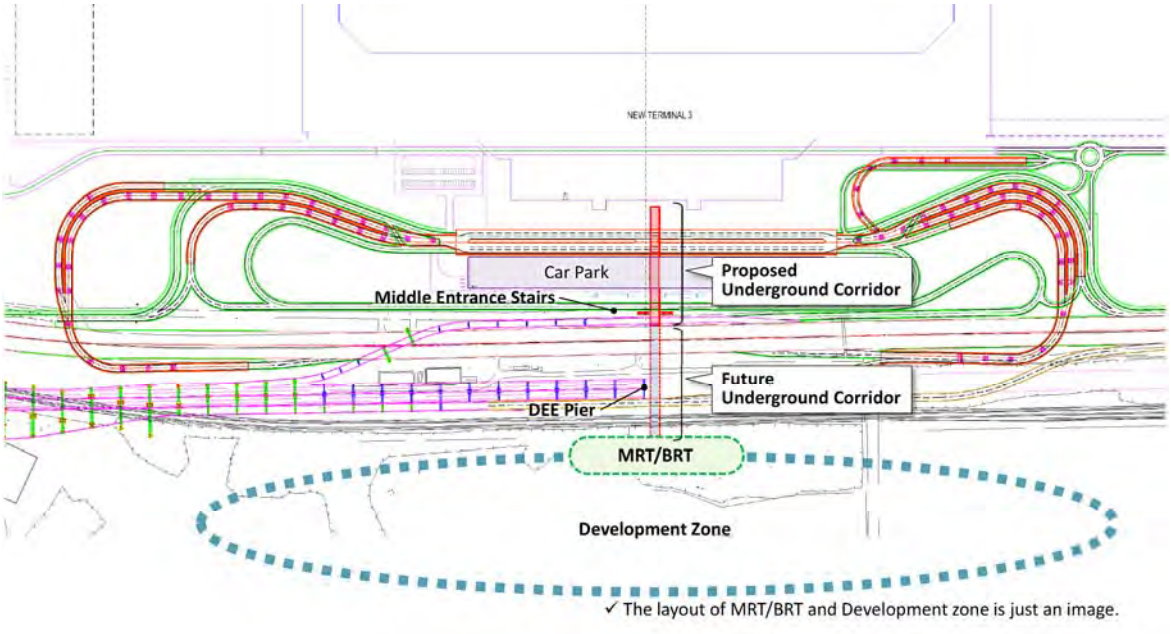
(7) Elevation and Section

Elevation and section design is basically not changed from the original design.

10.6 Underground Pedestrian Corridor

(1) Corridor Layout

In front of Terminal 3, the new MRT/BRT station and other developments are under separate studied to ensure public traffic access. Although the layout of a new station plaza and a development plan are still undecided, the underground pedestrian corridor should be provided for airport users' convenience between Terminal 3 and the new station plaza. On the other hand, the new parking building is planned over the underground corridor. Therefore, the underground corridor take into account future development and should be constructed in the airport landside in advance. Along with the new terminal construction. In addition, the DEE pier is expected opposite the center of the Terminal 3 building. Thus, the layout of the underground corridor should be adjusted to avoid the DEE pier.



Source: JICA Study Team

Figure 10-24 Layout of Underground Pedestrian Corridor

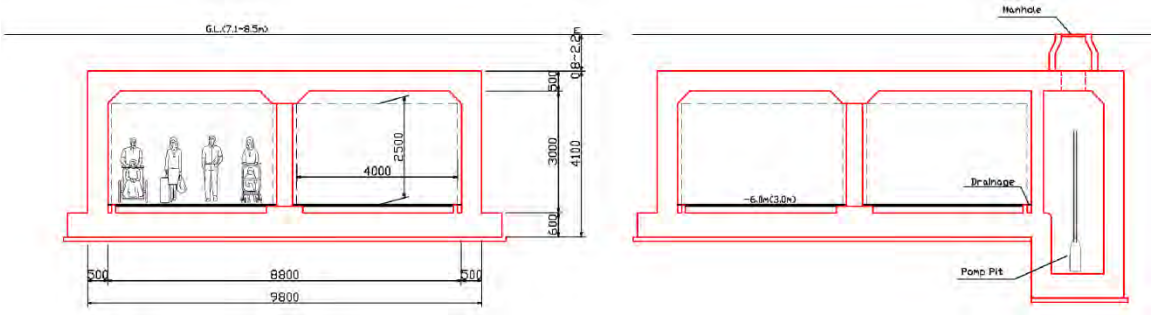
(2) Interior Dimensions

Working width should be planned with enough margin in consideration of future effective utilization.Vertical clearance, 2.8~3.0 m, should be ensured in consideration of some margin such as lighting and advertisement in addition to 2.5 m of pedestrian space. The passageway width is caciuulated for the case where the number of MRT users is assumed to be 30% of airport visitors in 2035:

Number of MRT users in 2035 : 75,500 per/day (JICA Study 2016)
In case of peak10%,

Number of Pedestrian :	Q = 7,550 per/h	(126 per/min)
Pedestrian Density :	k = 0.3per/m^2	
Walk Speed :	v = 60 m/min	
Traffic Capacity :	q = k･v	= 18 人/min･m
Required Width :	w = Q / q	= 7.0 m (3.5m x 2)

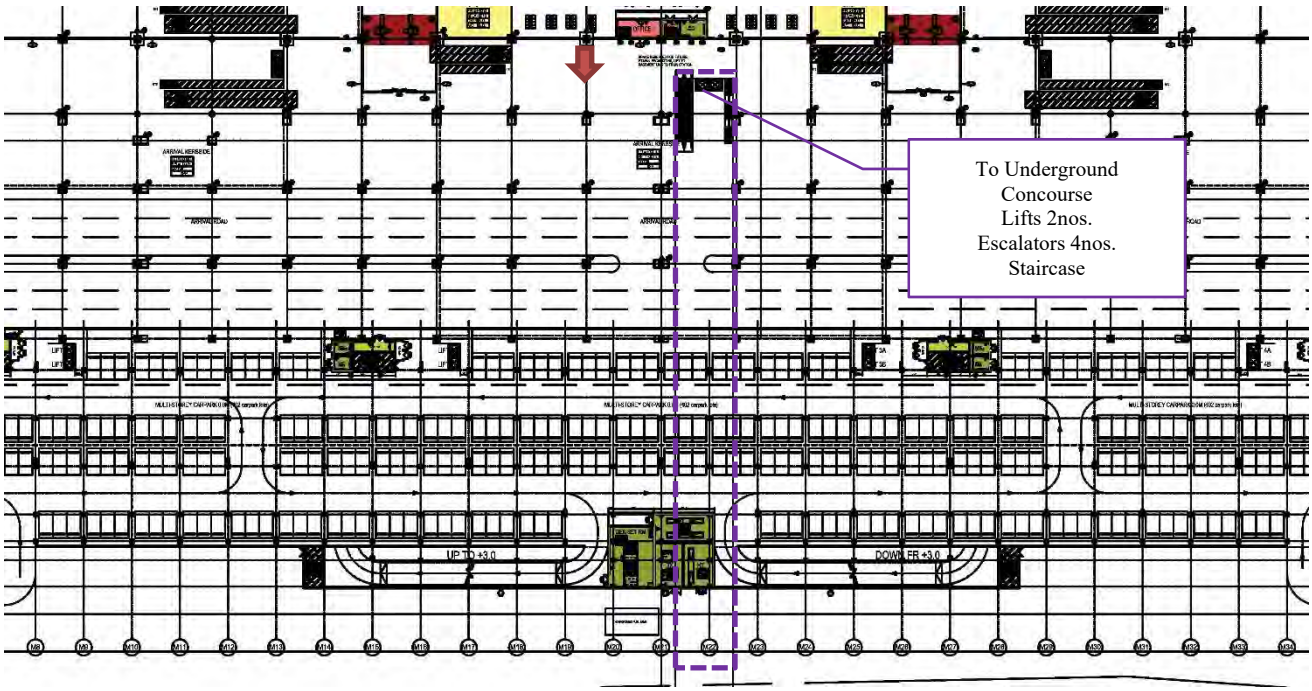
For the effective width of one side, 4.0 m is recommended in consideration of personal space and margin in addition to the above required width.



Source: JICA Study Team

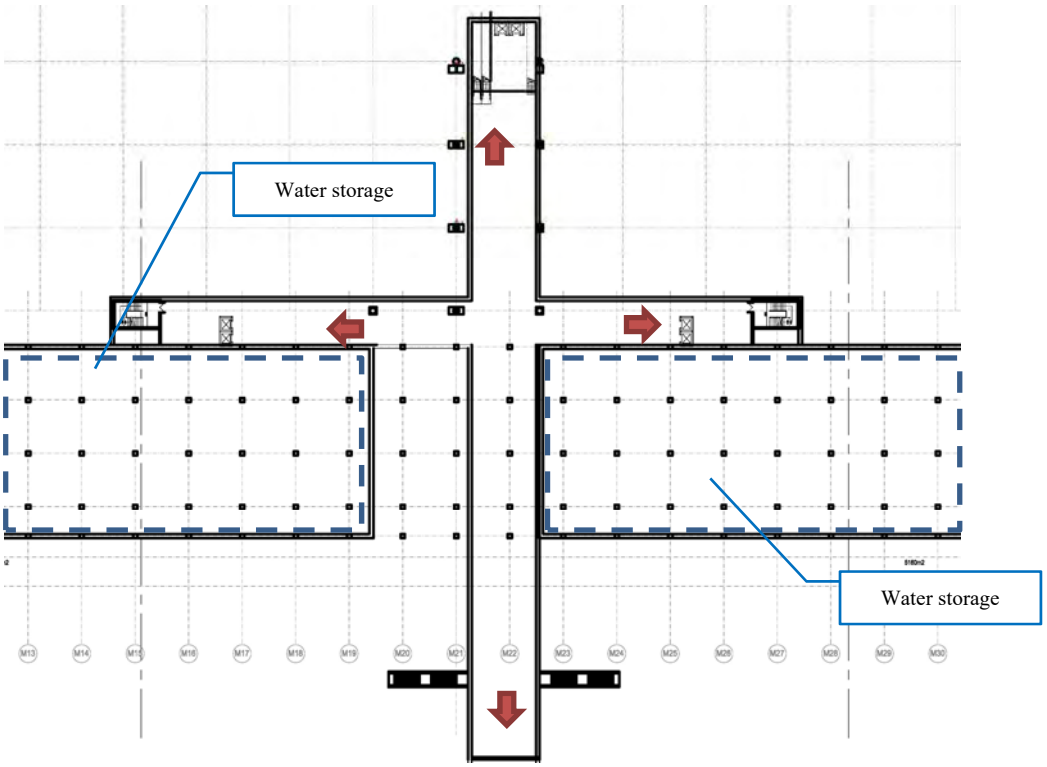
Figure 10-25 Cross Section of Underground Pedestrian Corridor

The level of the underground concourse is considered to be the same as the basement floor in the terminal building based on the original design of the terminal building; however, it will be necessary to coordinate with the underground water storage and design level of BRT/MRT. In this case, the underground water storage shall be designed as two separated tanks and requiring consideration of the details of the water storage system. Another option is to set the level of the underground concourse under the water storage; however, the depth will be required to be around 10 m deep. Considering the additonal cost, construction schedule, and waterproofing issues, this option is not suitable. In the meeting with CAAB held on 6th Feb 2017, JICA Study Team explained the above and confirmed to continue the detailed design in the next stage.



Source: JICA Study Team

Figure10-26 Layout of Parking on the Ground Floor



Source: JICA Study Team

Figure10-27 Layout of Parking on the Underground Floor

(3) Future Tasks

In the detailed design stage of this project, it is necessary to examine the design and location of the underground pedestrian corridor while adjusting with MRT line 1 project.

10.7 Apron (Terminal 3 Area)

New apron area for T3 is designed as follows based on the existing master plan in the view of reduction of construction period and quality assurance.

(1) Consideration for Apron Spot Location

In this survey, apron spot location is reconsidered based on the reviewed demand forecast and phasing development for T3.

(2) Consideration for Cost Reduction by Reviewing Pavement Structure

In the existing master plan, the bending strength of apron pavement structure is 4.5 N/mm2. On the other hand, there is a possibility to reduce of cost and shorten the construction period in the case of application of the bending strength of the japanese design standard, since the bending strength of the japanese design standard is 5.0 N/mm^2 and it can thin the thickness of apron pavement. However, since it is difficult to manufacture the concrete which has high bending strength such as 5.0 N/mm2 in Dhaka, it is necessary to confirm the possibility of procurement of it through the hearing to japanese company in Dhaka. If it can reduce the cost, the pavement structure should be modified.

(3) Consideration for Apron Structure

1) Design Criteria

Design criteria is primarily based on the master plan design criteria and the air traffic movement is based on the adjusted demand by this study.

Design Year: 20 years for apron and 10 years for apron shoulder

Design CBR: 7%

Pavement Thickness: Calculated based on AC150/5320-6F and FAA RFIELD

2) Design Air Traffic

Based on the adjusted aircraft movement forecast in this survey, the aircraft traffic volume for apron pavement design is shown in Table 10-6. The design period for apron pavement is 20 years, from 2016 to 2035.

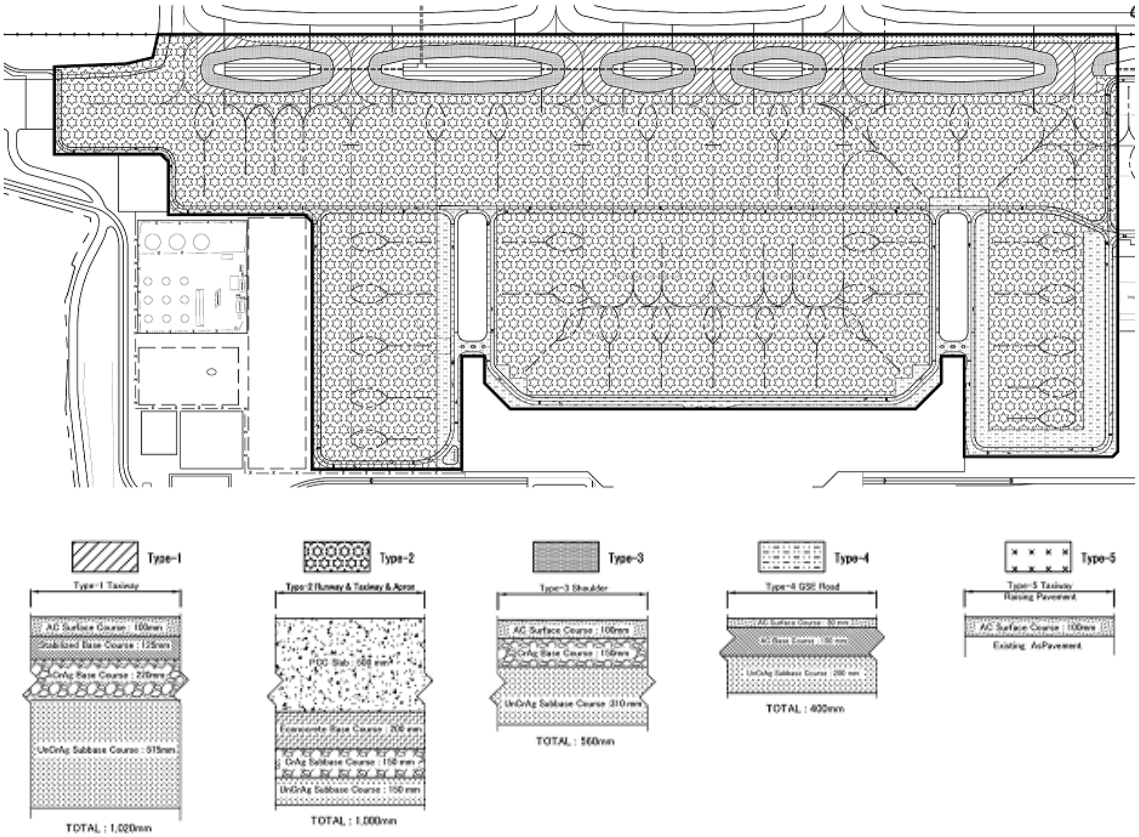
Table 10-7 AircraftTraffic Volume for Apron Pavement Design

ICAO Aerodrome Reference Code (Aircraft Type)	Total Departure andArrival (from 2016 to 2035)			Total Departure	Average Annual Departure for 20 years (number per year)	Input
	Domestic (20 years)	International (20 years)	Total (20 years)			Design Traffic Volume (number per year)
B (Small Propeller)	676,723	0	676,723	338,362	16,918	16,918
C (Turboprop)	250,587	147,124	397,711	198,855	9,943	9,943
C (Small Jet)	325,625	608,047	933,672	466,836	23,342	23,342
D (Medium Jet)	0	31,064	31,064	15,532	777	777
E (Large Jet)	0	751,448	751,448	375,724	18,786	18,786
F (A380)	0	15,532	15,532	7,766	388	388
Total	1,252,936	1,553,215	2,806,151	1,403,075	70,154	70,154

Source：JICA Study Team

3) Pavement Thickness

Pavement thickness is calculated by pavement program, FAA RFIELD v1.41 - Airport Pavement Design. The pavement thickness is different from the thickness in the master plan under the same design condition. In the detailed design, the pavement thickness should be recalculated.



Source: JICA Study Team

Figure10-28 Pavement Type of Apron

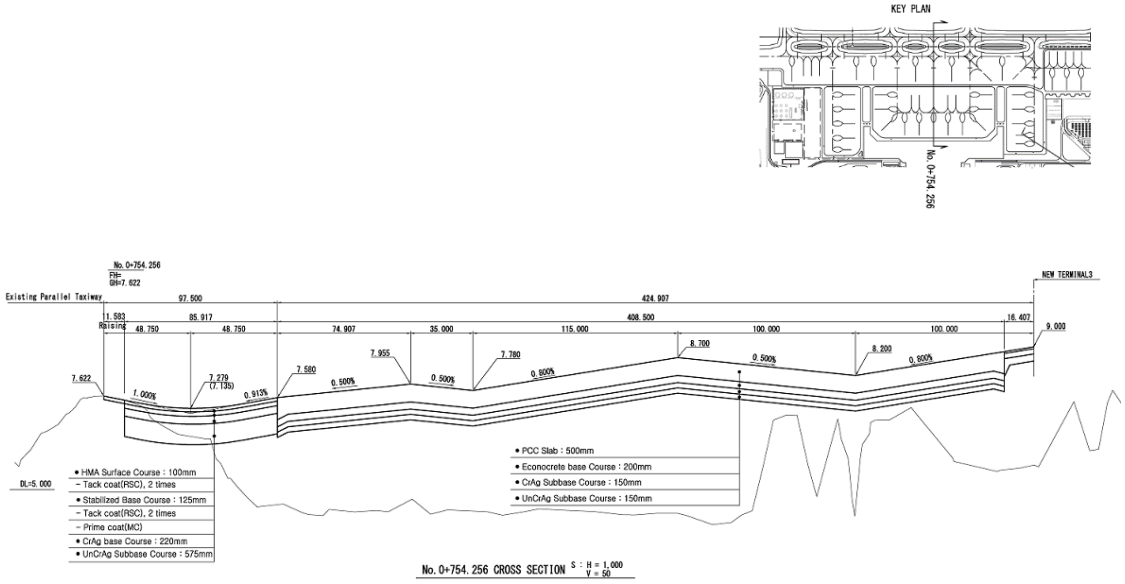
4) Longitudinal and Cross Section

The slope of apron follows the ICAO standards.The design slope of apron is as follows:

Apron: max 1.0%

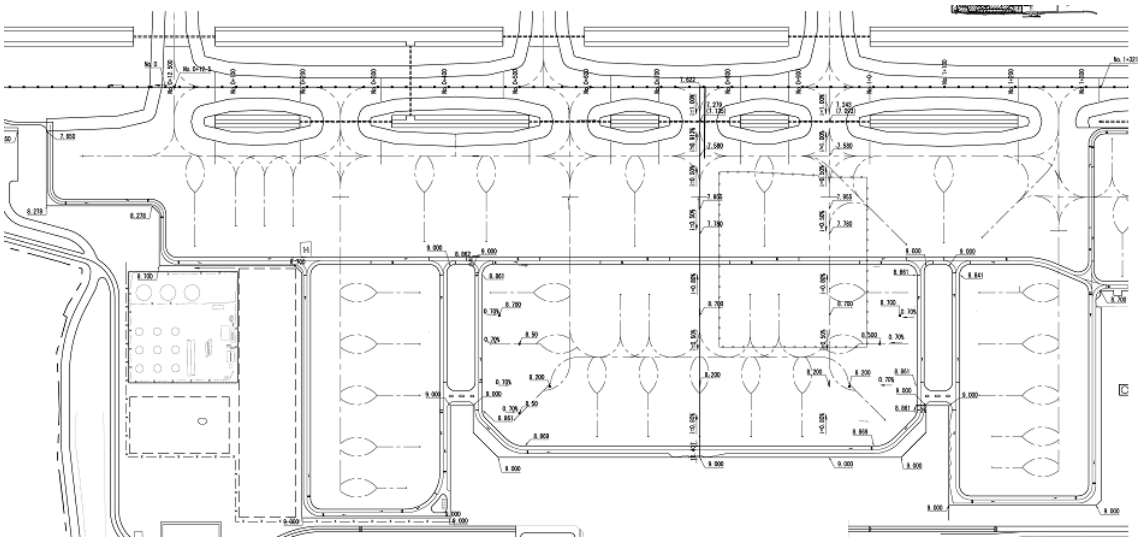
Apron shoulder: max 2.0%

Longitudinal slope: 0.5% to 1.0%



Source: JICA Study Team

Figure10-29 Apron Profile



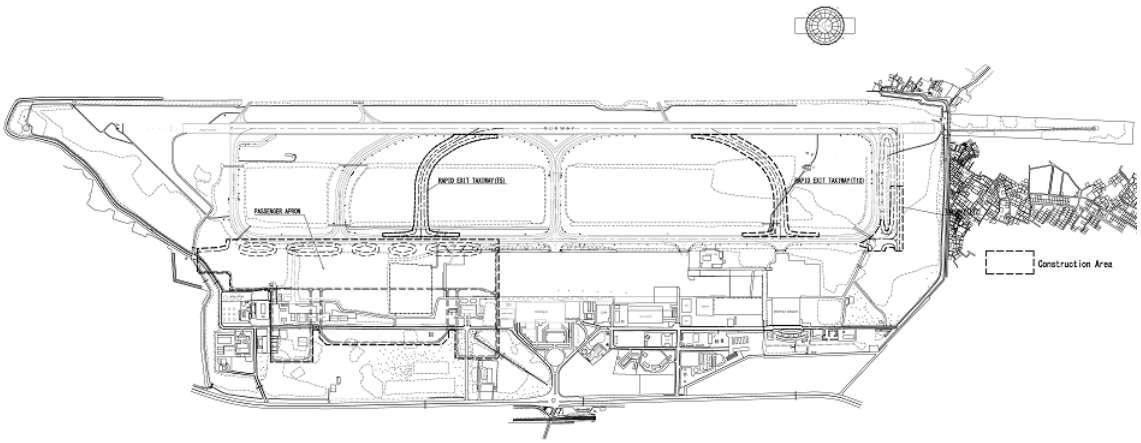
Source: JICA Study Team

Figure10-30 Apron Slope Plan

10.8 Taxiway

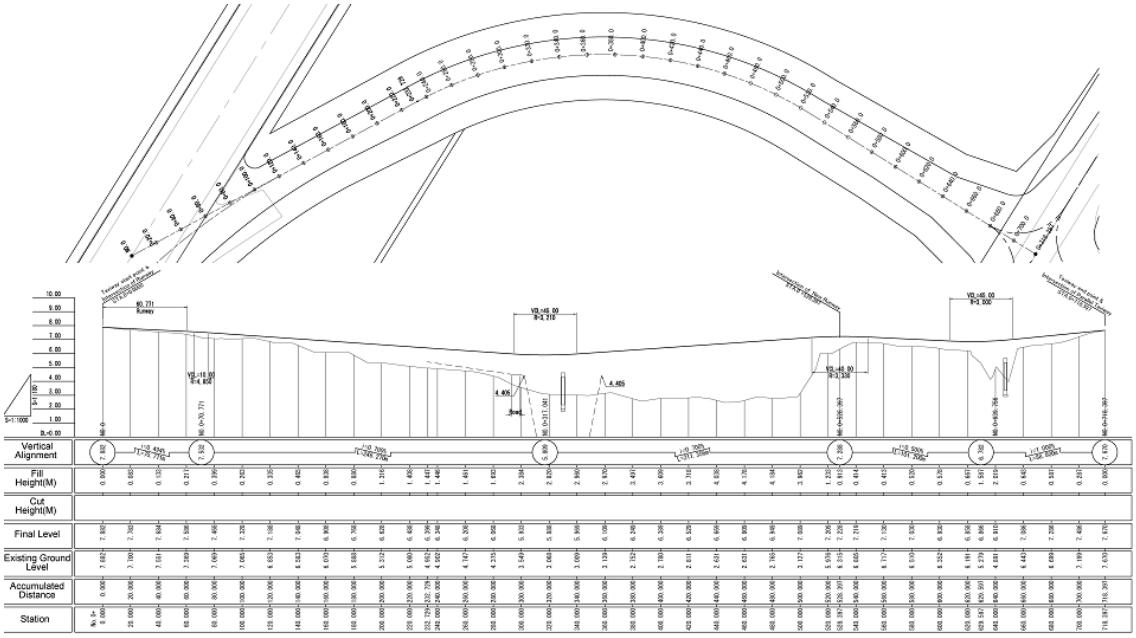
In the existing master plan, a trafic volume for pavement design of rapid exit taxiway and connecting taxiway is same as the runway pavement. It is possible to reduce the pavement thickness of connecting taxiway since the traffic volume of connecting taxiway may be reduced dependng on connecting location. In the detailed design stage of this project, it is necessary to recalculate the traffic volume and examine the pavement structure of the connecting taxiway taking into account the reviewed demand

forecast results.



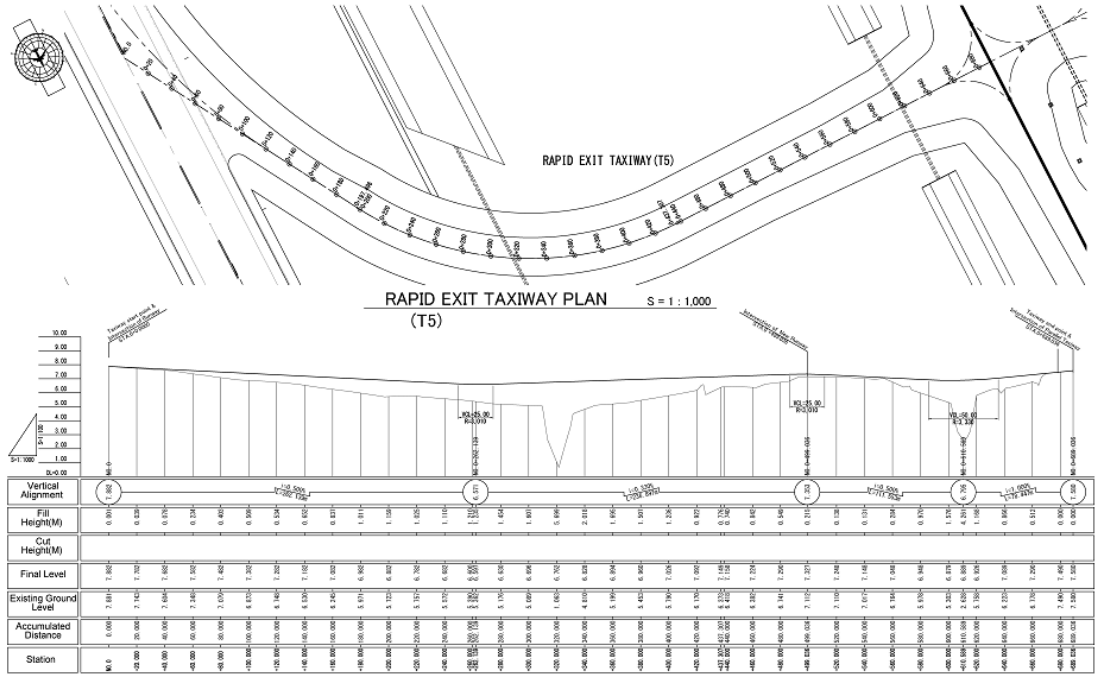
Source: JICA Study Team

Figure10-31 Taxiway Layout Plan



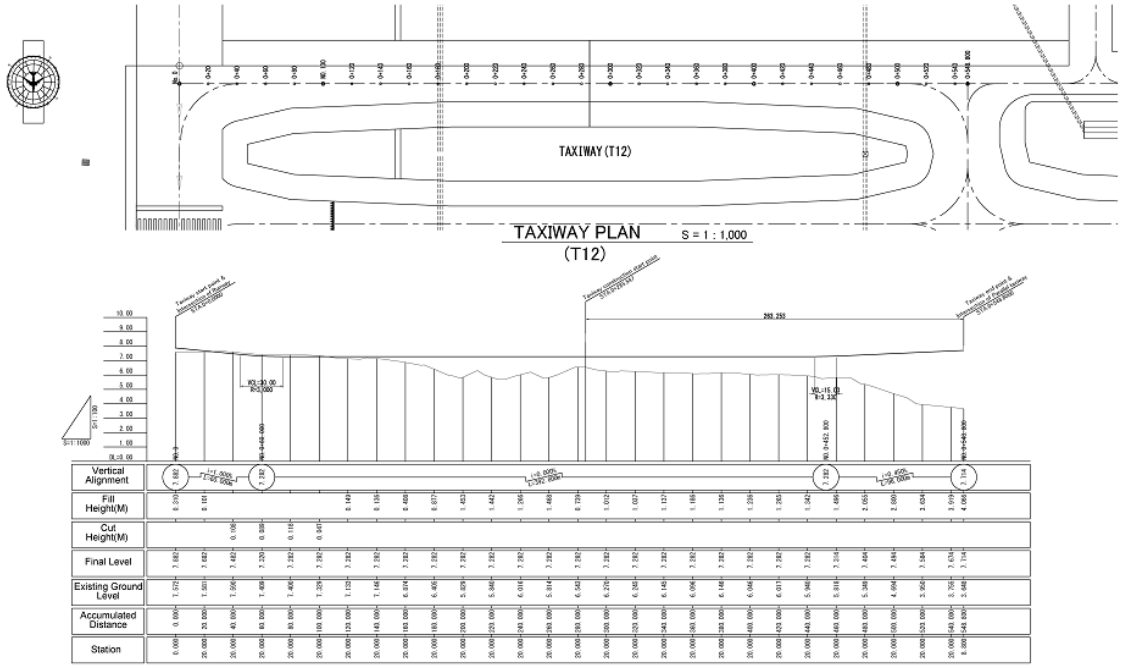
Source: JICA Study Team

Figure10-32 Rapid Exit Taxiway (North) Profile



Source: JICA Study Team

Figure10-33 Rapid Exit Taxiway (South) Profile



Source: JICA Study Team

Figure10-34 Runway End Taxiway Profile

10.9 Internal Road and Bridge (Elevated Road)

10.9.1 Internal Road

(1) Basic Policy

- ✈ Road facilities should ensure safe and smooth traffic.
- ✈ Possible higher service level should be provided in a limited landside space.

10.9.2 Road Classification and Component of Cross Section

(1) Road Classification

Table 10-8 Proposed Road Classification

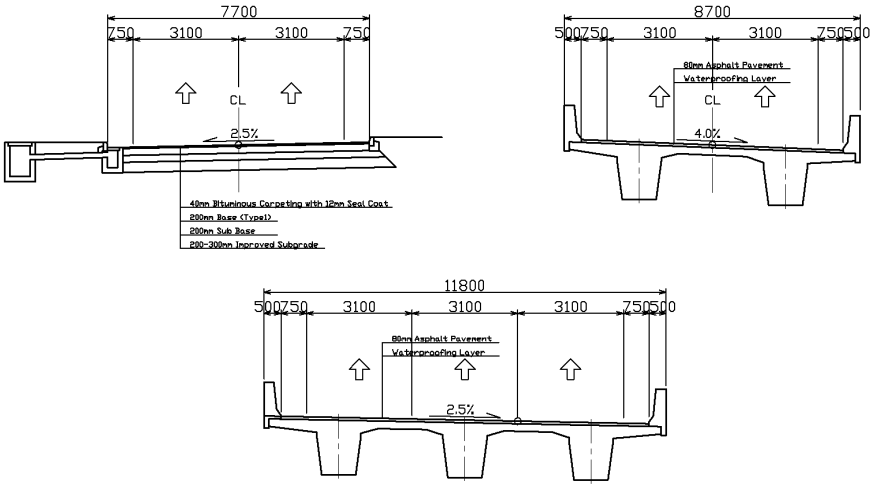
Parameter		Bangladesh			Asian Highway		Japan		Proposed
Road Classification		Type3	Type4	Type5	Class2	Class3	3-2	Ramp-B	
Design Speed	km/h	50-80	40-65	30-50	40-80	30-60	40-60	30-60	40 km/h
Lane Width	m	3.65	3.1	2.75	3.5	3.0 (3.25)	3.25-3.5	3.25	3.1 m*1
Shoulder	m	1.5	1.5	1.2	2.0-2.5	0.75-2.0	L:0.5-1.0 R:0.5-0.75	L:1.5 R:0.75	0.75 m*2
Crossfall	%	---	---		2	2-5	1.5-2.0	1.5-2.0	Standard: 2.5% *3 Kerbside:1.0%
Headroom	m	5.7			---		4.5		5.7 m
Footpath Width	m	(2)					2.0-4.0		2-3 m

*1: Lane width, although wide width is desirable, 3.1 m is adopted in the limited landside space in consideration of multi-lanes and track width.
*2: Shoulder, a reduced value is adopted for compactness, and 0.75 m should be provided for inspection and emergencies.
*3: Crossfall, 2.5% is adopted similar to that of standard road in Bangladesh.
Source: JICA Study Team

(2) Cross Section

1) Access / Approach Road

The cross section of an access/approach road is shown below. In case of one-lane roads, the width of carriageway including shoulder of more than 6 m should be provided for passing of an emergency vehicle.

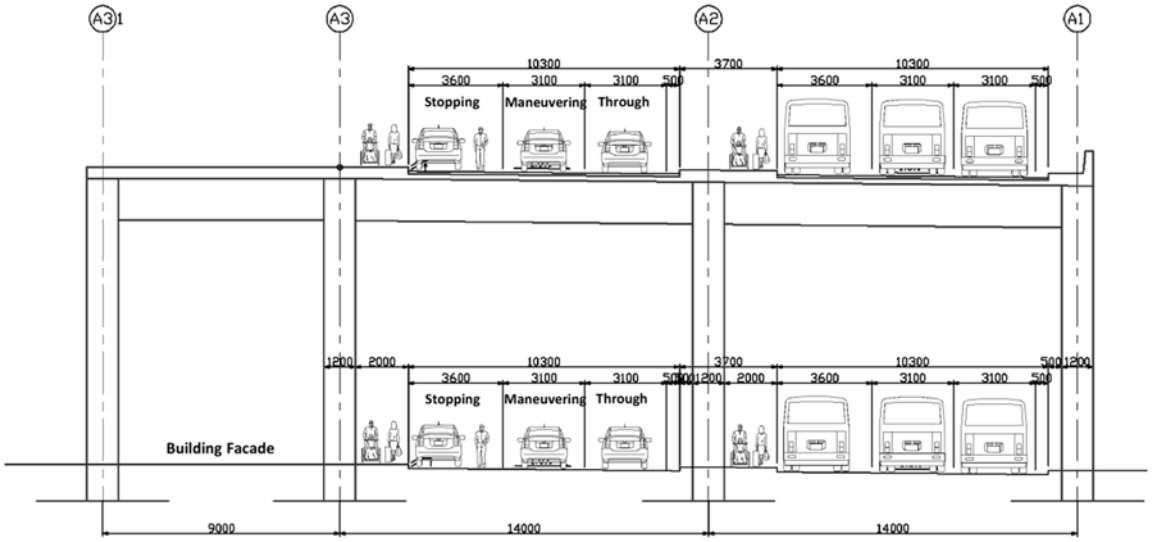


Source: JICA Study Team

Figure 10-35 Cross Section of Access / Approach Road

2) Curbside

Departure and arrival floors are each provided with two kerbsides for smooth traffic at peak hour. Each kerbside consists of three lanes for stopping, through traffic and maneuvering. In the stopping lane, wide width should be provided for stopping to let people get on and off and baggage handling. In a footway, width of more than 2 m should be provided in the resticted space around columns for passenger traffic and visibility.



Source: JICA Study Team

Figure 10-36 Cross Section of Curbside

(3) Geometric Design Standards

The geometric design standards corresponding to design speed is shown below.

Table 10-9 Geometric Design Standard

Item			Design Speed			Summary
			40km/h	30km/h	20km/h	
Sight Distance		SSD	45m	30m	(20m)	GDS/Table 2.3*1
Horizontal Alignment	Minimum Curve Radius	---	65m	35m	---	GDS/Table 2.3
		i=4%	67m	38m	17m	R = V^2 / 127 (i+f)
		i=2%	75m	42m	19m	f = 0.15
		i=0%	84m	48m	21m	
		i=-2%	97m	55m	25m	
Vertical Alignment	Maximum Vertical Gradient	I	Rolling: 5% Hilly: 7%			GDS/Table 6.3
	Minimum Vertical Curve	K-value	SSD: 4 (ISD: 9)*2	SSD: 2 (ISD: 4)	---	GDS/Table 6.1
	Minimum Vertical Curve Length	VCL	20m	15m	---	GDS/Table 6.2
	Maximum Change of Grade Permitted Without Use of Vertical Curve		1.2%	1.5%	---	GSD/Table 6.2

*1: GDS: Geometric Design Standards / Oct 2000 / Roads and Highways Department
*2: SSD: Stopping Sight Distance, ISD:Intermediate Sight Distance
Source: JICA Study Team

1) Horizontal Alignment and Superelevation

- Minimum curve radius is decided in consideration of superelevation and skid friction (f= 0.15).
- Superelevation is maximum 4% for comfort and cargo collapse of low-speed vehicles.

2) Extra Carriageway Width on Curves

The curve radius which is required by a track width of 3.1 m is 15 m for microbus and 60 m for large bus. According to the airport access traffic forecast, small vehicles and vehicle smaller than a microbus have a share of 98%. If a mega bus enters, the traffic effect will be small for multilanes. On the other hand, since road alignment has the continuous curve of multilanes and diverging/merging, the shift of extra width is complicated in the widening for each curve. Thus, standard lane width of 3.1 m is deemed to include widening. In addition, in a small curve and junction corner, carriageway width including road shoulder should consider track width. In that case, margin of more than 50 cm should be ensured.

Table 10-10 Track Width on Curve

Track Width on Curve

U = u + R − (R^2 − Σ Li^2)^(1/2) AASHTO 3.3.9 Offtracking

	Design Vehicle	Passenger Car	Micro Bus	Large Bus	Mega Bus
Size (m)	Vehicle Width : u	1.7	2.0	2.5	2.55
	Vehicle Length : L0	4.7	7.0	12.0	14.0
	Wheelbase : L1	2.7	3.7	6.5	7.4
	F. Overhang : L2	0.8	1.2	1.5	2.7
Track Width : U (m)					
R (m)	15	2.11	2.82	4.81	6.46
	20	2.01	2.61	4.17	5.29
	25	1.95	2.48	3.81	4.68
	30	1.90	2.40	3.59	4.30
	35	1.88	2.34	3.43	4.04
	40	1.85	2.30	3.31	3.85
	45	1.84	2.27	3.22	3.70
	50	1.82	2.24	3.14	3.58
	60	1.80	2.20	3.04	3.41
	70	1.79	2.17	2.96	3.28
	80	1.78	2.15	2.90	3.19
	90	1.77	2.13	2.86	3.12
	100	1.76	2.12	2.82	3.06
	150	1.74	2.08	2.71	2.89
	200	1.73	2.06	2.66	2.81

Note: Radius R is shown outside line of curve.

Source: JICA Study Team

3) Vertical Alignment

In case of vertical gradient of 5%, the alignment planning is difficult due to restrictions in landside space. Although it is a maximum 7% on the design standard, maximum 6% was adopted for smooth traffic of large vehicles in this study. In addition, HSIA desires a maximum 5%, and that adjustment will be studied in the detail design. The vertical curve radius, SSD (Stopping Sight Distance) and ISD (Intermediate Sight Distance) are shown on the Design standard. Since the Access/Approach road is one way traffic, adoption of the SSD value will be appropriate. In addition, in the case of a small gradient difference (1.2%) in a ground level road, the vertical curve is omissible based on the design standard.

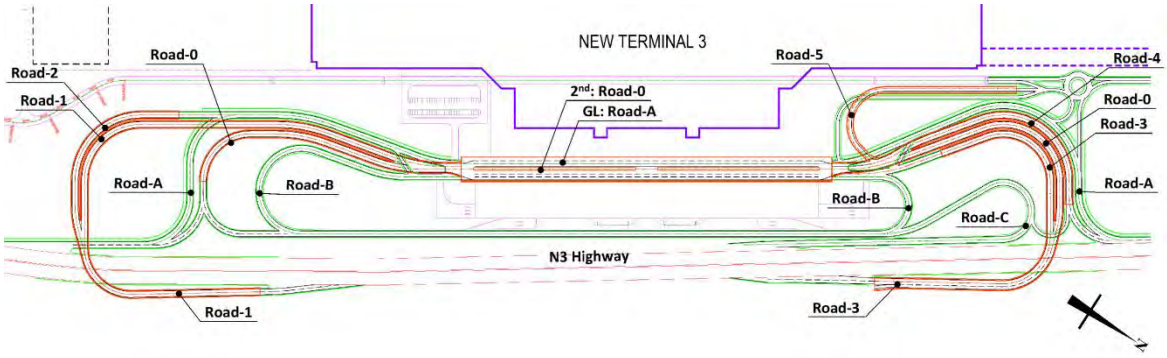
(4) Road Alignment Planning

The access/approach road is constituted by nine roads from Road-0 to Road-5 and Road-A to Road-C.The road alignment should promote route continuity and harmony of horizontal and vertical alignment. It should be decided in consideration of smooth and safe traffic, facilities layout, and landscaping. Especially, since internal road has many diverging/merging sections, suitable visual guidance and diverging interval should be provided for drivers unfamiliar with layout. Each road and horizontal alignment are shown below.

Table 10-11 Access / Approach Road List

Road	Function	Summary
Road-0	Elevated Approach Way to Departure	Road-A > Departure >Road-3
Road-1	Entrance Access Way Elevated Approach Way to Departure	Entrance HW North > Cross HW> Departure
Road-2	Elevated Approach Way to Arrival	Road-1 >Road-A > Arrival
Road-3	ExitAccess Way Elevated Approach Way from Arrival	Arrival> Cross HW> Exit HW South
Road-4	Elevated Approach Way from Departure	Departure >Road-0>Road-A
Road-5	Elevated Approach Way from Termainal 1 / Terminal 2	Terminal 1/Terminal 2 > Road-0
Road-A	Entrance / ExitAccess Way Approach Way for Arrival	Entrance HW South > Arrival> Exit HW North
Road-B	CirculationWay	
Road-C	Entrance Access Way from DEE	Entrance DEE-Exit > Road-B

Source: JICA Study Team



Source: JICA Study Team

Figure 10-37 Access / Approach Road Layout

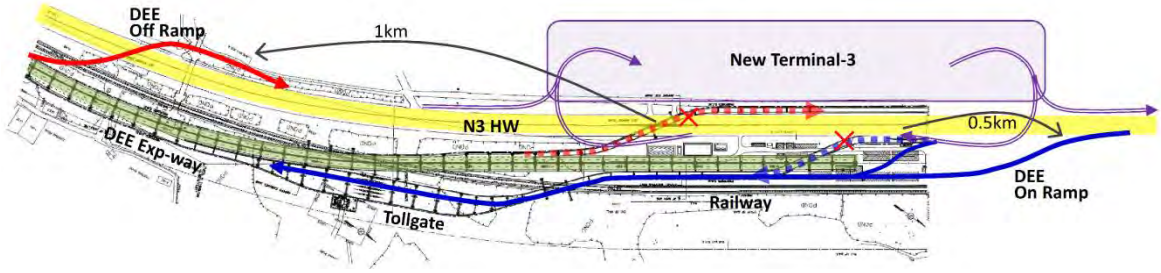
(5) Footpath

The footpath is allocated on the left side (airside) of Road-A for pedestrians from the outer side the airport, such as the highway.Width of 2-3 m should be provided in consideration of pedestrian with baggage.

(6) Access with DEE

The entrance/exit ramp in Dhaka Elevated Expressway (DEE) is planned to be linked near to the existing airport. On the other hand, the entrance ramp from the north for Terminal 3 access interferes with the DEE exit ramp, and the exit ramp to the south interferes with the DEE entrance ramp. According to the master plan in 2015 and feasibility survey, a layout which shifts the DEE exit ramp to the south by 1 km and the entrance ramp to the north by 0.5 km is recommended. However, since the DEE project is already under construction, the replanning of the access method of Terminal 3 and DEE is required. Thus, examination of alternatives was carried out regarding the connection method with DEE.

As a result, the consultant proposed "Alt-2A:Shift Terminal 3 access ramp to the south and U-turn road" as for the connection method with DEE for traffic safety and economy.



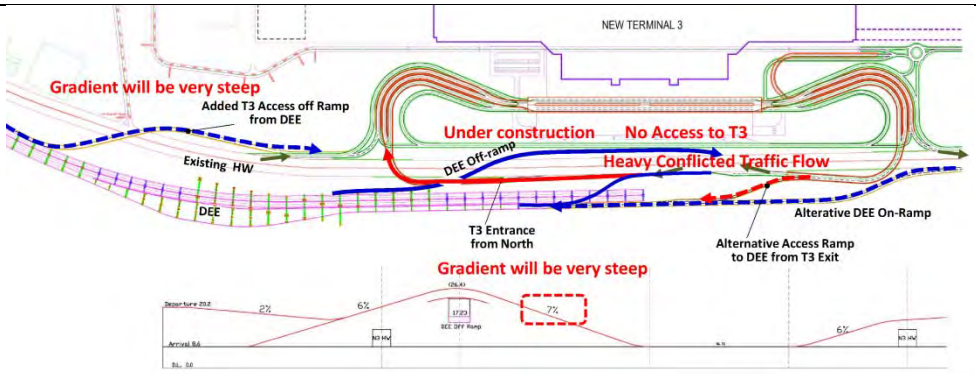
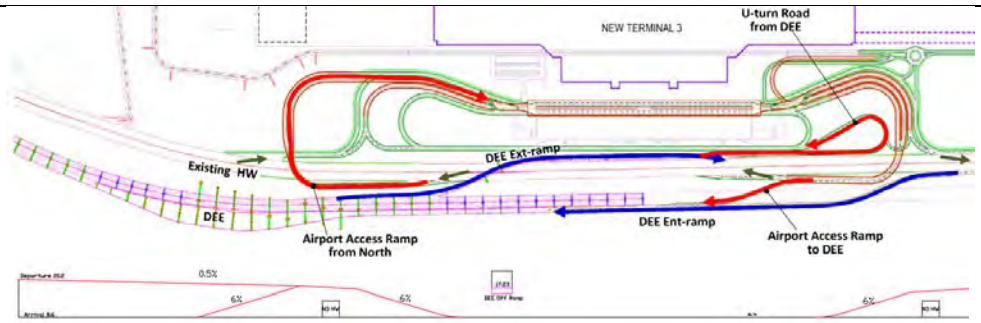
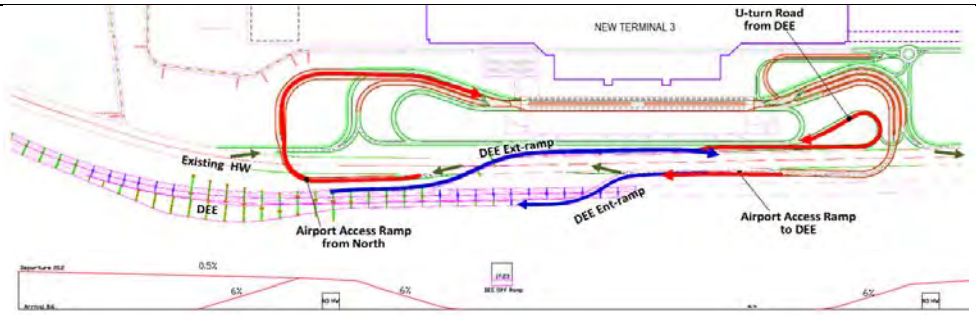
Source: JICA Study Team

Figure 10-38 Proposed Ramp Shift in Master Plan

Source: JICA Study Team

Figure 10-39 DEE Layout and Construction Situation Near Airport

Table 10-12 Alternatives of Connection Method with DEE

Alternative	Plan and Outline
Alt-1 Adds Access Ramp in South & Crosses over DEE	 • T3 access ramp from DEE is added in Airport Southside. • Access ramp from North is crossed over DEE Ext-ramp. • DEE entrance from North is shifted to Northside.
Alt-2A Connects by U-turn Road, Shift T3 Ent to South, & Shift DEE Ent Ramp to North	 • Access ramp from North is shifted to Southside. • Traffic to T3 from DEE is accessed using U-turn road in internal area. • DEE entrance from North is shifted to Northside.
Alt-2B Connects by U-turn Road & Shift T3 Ent to South (Original DEE Ent Ramp)	 • Access ramp from North is shifted to Airport Southside. • Traffic to T3 from DEE is accessed using U-turn road in internal area. • DEE entrance from North is used in original design.

Source: JICA Study Team

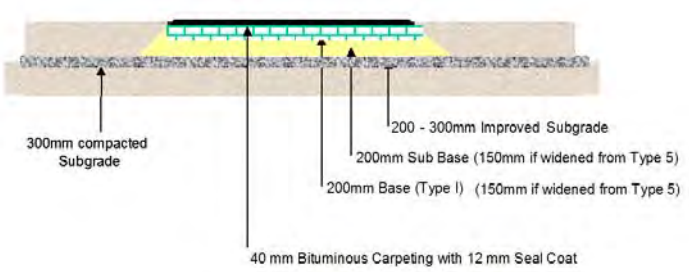
Table 10-13 Comparison of Alternatives

Alternative	Structure	Safety	Comfortable	Cost	Evaluation
Alt-1 Adds Access Ramp in South & Cross over DEE	★ Addition and widening DEE ramp. Extended high and long T3 ramp.	★ Long steep gradient 7% Small curve from down straight Heavy conflict traffic flow	★★ Uncomfortable long ramp.	★★ Extended T3 ramp 250m (Added ramp 400m)	
Alt-2A Connects by U-turn Road, Shift T3 Ent to South, & Shift DEE Ent Ramp to North	★★ Simple U-turn road of ground level. Indirect T3 Ramp	★★★ good	★★ Indirect and small U-turn curve.	★★★ Sifted T3 ramp 160m	Recommend (Requires relocation of DEE entrance)
Alt-2B Connects by U-turn Road & Shift T3 Ent to South (Original DEE Ent Ramp)	★★ Simple U-turn road of ground level. Indirect T3 Ramp.	★★ Conflict traffic flow	★★ Indirect and small curve.	★★★ Sifted T3 ramp 160m	

Source: JICA Study Team

(7) Pavement Design

Pavement design should be decided in consideration of the designed traffic volume, vehicle weight, and subgrade condition. Bridge surface pavement should be studied including installation of the layer of leveling and waterproof in a detail design phase. The standard pavement design of Type 3-4 on RHD is shown below.



Source: JICA Study Team

Figure 10-40 Standard Pavement Design of Type3-4 on RHD

(8) Issues for the Detail Design

- ✈ Road alignment was planned based on new T3 terminal of the basic design 2015 in this survey. In a detail design, the benchmark coordinate and elevation should be adjusted with new T3 building, the existing road, and DEE.
- ✈ Horizontal alignment should be examined in the detail design to adjustment such as a transition curve and improvement of diverging / merging.
- ✈ Adjustment of vertical gradient to accommodate CAAB request for maximum 5% should be studied in the detail design.
- ✈ The layout of DEE entrance ramp should allow for maximum weaving length

possible from the existing junction of T1 / T2.
- The northern section of DEE entrance ramp is not a DEE project but the DAEE (Dhaka Ashulia Elevated Expressway) project. In the detailed layout, adjustment with DAEA will be required.
- Bridge surface pavement should be studied including installation of the layer of leveling and waterproof in a detail design phase.

10.9.3 Bridge (Elevated Road)

(1) Basic Policy

Elevated roads are composed of two access bridges which cross the existing N3 expressway, and six approach bridges linked to each kerb of arrival (ground floor) and departure (second floor).

- The bridge planning should be adapted to conditions such as road alignment, topography, geology, weather, and any crossing.
- The pier layout should consider visibility (safety) and transparency (comfort) in addition to road layout.
- The bridge type should be decided in consideration of structure, construction, durability, landscape, and economy.
- The road layout on the ground should be adjusted to account for bridge structure, if needed.
- The continuous girder should be adopted for dynamics rationality and traffic comfort.

(2) Design Standard

The bridge design standard is decided based on the bridge design standard of Bangladesh and additionally refer to AASHTO and Japanese standards. Design live load is based on AASHTO, and IRC will be taken into consideration if needed. The applied design standard and design live load are as follows:

- Design Standard
  - Bridge Design Standards / Jan 2004 / Roads and Railways Division
  - AASHTO LRFD
  - Specification for Highway Bridges / Japan Road Association
- Design Live Load
  - AASHTO HS20-44, IRC Class-A

(3) Span Arrangement

The standard horizontal offset distance between a pier and a carriageway is 1.5 m. In case unavoidable, safety facilities such as guard fence and bollard should be installed for pier column guard and driver safety. The main crossing conditions are as follows:

Table 10-14 Crossing Condition

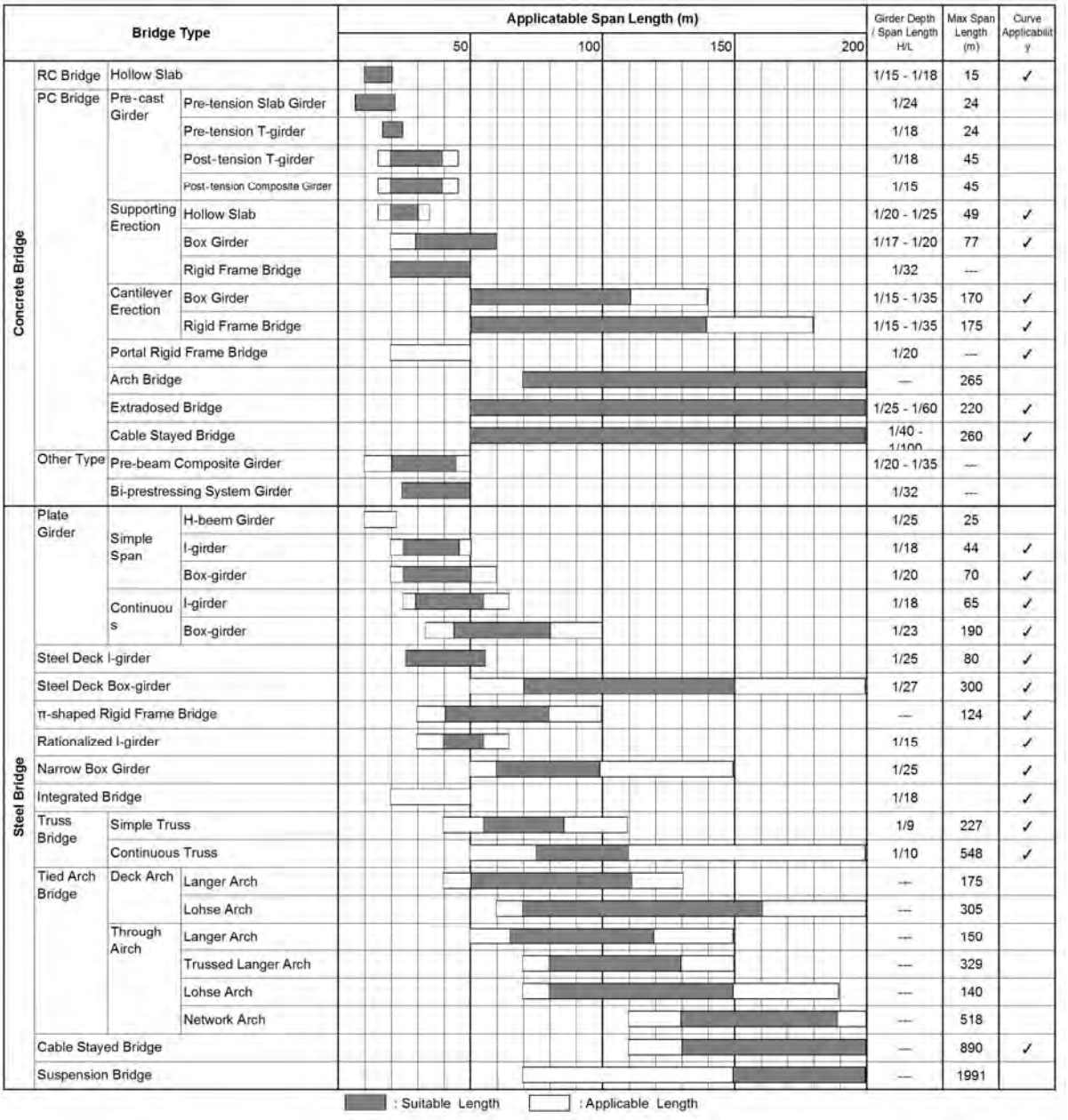
Name	Width	Headroom	Remarks
1) Dhaka-Mymensingh HW	30 m	5.7 m	N3 National HW/RHD, 8-lane
2) Internal Road	6-8 m	5.7 m	Proposed ground level road

Source: JICA Study Team

(4) Bridge Type

1) General

In bridge type selection, a standard type is first picked out based on applicable condition such as span length and curve. The suitable bridge type will be selected through comparison analysis. The standard bridge type and applicable span length are shown below.



Source: MLIT of Japan

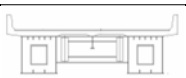
Figure 10-41 Bridge Types and Applicable Span Length

2) Comparison of Bridge Type

The bridge section has structure characteristics such as loop ramp with a small curve, diverging, and changing width. As for the construction conditions, although new Terminal 3

landside area can be used as a construction yard, the existing traffic should be ensured in the highway crossing. An applicable bridge type is picked out based on the above characteristic conditions, and comparison analysis was carried out in consideration of structure, construction, maintenance, visual, and economy.

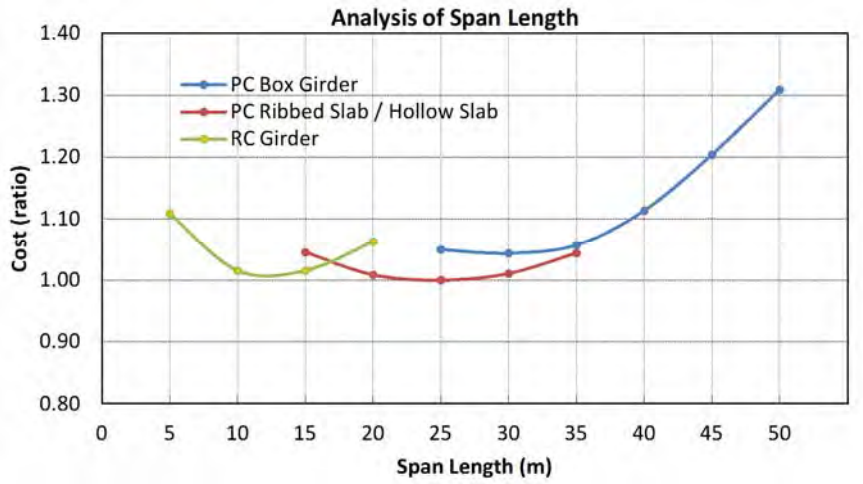
Table 10-15 Comparison of Bridge Type

Bridge Type	Cross Section / Span Length	Structure	Construction	Maintenance	Visual	Economy	Evaluation
Pre-cast PCT-girder	 L=16-40 m	★ Problem girder layout	★★★ Short period	★★★ No painting	★ Complicated	★★★ Good	
PC Hollow Slab	 L=20-30 m	★★	★ Problem of floating void	★★ Inspection of inside the void	★★★ Slender	★★★ Good	
PC Ribbed Deck	 L=20-30 m	★★	★★	★★★ No painting	★★	★★★ Good	Recommended
PC Box Girder	 L=30-60 m	★★	★★	★★★ No painting	★★	★★ Fair	Recommended for cross HW
Steel Box Girder	 L=40-80 m	★★	★★★ Short period	★ Repainting	★★	★ Costly	

Source: JICA Study Team

3) Analysis of Span Length and Cost

The analysis of span length and cost including substructure and foundation was carried out for each bridge type. The trend lines of the result is shown in the following figure.

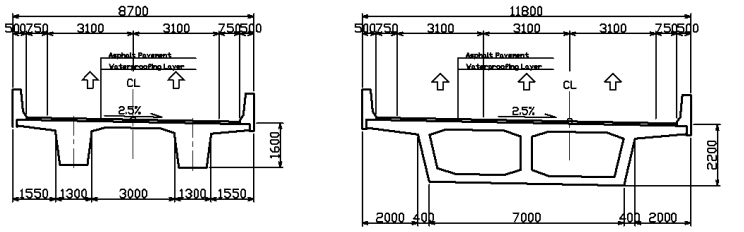


Source: JICA Study Team

Figure 10-42 Analysis of Span Length and Cost

4) Proposed Bridge Type

The consultant proposes "PC Ribbed Deck" with span of about 25 m in the standard section without restrictions. For the section over 40 m in span crossing over the existing highway, "PC Box Girder" is adopted.



PC Ribbed Deck PC Box Girder

Source: JICA Study Team

Figure 10-43 Cross Section of Proposed Bridge Type

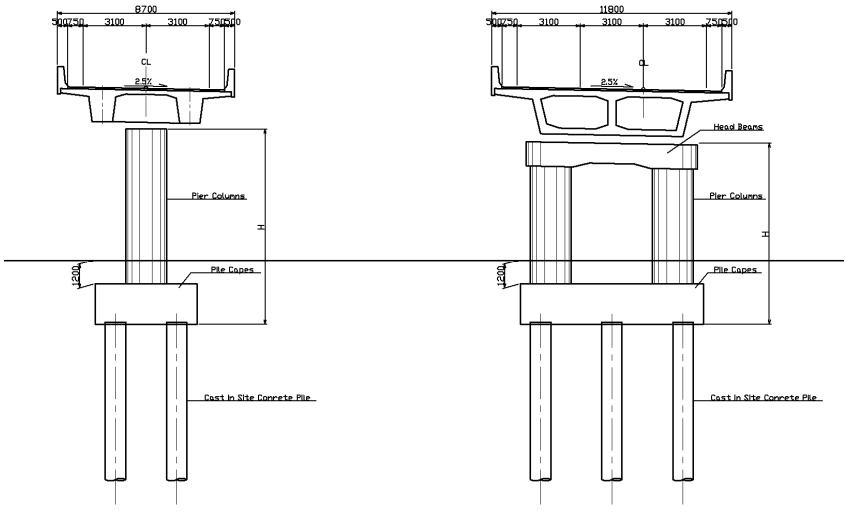
5) Erection Method

The erection method is cast in place concrete with support. As for the highway crossing, traffic restriction such as low clearance (bent supporting 3.5-4 m) or temporary detour road will be required for the existing traffic.

(5) Substructure and Foundation

1) Pier

The elevated road shows a form such as a loop ramp bridge, and there are various ways of setting the direction of the pier. Thus, the circular column type concrete pier is proposed for similar appearance from all view. The earth cover of footing of 1.2 m should be provided for drainage and utility facility.

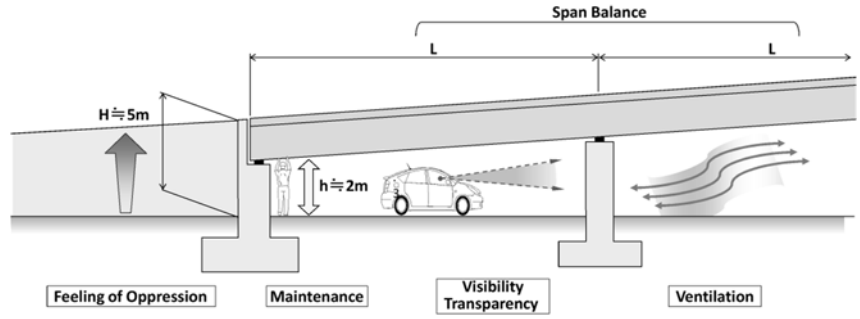


Source: JICA Study Team

Figure 10-44 Column Type Concrete Pier

2) Abutment

The inverted T-type abutment is adopted in consideration of the structure scale and foundation type. The landside environmental aspects such as drivers' visibility (safety), transparency (environment), and feeling of obstruction (visual intrusion upon the landscape) shall be fully considered. It should be noted that although the shorter bridge lengths have the advantage of favourable costs, in order to meet the above criteria, a setback of the abutment will have to be allowed for and in addition, a vertical clearance of about 2 m shall be secured under the superstructure for maintenance purposes.



Source: JICA Study Team

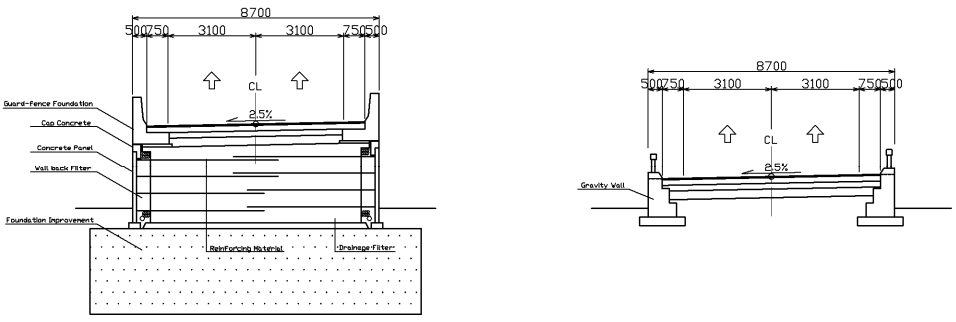
Figure 10-45 Abutment Position and Clearance

3) Bearing Layer and Foundation

According to the geological survey from the past projects, although an interlayer with N-value of more than 30 is rcorded, it does not have suitable continuity. Thus, in this study, S-4 layers (approximately GL-35 m) are thought to be the suitable bearing layer. The foundation type should be cast-in-place concrete pile D800-1200, which is suitable in consideration of structure scale. In addition, the pile length and diameter should be adjusted after detailed geological survey and selection of the terminal building foundation.

(6) Approach Embankment and Retaining Wall

Near the abutment backside, adoption of foundation improvement or earth replacement suitable for the ground situation is assumed for prevention of road surface difference with bridge. The approach embankment and retaining wall are shown below.



Source: JICA Study Team

Figure 10-46 Approach Embankment and Retaining Wall

(7) Issues for the Detail Design

- The topography of the landside has unevenness such as a pond, and the substructure is planned on the precondition such as a certain amount of embankment. The ground development in consideration of land use such as a terminal building, parking lot, and landscaping will be planned, thus the embedded depth of footing and foundation improvement of approach embankment should be studied.
- Additional geotechnical borehole survey based on bridge layout is desired, and the foundation pile should be detail studied based on that survey.

10.10 Water Treatment Plant

The following table and calculation of the required water supply volume at plant and plant facilities scale were prepared, since the exisiting water treatment plant does not provide the required water supply volume.

Raw water is collected and supplied from six deep well pumps. The water supply purification facilities shall be supplied and installed in line with the Bangladeshi water quality standard.

According to the specifications of CAAB, the sewage water volume of sewage treatment facilities is listed as follows:

VOLUME 5 OF 6: BUILDING WORKS DIVISION – 21

SPECIFICATION FOR WASTEWATER TREATMENT PLANT

Inflow Wastewater Characteristic

Black water	2,845	m^3/day
Grey water	655	m^3/day
Total wastewater flow rate	3,500	m^3/day
Peak duration	3	hours
Peak factor	3	
Average flow	145.83	m^3/hour

Black water is sewage water containing feces and urine discharged from toilets. Grey water is wastewater discharged from kitchen, pantry, and lavatory.

The quantity of water for processing by the sewage treatment facilities listed in CAAB specifications exceeds by approximately 20-40% compared with the processing quantity of water calculated from Japanese "building systems design standard" published by the Ministry of Land, Infrastructure, and Transport and in accordance with sections on "calculation of water supply" and Chapter 5 "wastewater treatment equipment", Section 1 "septic tank facilities", fifth "water supply and drainage sanitation", Chapter 1, Section 2, as well as in comparison with the septic tank disposal capacity of Ho Chi Minh's Tan Son Nhat Airport and Hanoi's Noibai Airport.

The septic tank inflow quantity of water and the equivalence of the specifications of CAAB made by this report are assumed and the processing quantity of water of water supply processing facilities is

calculated in proportion to the septic tank processing quantity of water. Because the processing quantity of water is deemed excessive, sewage treatment plant shall not provide for a spare system as is normal.

(1) Domestic Water Volume

The water supply facilities are targeted for the new buildings such as Terminal3, parking building, VVIP, cargo buildng, WTP, STP, fire station, power house, and the water supply to existing facilities such as catering facility, existing terminal, and control tower are not considered.

The water supply volume is calculated by the number of passengers, employees, pickup persons (pickup persons are not allowed free access to the arrival terminal building, but usage outside of the terminal building is assumed) and the use of staff such as in restaurants. In addition, it is necessary to add cooling tower make-up water for the air conditioning, faucet for the parking building car washing, and the make-up water for airplane.

The target number of people will be calculated from the projected passenger volume and the number of pick up people in existing reports.

After discussion with CAAB, the water supply was calculated separately for the number of employees and for the number of others for food preparation.

Table 10-16 Number of Pick Up Persons

	Passenger	Pick up	Pick up Ratio
CNG	1,992	10,274	5.2
CAR	12,825	29,476	2.3
Micro BUS	3,378	15,412	4.6
BUS	291	29,055	99.8
Total	18,486	84,216	4.6

Source: JICA Study Team

Table 10-17 Target Number of Water Users

Year		2025
Passenger		12,042
ATM	International	75,260
	International + Domestic	138,4600
Average Flights		207
Passenger	Peak Day Ratio	1/300
	Peak day passengers	40,138
	Peak Hour Ratio	0.1182
	Peak hour passengers	4,744
Pick up Persons		21,822
Staff	Terminal 3	3,320
	Cargo	1,200
	Other	1,762
WTP, STP Total		68,242

Source: JICA Study Team

Table 10-18 Food Preparation

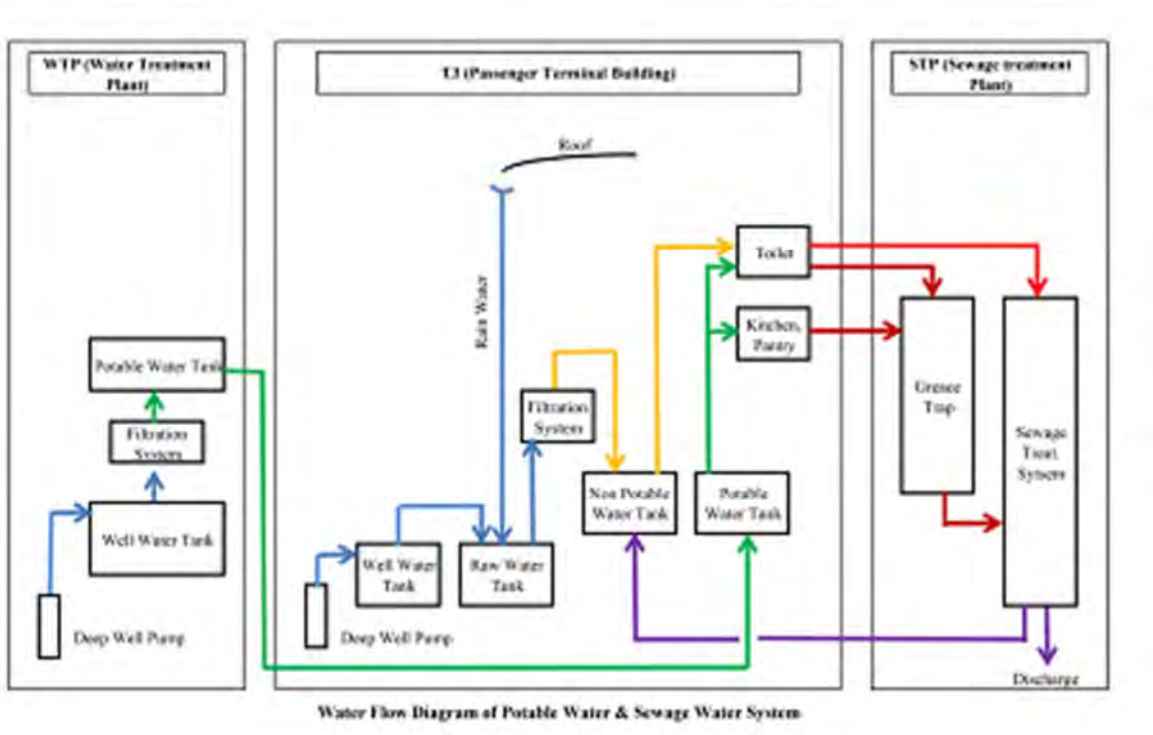
Item	Quantity	Base Water Use unit	Water Volume(m^3)
Passenger	40,138	40 L/man	1,606
Pick up persons	21,822	40 L/man	873
Staff	3,738	100 L/man	374
No. of restaurant	4,385	40 L/meal	171
Other	2,191		1,682
Total	72,274		4,706

※Others include cooling tower make-upwater, backwash water for filtration system in WTP, make-up water for the chemical feeder.
Source: JICA Study Team

Source: JICA Study Team

Figure 10-47 WTP Flow Sheet

- Raw water is obtained from six deep well pumps as mentioned in the specifications of CAAB.
- The storage water facilities are reserve facilities for water from deep well.
- The filtration facilities choose a filter device depending on raw water turbidity and do not install iron and manganese removal device because there are few cases where iron content and manganese content is mixed with the raw water
- The filtered water undergoes chlorination to maintain a value of residual chlorine.
- The water supply facilities install water pump and piping system to the necessary building.



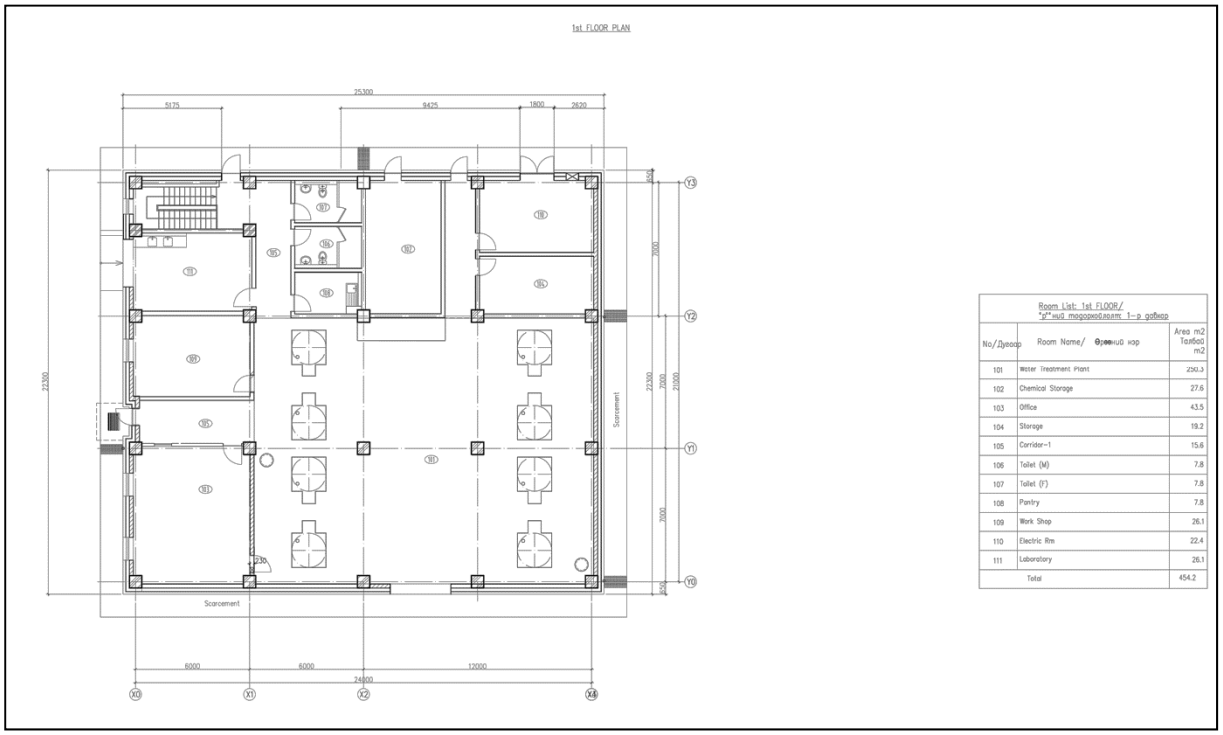
Source: JICA Study Team

Figure 10-48 Water Flow Diagram

Table 10-19 Design of Water Supply Amount

No.	Building Name	Description	Parameter	Numbers of Persons or Meals	Unit		Water Volume
					ℓ/person/day	ℓ/meals	(m3/day)
1	T3 Passenger Terminal Building	Passenger	Year 2025, Peak Daily Passenger	40,138	40		1,605.5
		Meeter and Greeter	Year 2025, Peak Daily Meeter and Greeter	21,822	40		872.9
		Office	Total Floor Area : 8,338m2 Occupant: 0.1 person/m2 8,338m2 x 0.1 x 2 shifts = 1,668	1,668	100		166.8
		Retail Shop	Total Floor Area : 7,842m2 Staff: 0.05 person/m2 7,842m2 x 0.05 x 3 shift=1,176	1,176	100		117.6
		Restaurants	Total Floor Area : 4,761m2 Staff: 0.05 person/m2 4,761m2 x 0.05 x 2 shift (avg.) = 476	476	100		47.6
			For Meal: Seating area: 60% of floor area No. of seat: 2m2/seat Turn-over: 3 times 4,761 x 0.6/2 x 3 = 4,285 meals	4,285		40	171.4
		Aircraft					67.0
		Sub Total					3,048.8
2	VVIP Terminal	Staff :	Office Floor Area : Total Floor Area 5% Occupant: 0.2 person/m2 5,000m2x0.05x0.2 = 50	50	100		5.0
		VIP & User	Toilet & Others	100	30		3.0
			Meal	100		40	4.0
3	Car Park	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		User	Meeter & Greeter : 5% 21822x0.05 =	1,091	20		21.8
4	Cargo Building	Staff :	Office Floor Area : Total Floor Area 2% Occupant: 0.2 person/m2 50,000m2x0.02x0.2 = 200	200	100		20.0
		Forwarder :		1,000	20		20.0
5	Fire Station	Staff :	Day Time : 50 Person, Night Shift : 30x2 Person	110	100		11.0
6	Power Station	Staff :	Day Time : 10 Person, Night Shift : 5x2 Person	20	100		2.0
7	STP (Sewage Treatment Plant)	Staff :	Day Time : 8 Person, Night Shift : 3x2 Person	14	100		1.4
		Plant :	Chemical Feeder & Others				10.0
8	WTP (Water Treatment Plant)	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		Plant :	Back-wash water & Others: 100 m3/day				100.0
		Total					3,249.4

Source: JICA Study Team



Source: JICA Study Team

Figure 10-49 Water Supply Equipment Layout

10.11 Sewage Treatment Plant

The sewage treatment plant is made based on the specifications in the basic design but considering the target processing material, there are many matters which need confirmation.

In the discussion with CAAB, the following matters are confirmed and assumed that the facilities will reflect these.

In addition, because the existing sewage treatment plant is reported to not operate smoothly, the sewage treatment plant for the whole airport was requested. However, it was decided to set the target facilities on the original scope because the request deviated from the conventional scope of JICA projects.

Since phosphorus and nitrogen are not prescribed as materials targeted under wastewater regulations, depending on the need, it is suggested to consider facilities which cope with these two materials in following recent trends in sewage treatment.

After confirming the existing sewage treatment plant from outside the facility, aeration processing space for the disposal of sludge was observed and a similar space will be secured for the new sewage treatment plant.

After the water supply capacity of the above was calculated, the necessary processing capacity was reduced for the make-up water or other water supply of the cooling tower for the air conditioning.

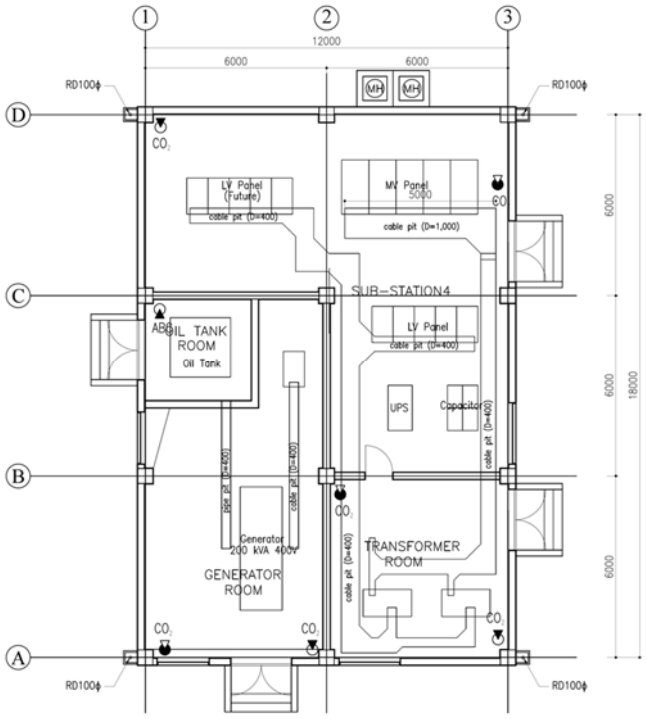
Based on the specifications of the CAAB, black water is the filthy water which is discharged from toilet, and grey water is wastage discharged from kitchen and canteen. Grey water shall be provided

with oil and grease trap to remove oils and fats prior to connection to the septic tank facilities. The expansion will only handle grey water in the future.

Table 10-20 Design of Sewage Treatment Amount

No.	Building Name	Description	Parameter	Numbers of Persons or Meals	Unit		Water Volume
					ℓ/person/day	ℓ/meals	(m3/day)
1	T3 Passenger Terminal Building	Passenger	Year 2025, Peak Daily Passenger	40,138	40		1,605.5
		Meeter and Greeter	Year 2025, Peak Daily Meeter and Greeter	21,822	40		872.9
		Office	Total Floor Area : 8,338m2 Occupant: 0.1 person/m2 8,338m2 x 0.1 x 2 shifts = 1,668	1,668	100		166.8
		Retail Shop	Total Floor Area : 7,842m2 Staff: 0.05 person/m2 7,842m2 x 0.05 x 3 shift=1,176	1,176	100		117.6
		Restaurants	Total Floor Area : 4,761m2 Staff: 0.05 person/m2 4,761m2 x 0.05 x 2 shift (avg.) = 476	476	100		47.6
			For Meal: Seating area: 60% of floor area No. of seat: 2m2/seat Turn-over: 3 times 4,761 x 0.6/2 x 3 = 4,285 meals	4,285		40	171.4
		Aircraft					67.0
		Sub Total					3,048.8
2	VVIP Terminal	Staff :	Office Floor Area : Total Floor Area 5% Occupant: 0.2 person/m2 5,000m2x0.05x0.2 = 50	50	100		5.0
		VIP & User	Toilet & Others	100	30		3.0
			Meal	100		40	4.0
3	Car Park	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		User	Meeter & Greeter : 5% 21822x0.05 =	1,091	20		21.8
4	Cargo Building	Staff :	Office Floor Area : Total Floor Area 2% Occupant: 0.2 person/m2 50,000m2x0.02x0.2 = 200	200	100		20.0
		Forwarder :		1,000	20		20.0
5	Fire Station	Staff :	Day Time : 50 Person, Night Shift : 30x2 Person	110	100		11.0
6	Power Station	Staff :	Day Time : 10 Person, Night Shift : 5x2 Person	20	100		2.0
7	STP (Sewage Treatment Plant)	Staff :	Day Time : 8 Person, Night Shift : 3x2 Person	14	100		1.4
		Plant :	Chemical Feeder & Others				10.0
8	WTP (Water Treatment Plant)	Staff :	Day Time : 6 Person, Night Shift : 3x2 Person	12	100		1.2
		Plant :	Back-wash water & Others: 100 m3/day				100.0
		Total					3,249.4

Source: JICA Study Team



Source: JICA Study Team

Figure 10-50 STP Layout

Source: JICA Study Team

Figure 10-51 Sewage Treatment Facilities Aeration Space (Existing Facilities)

10.12 Power Intake Station

(1) Existing Electricity Facilities

The power demand of the existing HSIA is estimated to be 8 MVA. It is supported by two intake power substations, namely, the CAAB DESCO Service Station in the north and ADA DESCO Service Station in the south. From these DESCO service stations, the 11 kV power cables are laid to the CAAB's Main Power Plant Service Substation in the north and Euro Tech Bangladesh (ETB) Service Substation in the south of the existing terminal building. From CAAB's Main Power Plant Service Substation and ETB Service Substation, power supply is further distributed to other service substations via the 11 kV cable infrastructure. The existing outgoing 11 kV cable infrastructure is designed with

redundancy, providing flexibility to tap power from either one of the DESCO power sources.

(2) New Power Intake Station

In this "Dhaka International Airport Expansion Project" plan, the expansion is planned with the new passenger terminal building, new cargo terminal building, and the VVIP building, so existing power receiving facilities and distribution lines do not have enough capacity.

Therefore, a new intake power station and HT distribution are to be installed.

The power station confirmed by CAAB to be planned to receive power supply from both ADA Power Station in the south side and CAAB Power Station in the north side, with an electric voltage of 11 kV.

In addition, in the meeting between CAAB and the Dhaka Power Supply Public Corporation, it wais confirmed that at least five years are required in the preparation of power station in the master plan of CAAB. This is a significant risk factor for planning of the construction schedule.

Therefore, reconfirmation by CAAB is requested, and it will be necessary to arrange countermeasures, such as temporary power supply, prior to commencement of construction if substation schedule does not meet the main construction schedule.

1) New Electric Equipment Capacity

Taking into consideration the plan of this "Dhaka International Airport Expansion Project" and future expansion plan, the total electric power capacity will be 57,520 kVA.Total power demand will be about 50,000 kVA (Intake power: minimum of 50,000 kVA required). Also, the generator is installed at each substation, and 100% backup excluding airconditioning, and refrigerator (chiller) demand is scheduled for power outage and accident. Total generator capacity is 64,000 kVA.

Table 10-21 Power Demand Estimate for HSIA Airport

HT CIRCUIT	FACILITIES	TRANSFORMER (KVA)	LOADING DEMAND(KVA)	SUB TOTAL (KVA)	BACK UP GENERATER(KVA)
1	HT SUB STATION 1 – FINGER	3000KVA x 2	3050	3050	2500 x 2 Total: 5000
2	HT SUB STATION 2 – PTB	3000KVA x 7	9890	9890	2500 x 5 Total: 12500
3	HT SUB STATION 3 – PTB	3000KVA x 7	9710	9710	2500 x 5 Total: 12500
4	HT SUB STATION 4 – FINGER	3000KVA x 2	3020	3020	2500 x 2 Total: 5000
5	HT SUB–STATION 5 – CHILLER	2000KVA x 7	8700	8700	2000 x 2 Total: 4000
6	HT SUB–STATION 6 – CHILLER	2000KVA x 7	8700	8700	2000 x 2 Total: 4000
7 – 1	FUTURE FIRE STATION	750KVA x 1	370	1570	500 x 1 Total: 500
7 – 2	VVIP COMPLEX	1600KVA x 1	1200		1500 x 1 Total: 1500
8 – 1	HT SUB STATION 8– CAR PARK	2000KVA x 2	2950	5510	2000 x 2 Total: 4000
8 – 2	HT SUB STATION 7– LINK–WAY	2000KVA x 2	1560		2000 x 2 Total: 4000
8 – 3	CONTROL TOWER	1000KVA x 2	1000		1500 x 1 Total: 1500
9 – 1	FUTURE DOMESTIC TERMINAL	1600KVA x 2	1700	5870	FUTURE 2000 x 1
9 – 2	FUTURE HANGER	750KVA x 1	330		FUTURE 500 x 1
9 – 3	FUTURE CARGO BUILDING	1600KVA x 2	1870		FUTURE 2500 x 1
9 – 4	2ND RUNWAY	1600KVA x 1	820		FUTURE 1000 x 1
9 – 5	FUTURE FLIGHT KITCHEN	1000KVA x 2	1150		FUTURE 1500 x 1
10	FUTURE FUEL FARM EXPANSTION FUTURE SEWERAGE TREATMENT PLANT & WASTE WATER TREATMENT PLANT	1000KVA x 2	1000 500	1500	2000 x 1
	TOTAL	107100		57520	64000

Source: JICA Study Team

2) New Distribution System（HT Distribution Schematic Diagram）

The new power intake station assumes a two system retreat from an electric power company and plans four system pulls in the future so that it is possible for including it (future HT loop).

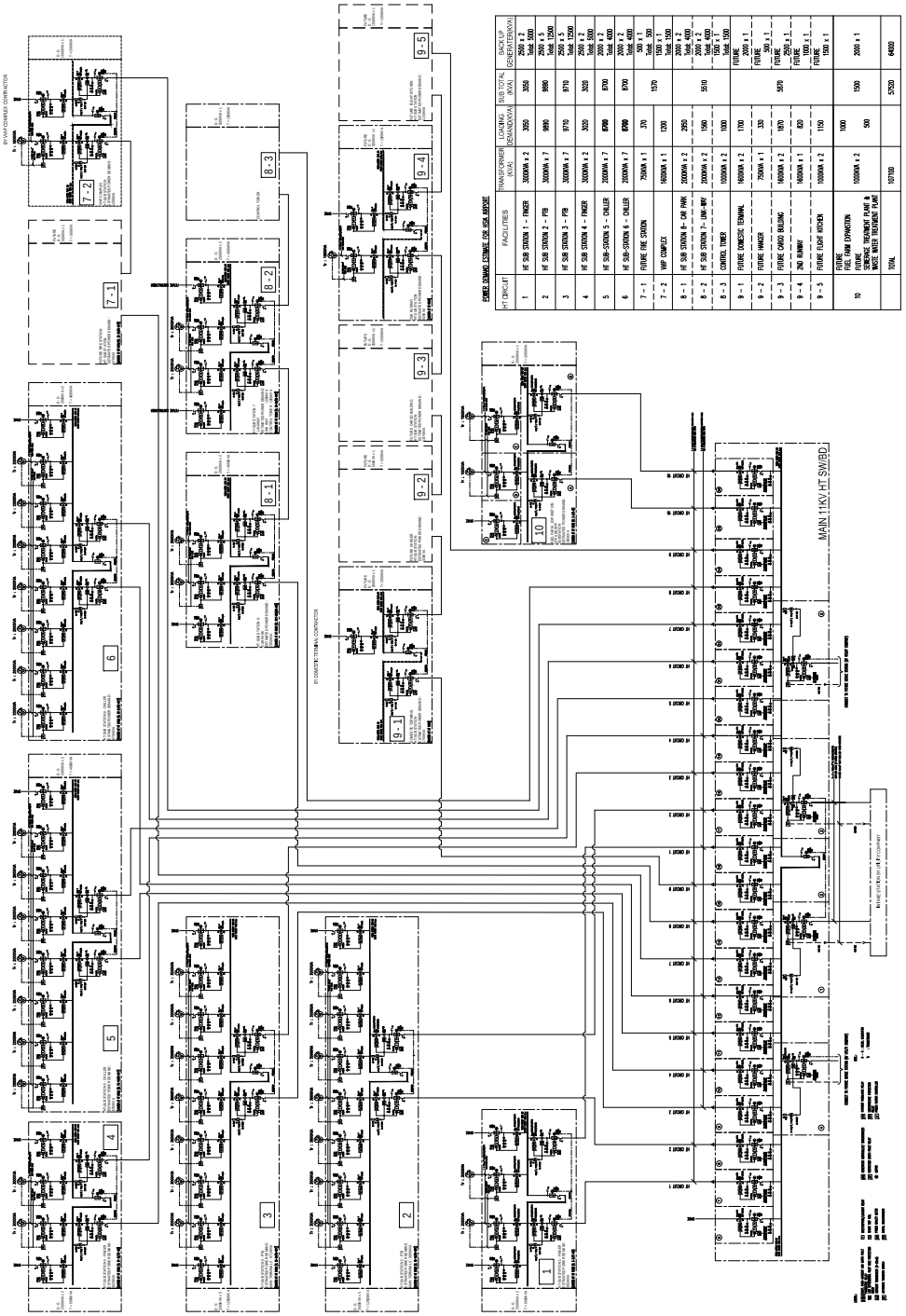
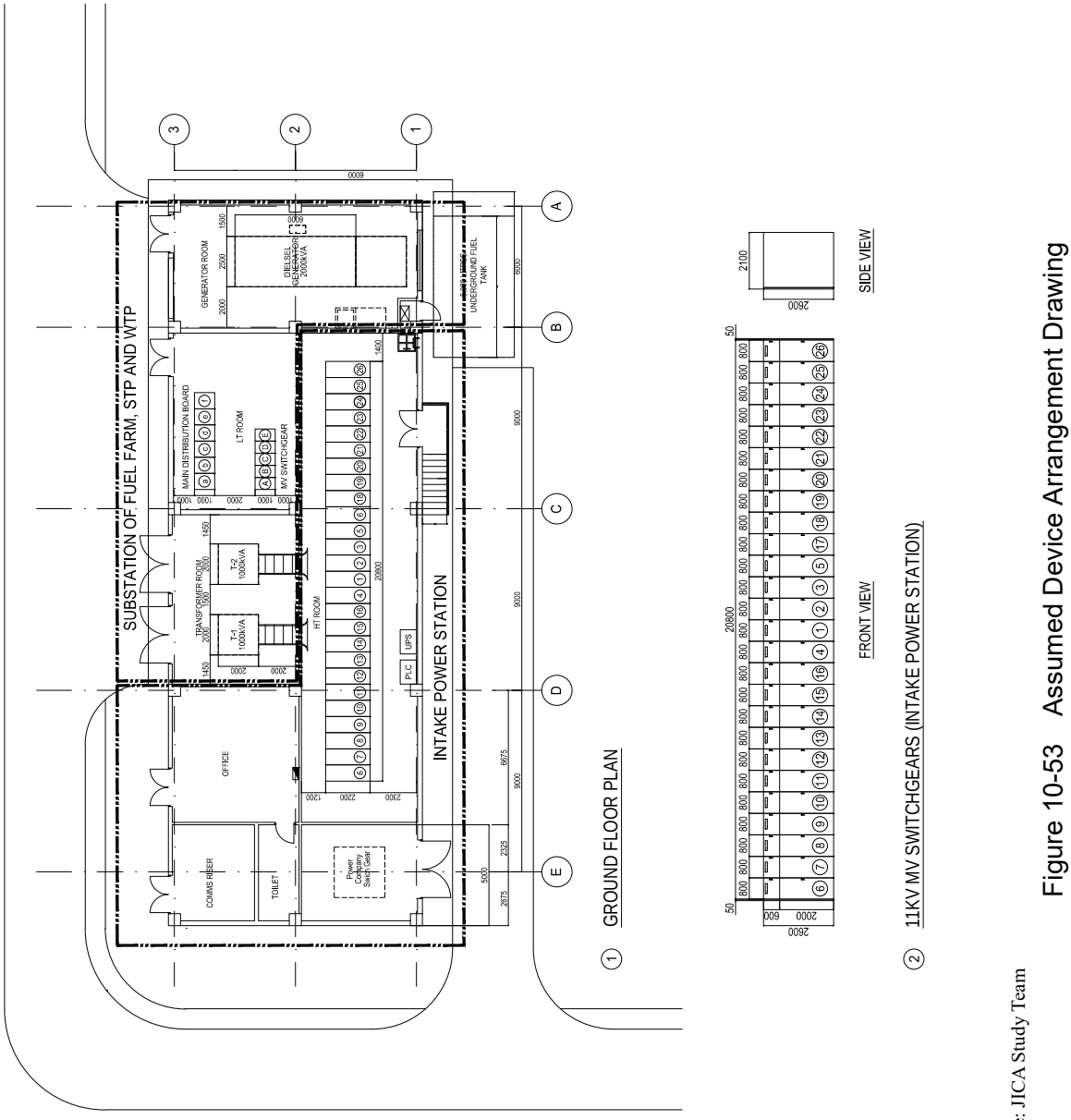


Figure 10-52 HT Distribution Schematic Diagram

Source: JICA Study Team

3) New Power Intake Station

The high voltage second side supply of electric power assumes underground piping and wiring of the PVC pipe duct. Figure 10-53 shows the placement of the assumed apparatus.

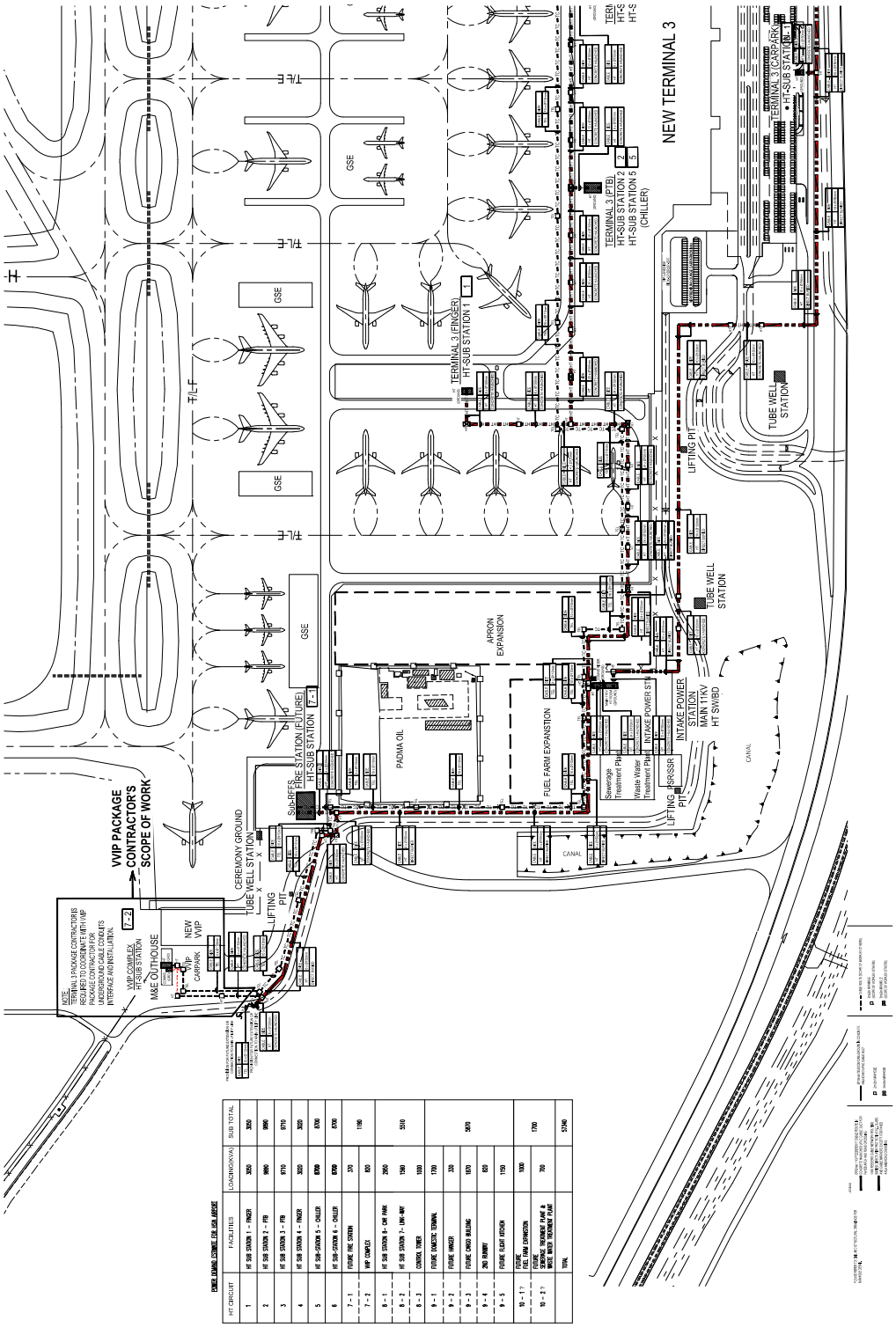


Source: JICA Study Team

Figure 10-53 Assumed Device Arrangement Drawing

4) New Supply of Electric Power Line (HT Distribution)

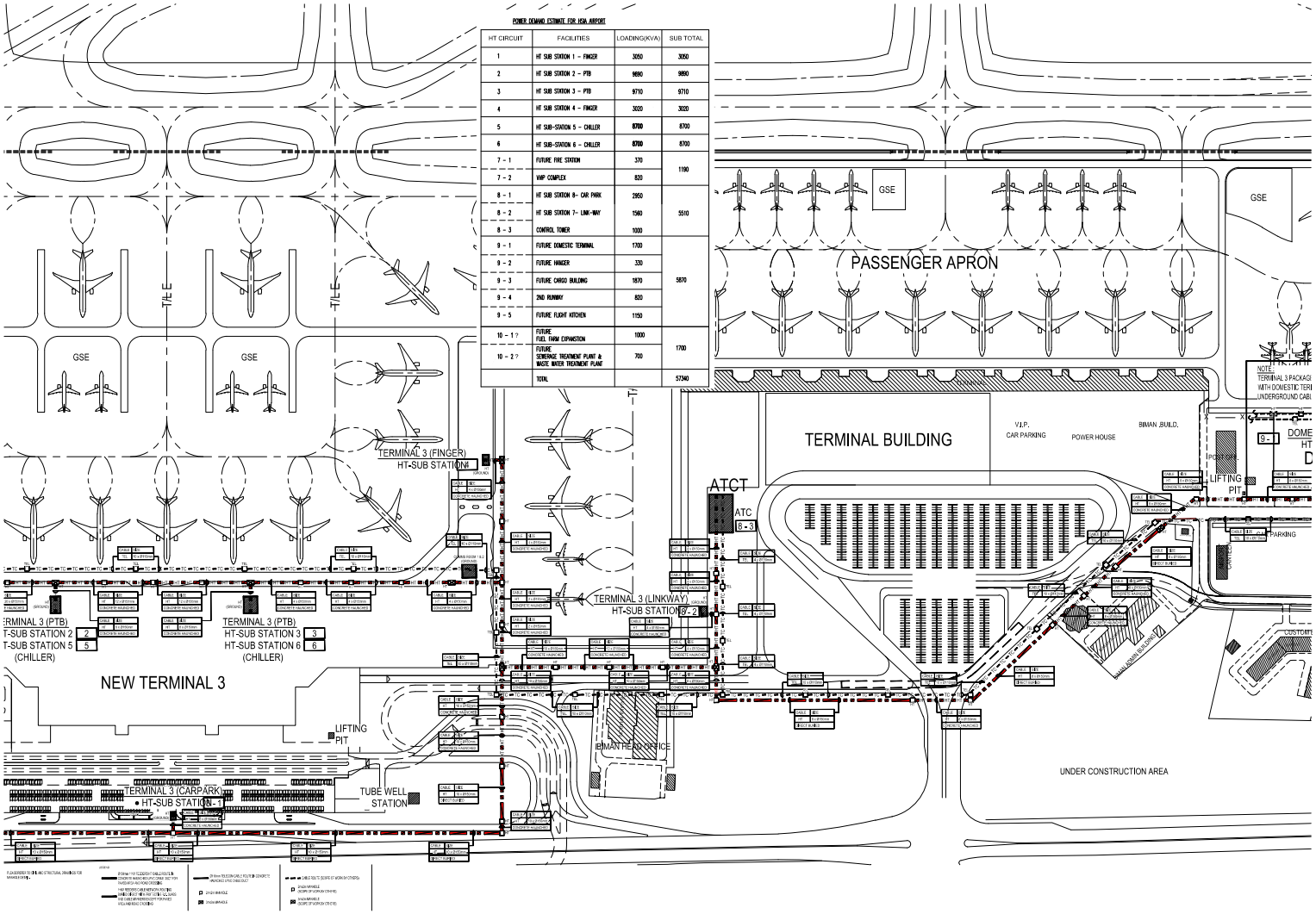
All the high voltage power lines assume underground piping of the PVC pipe duct and 11 kV high voltage cable wiring. Figure 10-54 to Figure 10-56 show the cable route.



HT CIRCUIT	FACILITIES	LOADING(KVA)	SUB TOTAL
1	HT SUB STATION 1 - FINGER	3020	3020
2	HT SUB STATION 2 - PTB	9860	9860
3	HT SUB STATION 3 - PTB	8770	8770
4	HT SUB STATION 4 - FINGER	3020	3020
5	HT SUB-STATION 5 - CHILLER	8700	8700
6	HT SUB-STATION 6 - CHILLER	8700	8700
7 – 1	FUTURE FIRE STATION	370	1180
7 – 2	VVIP COMPLEX	810	
8 – 1	HT SUB STATION 8- CAR PARK	2650	5510
8 – 2	HT SUB STATION 7- LINK-WAY	1360	
8 – 3	CONTROL TOWER	1500	
9 – 1	FUTURE DOMESTIC TERMINAL	1720	5670
9 – 2	FUTURE HANGER	330	
9 – 3	FUTURE CARGO BUILDING	1870	
9 – 4	2ND RUNWAY	850	
9 – 5	FUTURE FLIGHT KITCHEN	1150	
10 – 1 ?	FUTURE FREE TRADE EXPANSION	1000	1780
10 – 2 ?	FUTURE SEWERAGE TREATMENT PLANT & WASTE WATER TREATMENT PLANT	780	
	TOTAL		57240

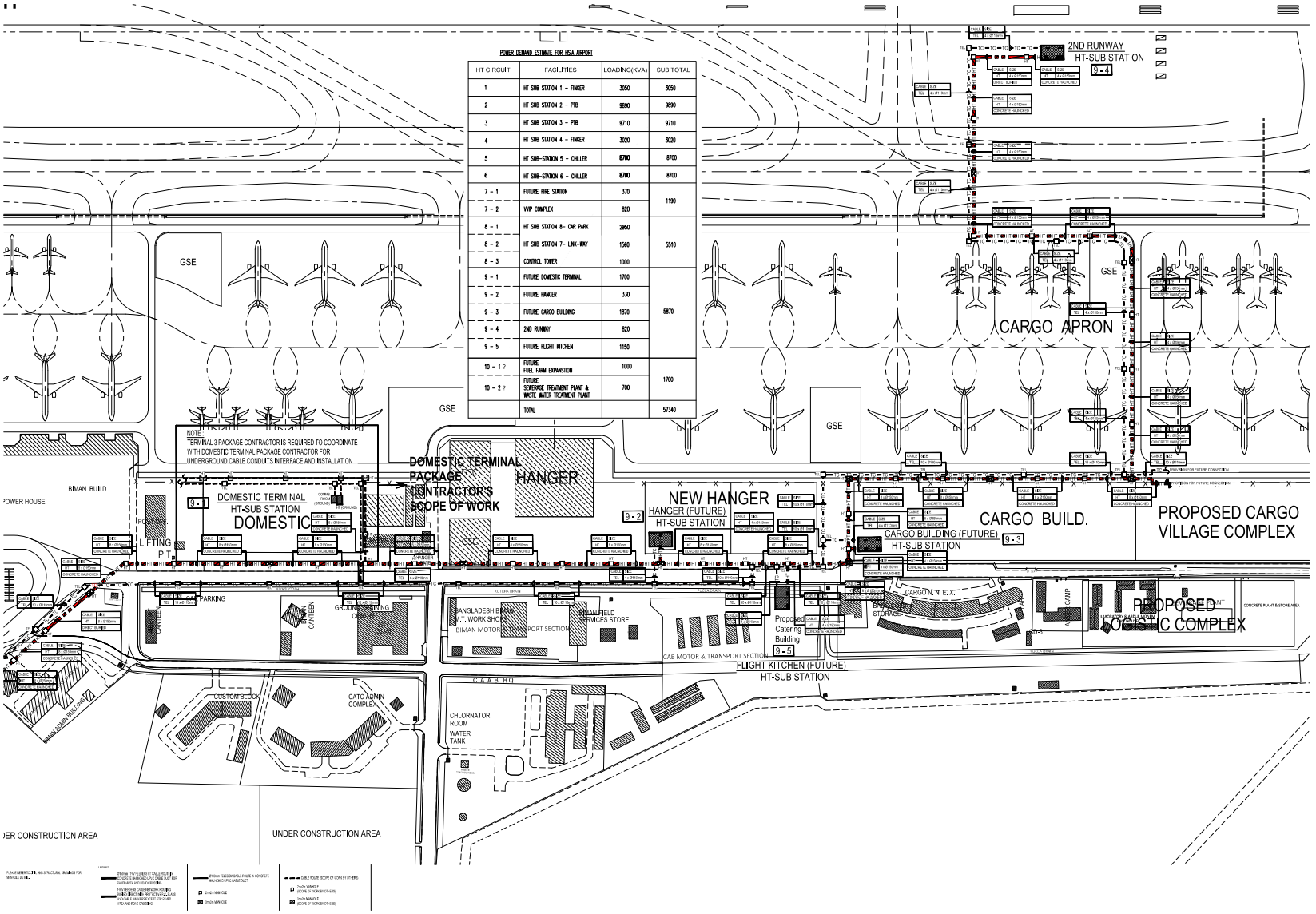
Figure 10-54 Substation and Power Cable Routing Layout No. 1

Source: JICA Study Team



Source: JICA Study Team

Figure 10-55 Substation and Power Cable Routing Layout No. 2



Source: JICA Study Team

Figure 10-56 Substation and Power Cable Routing Layout No. 3

10.13 Fuel Supply Facilities

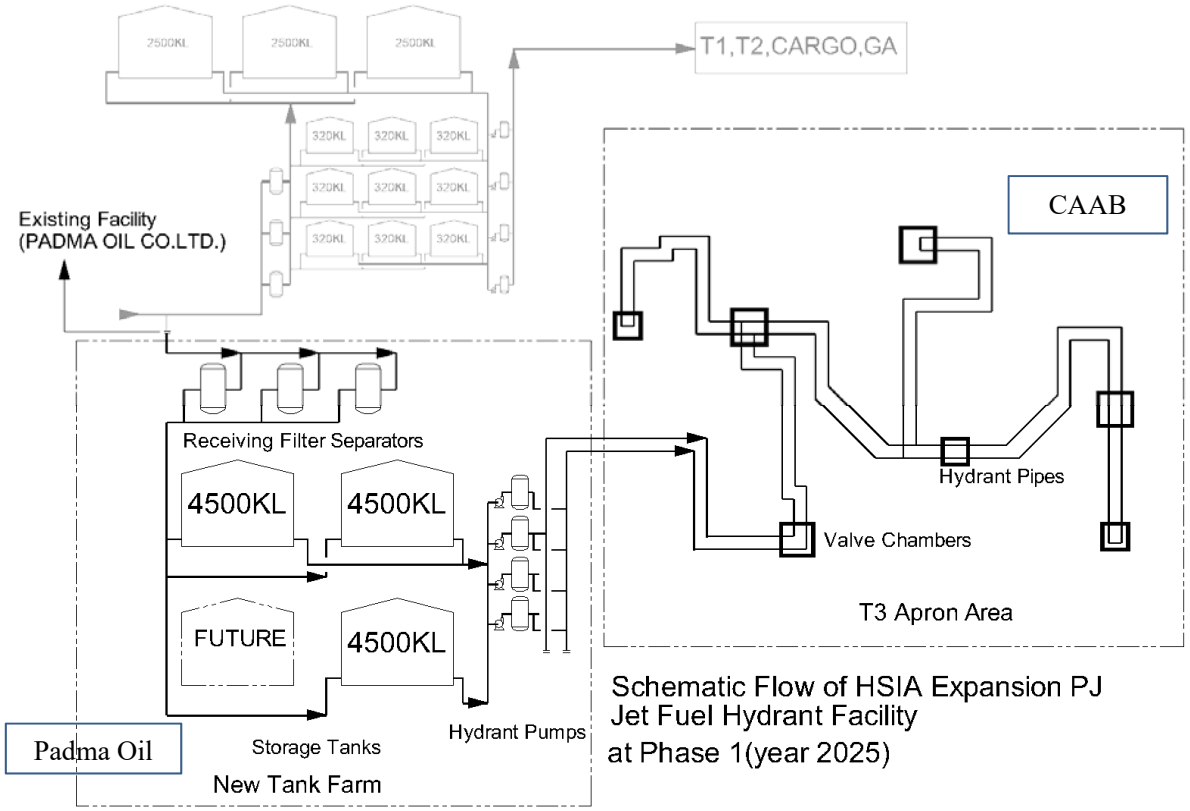
10.13.1 Fuel supply Facilities for Terminal 3

(1) Work Demarcation of Fuel Supply Facility

The fuel depot and hydrant facility are all in one system as a fuel supply system and it cannot be segregated individually. Therefore, the implementation of fuel supply system (Fuel depot and hydrant facility) for Terminal 3 must be done all in one system.

Further discussion for the work demarcation of fuel supply facility at Terminal 3 with Padma Oil Co., Ltd. will be required. However, we understand that fuel depot facilities will be provided by Padma Oil Co., Ltd and hydrant facility will be provided by CAAB.

Outline of Fuel Supply Facilities is shown in Figure 10-57.



Source: JICA Study Team

Figure 10-57 Outline of Fuel Supply Facilities

(2) Premises

- Facility Capacity: Described in Article 7 Fuel Supply Facilities
- Annual Fuel Demand Forecast for Terminal 3: Phase 1-1, 811kl/day, Phase 2-2, 429kl/day
- Storage Tanks: Phase 1 - 4,500kl x 3 nos., Phase 2 - 4,500 x 1 no.
- Hydrant Delivery Volume: Phase 1 - 817kl/h (3,600gpm), Phase 2 - 1,362kl/h (6,000gpm)
- Delivery Pump Discharge Pressure : 1.3MPa (Maxium)

(3) Design codes and standards

- ✈ Bangladesh local codes and standards
- ✈ ICAO Doc 9977 “Manual on Civil Aviation Jet Fuel Supply”
- ✈ Design, construction, commissioning, maintenance and testing of aviation fuelling facilities (EI 1540 5th edition ENERGY INSTITUTE)
- ✈ Japanese Fire Service Law

(4) Standards, etc.,

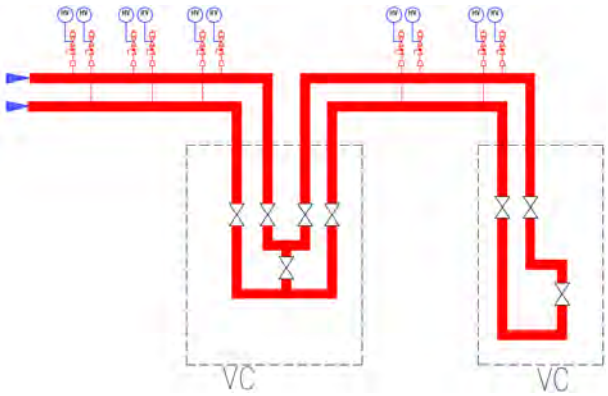
- ✈ IATA、ANSI、ASTM、JIS、JIG、SII、API、IEC、IEEE
- ✈ Jet fuel standard: ASTM D-1655
- ✈ Hydrant pit valve standards: API/IP Bulletin 1584

10.13.2 Hydrant Pipelines at Apron

Underground hydrant pipelines at apron shall be redundant system (installation of dual pipelines) for inspection, repairing and reinstallation purpose. The valve chambers are installed for each 5 to 6 aircraft parking spots and install valves in valve chamber to block problem area and minimize closing of aircraft parking spots.

Typical layout of hydrant pipelines and valve changers is shown in Figure 10-58.

Figure 10-58 is also shown normal operation condition and all valves are open status and it is able to supply jet fuel to all hydrant valves.

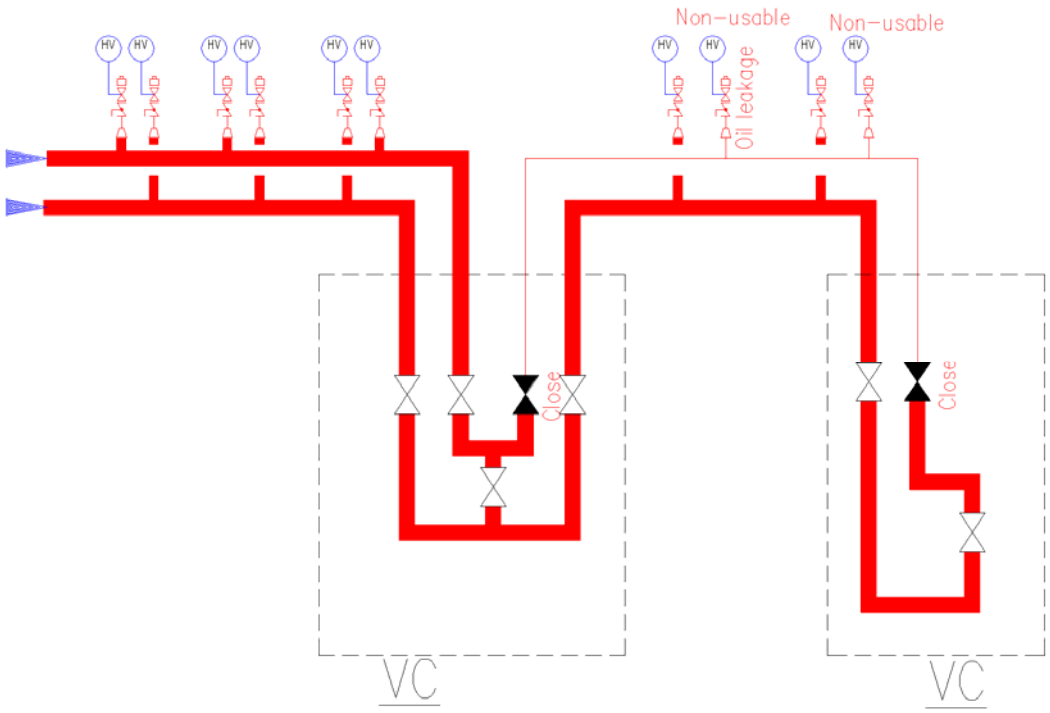


VC: Valve Chamber HV: Hydrant Valve

Source: JICA Study Team

Figure 10-58 Apron Pipeline – Function of Dual Pipelines and Valve Chambers (1)

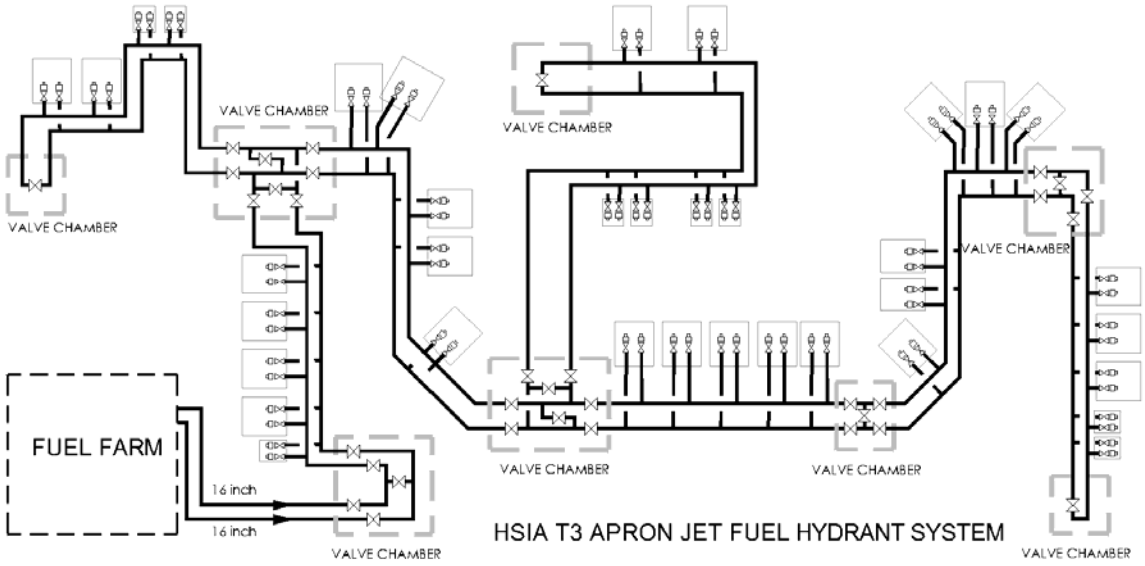
Reference to Figure 10-58, in case oil leakage is occurred at one hydrant valve, 2 valves are closed in valve chamber (Refer to the status of Figure 10-59). Then the oil leakage point and another hydrant valve cannot be used. However other hydrant valves can be used and it is possible to repair the oil leakage point under operation condition.



Source: JICA Study Team

Figure 10-59 Apron Pipeline – Function of Dual Pipelines and Valve Chambers (2)

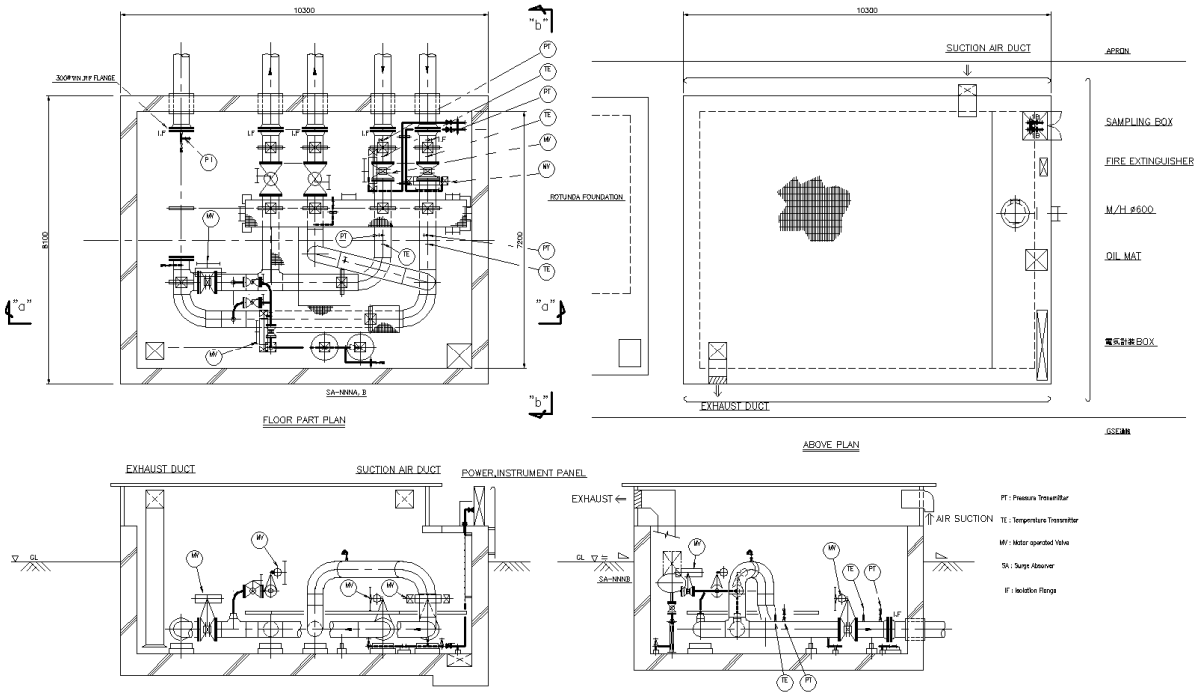
Process flow diagram for hydrant pipelines at terminal 3 apron is shown in Figure 10-60.



Total length of hydrant pipelines is approx. 11km
Source: JICA Study Term

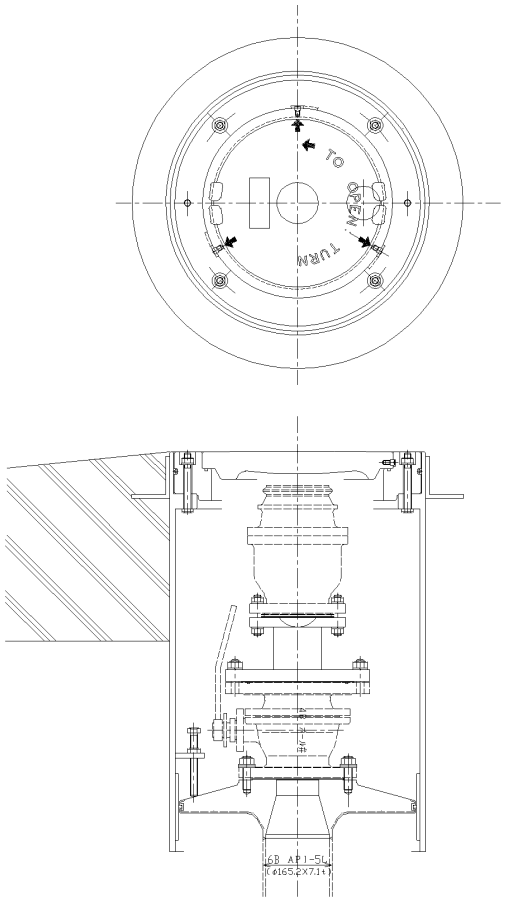
Figure 10-60 Process Flow Diagram for Hydrant Pipelines at Terminal 3 Apron

Reference drawing for valve chamber is shown in Figure 10-61 and reference drawing for hydrant pipelines is shown in Figure 10-62.



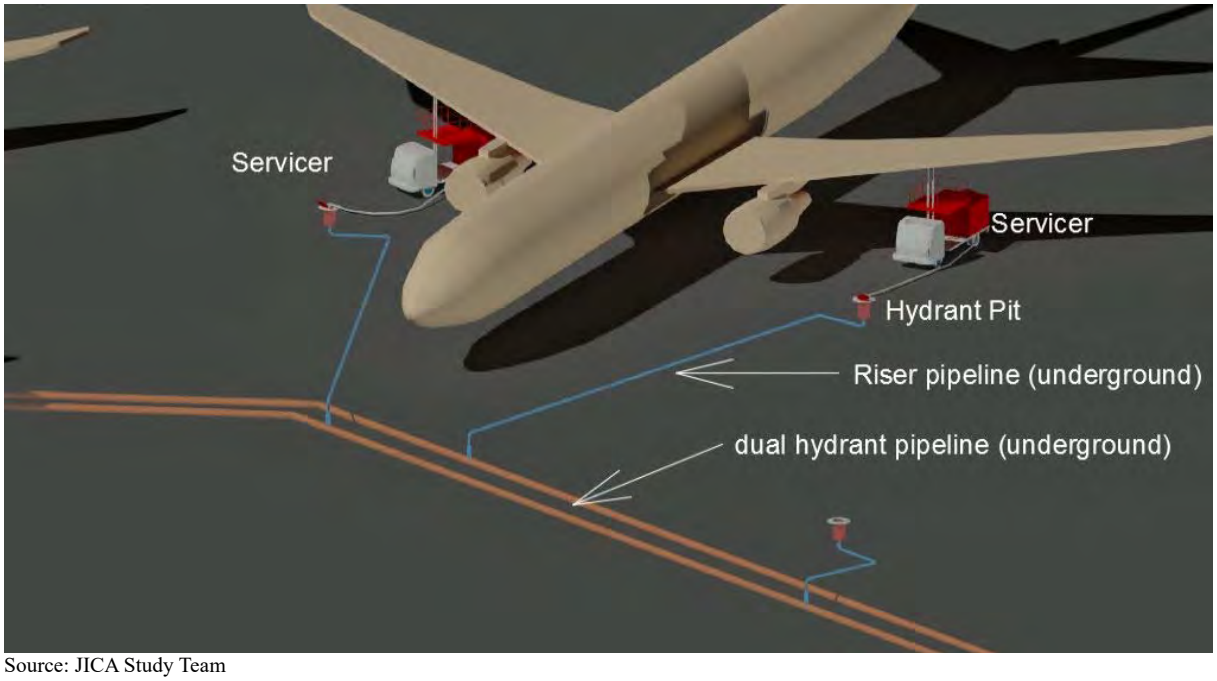
Source: JICA Study Team

Figure 10-61 Reference Drawing for Valve Chamber



Source: JICA Study Team

Figure 10-62 Reference Drawing for Hydrant Pipelines



Source: JICA Study Team

Figure 10-63 Reference Drawing for Hydrant Valves and Hydrant Pits

10.13.3 Fuel Depot (Receiving, Storage and Delivery Facilities)

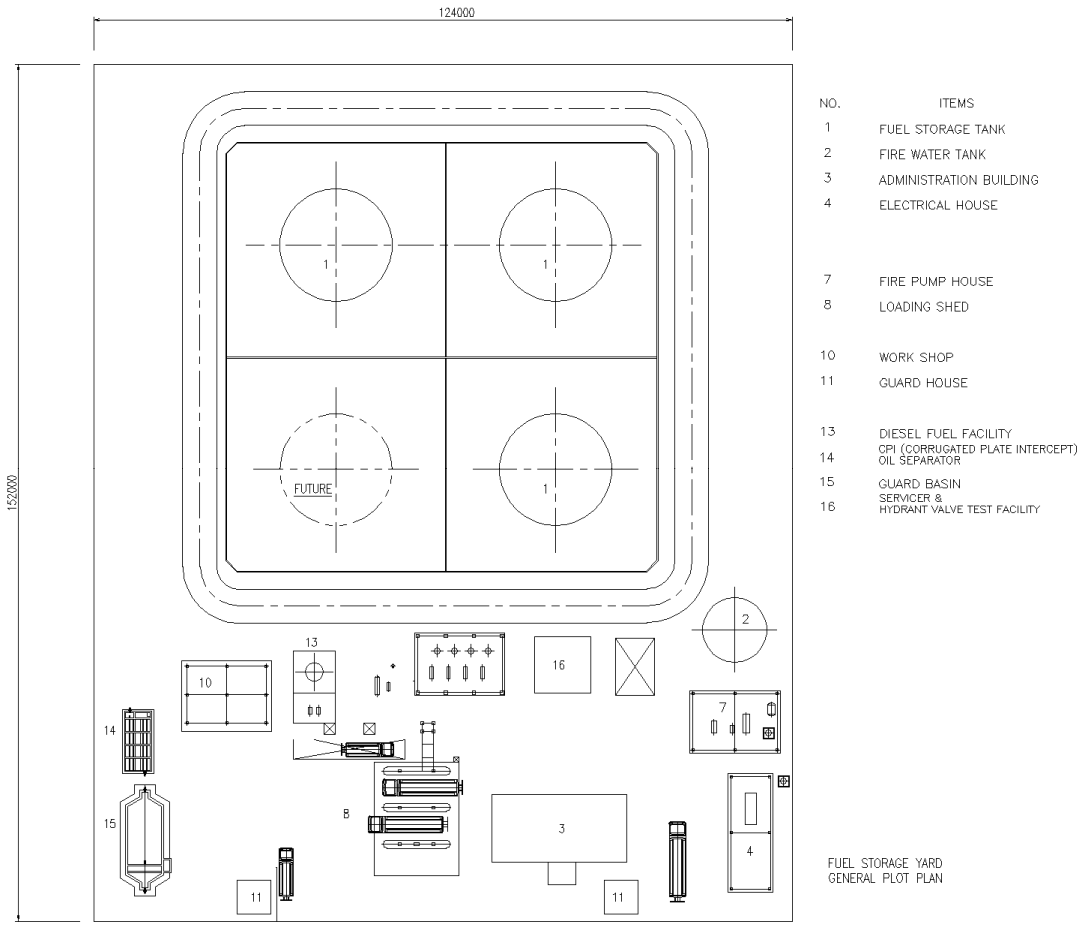
The hydrant pump control system, automatic hydrant oil leakage system and cathodic protection for the hydrant facility shall be installed at the fuel depot.

Required area for the fuel depot with storage tanks, hydrant pumps and other ancillary facilities is approx. 20,000m^2 (2.0ha).

The following items shall be considered for the fuel depot design.

- The facilities where flammable material is being handled, so it shall be satisfied the requirement of law and regulation for the safety distance.
- The location of fuel depot shall be refered to the law and regulation of airport.
- The fuel depot shall be accessible from the public area (outside) of airport.
- The Fuel Depot shall be accessible from the internal airport road.

For reference, Layout Plan for the Fuel Depot is shown in the Figure 10-64.



Source: JICA Study Team

Figure 10-64 Layout Plan for the Airport Fuel Depot

10.13.4 Future Tasks

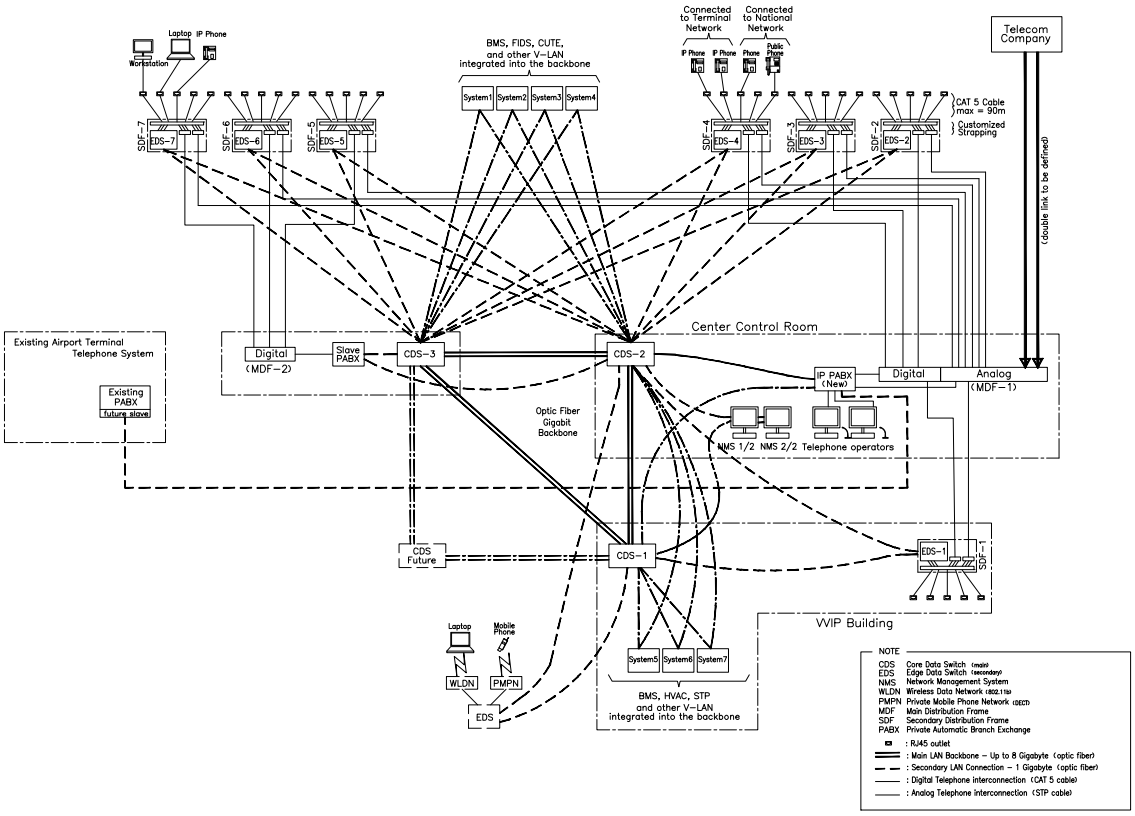
- ✈ Further discussion for the responsibility of new fuel depot facilities for Terminal 3 with Padma Oil Co., Ltd. will be required.
- ✈ It is necessary to harmonize the design of new fuel depot facilities and fuel hydrant facilities in the detailed design stage of this project

10.14 Communication Facility

In the HSIA Expansion Project Phase-1, significant extension, including the new terminal building, new cargo terminal, and VVIP terminal is scheduled. Therefore, the existing communication network will be utilized and the new communication network for expansion area will be newly built. The new network will be connected to the existing network to complete the whole built out network.

(1) Structure of New Communication Network

A new communication network covering Phase-1 of HSIA Expansion Project and future planned expansions in phase 2 will be established. It is a structured cabling network composed of optical cables and analog cables, if necessary. A system with sufficiently large capacity for future redundancy shall be adopted.

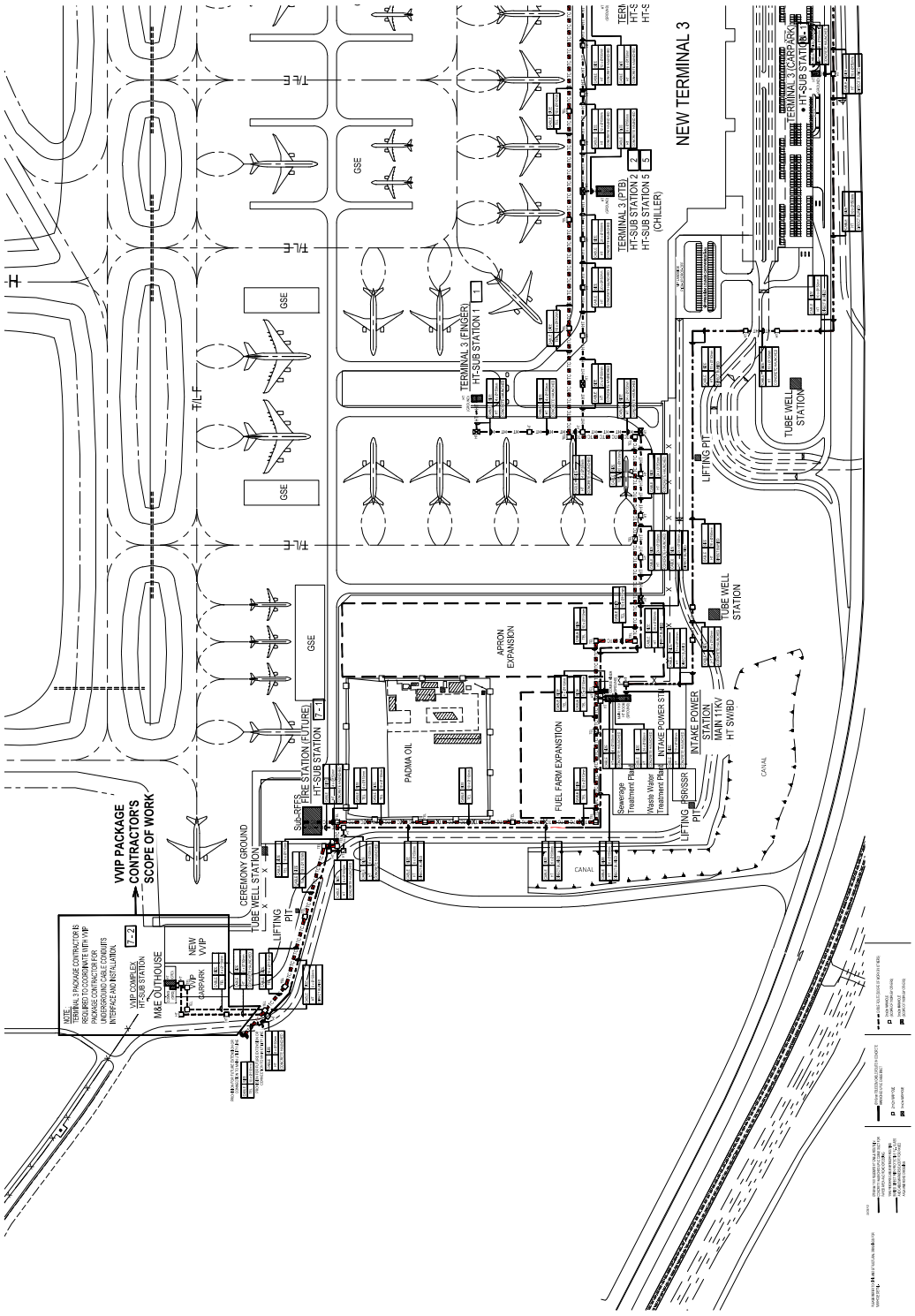


Source: JICA Study Team

Figure 10-65 Telecommunication and Structured Cabling Network Architecture

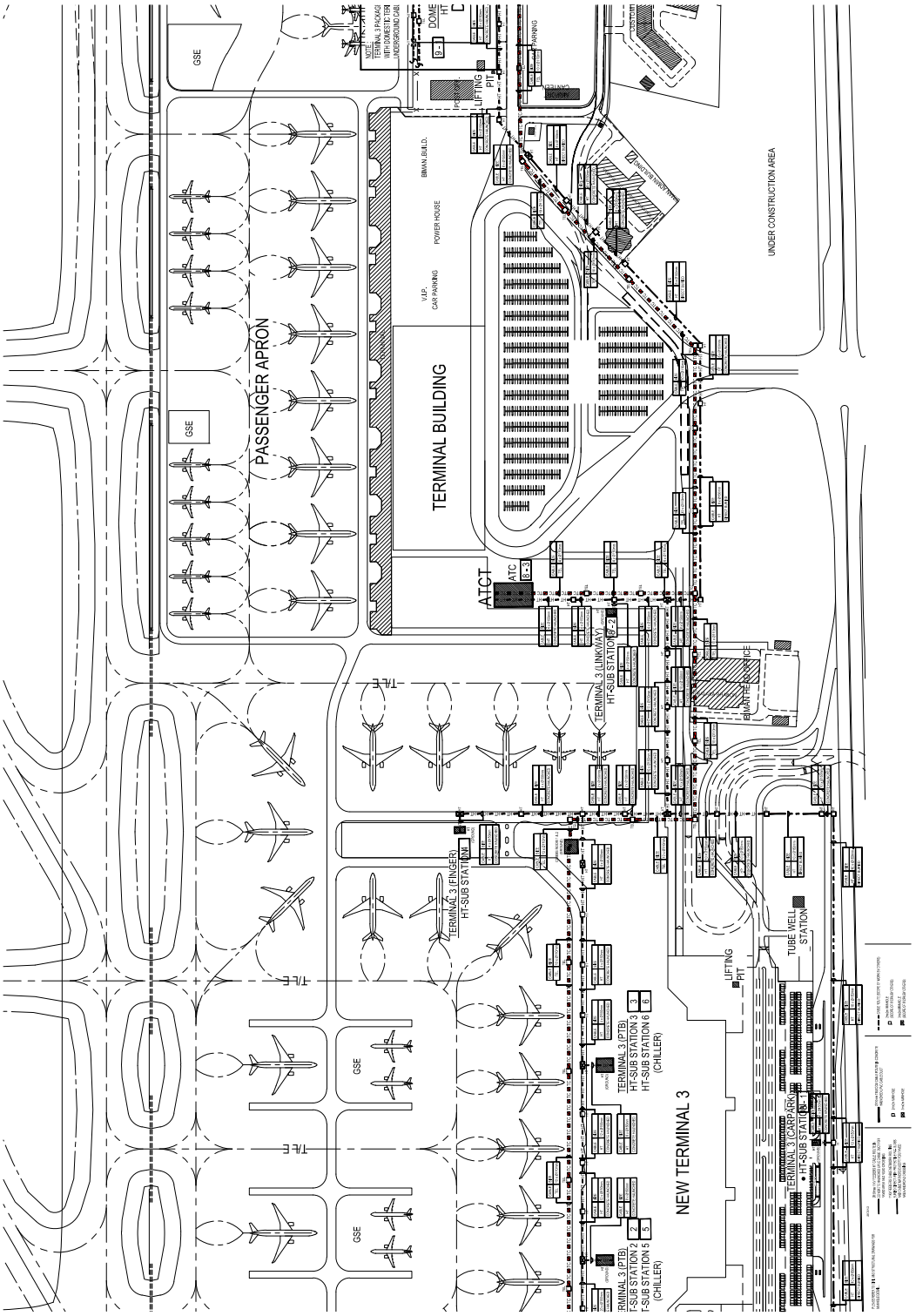
(2) Communication Cable Routing Layout

New communication network cable will be buried piping of PVC pipe duct. Figure 10-66 to Figure 10-68 show the communication cable routing layout.



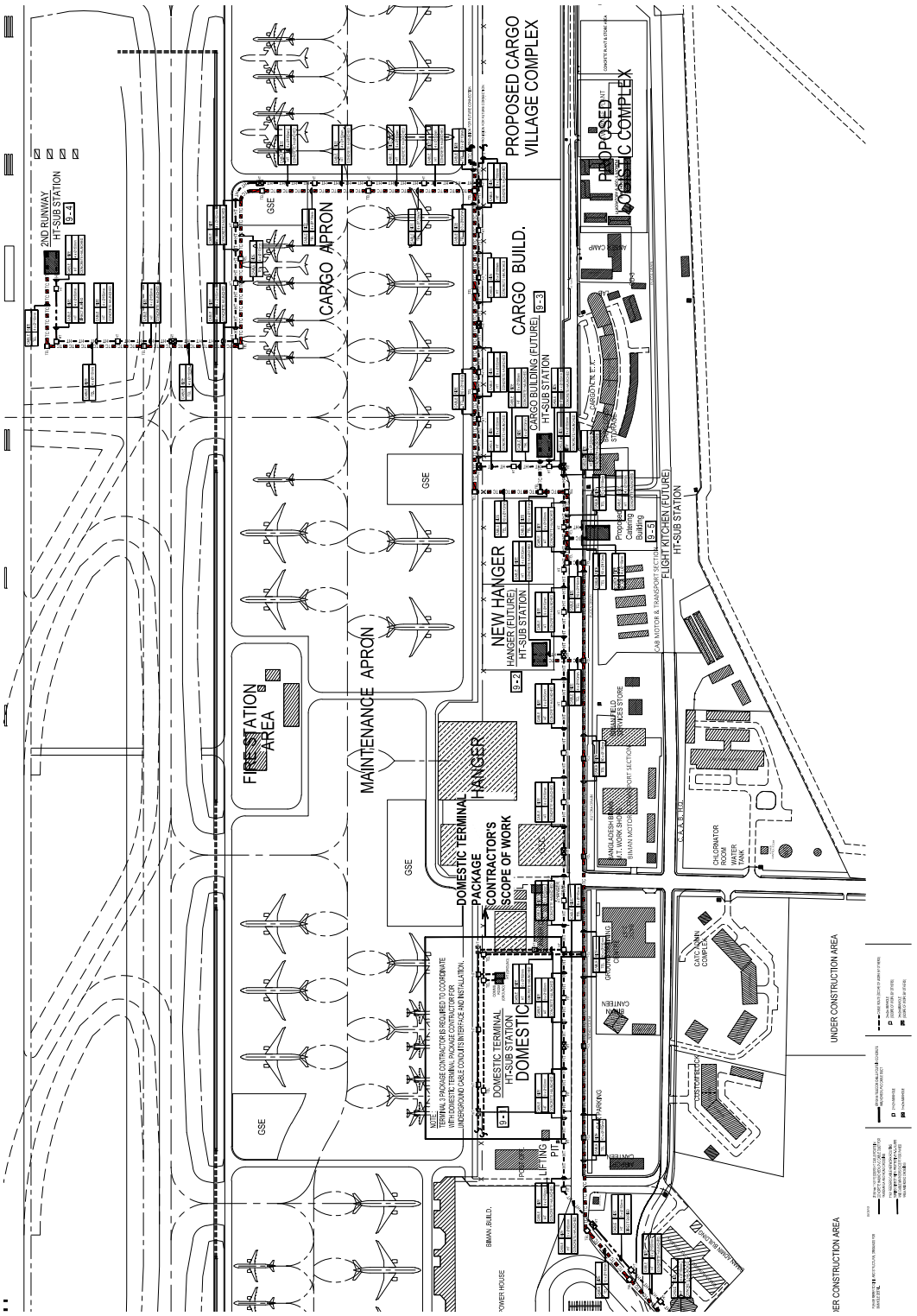
Source: JICA Study Team

Figure 10-66 Communication Cable Routing Layout No.1



Source: JICA Study Team

Figure 10-67 Communication Cable Routing Layout No.2



Source: JICA Study Team

Figure 10-68 Communication Cable Routing Layout No.3

10.15 Security Equipment

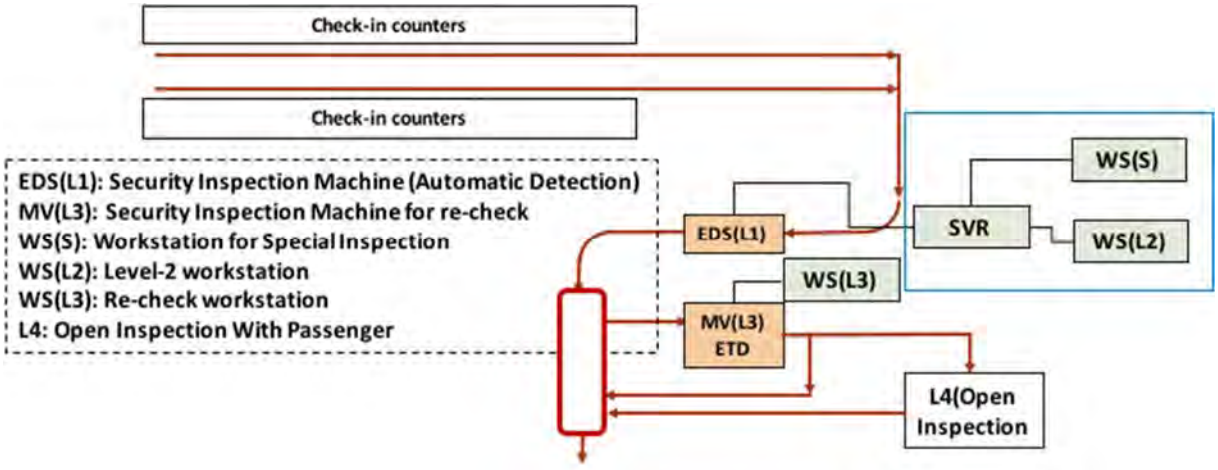
The security equipment was discussed with security operator and CAAB.

In the discussion, the following requests were confirmed from CAAB:

- ✈ HSB will follow the regulation of TSA and ECAC.
- ✈ HSB will comply with EU STD3 that will be operational at the time of Terminal3 opening
- ✈ HSB shall have a separate image inspection for handguns, etc. in addition to EDS evaluation functions on all baggage.
- ✈ The inspection of the carry-on is also based on regulation of TSA and ECAC.
- ✈ The regulation of ECAC in the carry-on will comply with the EU STD3 (C1 - C3) operation.
- ✈ The security check point will be provided with a smart security lane.
- ✈ In the inspection for passenger, will install ATI(MWD).
- ✈ The inspection machine of the customs excludes the installation of CAAB.

based on the above considerations HSB diagram can be shown as below:

Inspection	Special	Level-1	Level-2	Level-3 (Re-check)	Level-4
Method / Equipment	Image inspection by operator (Inspection room)	Automatic decision function	Image inspection by operator (Inspection room)	Image inspection by MV inspection machine and ETD (Re-check room)	Open inspection



Source: JICA Study Team

Figure 10-69 HBS Inspection Flow

（Intentionally Blank）

CHAPTER 11 STUDY ON APPLICABILITY OF JAPANESE TECHNOLOGIES

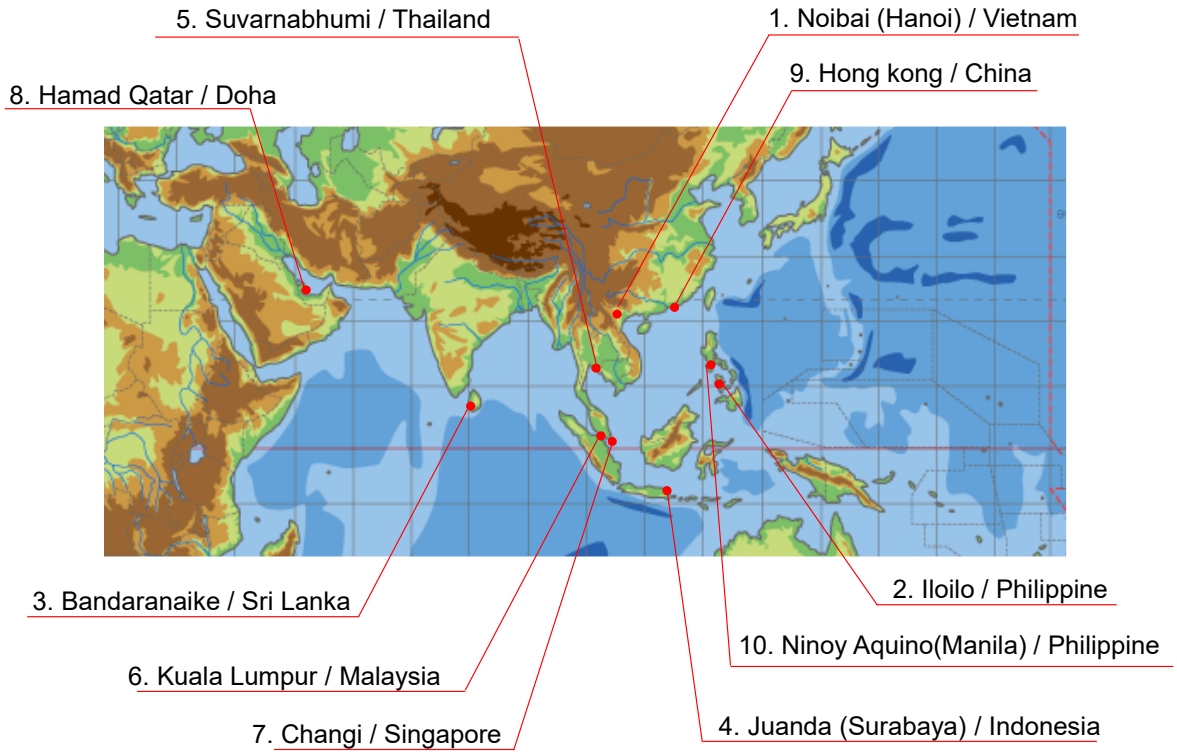
（Intentionally Blank）

Chapter 11 STUDY ON APPLICABILITY OF JAPANESE TECHNOLOGIES

11.1 Collection and Compilation of Examples

Figure 11-1 shows the airports constructed by Japanese companies in the past 20 years. Also, the Japanese technologies applied in these airports are listed in Table 11-1 to Table 11-4

There are various technical problems in each airport and various Japanese advanced technologies were used tin their solutions. Major problems of the Dhaka International Airport Expansion Project are airport construction under operation and soil improvement.



Source: JICA Study Team

Figure 11-1 Map of Airports Constructed by Japanese Companies

Table 11-1 Construction Technology of Japanese Contractors (1)

No.	Country/City	Airport Name	Contractor	Project Duration/Cost (JPY)	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
1	Vietnam	Noibai	Taisei, Vinaconex (Vietnam) JV	March 2010 to December 2014	Package Type Infrastructure Overseas Expansion	Passenger Terminal Building	Operational Airport	
	Hanoi			Yen loan: 12.6 billion(I), 20.5 billion (II), 26.0 billion (III), Construction cost: 44.7 billion	Airport operation underpublic and private cooperation Japanese high technical system for operation and maintenance (O&M) Fuel hydrant system, BHS, Data system	Four stories, one basement building and associated facilities, parking, viaduct, special equipment, sewerage disposal, andfuel hydrant		Hard: annual passenger: 10 million; terminal building and associated facility Soft: Support for airport operation and management
2	Philippines	Iloilo	Taisei, Shimizu JV	August 2000 to March 2007	Greenfield airport	Civil, Building, Air Navigation, Utilities		
	Iloilo			Yen loan: 14.3 billion	Fourth airport traffic activity of the Philippines	- Runway (2,500 m) - Passenger Terminal Building (12,000 m^2) - Cargo Terminal Building (1,300 m^2) - Taxiway, Apron (48,000 m^2) - Admin Building, Control Tower - Radar, Lighting facility - Utility (power, water, sewer, andsolid waste)	Resettlement	Annual passenger: 10 million Cargo handling: 10,000 ton
3	Sri Lanka	Bandaran aike	Taisei, Mitsubishi Corp. JV	August 1999 to February 2007	JICA－JBIC cooperation project	Civil, Building, Air Navigation, Utilities		
	Colombo			Yen loan: 12.0 billion Construction cost: 44.7 billion	Brownfield airport development	- Taxiway, Apron (60,000 m^2) - New Passenger Terminal (18,000 m^2) - Radar, Meteorological, High Frequency facility - Utility (power, water, sewer, and solid waste)	Operational Airport	Annual passenger: 9 million;Terminal and associated facility Phase II (next stage) is ongoing around JPY 28.9 billion

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

Table 11-2 Construction Technology of Japanese Contractors (2)

No.	Country/City	Airport Name	Contractor	Project Duration/Cost (JPY)	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
4	Indonesia	Juanda	Kajima, Mitsubishi Corp. with three Indonesian contractors JV	December 1996 to April 2010	New terminal development	Civil, Building, Air Navigation, Utilities		
	Surabaya			Yen loan: 12.8 billion (I), 14.5 billion (II)	New terminal development at the opposite side of existing runway	- Passenger terminal building (52,100 m^2) - Cargo terminal building (10,000 m^2) - Taxiway, apron (130,000 m^2) - Admin building, control tower - Radar, MET, HF facility - Utility (power water, sewer, and solid waste)	Resettlement	Annual passenger: 6 million, 120,000-ton cargo handling
5	Thailand	Suvarna-bhumi	Japan-Thailand JV nine groups	September 1996 to September 2007	Capital greenfield airport	Civil, Building, Air Navigation, Utilities		
	Bangkok		Japanese contractors (5) Obayashi, Takenaka, Shimizu Corp., Nishimatsu, Nippon Road	Yen loan: 194.4 billion	Greenfield airport at the center of ASEAN supply-chain	- Earthworks, ground improvement (3,100 ha) - Passenger terminal building (540,000 m^2) - Runway(3,700 m, 4,000 m) - Admin building, control tower - Air navigation facility - Utility (power, water, sewer, and solid waste)	Resettlement, Ground Improvement	Annual passenger: 45 million, 2.12 million ton cargo handling for the new airport
			Takenaka, Obayashi, Italian Thai JC	Around 100 billion	Steel structure, reinforced concrete, seven stories, one basement	New passenger terminal building (610,851 m^2)		

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

Table 11-3 Construction Technology of Japanese Contractors (3)

No.	Country/ City	Airport Name	Contractor	Project Duration/Cost (JPY)	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
6	Malaysia	Kuala Lumpur	Taisei, Takenaka JV	April1994 to June 1998	Capital greenfield airport (Terminal only)	Passenger terminal building	Design-build	
	Kuala Lumpur			Yen loan: 50.3 billion	Scope of Yen loan portion: Passenger Terminal Complex	- Building (457,000m^2) - Special equipment (BHS: Baggage Handling System, TTS: Track Transit System BAS: Building Automation System)	- Importance of project management (PM) due to several packages and projects - Detailed design (DD) and constructionbased on basic design (BD) and specifications - High technique of steel structure and roofing due to huge open space of main terminal building	Annual passenger: 25 million; The symbiotic relationship between nature and architecture is realized through the concentric garden in the airport. Architecture: Kisho Kurokawa. Main terminal by Taisei, satellite by Takenaka
7	Singapore	Changi				Building and associated facility		
			Takenaka	January 2014 to 2017 Around 80.0 billion (CAG)	No. 4 Terminal	- Passenger terminal building (490,000 m^2) - Parking（1,500 vehicle capacity） - Ramp Tower (H=68 m)		DD：SAA Architect, Benoy, Takenaka JV
			Takenaka	March 2015 to 2019 28.0 billion（CAG）	Expansion of No. 1 Terminal	- No. 1 terminal departure lobby - Check-in area - BHS		DD：RSP, Squire Mech
			Penta Ocean, Koon (Sin) JV	Nov. 2014 to 2020 95.3 billion (Singapore MOT)	Ground improvement for airport expansion area (No. 3 R/W, No. 5 Terminal Area)	- Ground improvement area 700 ha (whole area 1,080ha)	Airside construction under operational airport	

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

Table 11-4 Construction Technology of Japanese Contractors (4)

No.	Country/City	Airport Name	Contractor	Project Duration/Cost	Feature	Major Work Item	Particular Feature (Technical, Constrained Condition)	Others
8	Qatar	Hamad			Green field airport	Building and associated facility		
	Doha		Taisei, TAV (Turkey) JV	March 2006 to December 2012 USD 825 million (Qatar Government)	Passenger Terminal (24 million PAX) and associated facilities	- Passenger terminal building (490,000 m^2) - Special equipment (elevator, escalator, BHS)		Design and Supervision : Overseas Bechtel
			Takenaka, CDC (Qatar) JV	May 2006 to May 2008 Around JPY 27 billion (Qatar Government)	Emiri Terminal, Parking, and Mosque	- Emiri terminal building (9,100m^2) - Mosque, minaret (H=37 m) - Parking (1,409 vehicle capacity)		Design and Supervision : Overseas Bechtel
9	United Arab Emirates	Abu Dhabi			District Heating and Cooling Plant			
	Abu Dhabi		Shinryo	December 2013 to July 2017	EPC Contract	60,000 refrigeration ton capacity		
10	China							
	Hong Kong	Hong Kong		December 1992 to July 1998 Around JPY 1,500 billion (Government of Hong Kong)	Earthworks (CLK island area reclamation)	Land Reclamation Area: around 1,300 ha Offshore Artificial Island	- Huge Earthworks (Total volume: around 300 million m^3) - Reclamation Works	Construction period: around 3.5 years
					Passenger Terminal (3.5 million passengers)	Building Structure: 498,000 ㎡		Annual passenger: 35 million, 1.3 million-ton cargo handling

Source: The Survey on the Japanese Latest Technologies for Overseas Expansion of Airport Infrastructure

11.2 Applicability of Japanese Technology

In this chapter, the considerations for the applicability of Japanese technology to HSIA are summarized. These considerations are conducted through interview with various Japanese companies.

In addition to the issues with airport construction under operation and soil improvement at Dhaka International Airport Project, shortening of construction period is also required. Construction period is set until April 2021 for 37 months as the completion of the Terminal 3 building. However, there is congestion caused by different construction such as the huge scale of Terminal 3, apron construction at the front part of Terminal 3, and service roads including the elevated structure in Terminal 3 landside area. Therefore, it is necessary to adopt construction method that will contribute to the shortening of the construction period of Terminal 3 in order to smoothly implement the construction of Terminal 3, which is the main component of HSIA expansion.

Here, advanced technology is divided into two major categories, namely: construction method and material/equipment. Advanced technology in construction method is defined as the technology that must be adopted to solve a particular problem in this airport. At the tendering stage, it will be necessary to confirm the experience in the particular construction methods to secure construction quality.

On the other hand, the latest construction materials and equipment used in Japanese airports are technologies that work predominantly in terms of maintenance and operation such as reduction of the maintenance cost and improvement of image of the airport. However, they are not necessarily Japanese technology only, and there may be similar euqipment/materials which may be in use in other advanced countries. A contractor/supplier will select which country these things will come from at the bidding stage. Therefore,it is important that the specific characteristics are prescribed on the specifications.

The required technology is gathered for the following three items in the Dhaka International Airport Expansion Project as mentioned above:

- Construction under airport operation
- Construction method for shortening of construction period
- Soil improvement

Of these, construction under airport operation has already been carried out by CAAB such as apron expansion project from F taxiway to an existing export cargo terminal and asphalt overlay construction of the parallel taxiway. These constructions in the airport have been carried out according to Safety Management System (SMS) Manual based on the ICAO standards and airport construction under airport operation should not be necessarily considered as a Japanese advanced technology.

Therefore, for advanced technology in this airport, Screwed Steel Piling Method and soil improvement method are adopted for shortening the term of the works and soft ground countermeasure.

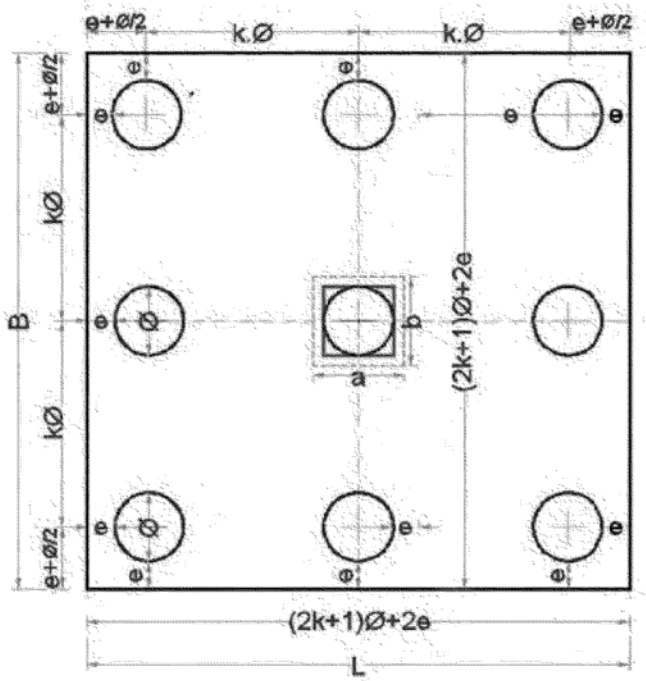
11.2.1 Screwed Steel Pile

(1) Cast-in-place Pile in Original Design

In the original design for Terminal 3, pile foundation will be constructed using cast-in-place pile which is the conventional pile method. This method will pour the concrete into a hole that is drilled by excavator. Even though this method is the cheapest and most popular, it has some issues such as surplus soil disposal and construction noise.

In the original design, nine cast-in-place piles (pile diameter: 1,000 mm) per one footing will be driven to hard ground base with depth of 30 m. The construction period for one footing is assumed to be about 13.5 days. Since this project is large-scale construction work, it will take 16 months using 20 parties for casting of the cast-in-place pile. This is almost half of the whole construction period of 37 months.

Therefore, pile foundation work is the critical path that might affect the construction period.



Source: JICAStudy Team

Figure 11-2 Placement of Footing and Pile (Cast-in-place Pile: Number of Piles is 9)

(2) Consideration for Shortening the Construction Period with the Application of Screwed Steel Pile

1) Case with Screwed Steel Pile for Piles

Since pile foundation work might be the critical path in the construction period in this project, the JICA Study Team conducted studies on the screwed steel pile for shortening the construction period.

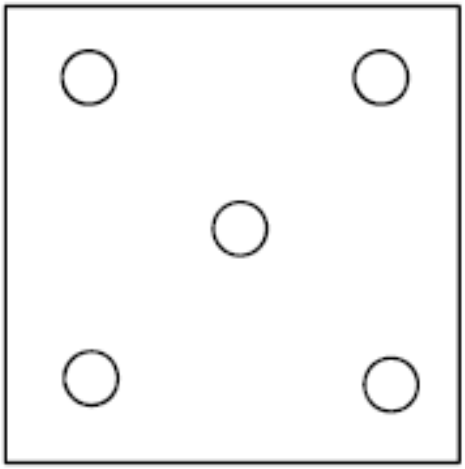
The screwed steel pile is a steel pile with a helical blade welded to the edge. During construction, a pile driver or casing rotator rotates the pile, and the blade on the edge performs the digging that drives the pile into the ground like a woodscrew. This method is often applied to large-scale construction when such pile foundation work is the critical path or if the construction work requires silence in an urban area. This method can shorten the construction period for pile foundation work since it can reduce the number of pile per one footing due to the increased bearing capacity as a result of the base enlarging effect of the blade.

Based on the boring investigation results in this study, it is revealed that the bearing capacity in the original design will be the same as that of five screwed steel piles per one footing to be driven to hard ground base with depth of 37 m.

The construction period for one footing is shortened to about 7.5 days due to the reduction of the number of piles. Therefore, if 20 parties could be used for casting, similar to the case of the cast-in-place pile, the construction period in the case of using screwed steel pile will be nine months. This result shows that screwed steel pile method can reduce the construction period by about seven months compared with the cast-in-place pile method.

However, according to interviews with Japanese companies, they can spare only seven parties for casting at present. If all footings are constructed by seven parties using screwed steel pile, construction will take 25 months and will take longer time than with the cast-in-place pile method.

Furthermore, the construction cost for one footing in the case of screwed steel pile is about JPY 6.5 billion higher than that of the cast-in-place pile.

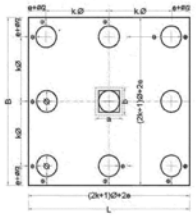
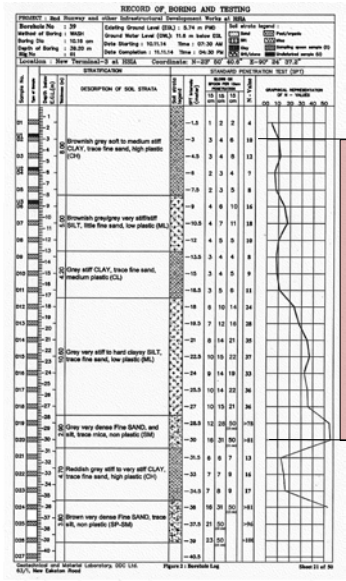
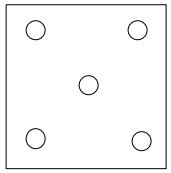
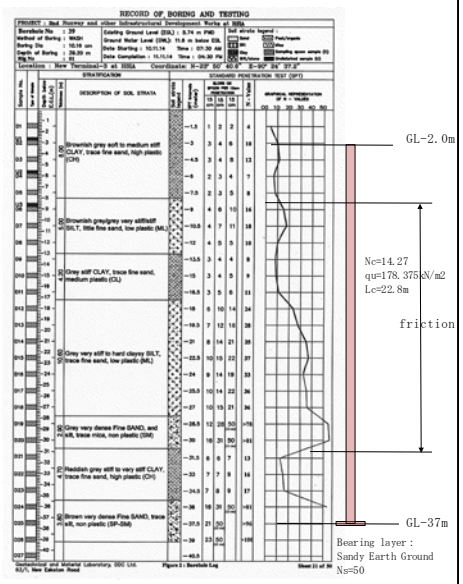


Source: JICAStudy Team

Figure 11-3 Placement of Footing and Pile (Screwed Steel Pile: Number of Piles is 5)

The comparison between the original design (cast-in-place concrete pile) and the alternative proposal by Japanese technology (screwed steel pile) is shown in Table 11-5 and Table 11-6.

Table 11-5 Comparison of the Original Design (Cast-in-place Concrete Pile) and the Alternative Proposal (Screwed Steel Pile)

	Cast-in-place pile	Screwed Steel Pile
Schematic	Pile Placement  Borehole No. 39 	Pile Placement  Borehole No. 39 
Specifications of the pile	Pile diameter D= 1000 mm Pile top GL- 2.0 m Pile tip GL- 30.0 m Pile length L= 28.0 m Number of pile n= 9	Pile diameter Dp= 900 mm Pile top GL- 2.0 m Pile tip GL- 37.0 m Pile length L= 35.0 m Number of pile n= 5 本 Blade diameter ratio 2.0 double diameter Blade diameter= 1,800 mm Steel pile thickness t= 15 mm Steel material SKK490
Test of bearing	・The long-term axial force (NL) All pile ΣN= 7297.36 kip 1kip= 453.6 kg Conversion = 3,310,082 kg = 33,101 kN Number of pile Σn= 9 NL= ΣN/Σn = 3,678 kN/one pile ・The long-term allowable vertical bearing capacity (RaL) RaL= 4,216 kN/one pile The long-term safety ratio : 2.5 (pile's pushing) ・Test of bearing capacity NL/RaL= 0.872 < 1.00 **O.K**	・The long-term axial force (NL) All pile ΣN= 7297.36 kip 1kip= 453.6 kg Conversion = 3,310,082 kg = 33,101 kN Number of pile Σn= 5 NL= ΣN/Σn = 6,620 kN/one pile ・The long-term allowable vertical bearing capacity (RaL) RaL= 7,396 kN/one pile The long-term safety ratio : 2.5 (pile's pushing) ・Test of bearing capacity NL/RaL= 0.895 < 1.00 **O.K**

Source: JICA Study Team

Table 11-6 Schedule Comparison of the Original Design (Cast-in-place Concrete Pile) and the Alternative Proposal (Screwed Steel Pile)

○Cast-in-pile(per one pile)

Item	1日 8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	2日 8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
Setting of casing rotator																		
The shaft portion drilling(φ1000×30m)																		
Precipitation waiting																		
Bottom dredging																		
Treatment of primary slime																		
Rebar construction																		
Ptolemy tube construction																		
Treatment of secondary slime																		
Ready-mixed concrete pouring																		
Pull-out casing																		
Backfilling																		

1.5days／per one pile×9＝13.5day／footing

○Csrewd steel pile(per one pile)
Specifications of the pile:SKK490 φ900×15t×35m(Upper pile＝12m、Middle pile＝12m、Lower pile＝11m)
Construction conditions:Borehole №.＝39、Length＝37m

Item	1日 8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	2日 8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
Installation of construction machinery																		
Lower pile press																		
Welding lower pile and middle pile																		
Middle pile press																		
Welding middle pile and upper pile																		
Upper pile press																		
Plier press																		
Backfilling, Mobilization																		

1.5days／per one pile×5＝7.5day／footing

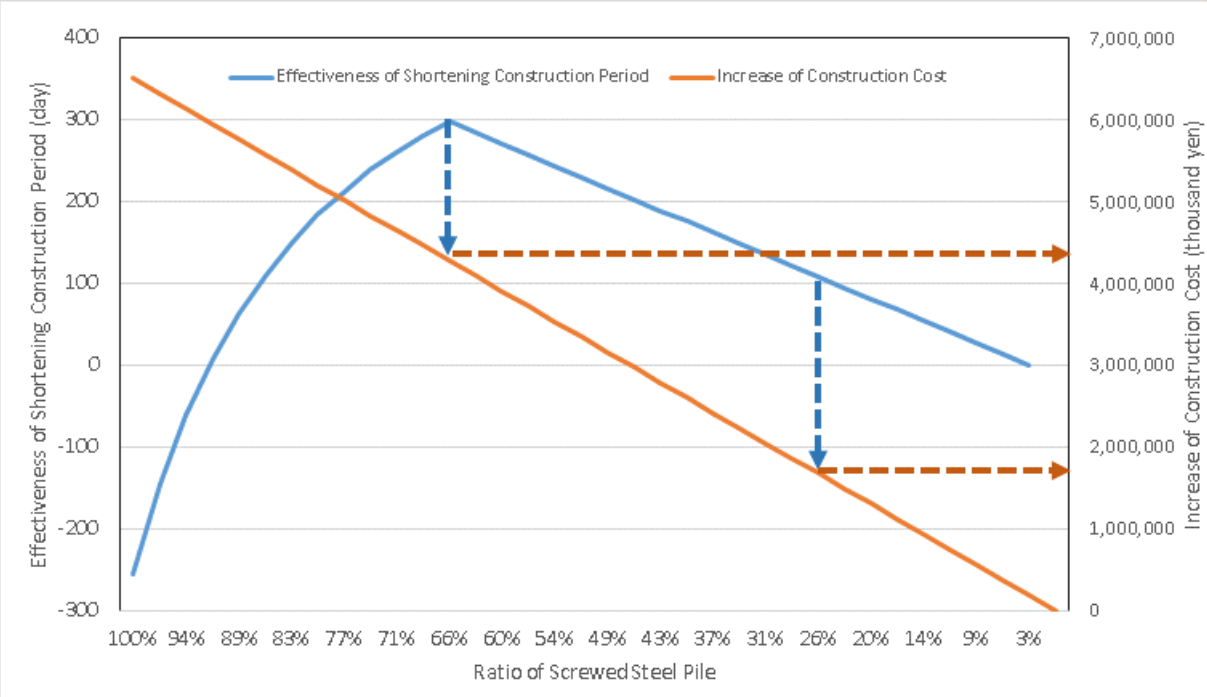
Source: JICA Study Team

2) In Case of Combination of Screwed Steel Pile and Cast-in-place Pile

It is difficult for local contractor to construct screwed steel pile because screwed steel pile is Japanese technology. According to interview with Japanese company, they can dispatch only seven parties at the moment. In view of the above, the JICA Study Team considers the mixed case of screwed steel pile and cast-in-place pile.

As a result, when the ratio of screwed steel pile and cast-in-place pile is 66:34, it is the most effective plan for shortening the construction period. In this case, the period can be shortened by about ten months. However, the construction cost will increase by JPY 4 billion. In the case where the ratio of screwed steel pile is 25%, the period can be shortened by about 100 days, and the construction cost will increase by JPY 1.5 billion. Figure 11.4 shows the relationship among the ratio of the screwed steel pile, the effectiveness of shortening the construction period, and the increase of the construction cost.

Condition for study: Screwed steel pile (7 parties), Cast-in-place pile (20 parties)



Source: JICA Study Team

Figure 11-4 Relationship among the Ratio of Screwed Steel Pile, the Effectiveness of Shortening the Construction Period, and the Increase of the Construction Cost

However, the above considerations might probably change since there is no detailed construction plan. Also, it is necessary to separate the structure of the building for different pile foundation since the elastic condition for each pile is different. Therefore, it is necessary to reconsider the structure of the building including the placement of expansion joint.

Table 11-7 Comparison of Cast-in-Place Pile and Screwed Steel Pile

Construction method	Original design (cast-in-place pile)	Japanese technology (screwed steel pile)
Prerequisites for Comparison	Both construction method are the same conditions. These were carried out compared by supporting force study in the same soil layer.	
Pile diameter (m)	1.0	0.9
Pile length (m)	28.0	35.0
The number of pile per 1 footing	9	5
Construction period per 1 pile	1.5	1.5
Construction period per 1 footing	13.5	7.5
Construction cost per 1 pile (1,000 yen)	1,680	4,882
Construction cost per 1 footing (1,000 yen)	15,120	24,410

Evaluation:

Construction period per 1 pile of screwed steel pile is same as the construction period per 1 pile of cast-in-place pile. However, the number of pile per 1 footing in the case of the screwed steel pile is less than the case of cast-in-place pile. Therefore, if the nuber of party is the same screwed steel pile and cast-in-place pile, screwed steel pile can be shortened construction period.

But, if a contractor that has management skill manages construction site using cast-in-place pile by increase the number of construction party, they can be shortened construction period since cast-in-place pile is generally used and it is easy to procure construction machinery, builders and material.

Since the cost of the cast-in-place pile is overwhelmingly cheap, the effect of adopting screwed steel pile aggressively is not seen.

However, it can be shortened the construction period in the case of using screwed steel pile for the portion that becomes the step on the critical, cast-in-place pile for other portions

（Calculation example for refference：It can be shortened construction period of about 100 days in the case of using screwed steel pile in 25%. But, it would be increase the construction cost of 25% about 1.5 billion yen.）

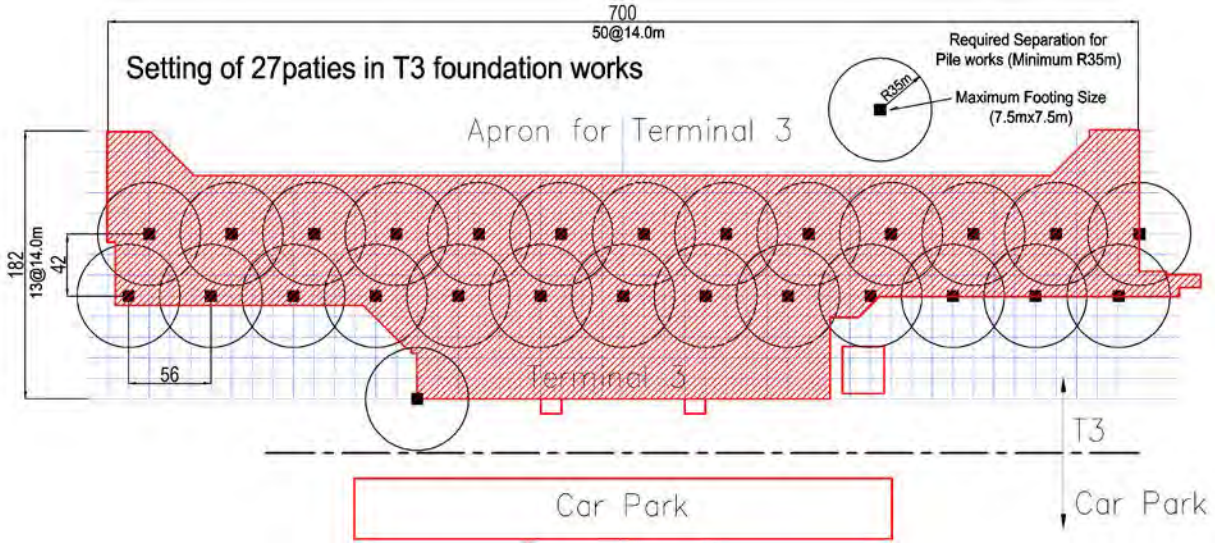
Source: JICA Study Team

(3) Applicability of Screwed Steel Pile to This Project

The applicability of screwed steel pile to this project is shown as follows:

- ✈ In the original design, pile foundation will be constructed by cast-in-place pile. It will become the critical path since it will take about 16 months. However, if it will be constructed by screwed steel pile, the construction period can be drastically shortened.
- ✈ Based on the result of a general study based on the boring investigation results of this study, it is revealed that the number of screwed steel pile for a single foundation will be reduced to 5 from 9 for cast-in-place pile. Furthermore, the construction period in case of screwed steel pile can be reduced to about 8 days from 14 days in comparison with the cast-in-place pile. However, the pile length of screwed steel pile is longer by approximately 7 m compared with the cast-in-place pile. But according to the interview with the Japanese companies, they can only dispatch seven parties. Thus, combination of screwed steel pile and cast-in-place pile will be used to shorten the construction period.

- Hereafter, it is necessary to confirm the structure and load of the building, hardness of the ground for each depth, and consideration of the separation of the building structure, among others. In the detailed design, it is necessary to design the separation of the building using expansion joint since there is no detailed drawing for expansion joint.
- As a result of the outline study, the construction period can be shortened by approximately ten months in case two thirds of all piles are screwed steel pile. However, the construction cost will increase by about JPY 4 billion. These considerations might still be changed during the detailed design and construction planning of the foundation and structure in the future.
- The construction area is very complicated since the footing at the center of Terminal 3 has 50 spans (1 span is 14 m); 2 parties per 4 spans will be placed in case of the installation of 27 parties. However, because the width required for the construction of screwed steel pile is about 10 m, it is necessary to ensure separation of about 35 m considering the drop of pile. In view of the above, the construction will be implemented using staggered placement.



Source: JICA Study Team

Figure 11-5 Arrangement of the Screwed Steel Piles in Consideration of the Work Clearance

- As a method of further shortening the construction period, day and night constructions are considered feasible. The additional construction cost due to labor cost such as night allowance and the establishment of night lighting facilities is a small amount of the entire cost of construction. In this case, it is necessary to ensure more than twice the number of technicians and operators. Also, the construction period in case of cast-in-place pile with day and night constructions can be reduced to about eight months. This is almost the same construction period shortening effect using screwed steel pile.
- In order to apply the heterogeneous pile to the pile foundation in the same building, it is necessary to reconsider the structure of the building and the construction plan during the detailed design phase (6 months).

11.2.2 Bonded Concrete Overlays

(1) Overview

When a concrete pavement becomes deteriorated, “reconstruction” will be chosen generally as the repair method. However, this method takes a long time and has huge cost and concrete scrap is produced in large quantities. On the other hand, “bonded concrete overlay” will be suitable if the crack of the pavement is very shallow and the concrete strength is sufficient. This method is obtained by using processing techniques that enhance the adhesion of the existing pavement surface, which is applied to the improvement of the apron pavement such as in Haneda Airport. Also, this method is developed by the National Institute for Land and Infrastructure Management (hereinafter NILIM) and Japanese pavement companies. Effect of reduction of construction costs and concrete scrap is expected.

(2) Applicability

There are so many cracks in the apron pavement in front of Terminal 2 and Terminal 3; this apron was constructed 40 years ago.

It is necessary to conduct the investigation to confirm the strength of the current apron pavement. This investigation will take at least three months.

Also, it is necessary to conduct the test to confirm the quality of concrete and the influence of weather conditions since these conditions are different from Japan. This test will take at least three months.

There will be no place that can be applied with bonded concrete overlays since there is no demolition of existing concrete pavement.

11.2.3 Soil Improvement

The purpose of the ground improvement is divided into subsidence measures, stabilization measures such as the increase in ground strength, and stabilization measures at the time of an earthquake. The soil improvement method of construction adapts to the most improved purpose and furthermore, it is necessary to choose the most economic method in consideration of the characteristic of soil layer of the existing ground and the facilities built above.

(1) Soil Condition

Soil stratification was reviewed and classified into eight layers, namely: clayey soil layer (C-1, C-2, C-3, and C-4) and sandy soil layer (S-1, S-2, S-3, and S-4), based on soil type and N-values as shown in Table 11-8.

Table 11-8 Proposed Soil Stratification

Layer	Soil	N-value	Relative Density or Consistency
C-1	Clayey Soil	0 to 5	Very Soft to Soft
C-2	Clayey Soil	5 to 10	Medium Stiff
C-3	Clayey Soil	10 to 30	Stiff to Very Stiff
C-4	Clayey Soil	More than 30	Hard
S-1	Sandy Soil	0 to 10	Very Loose to Loose
S-2	Sandy Soil	10 to 30	Medium Dense
S-3	Sandy Soil	30 to 50	Dense
S-4	Sandy Soil	More than 50	Very Dense

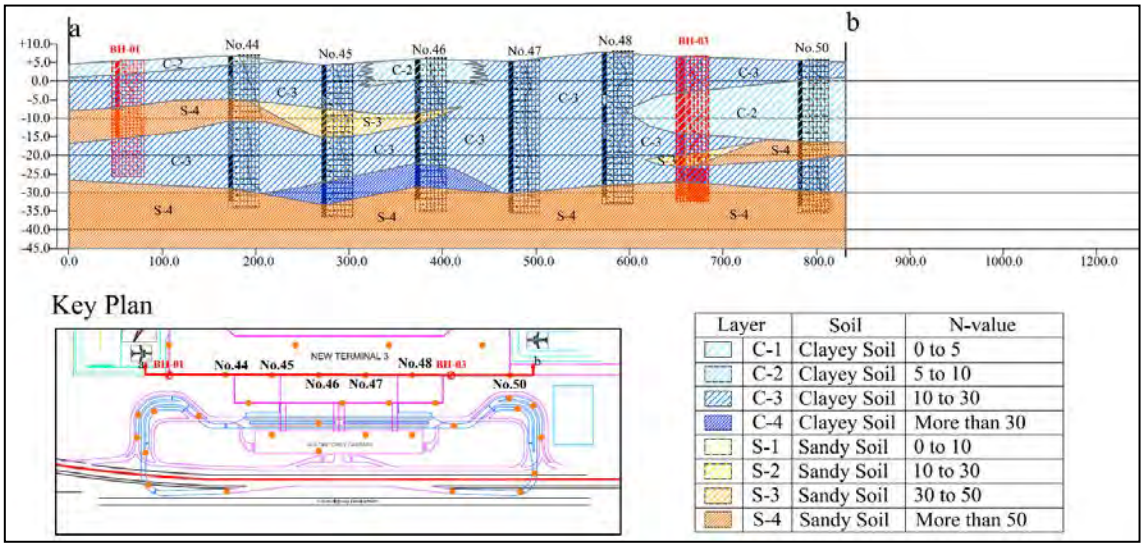
Source: JICA Study Team

- C-1 is very soft to soft clayey soil layer of the project area. C-1 layers are found in only few locations in the project area. C-1 layer appears only at the area near the ground level surface.
- C-2 is medium stiff clayey soil layer distributed mainly at the shallow portion. C-2 layers are mainly found at the boreholes at the airside compared with the landside and settlement is a concern. It is a stratum that needs attention for pavement design.
- C-3 is stiff to very stiff clayey soil layer distributed widely from the surface to the deep portion. The soils around the project area are mainly composed of C-3 layers.
- C-4 is hard clayey soil layer distributed at mainly deep portion around C-3 and S-4 layers.
- S-1 is very loose to loose sandy soil layer. S-1 layers are found in only few locations in the project area. S-1 layers appear only at the area near the ground level surface. It is a stratum where liquefaction at the time of an earthquake is a concern.
- S-2 is medium dense sandy soil layer. S-2 layers are found in only few locations in the project area. S-2 layer cannot be found at deeper level.
- S-3 is dense sandy soil layer distributed mainly at a depth of 0 ~ -30 m from the ground level.
- S-4 is very dense soil layer. S-4 is widely distributed at deeper portion with depth of around -30 m.

(2) Ground Condition at Each Area

1) Terminal 3 Area

The pile foundation structures for the new passenger terminal building are planned in this area. The clayey soil layers which have N-value of over 30 and the sandy soil layers which have N-value of over 50 can be the bearing layer of pile foundation for the terminal buildings. Therefore, C-4 and S-4 layers are suitable as bearing layer. Since the existence of C-4 layer in the new terminal area is limited depending on the location and S-4 layer exists widely at a depth of around -30 m, S-4 layers should be selected as the main bearing layer for the design of the pile foundation.



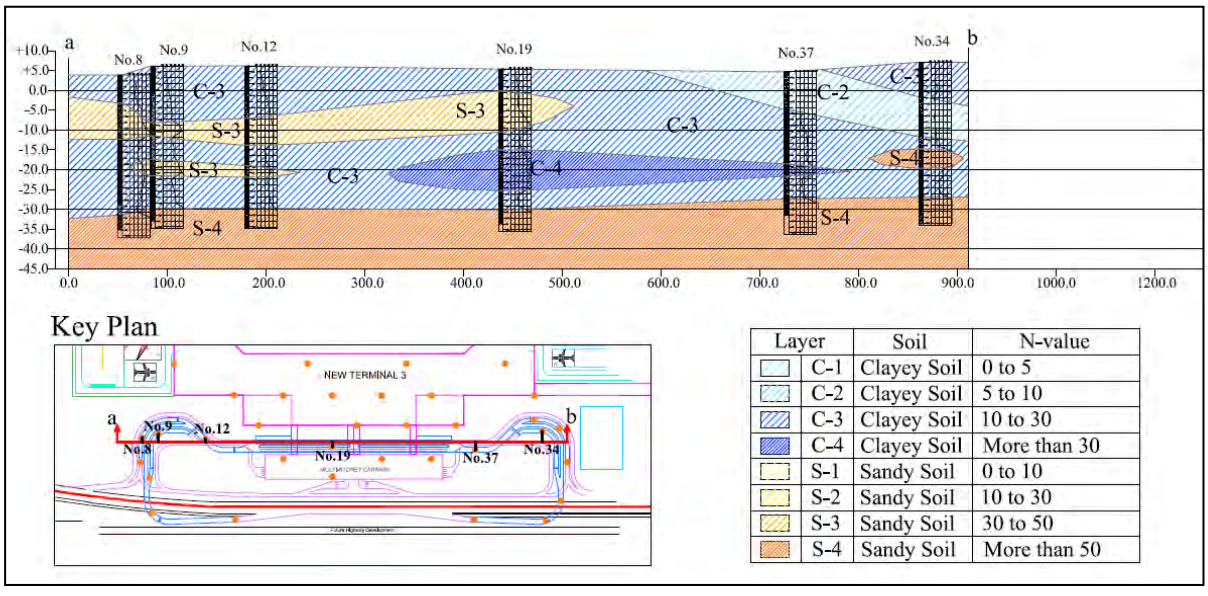
Source: JICA Study Team

Figure 11-6 Soil Profile (New Terminal 3)

2) Access Road and Car Parking Area

The pile foundation structures for the multi-storied car parking and elevated road are planned in this area too. With the same reasons as for the new Terminal 3, C-4, and S-4 layers are suitable as bearing layer of pile foundation for the elevated road structures and the car park building, and S-4 layers should be selected as the main bearing layer for the design of the pile foundation.

The soil profile of the new Terminal 3 is shown in Figure 11-7 and Figure 11-8.



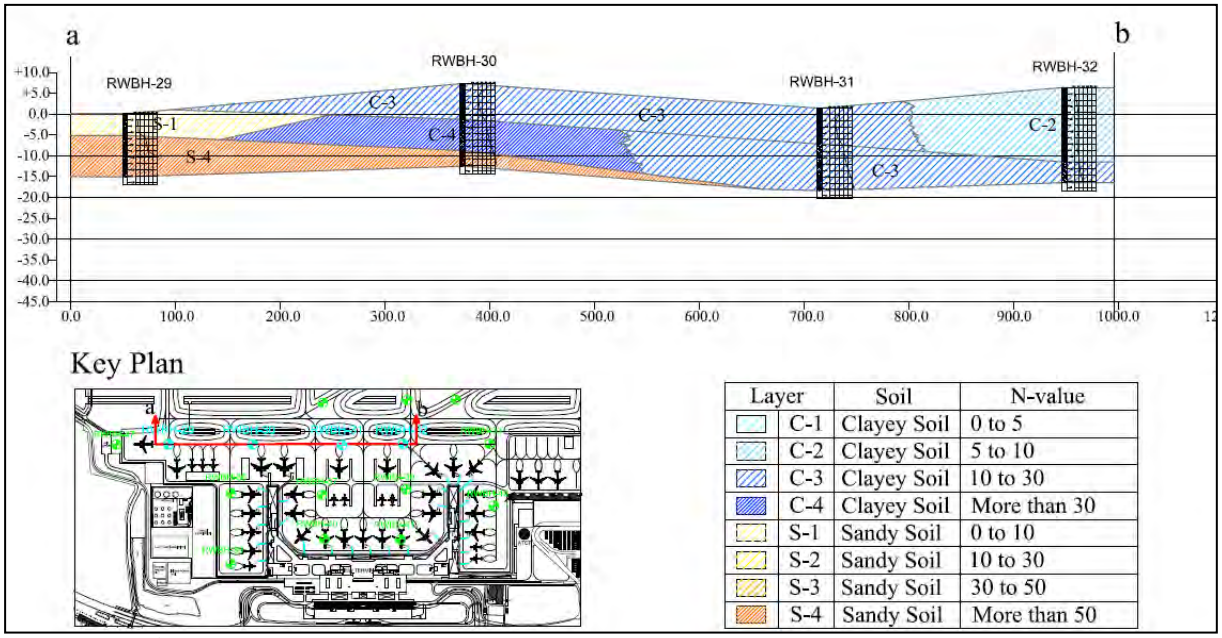
Source: JICA Study Team

Figure 11-7 Soil Profile (New Terminal 3) (1)

3) New Apron Area

There are relatively large-scale C-2 layers at some locations of the new apron area. The examination for settlement of the apron pavement structure may be needed at these locations.

In the new apron area, S-1 layer is found (RWBH-29). Since loose sand layer may cause liquefaction when earthquakes happen, the examination for liquefaction is needed at this area.

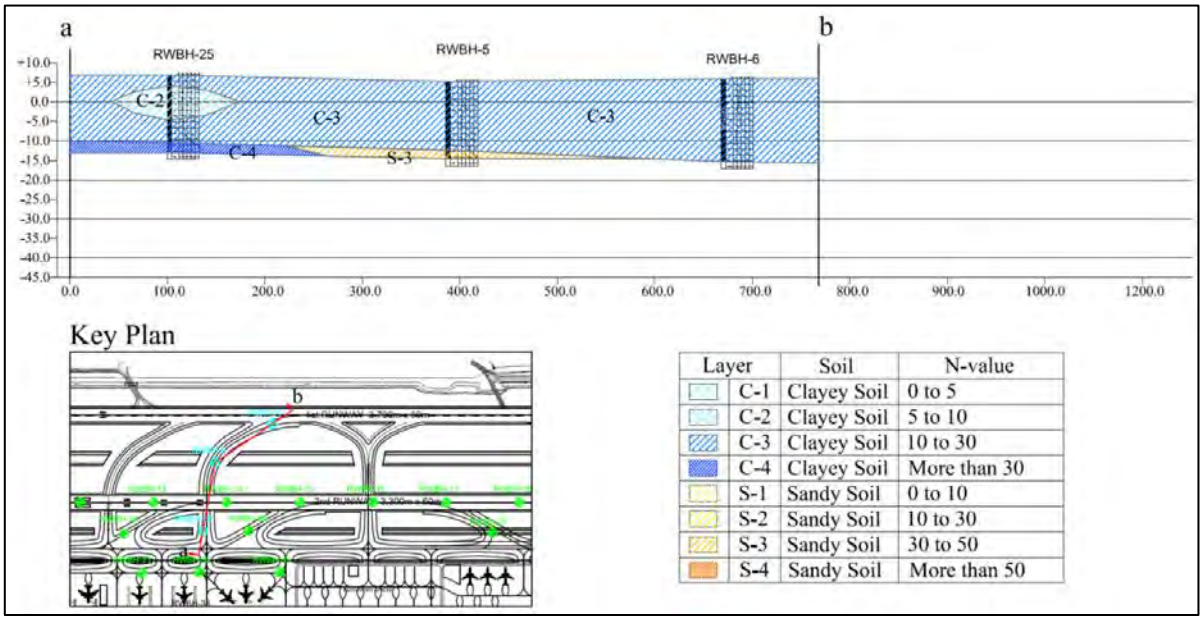


Source: JICA Study Team

Figure 11-8 Soil Profile (New Terminal 3) (2)

4) Taxiway Area (Southern New Rapid Exit Taxiway)

The C-2 layers are found at some locations of the taxiway area like in the new apron area. The examination for settlement of the pavement structure may be needed at these locations.



Source: JICA Study Team

Figure 11-9 Soil Profile (Southern New Rapid Exit Taxiway)

Gathering the above, the necessary area for soil improvement is assumed as follows:

Source: JICA Study Team

Figure 11-10 Assumed Soil Improvement Areas

(3) Soil Improvement Method

Soil improvement method has various methods of construction, and the impact varies according to the kind of the method of construction,

The method has primary effects based on the main purpose and has also some associated secondary effects.

As an example, the sand compaction pile method does not only have the effect of ground compaction but also various effects such as reduction of settlement and prevention of liquefaction.

The outline of the soil improvement method is mentioned below.

1) Consolidation-Promotion Construction Method

The ground is strengthened by removing underground water before construction. Because consolidation promotion time is necessary, the upper part of construction cannot start promptly. There are vertical drain method and loading method of construction. They are subdivided into the methods of construction such as paper drain, cardboard drain, sand drain, and vacuum drain depending on the loading method based on materials and method to be used.

2) Replacement Method

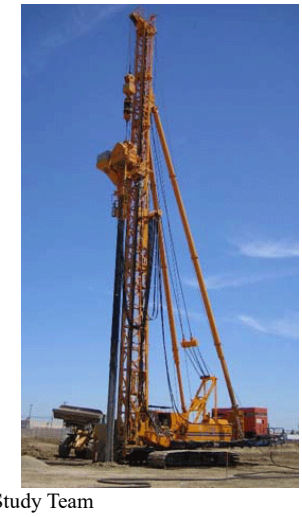
This method replaces a soft soil layer with high quality soil and certain improvement can be expected. This method has the advantage of low cost per improved soil and finishing the works in a short term. There are damage control effects on the superstructure from settlement and liquefaction prevention effect from compaction of the soil substitute.

3) Sand Compaction Method

This method improves a soft layer and develops strong ground by casting sandpiles in the soft layer. The required strength of the ground can be achieved by replacing the existing ground with the appropriate diameter and pitch sandpile. The strong ground provided by sand piles limits damage to the superstructure from settlement and as a secondary effect prevents liquefaction.

Source: JICA Study Team

Figure 11-11 Replacement Method



Source: JICA Study Team

Figure 11-12 Sand Compaction Method

4) Cement Deep Mixing Method

This method is applicable to every soft ground. This method secures the necessary strength by setting an additive rate of hardening materials depending on the quality of soil of the target ground.

5) Dynamic Compaction Method

A method of construction to compact the ground by letting a steel weight of around 10-25t to freefall from a height of 10-25m repeatedly, and giving shock on the earth surface. The compaction depth depends on the energy of the fall of the weight and improvement from the surface up to around 20m depth is possible.

A liquefaction prevention effect is produced other than the damage control effect to the upper part structure with settlement by compacting forcibly, and hardening soft ground.

(4) Applicability

Consolidation settlement will occur in the new taxiway and Terminal 3 construction site after completion of construction since there is an existing regulating reservoir.

There is a possibility to deviate from the required gradient of the International Civil Aviation Organization (ICAO) standard (vertical and crossing gradient of taxiway is provided at less than 1.5%, apron is provided at less than 1.0%) by consolidation settlement. After the airport opens, it is likely to be a major problem in the next few years.

When liquefaction occurs, the pavement grade cannot satisfy the rated value or the pavement is more likely to be destroyed.

Based on the above, it is required to select the most economic and effective method of improving the soft soil.

Source: JICA Study Team

Figure 11-13 Cement Deep Mixing Method

Source: JICA Study Team

Figure 11-14 Dynamic Compaction Method

11.2.4 Advanced Technology in Materials and Equipment

The advanced technologies that will enable the reduction of maintenance and construction cost are as follows:

(1) Earthenware Perforated Pipe for Underground Buried Cable Protection

1) Outline of the Material

The earthenware pipe segment of approximately 65cm length,with several earthenware pipes are united, is connected by bolt and duct for cable laying installations.

Construction process is simple and construction period is short, because the construction work simply connects the earthenware pipe segments, each 65cm in length. In the case of a polyvinyl chloride pipe and a steel tube, the work period increases by approximately 20% including a curing period because it is necessary to fix a duct line with concrete and sand.

The load resistance of an earthenware pipe is huge. It is applicable to be used under runway and taxiway.

2) Applicability

This pipe material is newly developed and an advanced technology with competitiveness and it contributes to shortening the construction period. But the contractor may not be a Japanese-affiliated company because it is a construction material.

Source: JICA Study Team

Figure 11-15 Earthenware Perforated Pipe for Underground Buried Cable Protection (1)

Source: JICA Study Team

Figure 11-16 Earthenware Perforated Pipe for Underground Buried Cable Protection (2)

(2) Multi Corrosion Prevention Paint for Steel Structure

1) Overview

This is a fluorine resin coating which is used for painting of external steel wall, door, and pillar. It is expected to reduce maintenance costs because it is maintenance-free and stain resistant.

2) Applicability

Even though Japanese products are slightly more expensive, there is some possibility to suggest that these products are effective materials for painting if they can be proven to have effectiveness in terms of life cycle cost.

(3) Photocatalyst

1) Overview

A photocatalyst is a material that functions as a catalyst that decomposes source materials of stains and smell.

Utilizing photocatalyst for building materials and electrical appliances is effective for anti-fogging, anti-bacteria and virus, gas decomposition, and anti-smell.

This material is developed in Japan. Also, almost all products with photocatalyst are made in Japan.

Using photocatalyst for roof material, window glass, tiles, and walls is effective to prevent dirt and reduce maintenance costs such as cleaning cost.

The usage period is almost the same as that of general products.

The initial cost is more expensive than general products; however, it is useful for reducing maintenance cost due to the reduction of cleaning times and water volume.

2) Applicablity

Many types of products, such as window glass, outer tent, interior panel (floor or wall) in terminal building, exterior panel and toilet flooring tiles, could be used in this project. Many airports adopt photocatalyst products by promoting Eco-Airport.

Noi Bai International Airport in Vietnam installed photocatalyst tiles in the flooring of toilet located in the international terminal. Regarding the performance index of photocatalyst products, Japanese standards have been developed. On the other hand, international standards, which could be applicable in foreign countries, have not yet been developed. If the performance indicators about the reduction of life cycle cost or sanitation can be demstrated, these products could be proposed as building materials.

Source: JICA Study Team

Figure 11-17 Photocatalyst Adopted in Toilet Flooring Tile

Source: JICA Study Team

Figure 11-18 Photocatalyst adopted in Interior Panel Wall

(4) Facial Recognition System

This system distinguishes different types of individual automatically by camera system from original algorithm. Based on the result, the system can issue a warning alarm or notice.

Systems with more than 700 devices in 70 countries are introduced including in JFK Airport in USA and 14 Brazilian main international airports.

The system developed by a Japanese company has achieved three consecutive first place evaluations in a contest by the American National Institute of Standards and Technology (NIST) and has worldwide superior quality. Furthermore, it is effective for convenience, results in cost reductions through behavior detection system which discovers suspicious individual or an automatic boarding system integrated with other security systems.

(5) Liquid Scanner

The scanning device will analyze and test liquids in containers for explosives at airport security points without the staff having to open them. Glass, plastic bottle, canned aluminum, and any container including steel can are testable. The liquid scanner is installed in all airports around the world. It is regulated around the world that hand-carried liquid quantity should be less than 100 mL and this device is mainly used for examination of transit passengers, since bigger liquid containers are intercepted at the time of departure security control.

Table 11-9 shows the applicable advanced technologies.

Source: JICA Study Team

Figure 11-19 Facial Recognition System

Source: JICA Study Team

Figure 11-20 Liquid Scanner

Table 11-9 Summary of the ApplicableAdvanced Technology

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
1	Construction work	Screwed Steel Pile	The screwed steel pile is a steel pile with a helical blade welded to the edge. During construction, a pile driver or casing rotator, for example, rotates the pile, and the blade on the edge performs the digging that drives the pile into the ground like a woodscrew.	・Reduction of pollution（low noise, low vibration） ・Shortening of the construction period ・Because mine soil dueto the digging does not occur, it does not take processing cost.	+++	Construction Experience of Screwed Steel Pile of more than 900 mm diameter	【Contractor】 Shimizu Corporation Taisei Corporation Oobayashi Corporation Tokyu Construction Hazama Andou Corp. Torishima Pump 【Contractor for Screwed Steel Pile】 Nippon Steel and Sumikin Engineering JFE Engineering 【Sub-Contractor】 Toyo Techno Marutai Doboku 【Manufacturer】 JFE Steel Nippon Steel	【Construction Experience】 **Japanese Airport:**Haneda International Airport Terminal 2、Kitakyushuu Airport PTB、 **Abroad:** No experience in airport, but there are experiences in elevated road and building work. （Mongolia：The Project for Construction of Railway Flyover in ULAANBAATAL City by JFEEngineering co., Grant Aid) （Myanmar：The Project for Urgent Improvement of Water Supply System in YANGON City by Torishima Pumps.,Grant Aid) （Vietnam：Bridge exceeds HOANG MINH GIAM-NGUYEN CHANH Project by Thang Long Construction, Grant Aid） 【Overseas Rival Company】It is Japanese original construction method. There are few experiences by non-Japanese companies including China and Korea. Non-Japanese companies do not have construction experience on 900 mm diameter required in this project having only experience of smaller pile of less than 500 mm. 【Cost】When comparison of construction cost per unit will be made with the conventional construction method, cost of the construction may become higher due to the special equipment/machine and required skill from the workers (cost increase of JPY 1,500 million assumed by this project) 【Construction Period】The detailed examination is necessary, but is more likely to contribute to shortening the term of works. (approximately three months shortening of the term of the works assumed by this projects) 【Consideration】The introduction is difficult without the participation of Japanese medium and small-sized enterprises, because they are more likely to undertake the construction of Screwed Steel Pile as sub-contractor. (Nippon Steel & Sumikin Engineering, a company which can construct Screwed Steel Pile by itself, is planning to establish itself in Bangladesh) 【Applicability to the Project】 The applicability of this construction method is high due to the high competitiveness of Japanese technology and contribution to the shortening of construction period.
2		Bonded Concrete Overlays	This method is obtained by using processing techniques that enhance the adhesion of the existing pavement surface, which is applied to the improvement of the apron pavement	・Slash of the discharge of the by-product ・Reduction of the cost of construction.	-	Construction Experience		【Construction Experience】 【Overseas Rival Company】 【Cost】 【Construction Period】 【Applicability to the Project】In this project, removal/remedial work of the concrete pavement of the existing apron is not included; said construction method is not adopted and is not an application target.

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
3		Earthenware Perforated Pipe for Underground Buried Cable Protection	The earthenware pipe segment of approximately 65cm length,where several earthenware pipes are united, is connected by bolt, and duct for cable laying is installed.	・High load-resistant ・Shortening of the construction period ・Flexibly following the unequal settlement	+++	Construction experience of more than 500m length of duct by earthenware perforated pipe	【 Contractor】 General contractor 【Manufacturer】 Sugie Seito Co.	**【Construction Experience】**There are many construction results at the airport. In overseas, there are introduction results in the new apron area of Changi Airport. **【Overseas Rival Company】**It is a Japanese original product. **【Cost】**The earthenware pipe is made with the materials of construction grime and industrial waste as raw materials of50%.There is little environmental load and it is cheap.However, it is necessary to export them from Japan because the field does not have a production base and it takes transportation cost.→It costs the DAP shipping charge of JPY 116,000/container for the pipe based on the results in Changi Airport.(DAP: Deliver at place= By construction site handing over, the custom duty is for the person withordering burden.) In addition, pipe materials of approximately 700 m have material cost of approximately JPY 72 million, 116,000 x 21 fare container = approximately JPY 2,4 million altogether. The CIF shipping expenses (arrival at Chittagong) to Dhaka are still estimated at JPY190,000/container and total shipping expenses are approximately JPY 4 million if the same quantity in Changi is assumed. **【Construction Period】**Construction process is simple and construction period is short because the construction work simply connects earthenware pipe segments of 65cm length each. In the case of a polyvinyl chloride pipe and a steel tube, the process period increases by approximately 20% including a curing period because it is necessary to fix a duct line with concrete and sand. **【Applicability to the Project】** New construction materials include competitiveness and contribute to shortening the term of the works. However, the construction company may not be a Japanese-affiliated company because it is a construction material.
4		Soil Improvement Method (including counter measure of liquefaction)	The ground improvement method is adopted when it is judged that the ground supporting the upper part structure is soft, and upper part structure is not supported. Various improvement methods as shown below will be studied and adopted.	Settlement counter measures to secure the soundness of the upper structure and liquefaction countermeasure at the time of earthquake.	+++	Construction experience of soil improvement for settlement and liquefaction under pavement for more than 15ha under airport operation	【General Contractor and/or Marine Contractor that have construction experience for more than 15ha】 Kajima Corp. Aomi Const. Obayashi Corp. Penta Ocean Const. Shimiz Corp.	**【Construction Experience】**Many construction experiences in marine airport such as Haneda, Kansai and Chuubu international airport. In addition, the ground/soil improvement is carried out in the port construction project such as Vietnam Haiphong Port and Bangladesh Matarbari Coal-fired Power Project. It may be said that it is the Japanese specialty being a maritime country. **【Overseas Rival Company】** This is a technical area that is excelled by Japanese companies, and non-Japanese companies do not have many experiences. **【Cost】** The ground improvement cost is decided by the ground situation and improved target quality and it is required to select the method with lower cost.

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
							Taisei Corp. TOA Corp. Toyo Const. Nishimatsu Corp. Maeda Corp. Mirai Corp. Wakachiku Const.	**【Construction Period】** It is important to choose a method of construction that can complete the whole process within the shortest period, since the construction period of the ground improvement varies according to the method of construction. **【Issue】**It is most important to confirm that the ground reaches the target quality by analyzing the improved quality and strength of the ground through investigations after the improvement work. **【Applicability to the Project】** ① Japanese construction company has many ground improvement experiences and competitiveness is higher than non-Japanese companies. In the design stage, the most proper method of construction is selected by examining the quality of soil, construction process, equipment and cost. However, when a contractor proposes an alternate method of construction inthe bidding stage,it is needed to judge the merit. Thus, it is unreasonable to prescribe one method of construction at present. Then, it is valid to ask the airport construction experience in operation and ground improvement experience under the airport pavement. ②In Japan, it is common to place a separate order forearthwork such as soft ground improvement and paving work.However,Haneda D Runway Project placed an order for earthwork and pavement work in one contract package due to the design-build contract. The soft ground improvement tenders the airport pavement in an airport operation was carried out in embankment area (approximately 950,000 square meters), the pavement area of the runway, taxiway portion except shoulder part was approximately 160,000 square meters. The construction was carried out by the joint venture of 15 companies including Kajima,Aomi,Obayashi,Penta Ocean, Nippon Steel Engineering, JFE Engineering, Taisei, Toyo, Nishimatsu, Maeda, Mirai, and Wakachiku. ③Because the ground improvement area in this project is assumed to be almost around 250,000-300,000 square meters of half of the apron and taxiway area with approximately 600,000 square meters in total, the construction experience required is for half of the construction area of this project and furthermore, considering the construction experience in the Haneda D Runway Construction Project, it is desirable that experience on 150,000 square meters is prescribed. In addition, it is considered that overseas companies including from China and Korea can enter ifthe construction experience onpavement is lowered to around 10,000 square meters. ④Japanese contractors during present construction in Bangladesh are Shimizu, Obayashi, IHI and JFE (Kachi pool,Megna, Gumty bridges), Penta-Ocean(Matarbari coal-fired power), Tokyu (MRT

No.	Category	①Method of Construction, Technical Reputation		② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
									train base).
4.1		Ground Improving Method	Consolidation-Promotion Construction Method	The ground is strengthened by removing underground water before construction forcibly. Because consolidation promotion time is necessary, upper part of construction cannot start promptly. There are vertical drain method and loading method of construction. It is subdivided into the methods of construction such as paper drain, cardboard drain, sand drain, and vacuum drain, due to the loading method by materials and method to be used.	・Prevention of settlement after the construction completion ・Restraint of the damage to a structure associated with the settlement	++			**【Construction Experience】**The construction results are abundant.These methods of construction are used alone or in combination in the marine airports of Haneda, Kansai,Chuubu and Changi Airport. **【Overseas Rival Company】**There are few overseas companies holding a construction heavy equipment (casting machine of various drain materials).It is advantageous to the Japanese company. **【Cost】**Generally, the cost per improved soil is cheap.The existing design does not consider soil improvement.Therefore, it is necessary to include cost of what kind of soil improvement is chosen. **【Construction Period】**Because accelerating consolidation time is necessary after construction completion, work period is generally long.It depends on the structure of loading, but there are generally many examples of three to six months to wait for accelerating consolidation. **【Issue】**In the application of the method of construction, it is necessary to choose the most suitable method of construction considering the following: 1) Confirmation of a layer targeted for settlements. 2) Settlement prediction on the basis of embankment height and thickness of pavement. 3) Selection of improvement method and examination of cost and work period based on the magnitude and time of the settlement. **【Applicability to the Project】** According to the soil investigation in the data collection survey, there is soft layer with possibility of settlement in a part of the Terminal 3 apron area northside and high-speed exit taxiway area.The applicability of this method of construction is high considering influence on pavement by thesettlement after the completion.
4.2			Replacement Method	It is a method of construction to replace a soft layer with high quality soil and certain improvement effect can be expected. There is an advantage of low cost per improved soil and finishing the works in a short term.	・Prevention of settlement after completion of construction ・Restraint of the damage to a structure associated with the settlement ・Restraint of the liquefaction of the ground	-			**【Construction Experience】**For the simplest method of construction,there is not need for a special technique, and there are many experiences.It is adopted in case of partial soft ground processing inairport construction, earthwork construction, and roadwork or shore protection works. **【Overseas Rival Company】**A contractor who can do the earthwork is possible other than a Japanese contractor. **【Cost】**Generally, cost per improved soil is lower, **【Construction Period】**Because after the replacementof the soil, next process of the work can start promptly,this method is advantageous. **【Issue】**Because this method of construction is not Japan's original

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
								technique, it is inapplicable for Japanese original technique. However in an application, it is necessary to examine the following. 1) High quality material choice and security, and influence on environment in the transportation of the material. 2) The introduction of other methods of construction that considered the local situation and change if necessary. **【Applicability to the Project】** According to the soil investigation in the data collection survey, Terminal 3 apron area, the yard road district are dotted with an pondage and small reservoirs and because there is sullage at the reservoir bottom thinly, a replacemnt method of construction is recommended as the simplest and easiest method for ground improvement method. Furthermore, this replaced soil can plan the utilization of resources by diverting it to vegetation soil.
4.3		Sand Compaction Method	To improve a soft layer and develop land with strong ground by casting sandpile in the soft layer. Necessary strong ground in a design can be made in exchanging the replacement rate of the existing ground by diameter and pitch of the sandpile.	･Prevention of settlement after completion of construction ･Restraint of the damage to a structure associated with the settlement ･Restraint of the liquefaction of the ground	++			**【Construction Experience】**It is soft ground improvement construction, and there are many construction experiences in Japan and abroad by the Japanese company. With the train base construction package of Dhaka Urban Traffic Project (Route 6), this construction method is adopted in train-track lane area. **【Overseas Rival Company】**Because the overseas company does not have the construction equipment of the SCP method, the contractor except for Japanese firm cannot undertake construction. **【Cost】**Securing of high quality sand is a point and is higher than theconsolidation promotion method, but is cheaper than the CDM (Cement Deep Mixing) Method. **【Construction Period】**There is the advantage that the construction of upper facilities can commence after pile casting promptly. **【Applicability to the Project】** According to the soil investigation in the data collection survey,there is the loose sand layer in the southside of the Terminal 3 apron area and it is feared that it will liquefyduring earthquake and destroy the pavement. Therefore,it is very likely to be apply this method of construction as a liquefaction measure. But it is necessary to study cost and work period againstdynamic compaction methods, and to choose it.
4.4		Cement Deep Mixing Method (CDM)	It is a method that is applicable to every soft ground. This method secures necessary strength in setting an additive rate of hardening	･Reduction of the pollution (transformation of the improved ground, restraint of the water pollution)	++	【 Construction Experience】		**【Construction Experience】**In Japan,this method was used for the revetment of Kansai and Haneda Airport on the soft ground improvement construction **【Overseas Rival Company】**Because non-Japanese companies do not have the construction equipment of the CDM method, only Japanese firms can undertake construction. **【Cost】**The cost per improved soil is relatively high.

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
			materials depending on quality of soil of the target ground.	(low noise, low vibration) ・Reduction of the environmental influence ・Shortening of work period				【Construction Period】This method contributes to shortening the work period because an improved effect is shown early and upper construction work is possible to commence promptly after soil hardening. 【Issue】In the application of this method of construction, it is necessary to examine the following: 1) What can reduce influence on environment in comparison with other construction method. 2) Confirmation of the need and the validity from the viewpoint of coverage, term of works, and economy. 【Applicability to the Project】 The purpose of this method of construction is for strengthening of deep stratum of more than 10m and improvement of the stability of the ground. However,this method of construction has low applicability in this project because the soft layers are at10-15m depth from the surface at Terminal 3 apron and service road area,
4.5		Dynamic Compaction	A method of construction to compact the ground by letting a steel weght of around 10-25 t in weight freefall from a height of 10-25 m repeatedly, and giving a shock on the earth surface. The compaction depth depends on the energy of the fall of the weight and the improvement from surface up to around 20 m depth is possible.	・Prevention of settlement after completion of construction ・Restraint of the damage to a structure associated with the settlement ・Restraint of the liquefaction of the ground ・The cost is lower than that of other improvement method	+++			【Construction Experience】There are many results in Japan and abroad. With the train base construction package of Dhaka Urban Traffic Project (Route 6), this construction method is planned to be adoped as a liquefaction measure. However, it was changed to the sand compaction method because subcontractor gave up after the Dhaka case. 【Overseas Rival Company】The construction is simple by a combination of crane and steel weight.But there are few experiences by non-Japanese companies due to the extreme confirmation investigations after construction and precise construction management 【Cost】The cost per improved soil is low. 【Construction Period】This method contributes to shortening of the work period and can enable to start the next process promptly after investigating the strength. 【Issue】 The securing of subcontractor who can carry it out is important. 【Applicability to the Project】 As an application condition of this method, the layer to be improved shall be shallower than 20m and loose sand layer with N-value less than 10. It is judged that the applicability of this method of construction is high because there is a loose sand layer in the Terminal 3 apron area at10-15 m depth from the surface. In addition, in all the soil improvement works, it is most important to analyze and confirm the improvement quality and strength of the soil by ground investigations after the ground improvement construction.

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
5	Construction Supervision	Information - oriented construction （BIM、CIM）	In construction work, it makes the design's basic information including the design drawing three-dimensional model, In each stage of plan design, construction, and maintenance, it develops three-dimensional model and plan the efficiency and advancement of series of construction production systems by sharing information between thepersons concerned for the whole Project. BIM:Building Information Modeling CIM:Construction Information Modeling	・Visualization of design・ Automation of quantity calculation ・Confirmation of consistency of design ・Workability improvement ・Improvement of construction safety ・Efficiency ofmaintenance	+	Construction Experience		**【Construction Experience】**There are no results in the airports in Japan. Ministry of Land, Infrastructure and Transport plans penetration of this system and it is developing mainly in building projects. It has been carried out abroad led by the U.K. and the United States. For example, Denver International Airport expansion (2013 completion), baggage inspection system in the Heathrow Airport Terminal 2 and J.F.Kennedy Airport, **【Overseas Rival Company】**It is still a developing technology apart from the U.K. and the United States. **【Cost】**By becoming three dimensional and being visualized, reduction of the design cost and security of the construction environment are achieved **【Construction Period】**Shortening of work period is possible due to decrease of reworking with reduction in cost.
6	Maintenance	Corrosion-proof coating for steel structure	The fluoropolymer coatings which become hard to have dirt by painting it on an outer wall, door, and the pillar of steel materials.	・Reduction of maintenance cost ・Reduction of water consumption ・Image improvement ofairport terminal	+	Construction experience	Japanese contractor	**【Construction Experience】**It is applied to the steel structure including the bridge along a river and the shore. **【Overseas Rival Company】**There is a similar overseas product. **【Cost】**Initial introduction cost is slightly more expensive than that of an overseas product. **【Construction Period】**The work period is approximately similar for usual paint.
7		Photocatalyst	It is the generic name of the material which resolves an agent causing dirt and smell or bacteria by light shine, and the material shows effect such as antifouling, defogging,	・Reduction of maintenance expenses such as cleaning ・Reduction of water consumption ・Improvement of the hygiene level	+++	Construction experience	Japanese contractor 【Manufacturer】 Showa Denko Ceramics Toto Panasonic	**【Construction Experience】**It is introduced at many airports in Japan. It is used in the tile of the restroom in Noi Bai International Airport in Vietnam. **【Overseas Rival Company】**It is a technique developed and produced mainly in Japan. There is a similar product overseas. However, only Japanese product shows response to not only sunshine but also visible light. When it is applied to a room such as restroom, Japanese product has superiority in terms of the display effect of

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
			antibacterial, antivirus, air cleaning and deodorization in using it to construction materials and household appliance.	・Image improvement of the airport terminal				visible light. 【**Cost**】Initial introduction cost rises, but the reduction effect of the maintenance cost is high. 【**Construction Period**】The construction is similar to a general product and is at the same level for the work period. 【**Applicability to the Project**】 It is a finishing material representing an eco-airport,and the applicability to this project is high. But the contractor may not be a Japanese company because it is construction material.
8		Inteligent Fire Suppression System	It starts by fire detection of automatic fire alarm system and drain water off locally for a fire outbreak source and die down after exploring and determining fire breaking location with the sensor of the nozzle part,	・Reduction of water consumption. ・Restraint of apparatus deterioration and abrasion. （reduction of the life cycle cost） ・Image improvement of the airport terminal. （It is inconspicuous by intramural housing）	++	Construction experience	Japanese contractor （manufacturer） NOHMI BOSAI LTD.	【**Construction Experience**】It is introduced at many airports of Japan. In addition, it is introduced into the major airports in Philippines, Vietnam, and Qatar. 【**Overseas Rival Company**】It is a technique developed in Japan and is an original product of Japan. 【**Cost**】As for the cost of the product, sprinklers are usually cheaper. The product concerned may reduce cost, when compared with material costs such as plumbing. But the adjustment of the system, the apparatus, and the cost of commissioning may increase depending on the setting condition. 【**Construction Period**】Plumbing is reduced and may contribute to shortening the period of the works. But the adjustment of a system, the apparatus and commissioning may take time depending on the setting condition. 【**Applicability to the Project**】It is necessary to confirm whether the product is imported into Bangladesh or not, because the tip in the sensor which is a part of the product is made in Israel.
9		FOD (Foreign Object Debris)	System device which always watches Foreign Object (FO) on the runway. It can reduce closedown time of runway and use runway effectively. It allowshigh-density operation of runway	・Reduction of maintenance cost ・Safety improvement	+	Construction experience	Hitachi, Ltd.	【**Construction Experience**】It is at proof experiment stage in Japan. But introduction advances abroad in a major airport. 【**Overseas Rival Company**】Not a Japanese original technique, there are leading overseas company including Israel, Singapore and U.K. In addition, regarding detective speed and detective precision, the European technical standard (EUROCAE) was just devised. It is under verification work now in the manufacturer side whether Japanese device complies with this standard. 【**Cost**】The initial introduction costs are high. But, the total cost may decrease, considering the drop of maintenance administrative cost including labor cost for the normal visual confirmation by specialized personnel and drop of the accident incidence. 【**Construction Period**】It is necessary to verify validity from the viewpoint of the term of works, economy due to the period for the introduction of the system and training to the personnel required.

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
								【Applicability to the Project】This system is under a proof experiment now in Electronic Navigation Research Institute (ENRI) and Narita Airport. It has not been released yet. In addition, application is unreasonable because the product cannot be evaluated that a Japanese product has superiority under the international standard. Therefore, validity and rationality are low for this project. In addition, because the runway will be extended and widened in the future in Phase 2, it is expected that introduction of the product will be examined at that time.
10	Security	Facial Recognition System	Distinguishes different types of individual automatically by camera system from original algorithm. Based on the result, the system can issue a warning alarm or notice.	・Safety improvement ・Reduction of time for passport control	+++	Construction experience	NEC	**【Construction Experience】**Systems of more than 700 devices in 70 countries are introduced including JFK Airport in USA and 14 Brazilian main international airports. **【Overseas Rival Company】**The system which Japanese company developed gets consecutive first place evaluations in a contest of the American National Institute of Standards and Technology (NIST) three times and has worldwide superior quality. 【Cost】Although there is initial introduction expense, considering total cost of the security enhancement with the security condition of these days, personnel expenses and other system introduction cost are reduced. In addition, the cost of Japanese product is around JPY 300 million for 30 cameras whole system installed (including server and SE work). On the other hand, it is difficult to compare with the price of U.S.or Europe product (Rockwell Collons, HUMAN Recognition systems, FACE-SIX) because they vary according to function. However, it is thought that cost does not have big difference when same level of precision is required. **【Construction Period】**During the construction period, it is approximately similar to system introduction for normal passport control.。 **【Situation】**① In Bangladesh, the security in each place is strengthened after terrorism of July 2016 and security enhencement measures of the airport become important and pending issues ② Furthermore, it is effective for convenience andcost cut by behavior detection system discovering a suspicious individual or an automatic boarding system being unified with other security system. **【Issue】**It is neccessary to confirm whether the other project also provides technical assitance (grant base or others) for equipment and system provision.
11		Liquid Scanner	The scanning device will analyze and test liquids in containers for explosives at	・Safety improvement ・Reduction of time for passport	++	Construction experience	Kumahira Co.	**【Construction Experience】**The liquid scanner is installed in all the airports in the world.. **【Overseas Rival Company】**The device passed ECAC(European Civil Aviation Conference) performance test, which is the only

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
			airport security points without staff having to open them. Glass, a plastic bottle, canned aluminum, any container including steel can are testable.	control ・Inspection of hand-carried liquid container for transit passenger				performance standard for liquid explosive tester. It can judge the risk of the liquid in the container in a short time called from one to four and as for the smallest detective ability, quantity of 10 mL is possible.An overseas competitor includes products made in Italy. 【**Cost**】Although there is initial introduction expense, considering total cost of the security enhancement with the security condition of these days,personnel expenses and other systems introduction cost are reduced. The announced scanner expense is JPY 7,340,000. 【**Construction Period**】Because the scanner is only connected to the pow**er,**setting time is very short. In addition, the device is 25 cm in width X 27cm in height X 26cm in depth, around 7.5 kg of small things。 【**Situation**】 In Bangladesh, the security in each place is strengthened after terrorism of July 2016 and sacurity enhancement measures of the airport become important and pending issues. 【**Issue**】①It is neccessary to confirm whether the other project also provides technical assitance (grant base or others) for equipment and system provision. ②It is regulated that hand-carried liquid quantity is less than 100 mL in the world and this device is mainly used for examinations of transit passenger, because the bigger liquid container is scrapped at the time of departure passport control.
12	Environment	Eco-airport-related technology	It is the technology that is effective for reduction of the environmental load including air pollution, noise, reduction of the waste and resources saving. Typically, these arethe following: GPU (ground power unit), electric car, noise reduction hangers, water processing facilities, BEMS (building energy management system), photovoltaic power generation, low power illumination (LED)	・Reduction of maintenance cost ・Reduction of the CO_2 discharge. ・ Saving of maintenance resources such as water. ・Image improvement of the airport terminal.	+	Construction experience	Japanese contractor	【**Construction Experience**】Not only in Japanese airport but also major airports in many foreign countries, environmental consideration is made seriously and some technologies are introduced. 【**Overseas Rival Company**】About Japanese product, price competitiveness is lower than a similar overseas product. 【**Cost**】An initial introduction cost is high. 【**Construction Period**】During construction periods, it is approximately similar to a usual product. 【**Situation**】A CO_2 reduction target was set in aviation industry in ICAO general meeting of 2016 and reduction is going to be made mandatory in the future in the developing country.

No.	Category	①Method of Construction, Technical Reputation	② Overview	③Introduced Effects	④ Application Possibility	⑤Assumed Requirement for Qualification	⑥Contractor to be Assumed to beAble to Do	⑦More Specific Consideration Concerning Application
13	Anti-disaster measures	Technology for control of vibration	Preventing the building damage at the time of an earthquake, and improving livability at the time of storm by centralizing vibrational energy caused by an earthquake and storm wind to vibration damper.	・Effective for both rolling of an earthquake and strong wind ・Introduction cost is relatively lower than seismic base isolation structure or strengthenning of structure ・It can be introduced in short term of works	++	Construction experience	Japanese contractor	【**Construction Experience**】In Japan, it is utilized in many building structures. 【**Overseas Rival Company**】A Japanese product is the best worldwide in terms of the construction experience and the technical level although there are some study and introduction example in advanced countries such as the United States where earthquakes are frequent. 【**Cost**】Introduction cost is relatively cheaper than other earthquake measures technology althoughthe introduction of the control on vibration damper will increase the costs of construction.It is necessary to examine validity of the introduction from the viewpoint of general economy in consideration of the need of earthquake measures and the risk at the time of earthquake occurrence. 【**Construction Period**】Introduction is possible in a shorter term than other earthquake measures technology. 【**Applicability to the Project**】The earthquake coefficient around Dhaka becomes 0.2 in accordance with BNBC(Bangladesh National Building Code) and it is an area with many earthquakesalthough there is not much outbreak frequency as Japan. The application of this technology is possible forimprovement of amenity at airport terminal and minimization of damage at the time of the disaster because it is exposed to a rainstorm in rainy season.

Source: JICA Study Team

Price-competitive products related to airports are shown in Table 11-10.

Table 11-10 List of Price-competitive Products

No.	Section	Item	Product Details	Company
1	Equipment	Baggage Handling System	Equipment Complete Set	**【Maker】** TKK Sanki Engineering Co., LTD. DAIFUKU
2		Passenger Boarding Bridge	Equipment Complete Set	**【Maker】** ShinMaywa
3		Elevator, Escalator and Moving Walkways	Equipment Complete Set	**【Maker】** Mitsubishi Electric, HITACHI, TOSHIBA
4		Power Supply System	Transformer, Switchgear, Generators, Photovoltaic power generation, etc.	**【Maker】** Mitsubishi Electric, TOSHIBA, Fuji Electric
5		Plumbing/ Sanitary System	Pumps, Valves, Sanitary equipment	**【Maker】** Teral, EBARA, TOMOE, TOYOKOGYO, KITZ, TOTO
6		Air Conditioning System	Refrigerator, Air conditioner, Duct	**【Maker】** DAIKIN, HITACHI, JEE, JSW, NISSHIN STEEL
7		Fire Protection System	Pump, Fire hydrant, Sprinkler	**【Maker】** Teral, EBARA
8		Public Adress System	Equipment Complete Set	**【Maker】** TOA
9		Master Clock System	Equipment Complete Set, Clock	**【Maker】** Sony, Citizen
10		Master Antena TV System	Equipment Complete Set	**【Maker】** Maspro
11		Building Management System	Equipment Complete Set	**【Maker】** **Azbil**, NEC, Sumitomo Densetsu
12		CCTV System	Equipment Complete Set	**【Maker】** Panasonic
13		Flight Information Display System	Equipment Complete Set	**【Maker】** NEC
14		Information Multimedia Kiosk System	Equipment Complete Set	**【Maker】** NEC
15		Apron Flood Lighting, Road Lighting	Equipment Complete Set	**【Maker】** TOSHIBA, Panasonic
16		Incinerator	Equipment Complete Set	【Maker】 TESCO

Source: JICA Study Team

（Intentionally Blank）

CHAPTER 12 CONSTRUCTION PLANNING

（Intentionally Blank）

Chapter 12 CONSTRUCTION PLANNING

12.1 Procurement Situation

The local procurement situation for the procurement of materials for civil engineering facilities works and building facilities works, which shall be the main works in the construction of HSIA Expansion Project, are summarized below.

However, based on the applicable standards and specifications, special equipment and plant, such as baggage handling system, passenger boarding bridge, aeronautical navigation radio facility, and lighting facilities, will have to be imported.

12.1.1 Construction Materials

Basically, general materials are available within Bangladesh. However, VAT of country's tax is levied upon purchase.

(1) Earthworks

Earth filling material for pond is also available locally. This soil is carried from a site located 5km away from HSIA. Carrying in/out these materials to/from the site using dump truck requires a permit from the related department.

(2) Building Works

For building work, the cast-in-place pile and the screwed steel pile are used. It is easy to procure the cast-in-place pile in the country. Also, the screwed steel pile can shorten the construction period. Steel products used for reinforcement works are also available in the country. However, large materials such as I-beams and structural pipes are to be imported from abroad.

Although it is necessary to survey the situation of manufacturing, industry and quality in Bangladesh, in general, most products are considered to be procured from overseas except for bricks and tiles.

(3) Pavement Works

Materials for asphalt and concrete pavement are available in the country. For base course material, sand is available in Dhaka City and stone is available in the north area of Bangladesh.

(4) Drainage Facilities Works

On the drainage facilities works, secondary product such as pipes, U-shape gutter, concrete used for inlets, and reinforcement bars are available, except for special materials.

(5) Structure Works

Steel products used for reinforcement works are also available in the country. However, large materials such as I-beams and structural pipes are to be imported from abroad.

12.2 Scope of Construction Work

(1) Earthworks

1) Removal of Topsoil

Removal of topsoil will be done in the section of pavement area and building area. The removed soil will be carried to the other area of pavement area and building area.

2) Sand Filling in Pond

Sand filling in pond will be done after relocating existing drainage and draining stored water and removal of soft soil deposited on the bottom of the pond. The surplus soil will be carried to the site outside the pavement in the airport area and building construction area.

3) Soil Improvement Work

Soil improvement work will be done in the areas where liquefaction and uneven settlement at the time of earthquake are expected in the taxiway area, new apron area, and new access road.

4) Earth Cut

The generated soil during earth cut will be divided into good-quality soil and expansive clay; good-quality soil will be used for the subgrade of the pavement. The surplus clay will be used for earthwork except for the pavement and building works.

(2) Building Works

The building work will be done in each area listed in Table 12-1.

Table 12-1 Building Works

Facilities	2018	2019	2020	2021
International Terminal (Terminal 3)	preparation work, earthwork, piling work, foundation work, concrete work, steel frame work	earthwork, piling work, foundation work, concrete work, steel frame work, roof work, outer wall, interior, M&E work	steel frame work, roof work, outer wall, interior, M&E work	interior, M&E work
Cargo Terminal	preparation work, earthwork, piling work, foundation work, concrete work	concrete work, steel frame work, roof work, outer wall, interior, M&E work	interior, M&E work	
VVIP	preparation	earthwork, foundation, concrete work, steel frame work, roof work, outer wall, interior, M&E work		
Fire Station		earthwork, foundation, concrete work, steel frame work, roof work, outer wall, interior, M&E work	interior, M&E work	
Parking	preparation work, earthwork, piling work, foundation work, concrete work	earthwork, piling work, foundation, concrete work, roof work, outer wall, interior, M&E work	roof work, outer wall, interior, M&E work	interior, M&E work

Source: JICA Study Team

(3) Pavement Works

The pavement works are listed below.

Table 12-2 Pavement Works

Facilities	2018	2019	2020	2021
Taxiway	Connecting taxiway: 2 Main area: 13,200m^2 Shoulder area: 16,000m^2	Connecting taxiway: 4 Rapid exit taxiway: 2 Main area: 70,000m^2 Shoulder area: 88,300m^2	Connecting taxiway: 3 Rapid exit taxiway: 1 Main area: 37,900m^2 Shoulder area: 37,600m^2	
Apron	Existing apron side: 38,400m^2	Front of VVIP apron: 201,600m^2	Front of VVIP apron and Terminal 3 apron: 201,600m^2	Front of existing VVIP apron and Terminal 3 apron: 38,400m^2
Service road	Apron area	Apron area	Apron area	Apron area
Security road	VVIP area	VVIP area	VVIP area	VVIP area
GSE Road	Apron area	Apron area	Apron area	Apron area
Access road	Up to the supply and treatment facility andsewage treatment facility	-	-	-

Source: JICA Study Team

(4) Drainage Facility

Drainage facilities in the terminal and car parking area, and regulating reservoir to pool water from the runway strip and taxiway strip and apron drainage facility will be constructed.

(5) Utility Facility (Supply and Treatment Facility, Sewage Treatment Facility, Electric Power Supply Facility, Fuel Facility, Community Facility)

Utility facilities around the terminal will be constructed.

12.3 Construction Planning

The following are the important points in the construction planning of the HSIA Expansion Project:

- ✈ The construction planning has taken into consideration the schedule of piling work.
- ✈ The onsite construction work as well as related planning would take into consideration the bad nature of the site soil.
- ✈ The timing of infrastructure connection, such as mechanical, electrical and fuel should be coordinated.

12.4 Study on Construction Works Progress

(1) Preconditions

1) Working Ratio

a) Rainfall

In Dhaka area of Bangladesh, as stated in Section 4.2.1, there are rainfalls of 50 mm/h or more concentrated during the four months of June through September; there is a dry season with

almost no rainfall during the six months of October through March. 70% of the rain will fall in the rainy season. The weather data of 2014 measured in HSIA is shown in Table 12-3. The table shows the relation of rainy date classed by rainfall per day.

Work suspension day is 0.5 day in case of 1-10 mm rainfall per day, and work suspension day is 1.0day in case of more than 10 mm rainfall per day. In that case, total work suspension days of rainy season is 55 days and the days of other season is 22.5 days.

Table 12-3 Rainy Date Divided in Rainfall per day and Work Suspension Days

Rainfall per day (mm)	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1-10	1	2	1	3	3	6	4	11	7	5	0	0	43
More than 10	0	1	0	6	7	8	17	7	9	1	0	0	56
Work suspension days	0.5	2	0.5	7.5	8.5	11	19	12.5	12.5	3.5	0	0	77.5

Source: JICA Study Team

b) Holidays

There are 22 holidays in Bangladesh for 2017, as listed in Table 12-4; excluding for the disability period during the rainy season, 11 days per year can be considered as official holidays. Islamic holidays move against the western calender due to progression of the Islamic calender, but the annual holidays can be considered 22 for the period under study. Also, the holidays during the rainy season can be considered 11 days same as 2017.

Table 12-4 Holidays in Bangladesh

Holidays	Holiday Days	Rainy Season	Holiday Name
2017/2/21	1		Shaheed Dibash
2017/3/17	1		Birth Day od Sheikh M. Rahman>
2017/3/26	1		Independence Day
2017/4/14	1		Bangla New Year's Day
2017/5/1	1		May Day
2017/5/10	1		Buddha Purnima
2017/5/12	1		Shab-E-Barat
2017/6/23		1	Shab-E-Qudar
2017/6/23		1	Jumatul Bida
2017/6/25～2017/6/27		3	Eid-Ul-Fitr
2017/8/14		1	Janmastami
2017/8/15		1	National Mourning Day
2017/9/1～2017/9/3		3	Eid-Ul-Azha
2017/9/30		1	Durgapuza
2017/10/1	1		Moharram (Asura)
2017/12/1	1		Eid-e-milad-un-Nabi
2017/12/16	1		Victory Day
2017/12/25	1		Christmas Day
Total	11days	11days	Total Holiday Days: 22

Source: JICA Study Team

c) Working Ratio

Working ratio is determined at 75.7% (1.32), as shown in Table 12-5, omitting rainy days as disability period and holidays.

Table 12-5 Calculation of Operating Rate

Year (days)	Work Inability Date			Working Days	Operating Rate	
	Rainfall Date	Holidays	Total			
365	77.5	11	88.5	276.5	75.7%	1.32

Source: JICA Study Team

2) Working Period

a) Civil Work

Working period of main work of civil facilities is calculated based on the construction capacity by the standard construction machine.

For earthwork, the dump truck to be used is a maximum of 11t class, since it is necessary to use general road for transportation of landfill earth. In that case, the number of work days of the earthwork is determined from the number of 11t class dump trucks rather than the capacity of compaction or leveling. The work capacity when the number of dump trucks is 50 or 100 is shown in Table 12-6.

- Soil quantity in one loading: C = 7.2 (m^3)
- Soil quantity conversion factor: f = 0.77
- Work efficiency: E = 0.9
- Cycle time: Cm = 75 (min)
- Workload per driving time: Q = 60・C・f・E/Cm = 4.0 (m^3 / h)
- Work time per day: 8 (hour)

Table 12-6 Work Capacity

Number of Dump Truck	Transport Volume per day (m^3)	Annual Amount of Earthwork (m^3)
50	1,600	442,800
100	3,200	884,000

Source: JICA Study Team

For pavement works, a dedicated plant will be constructed on site to manufacture concrete. The number of work days of the pavement work is determined from the capacity of the concrete plant. The volume of plant mixer and standard capacity per hour in large-scale construction are shown in Table 12-7.

Table 12-7 Relationship between Mixer Volume and Mixing Capacity of Plant (2-axis Forced Type)

Volume of Mixer	Number of Mixer	Continuous Mixing Capacity (m^3/h)
1.0	1	40
	2	60
1.5	1	60
	2	90

Source: JICA Study Team

Althoughthe continuous mixing capacity will be changed according to the volume and the number of mixer, the capacity is set to 60 (m^3/h)in this report. Assuming that the daily work time is 8 hours, the daily work volume is 480 (m^3/day). Assuming that the thickness of

pavement is 50 (cm), the annual construction area of concrete pavement is 960 (m^2/day). Considering the working ratio, the monthly construction volume will be 21,800 (m^2/month).

Main work volume and working days are shown below.

Table 12-8 Working Period

Engineering Work	Classification	Quantity	Working Days (days)	Working Months (months)	Remark
Earthwork	Removal of Topsoil	760,000 m^3	270	12	
	Sand Filling in pond	425,000 m^3			
	Soil Improvement Work	200,000 m^3			
	EarthCut	—			
Pavement work	Taxiway	108,000 m^2			
	Apron	498,500 m^2	500	22	
	Facilities Road	1 Lot	520	23	
Drainage work	Main Drainage	1 Lot	630	28	
	Reservoir	1 Lot	770	34	
Miscellaneous work	Security Fence	1 Lot	200	9	

Source: JICA Study Team

b) Building Work

For constructing an airport on new land, the following are the main types of construction work that have been taken into consideration:

Table 12-9 Main Types of Construction

Facility	Work Item
Construction of Terminal 3, Cargo Terminal and VVIP Terminal	Earthwork, piling work, foundation work, concrete work, steel frame work, roof work, outer wall, interior, M&E work, special equipment and elevator work, exterior
Construction of the Kerbside Road and Car Parking Areas	Earthwork, piling work, foundation work, concrete work, roof waterproofing work, outer wall, interior, M&E work, elevator work, exterior
Construction of the Supply and Treatment Facilities	

Source: JICA Study Team

It is necessary to have an efficient and reliable overall construction plan which takes into account the abovementioned construction works along with their respective construction schedules, airport opening, and trial and testing period.

(2) Work Progress Plans

3) Civil Engineering Facilities Works

The progress plans were made based on the following conditions:

- Preparation period for works: two months
- Earthworks will start after one month of preparation period for works.
- Pavement works, considering preparation period for works after start of the earthworks, will start after four months of the start of the works. Meanwhile, works on apron pavement will start early since this work takes the longest time and is related to the soft opening and start of the VVIP terminal building.
- Other pavement works will start at different times of completion of the main works in order to disperse pavement machinery usage.

- Works on pipes for drainage facilities will start a month after the start of earthworks since the works will be done underneath the pavement.
- Security fences will be installed a month after the start of earthworks.

12.5 Project Implementation Schedule

12.5.1 Conditions

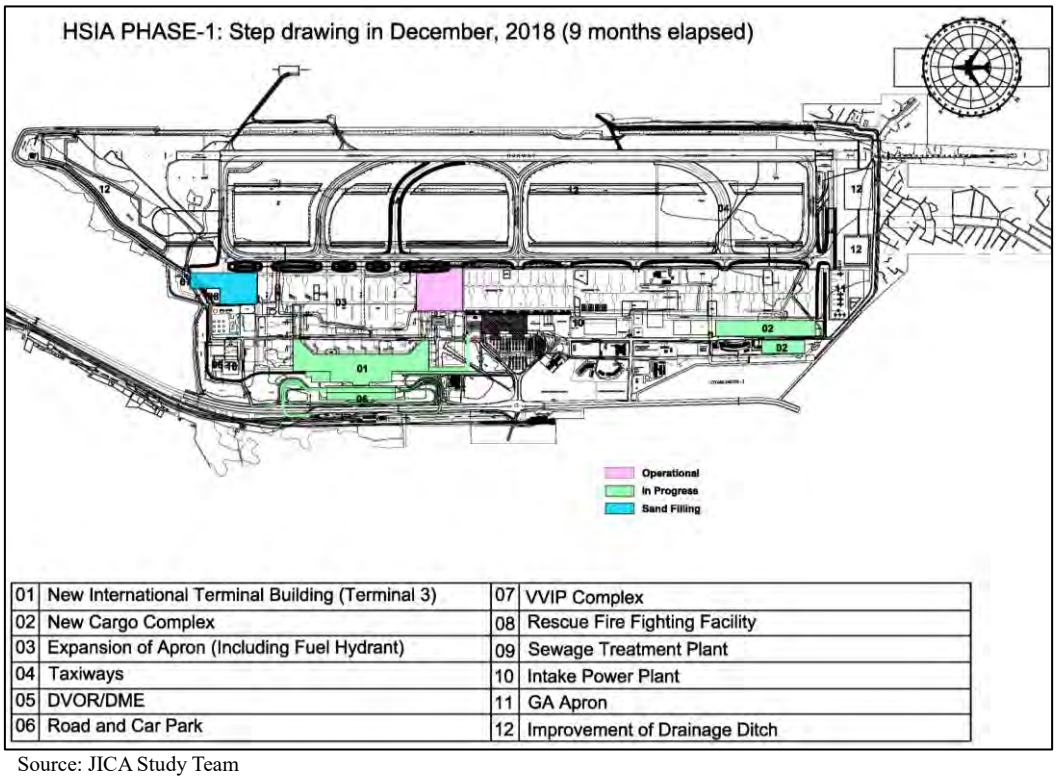
(1) Precondition

Based on the intention of the Bangladeshi government of early completion, the procurement procedure shall be of a minimum period.

- Consulting service will start in April 2017.
- The period of detailed design is shortened to six months by utilizing existing drawings as much as possible.
- Construction will start in April 2018 based on the above condition.
- Construction period for international terminal (Terminal 3) is 37 months.
- Construction period for apron is 34 months.
- At the time of the soft opening planned in January 2019, the service of the new VVIP building shall start.

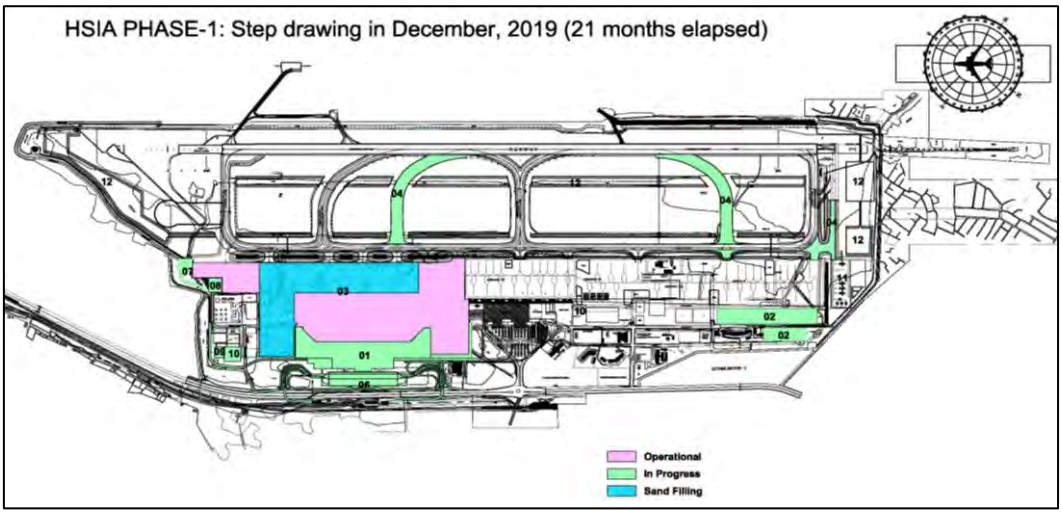
(2) Project Implementation Schedule

Project step drawing is shown in Figure 12-1 to Figure 12-4. Also, project implementation schedule is shown in Table 12-10.



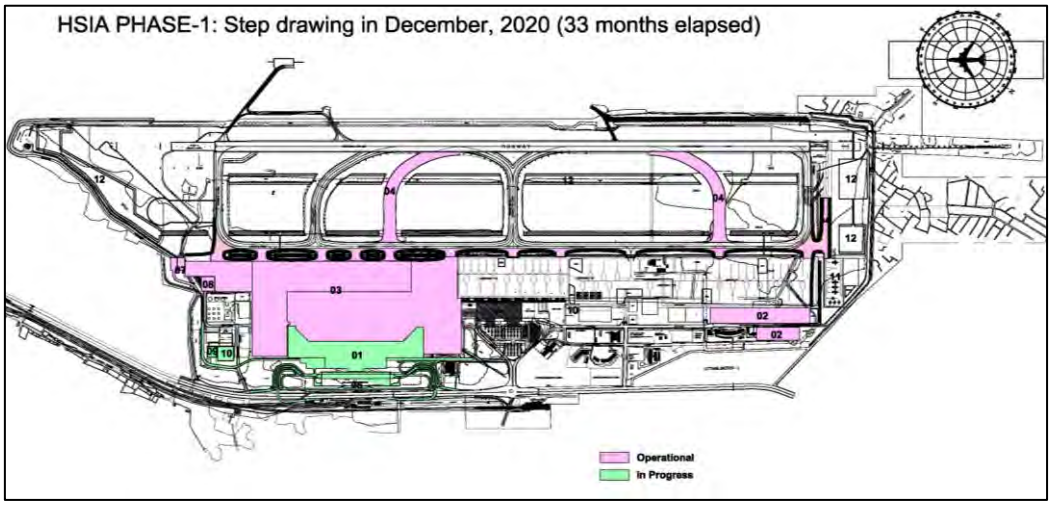
Source: JICA Study Team

Figure 12-1 Step Drawing in December 2018 (9 months elapsed)



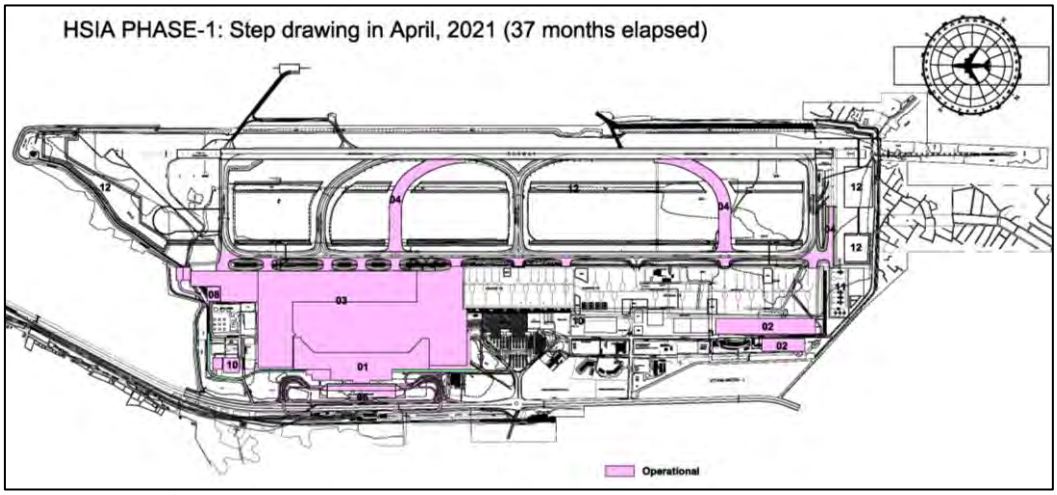
Source: JICA Study Team

Figure 12-2 Step Drawing in December 2019 (21 months elapsed)



Source: JICA Study Team

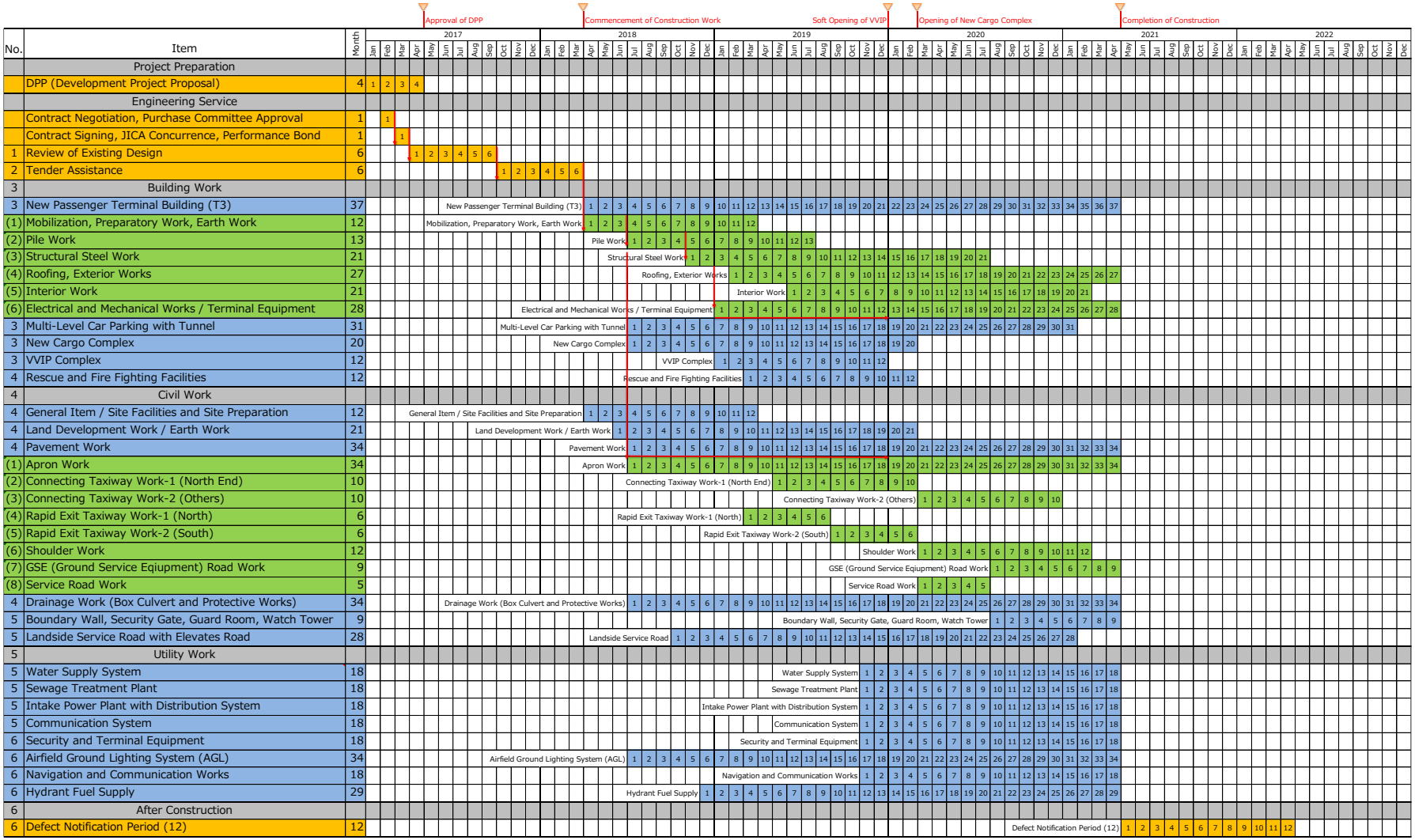
Figure 12-3 Step Drawing in December 2020 (33 months elapsed)



Source: JICA Study Team

Figure 12-4 Step Drawing in April 2021 (37 months elapsed)

Table 12-10 Project Implementation Schedule



No.	Item	Month
	Project Preparation	
	DPP (Development Project Proposal)	4
	Engineering Service	
	Contract Negotiation, Purchase Committee Approval	1
	Contract Signing, JICA Concurrence, Performance Bond	1
1	Review of Existing Design	6
2	Tender Assistance	6
3	Building Work	
3	New Passenger Terminal Building (T3)	37
(1)	Mobilization, Preparatory Work, Earth Work	12
(2)	Pile Work	13
(3)	Structural Steel Work	21
(4)	Roofing, Exterior Works	27
(5)	Interior Work	21
(6)	Electrical and Mechanical Works / Terminal Equipment	28
3	Multi-Level Car Parking with Tunnel	31
3	New Cargo Complex	20
3	VVIP Complex	12
4	Rescue and Fire Fighting Facilities	12
4	Civil Work	
4	General Item / Site Facilities and Site Preparation	12
4	Land Development Work / Earth Work	21
4	Pavement Work	34
(1)	Apron Work	34
(2)	Connecting Taxiway Work-1 (North End)	10
(3)	Connecting Taxiway Work-2 (Others)	10
(4)	Rapid Exit Taxiway Work-1 (North)	6
(5)	Rapid Exit Taxiway Work-2 (South)	6
(6)	Shoulder Work	12
(7)	GSE (Ground Service Eqiupment) Road Work	9
(8)	Service Road Work	5
4	Drainage Work (Box Culvert and Protective Works)	34
5	Boundary Wall, Security Gate, Guard Room, Watch Tower	9
5	Landside Service Road with Elevates Road	28
5	Utility Work	
5	Water Supply System	18
5	Sewage Treatment Plant	18
5	Intake Power Plant with Distribution System	18
5	Communication System	18
6	Security and Terminal Equipment	18
6	Airfield Ground Lighting System (AGL)	34
6	Navigation and Communication Works	18
6	Hydrant Fuel Supply	29
6	After Construction	
6	Defect Notification Period (12)	12

Condition of Soft Opening: 1) Open of VVIP Complex

Source: JICA Study Team

（Intentionally Blank）