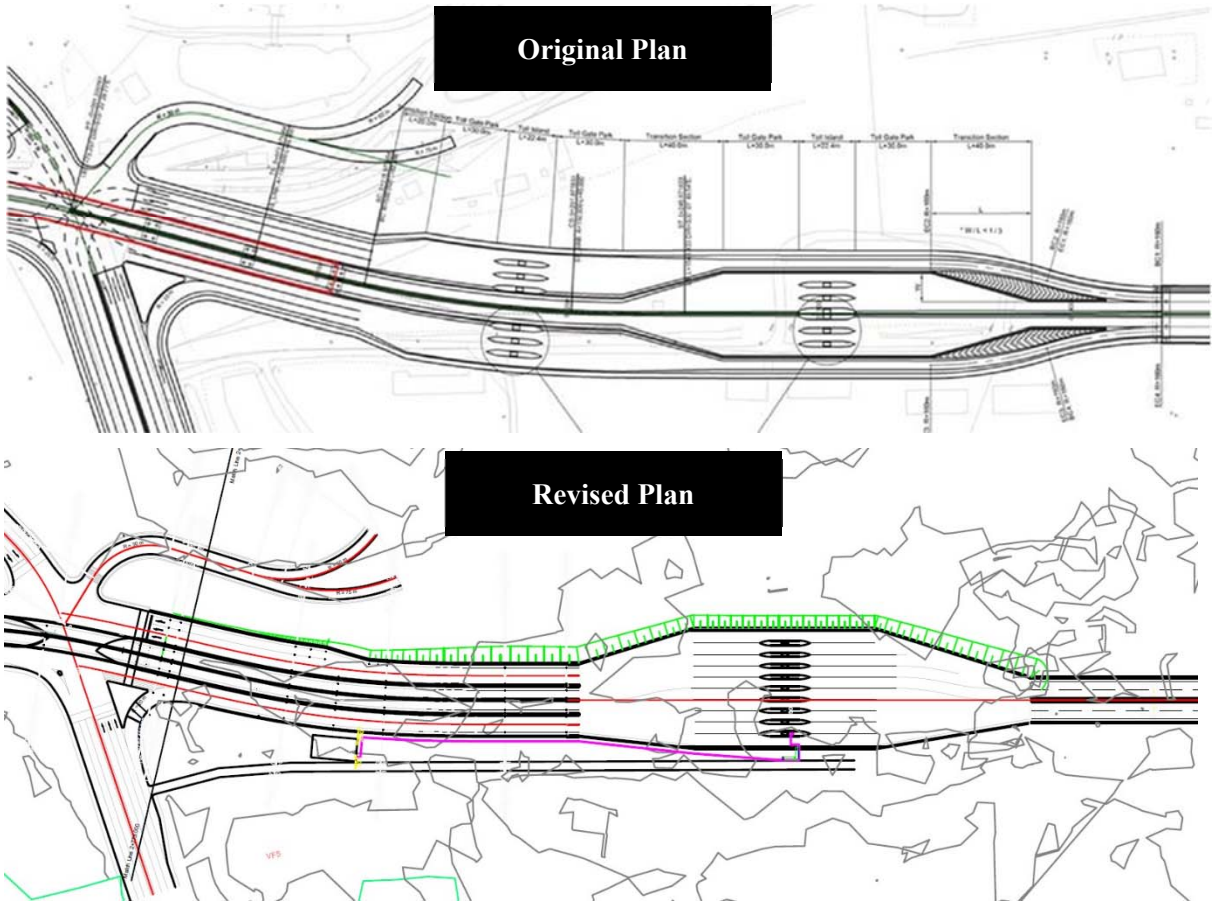
CHAPTER 5. TOLL COLLECTION FACILITY

5.1 TOLLGATE WORKS

5.1.1 Plan of Tollgate Facility

Tollgate consists of large roof, toll island, toll booth (toll collection booth, machinery booth), staircase for access, administrative office, etc.

The preliminary design of tollgate in the supplemental survey was reviewed in terms of efficiency and safety for the operation of traffic and toll collection according to the latest condition. Then the layout of the tollgate was revised as shown in the below Figure 5.3.1. The tollgate facilities are aggregated as much as possible, then the number of tollgates are reduced from 4 to 2. This revision is made possible with the shift of road alignment of the through traffic itself to the north to avoid the community road located south of the tollgate.

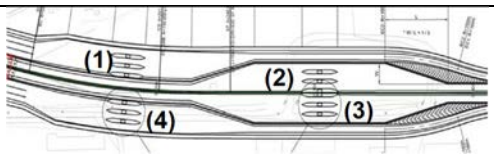


Source: JICA Study Team

Figure 5.1.1 Revision of Tollgate Facility Layout

Table 5.1.1 Revision of Tollgate Plan

Items	Revised Plan	Original Plan
Number of Tollgate	2 tollgates	4 tollgates
	(1) Tollgate (For Taketa) (2) Tollgate (For Thanlyin)	(1) Tollgate for Approach Ramp (For Taketa) (2) Tollgate for Through Traffic (For Taketa) (3) Tollgate for Through Traffic (For Thanlyin) (4) Tollgate for Approach Ramp

		(For Thanlyin)
Number of Lane	5 lanes × 2	3 lanes × 2
Number of Toll Collection Booth	9 toll collection booths in total	12 toll collection booths in total
Facility Layout		

Source: JICA Study Team

The outline of the revised tollgate facility is stated as follows:

- Total number of lanes: 10 lanes
  (This was calculated using the traffic volume at peak hour.)
- Total number of toll booths: 9 toll collection booths
  (Both sides of traffic are handled at the 5th booth located at the middle of 10 lanes.)
- Basically, each toll booth is designed for left-hand drive cars. However, taking the current situation of considerably high volume of right-hand drive cars into account, windows are set both sides of the toll booth to cope with right-hand drive cars.
- Lanes between the 4th and 7th which are located at the center of tollgates are designed to be applicable for reversible lane to adjust the future traffic condition and keep the traffic smooth. Because of that, structures such as mount-up type median is not installed in the toll plaza.
- In the toll collection booth, the equipped function is limited to collect toll. (The resting room for napping and toilet is placed in the Administrative Office, which is located near the tollgate facility.)
- Large roof is installed to avoid rains.
- The structure and specification are decided as discussed below in consideration of construction work and cost economy.

5.1.1.1 Large Roof

- Structure: Steel construction, which is lightweight and can reduce the construction works at the site.
- Story: One-story
- Total Area of Shed: 650.4 m^2 (54.2 m x 12.0 m)
- Clearance Limit (Height): 6.0 m
- Auxiliary Facility: Lighting facility
- Others: Installation of the ceiling is canceled to allow for drop out.

  The power cable is to be taken to each toll booth via rack crawling on the inferior surface of roof and duct attached to the booth.

5.1.1.2 Toll Island

- Structure: Reinforced concrete is applied, which has high durability.
- Number of lanes: 10 lanes
- Length: 25.0 m (The required space for the future installation of ETC is considered.)
- Width: -Lane for the non-large vehicle: 3.2 m
  -Lane for the large vehicle: 4.6 m

5.1.1.3 Toll Booth (Toll Collection Booth)

- Structure: Steel construction, which is lightweight and can reduce the construction works at the site.
- Story: One-story
- Area of a Toll Booth: Approx. 4.5 m^2
- Number of Booths: 9 booths
- Auxiliary Facility: Air conditioning facility, lighting facility
- Others: Toll booths between the 4th and 6th are designed to be applicable for reversible operation to adjust for future traffic conditions. Sliding door is applied.

5.1.1.4 Toll Booth (Machinery Booth)

- Structure: Steel construction, which is lightweight and can reduce the construction works at the site.
- Story: One-story
- Area of a Toll Booth: Approx.7.7 m^2
- Number of Booths: 1 booth
- Auxiliary Facility: Air conditioning facility, Lighting facility
- Others: The power cable is to be taken to machinery booth first. Power distribution to each toll booth is equipped in machinery booth.

5.1.1.5 Staircase

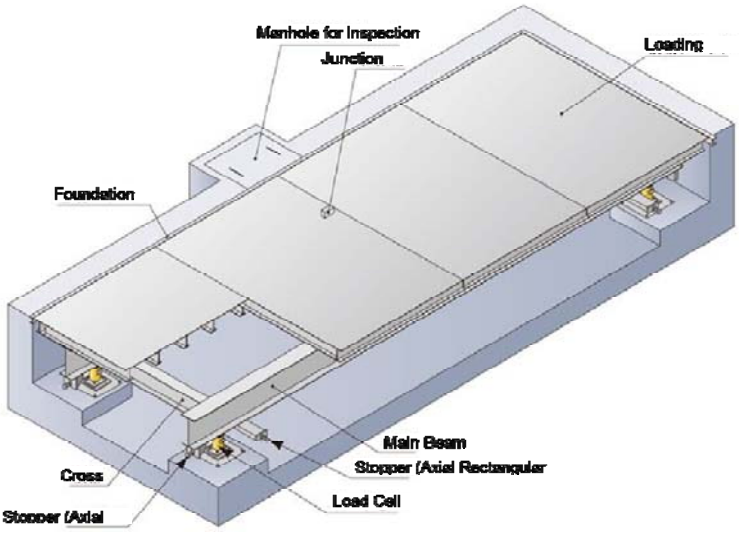
- Structure: Steel construction
- Size: Stair tread is 260 mm, Height of the riser is 180 mm
- Auxiliary facility: Lighting facility

5.1.1.6 Truck Scale

- Type: Pit type
  (The loading surface is at the same level with the ground surface and there is no slop.)
- Maximum measurable weight: 60 t
- Size of the box for blockout:

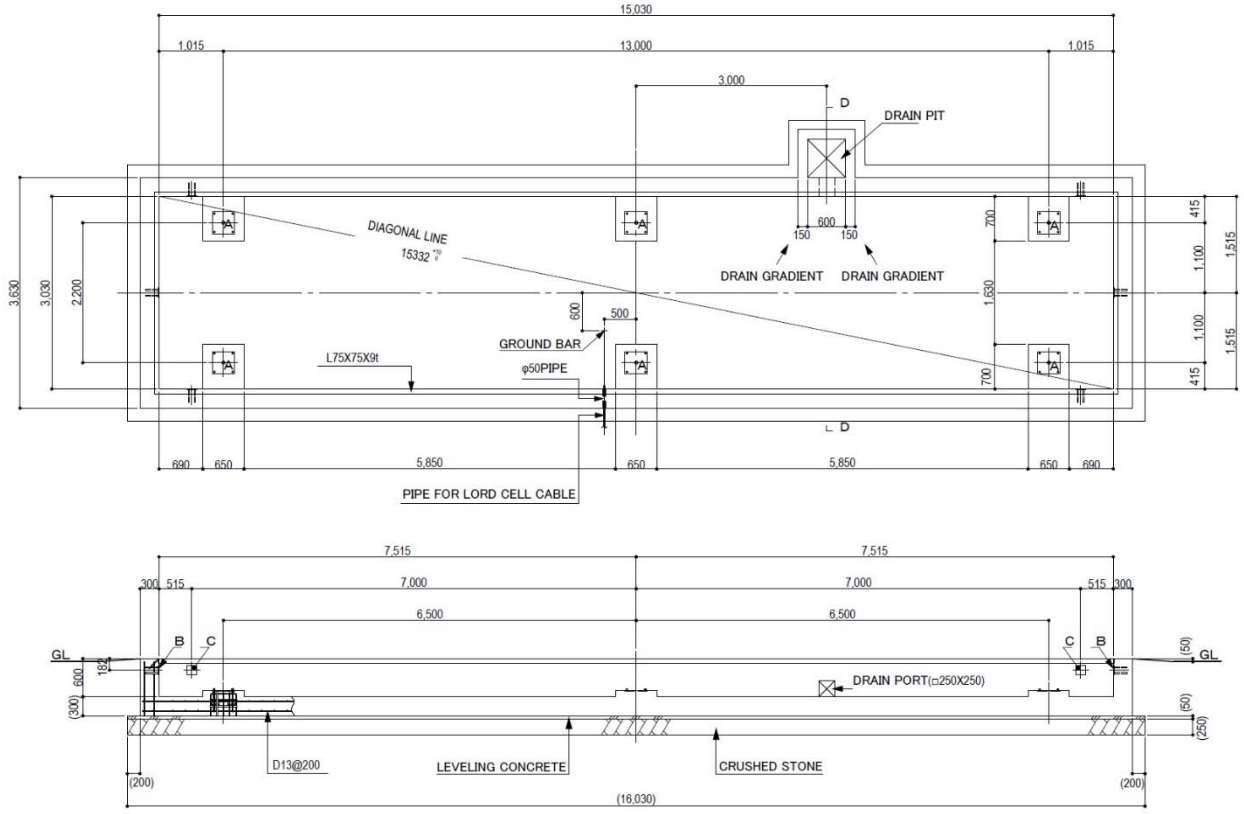
(width) 3,500 mm x (length) 15,630 mm x (depth) 1,700 mm

- Number of truck scales: 2 sets (1st lane and 10th lane)
- Drain Pit: (width) 600 mm x (length) 600 mm x (length) 1,700 mm



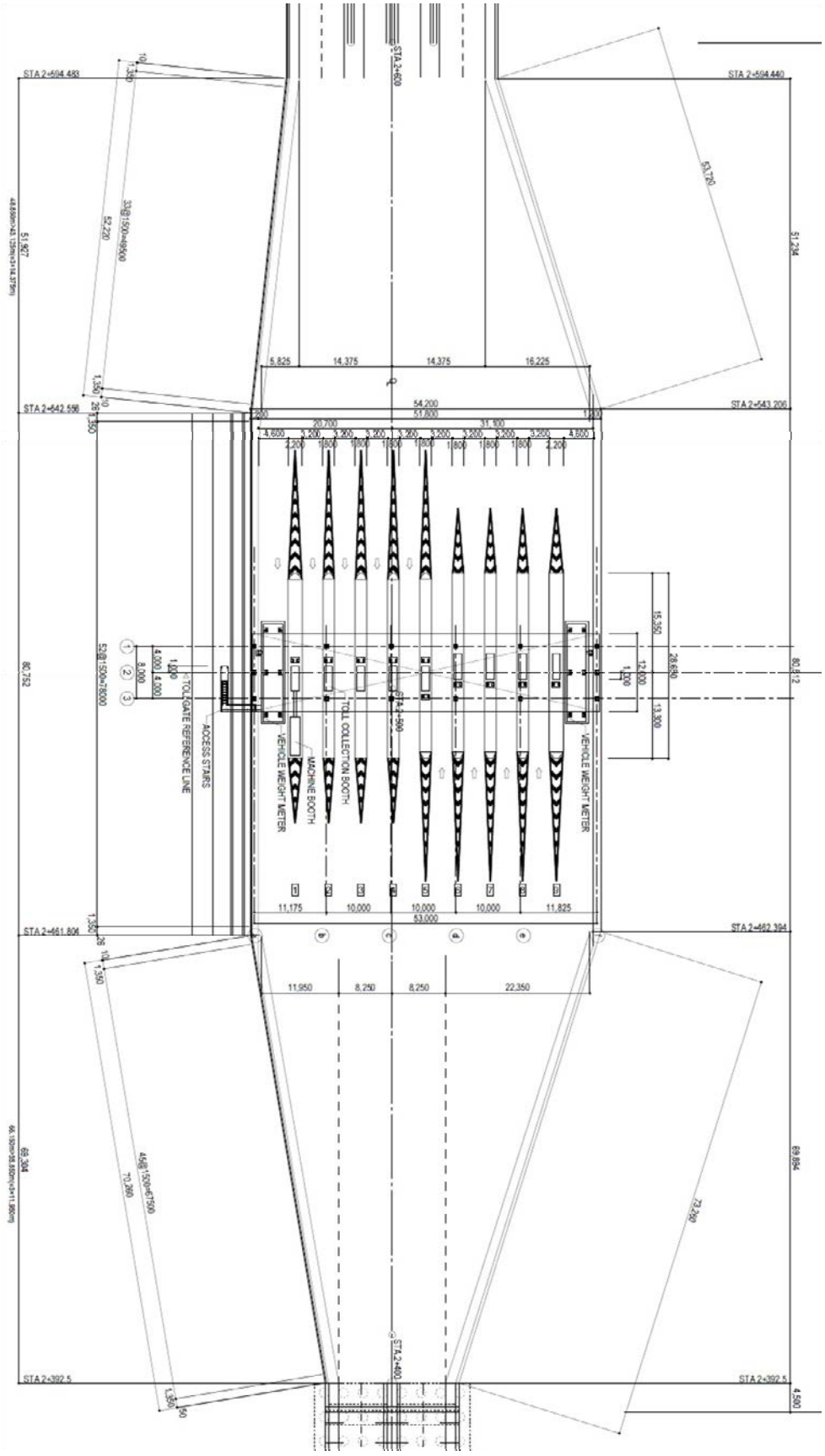
Source: Website of Kamacho Scale Co., Ltd.（http://www.kamacho.co.jp/products/truckscale/lineup/ts.html）

Figure 5.1.2 Layout Image of Truck Scale



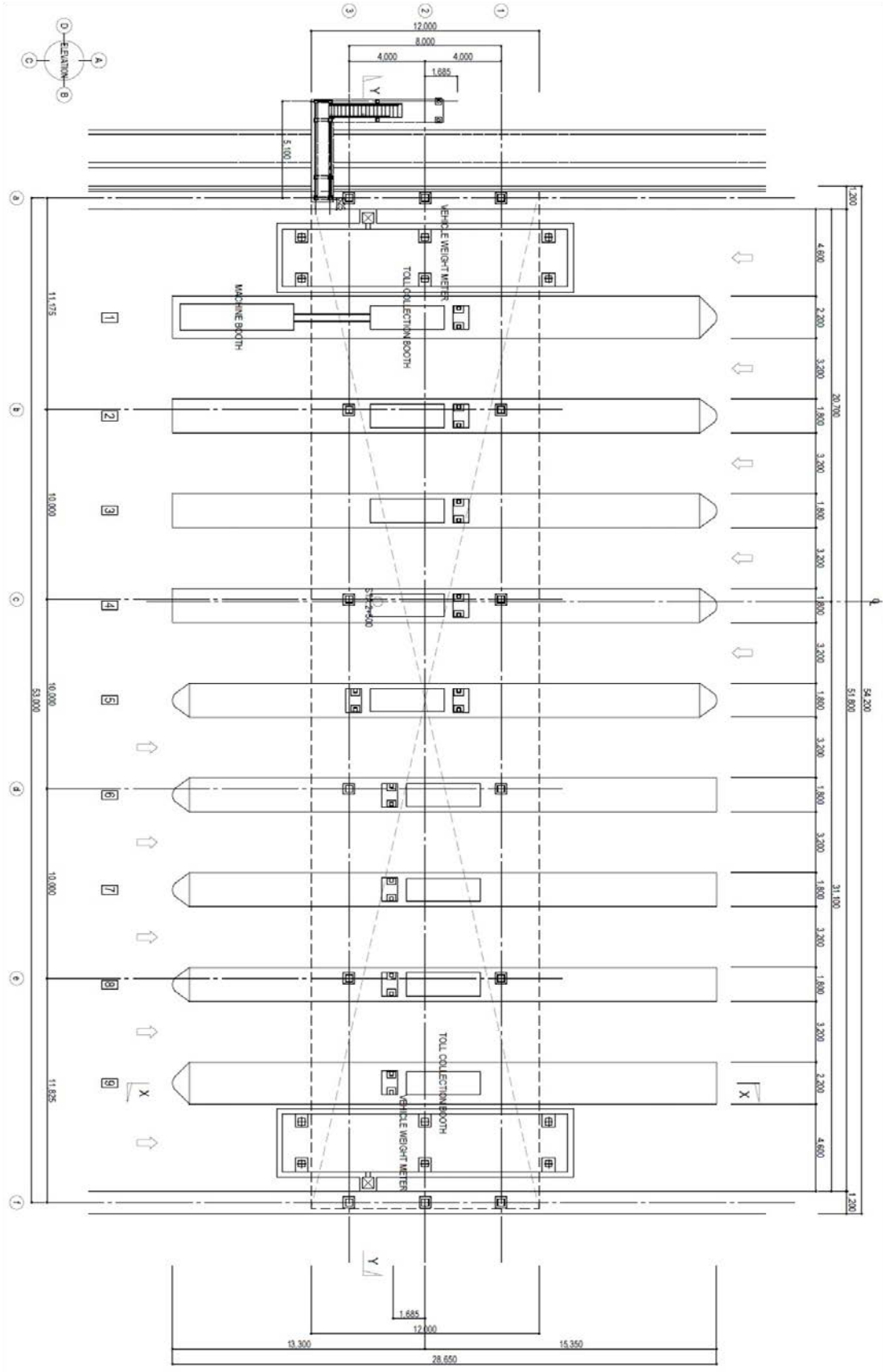
Source: JICA Study Team

Figure 5.1.3 Plan and Elevation of Truck Scale



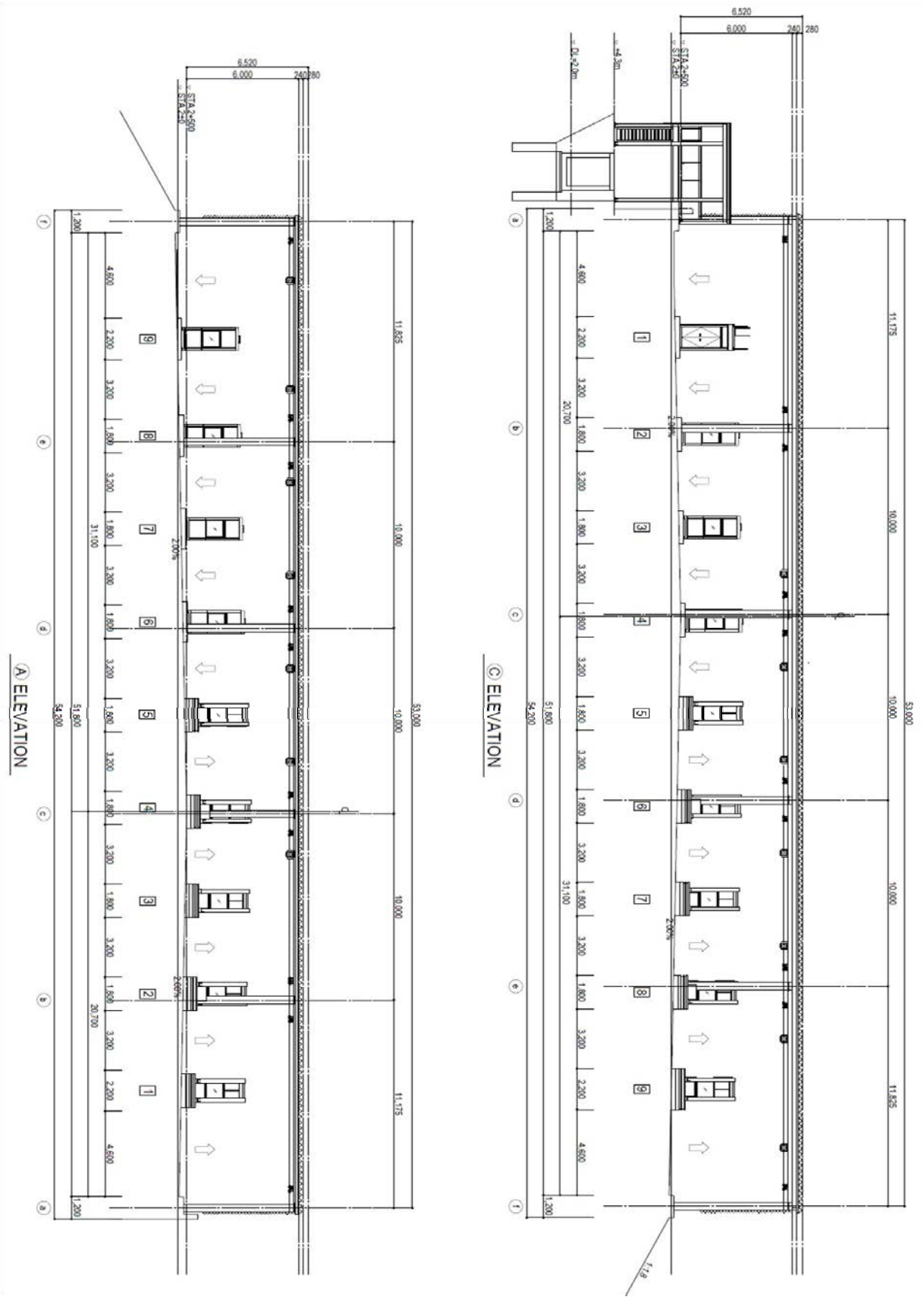
Source: JICA Study Team

Figure 5.1.4 Layout of Tollgate



Source: JICA Study Team

Figure 5.1.5 Plan View of Tollgate



Source: JICA Study Team

Figure 5.1.6 Elevation View of Tollgate

5.1.2 Materials to Be Used

Used materials for tollgate facilities are shown in Table 5.3.2.

Table 5.1.2 Used Materials for Tollgate Facilities

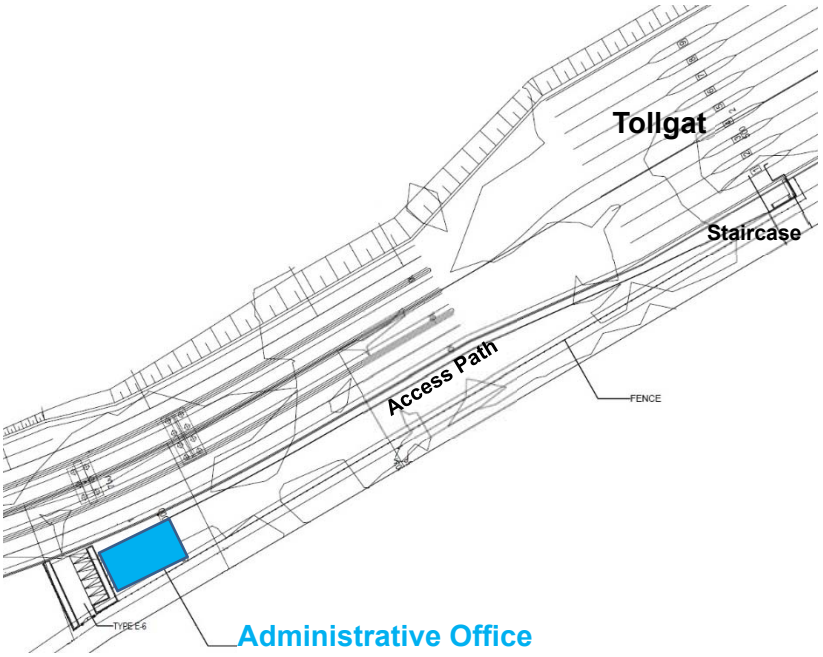
Facility	Part	Material
Large Roof	Roof	- Bolting Folded Plate (Steel), Steel Shingle board Height 150 mm, Thickness 0.8 mm - Eaves: Decorative plate is set at the edge of the upper side eaves - Roof: Exposed folded plate
	Column	- Rectangular Steel Pipe
	Wall	- Perforated Folded Plate (Steel) Width 200 mm, Height 88.2 mm
	Gutter	- Eaves Gutter (Rigid polyvinyl chloride) with overflow hole - Vertical Gutter (Rigid polyvinyl chloride)
Toll Island	Floor, Protective Barrier	- Concrete
	Protection Pole	- Concrete, Rectangular Steel Pipe
	Pit	- Installed between the 1st toll collection booth and machinery booth
Toll Booth (Toll Collection Booth)	Footing Beam	- Steel (c-200 x 90 x 8.0 x 13.5)
	Column	- Rectangular Steel Pipe (100 x 100)
	Wall	- External Steel Plate: Thickness 2.3 mm - Internal Steel Plate: Thickness 0.7 mm
	Floor	- Steel Plate: Thickness 3.2 mm
	Roof	- Steel Plate: Thickness 2.3 mm
Toll Booth (Machinery Booth)	Footing Beam	- Steel (c-200 x 90 x 8.0 x 13.5)
	Column	- Rectangular Steel Pipe (100 x 100)
	Wall	- External Steel Plate: Thickness 0.8 mm - Internal Steel Plate: Thickness 0.5 mm
	Floor	- Steel Plate: Thickness 3.2 mm
	Roof	- Bolting Folded Plate (Steel): Height 85 mm, Thickness 1.0 mm
Staircase	Column	- Rectangular Steel Pipe
	Roof	- Bolting Folded Plate (Steel): Height 85 mm, Thickness 0.8 mm
	Handrail panel	- Aluminum resin laminated composite plate: Thickness 4.5 mm
	Gutter	- Eaves Gutter (Rigid polyvinyl chloride) with overflow hole - Vertical Gutter (Rigid polyvinyl chloride)

Source: JICA Study Team

5.2 ADMINISTRATIVE OFFICE WORKS

5.2.1 Plan of Administrative Office Facility

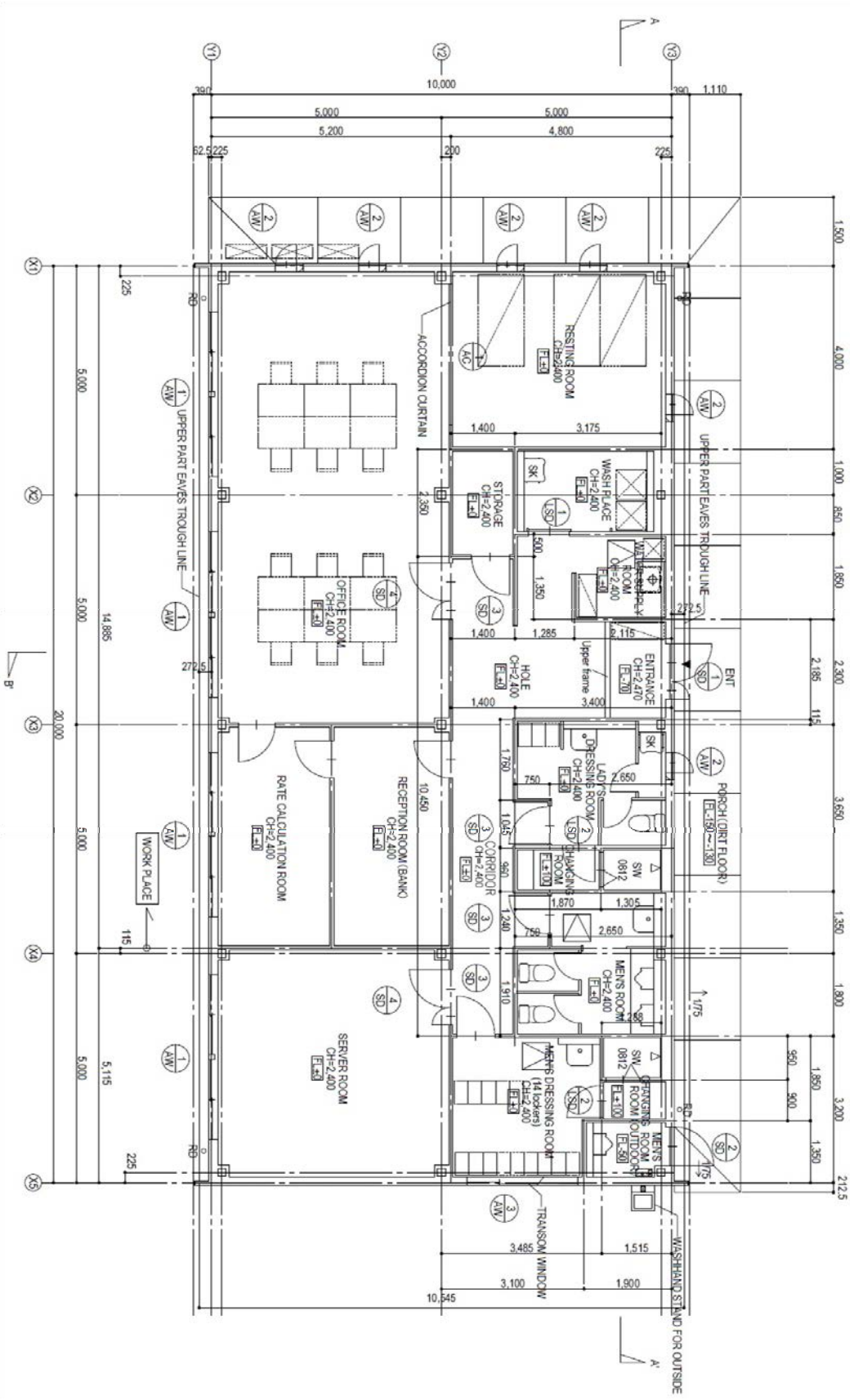
For the purpose of managing and monitoring the tollgate and toll collectors, holding collected cash temporarily, providing the resting place for toll collectors, etc., an administrative office shall be built near the tollgate at the location shown in Figure 5.4.1.



Source: JICA Study Team

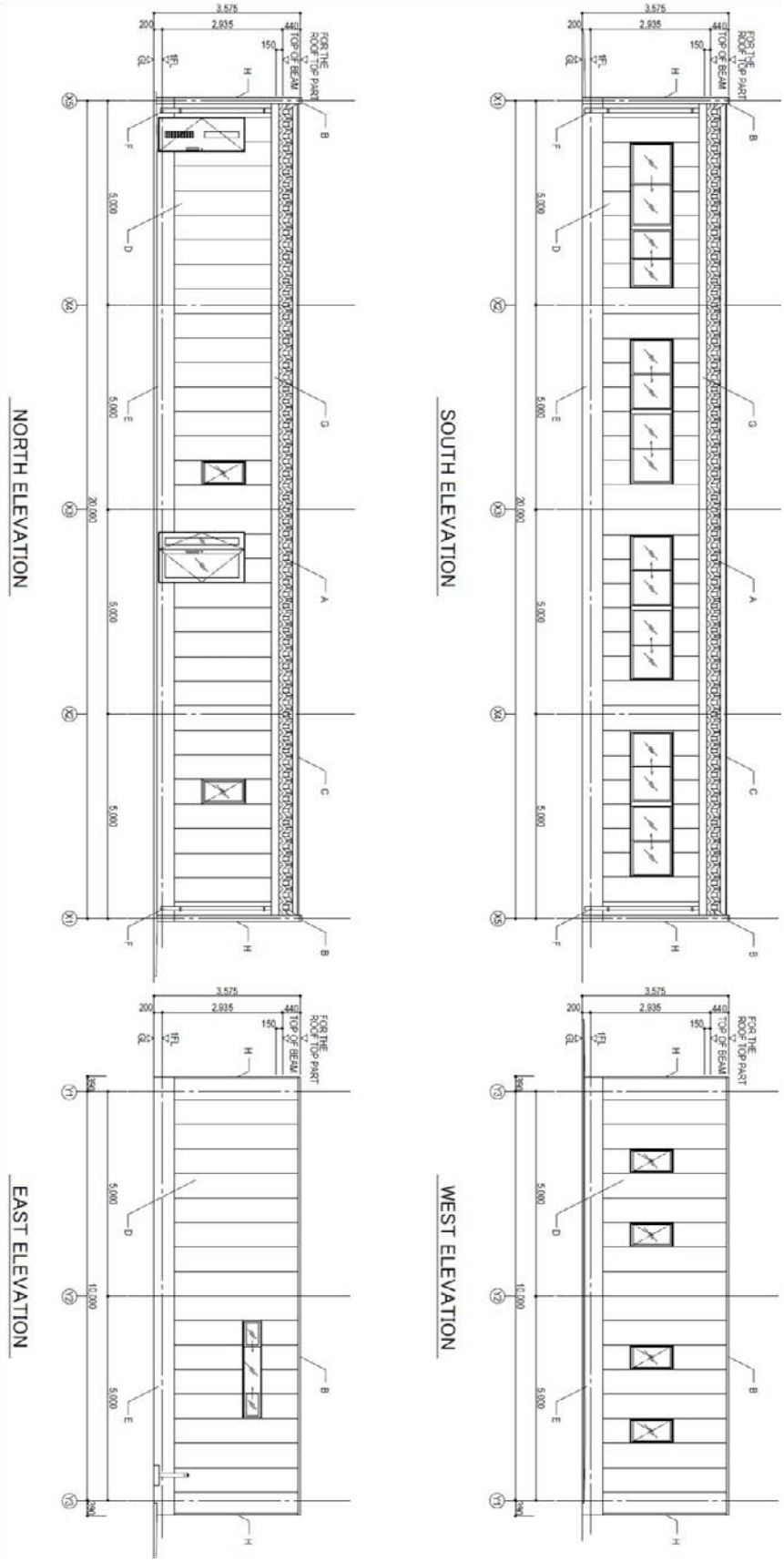
Figure 5.2.1 Location Map of Administrative Office

- Structure: Steel construction, which is lightweight and can reduce the construction works at the site.
- Story: One-story
- Total Area of Floor Space: 210.9 m^2
- Rooms: Office Room, Counting Room, Reception Room, Server Room, Resting Room, Toilet, Locker Room (Men/Women), Shower Unit, Hot Water Supply Room, Storage
- Others: Septic Tank, etc.



Source: JICA Study Team

Figure 5.2.2 Plan View of Administrative Office



Source: JICA Study Team

Figure 5.2.3 Elevation View of Administrative Office

5.2.2 Equipment and Materials

Materials to be used for the Management Office are shown in the following Table 5.4.1.

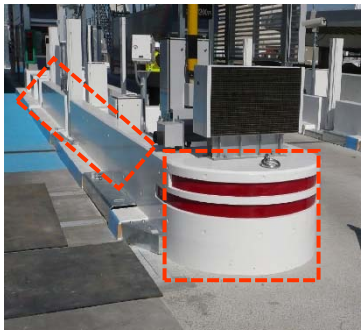
Table 5.2.1 Materials to be Used for Administrative Office

Part	Material
Roof	Folded Plate (Galvalume board)
External Wall	Autoclaved Lightweight Concrete
Foundation	Concrete
Gutter	Eaves Gutter (Aluminum), Vertical Gutter (Hard Vinyl Chloride Resin)
Boundary Fence	Wire Fence

Source: JICA Study Team

5.3 SAFETY MEASURE

To avoid the accidental contact of vehicle to the toll booth, the barrier, side protection for island, and protection pole are set up as shown in below Photos 5.5.1 and 5.5.2.



Source: JICA Study Team

Photo 5.5.1 Barrier and Side Protection

Photo 5.5.2 Protection Pole

5.4 FUTURE UPGRADE PLAN

In the main report, in preparation to utilization of the Electronic Toll Collection (ETC) system in the future, comparison of ETC types, list of assumed equipment, example of installation position of ETC equipment around toll booths and considerations for implementation are introduced.

CHAPTER 6. ELECTRIC WIRING AND LIGHTING FACILITY

6.1 GENERAL

Road lighting is an essential function to ensure road safety and comfortability of road users. This section provides the basic design for roadway lighting and electric wiring for the project bridge and road.

6.2 SCOPE OF WORK

The scope of work for road lighting and electric wiring design is as follows:

(a) Road Lighting for the Bago River Bridge
(b) Road Lighting for the Flyover (on Thaketa Side)
(c) Road Lighting for the Thanlyin Chin Kat Road
(d) Road Lighting for On-ramp
(e) Tollgates Area Lighting
(f) Shukhinthar Intersection Lighting
(g) Yadanar Intersection Lighting
(h) Star City Intersection Lighting
(i) Bridge Nightscape Lighting
(j) Obstruction Lights
(k) Traffic Signal System
(l) Temporary Traffic Signal System

6.3 DESIGN CONDITION

6.3.1 Design Standards

Design standards applied to this project are as follows:

- The Standards Japan Highway Design Manual
- LED Road and Tunnel Lighting Guidelines 2011, MLIT Japan
- Express Highway Research Foundation of Japan (EHRF)
- Japan Road Association (JRA) Standards
- Japan Electric Association (JEAC), Regulations
- Nippon Expressway Company Limited (NEXCO), Design Manual 2004
- Annex 14, International Civil Aviation Organization (ICAO)
- International Association of Marine Aids to Navigation and Lighthouse Authority (IALA) Guidelines

6.3.2 Design Condition

(1) Road Lighting Aims and Requirements

The aim of the road lighting is to ensure safety and smooth road traffic at night time and in poor weather conditions. Good lighting also improves traffic volume capacity.

The road lighting system must be able to function at low power consumption and low running costs.

Design principles are:

1) Arrange lighting depending on road alignment;

2) Provide adequate lighting for driving;

3) Provide adequate lighting to see other road users;

4) Provide sufficient lighting to see and avoid parked vehicles or obstruction; and

5) Provide adequate lighting to see roadside facilities.

6.4 ROAD LIGHTING

6.4.1 Introduction

Road lighting shall ensure clear visibility to surely grasp road conditions and traffic conditions by drivers; hence, road safety and smooth road traffic can be secured by the installation of road lightning.

6.4.2 Selection of Equipment and Material

(1) Luminaire Supports

1) Types of Lightning Pole

The result of comparative study was reviewed and "steel pole" was adopted for the design.

2) Figures of Lightning Pole

In B/D, according to the comparative study as shown in Table 6.4.1in terms of illuminance rate, forward visibility and comfortable driving, the straight-line type had been recommended for the road lighting in this project.

Table 6.4.1 Comparative Study on the Figures of Lighting Pole

Items	Alt-1 Straight Line Type	Alt-2 Arm Type
Schematic view		
Luminaire support	Top of pole	End of arm
Illumination rate	Big	Small
Forward visibility in raining	Good	Poor visibility on shoulder
Comfortable driving	High	Low
Local lighting	Complied	Not complied
Evaluation	**Recommended**	Not recommended

Source: JICA Study Team

In D/D, the result of comparative study was reviewed and "straight-line type" was adopted for the design.

3) Height and Spacing of Lighting Pole

When luminaires are arranged based on JRA standards, glare depression, proper uniformity ratio, and clear road alignment can be ensured by means of the road lighting. In D/D, pole height is 12 m for the lighting of river bridges, approach bridge, and approach road, on the other hand, 11 m for flyover bridge and 9 m for the lighting of on-ramp, taking into consideration Table 6.4.2 below.

Table 6.4.2 Applicable Height and Spacing of Lighting Pole

Type of Luminaire	Cutoff type		Semi Cutoff type	
Type of Arrangement	Height (H)	Spacing (S)	Height (H)	Spacing (S)
One-sided arrangement	H ≧1.0 W	S≦3.0 H	H≧1.1 W	S≦3.5 H
	H ≧1.5 W	S≦3.5 H	H≧1.7 W	S≦4.0 H
Two-sided staggered arrangement	H ≧0.7 W	S≦3.0 H	H ≧0.8 W	S≦3.5 H
Two-sided opposite arrangement	H ≧0.5 W	S≦3.0 H	H ≧0.6 W	S≦3.5 H
	H≧0.7 W	S≦3.5 H	H≧0.8 W	S≦4.0 H

Note) W : Road Width

Source: JICA Study Team

Spacing of lighting poles for the curved road such as ramp way is specified in Table 6.4.3.

Table 6.4.3 Spacing of Lighting Poles on Curved Road Section

Item		Spacing			
Curving radius (m)		300 m≧R	250 m≧R	200 m≧R	R<200 m
Height(H)					
Spacing (S)	Less than 12 m	35	30	25	20

Source: Japan Road Association (JRA) Standards

4) Type of Luminaire

Based on the condition of the lights along road: B, the type of luminaire adopted is cutoff type as shown in Table 6.4.4.

Table 6.4.4 Selection of Luminaire Type

Surrounding Areas along the Road		A	B	C
Expressway		Semi cutoff	Cutoff	Cutoff
National road	Major arterial road	Semi cutoff	Cutoff	Cutoff
	Collector and local road	Semi cutoff	Semi cutoff	Cutoff

Source: Japan Road Association (JRA) Standards

Table 6.4.5 Comparative Study on the Types of Luminaire

Item	Alt-1 Cutoff Type	Alt-2 Semi Cutoff Type
Schematic View		
Horizontal Light Distribution	Completely limited	Partially limited
Installation Area	Area dotted with lights	Residence and city
Glare to Driver	Ignore	Weaken
Lighting Pole Spacing	Narrow	Wide
Evaluation	Not recommended	**Recommended**

Note) The amount of glare generated by a luminaire is strongly influenced by the intensity (candle-power) emitted at angles close to horizontal angle. The cutoff classification is based on the intensity of rays emitted at 80 degrees and 90 degrees vertical angle.

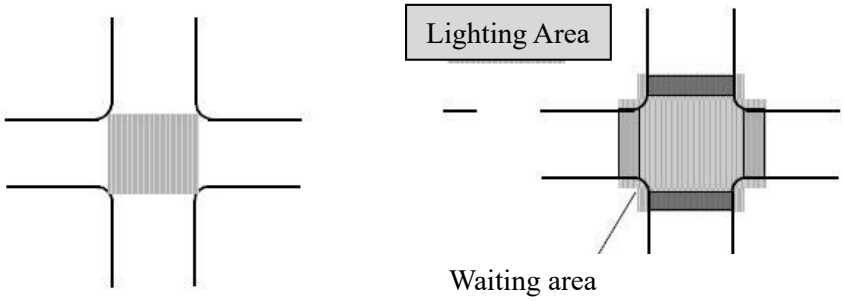
Source: JICA Study Team

6.4.3 Intersection Lighting

(1) Introduction

In addition to the visual recognition effects of continuous road lighting, such fixtures should also be installed at intersections so that drivers can be aware of the existence of intersections and road conditions in/adjacent to the intersection.

1) Lightning Area



Intersection without crosswalk Intersection with crosswalk

Source: Japan Road Association (JRA) Standards

Figure 6.4.1 Lightning Area at Intersections

2) Average Illumination

The required average illuminance is given in Table 6.4.6.

Table 6.4.6 Criteria of Average Illumination

Name of Intersection	Total Lanes of Intersection	Average Illuminance (lux)
Shukhinthar Intersection	28	15
Yadanar Intersection	16	15
Star city Intersection	19	15

Source: JICA Study Team

(2) Design Result

The results of calculation in D/D are shown in Table 6.4.7.

Table 6.4.7 Results of Calculation

Name	Area (m^2)	E (lx)	Luminaire		Pole	
			Type	F (lm)	H (m)	N (set)
Shukhintar	3,726	15	HID	39,000	12	5
Yadanar	1,387	15	LED	19,800	12	4
Star City	2,060	15	LED	19,800	12	5

Source: JICA Study Team

6.4.4 Tollgates Lighting

(1) General

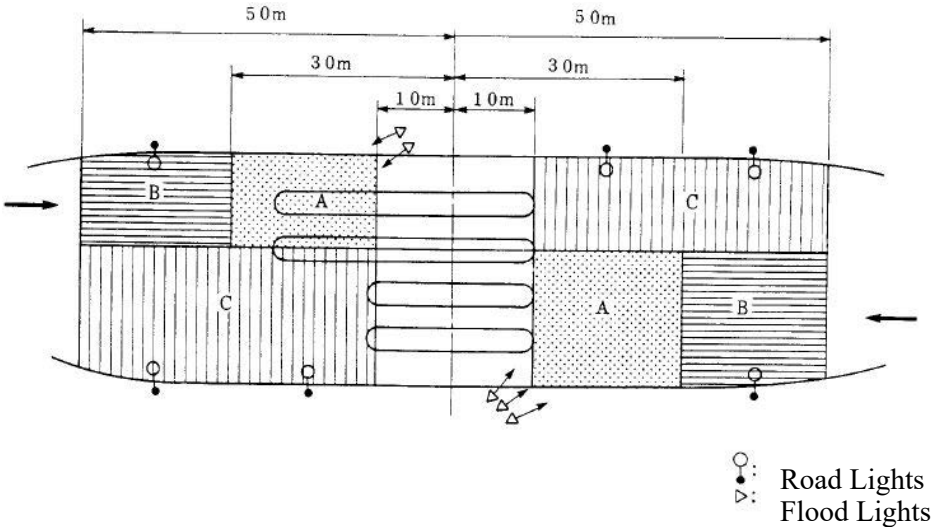
The requirements for tollgates lighting are as follows:

- Illumination range for the approach area should be from 10 m to 50 m in distance on both sides of the gate centerline

- Illumination range for the area for identification of vehicles should be from 10 m to 30 m in distance in front of the gate centerline, where the entry area is via a national road and the exit area is via an expressway.
- Average vertical plane illumination should be the illumination on the plane forming a right angle to the driving centerline and at 0.5 m elevation.

(2) Design Criteria

The average illuminance and vertical plane illuminance are utilized for the evaluation of tollgate lighting.



Source: EHRF Standard

Figure 6.4.2 Illumination Area Classification

(3) Design Result

1) Height of Lighting Mast

According to EHRF, the height of lighting mast was determined as 25 m in D/D.

2) Vertical Plane Illumination

If the sight level of the driver of a vehicle is 1.5 m, and the ascending vertical angle is less than 25 degrees, the driver's vision may be glared by the lighting mast. Therefore, the height and location of the mast should be selected to limit the glare due to lighting.

Table 6.4.8 Height of Lighting Mast

Name of Area	Height of Mast (m)
Toll plaza area	H ≧ 0.5W

Note) W: Total width including all of the entry and exit lanes
Source: EHRF Standard

6.4.5 Traffic Signal Systems

(1) Pedestrian Traffic Signal

As stated in the Road Traffic Law Act, Japan, in case of intersection with crosswalks controlled by traffic signals, pedestrian traffic signals should be installed.

(2) Vehicle Traffic Signal

Generally, each approach of traffic lane needs only one traffic signal. In the point of view of layout of intersection and road width, in order to ensure the visibility of traffic signals, two sets of traffic signals should be installed according to the Road Traffic Law Act, Japan.

(3) Traffic Signal Phasing

The control of traffic signals is based on cycle, split, and offset performances at the traffic signal phasing to put smooth traffic flow into practice.

(4) Traffic Signal Control System

1) Signal Head

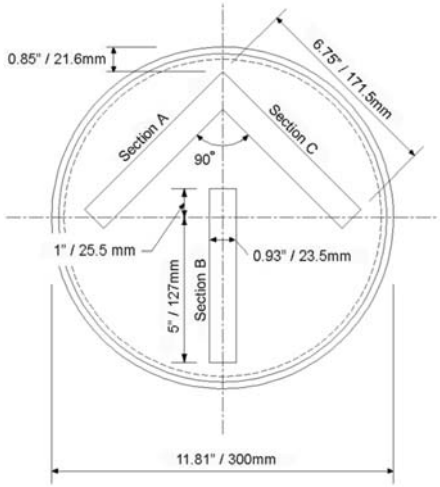
The 300 mm dia. signal is adopted to increase the visibility of driver with the following minimum luminous intensity.

Table 6.4.9 Signal Head

Vertical Angle	Horizontal Angle (Left and Right)	300 mm Signal (cd)		
		Red	Yellow	Green
2.5° up	17.5°	58	115	115
	2.5°	220	441	441
-2.5° down	2.5°	339	678	678
	7.5°	251	501	501
	12.5	141	283	283
	17.5	77	154	154
-7.5° down	2.5	226	452	252
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178

Source: JICA Study Team

The configuration of the arrow icon for the LED arrow lens is illustrated below.



Source: JICA Study Team

Figure 6.4.3 Configuration of the Arrow Icon for the LED Arrow Lens

LED modules shall provide the maximum wattage as shown below.

Table 6.4.10 LED Modulus

Modules	Wattage
300 mm Red Ball	10 or less
300 mm Yellow Ball	22 or less
300 mm Green Ball	12 or less
300 mm Yellow Arrow	11 or less
300 mm Green Arrow	5 or less

Source: JICA Study Team

2) Signal Support Poles

− Requirements for Galvanized Steel Mast Arm Poles and Galvanized Steel Mast Arms

The Contractor shall submit copies of design drawings unless otherwise specified. Contractor's estimated weights of the various units shall appear in the design drawings. The Contractor shall be required to submit shop drawing for approval.

− Pedestal Poles

The pedestal poles shall consist of one upright pole with suitable base and any other accessories or hardware as required to make a complete installation.

− Concrete Poles

The concrete polls shall be used for the temporary traffic signal system to make overhead span between concrete poles with messenger wire and other accessories and hardware as required.

3) Signal Cable

All multi-conductor control cables (three or more conductors) shall have individual conductor size no. 2.0 mm^2, high molecular weight polyethylene color-coded insulation, suitable fillers and binder tape with a SVV overall jacket and be rated at 600 volts. These cables shall be suitable for use in conduit, duct, aerial, or direct burial installations.

6.5 OBSTRUCTION LIGHTS

6.5.1 Aviation Obstruction Lights

Aviation obstruction light is a device to warn aircraft of potential danger from above ground level structures like towers, smokestacks, tall buildings, etc. In some cases, it is also called Aircraft Warning Light. When it comes with a controller to realize the extra functions like sending an alarm signal, flash synchronizing, and auto switch-on at night, it can also be called Aircraft Warning Light System.

Table 6.5.1 Characteristics of Obstacle Lights

Light Type	Color	Signal Rate (Flash Rate)	Peak Intensity (cd) at a Given Background Luminance			
			Above 500 cd/m^2	50 to 500 cd/m^2	Blow 50 cd/m^2	Vertical Beam Spread (degree)
Medium-Intensity Type A	White	Flashing (20 to 60 fpm)	20,000 ±25%	20,000 ±25%	2,000 ±25%	3.0
Medium-Intensity Type B	Red	Flashing (20 to 60 fpm)	N/A	N/A	2,000 ±25%	3.0
Medium-Intensity Type C	Red	Fixed	N/A	N/A	2,000 ±25%	3.0
Recommendation	**Type A**					

Source: ICAO Annex 14, Chap. 6, Table6-3

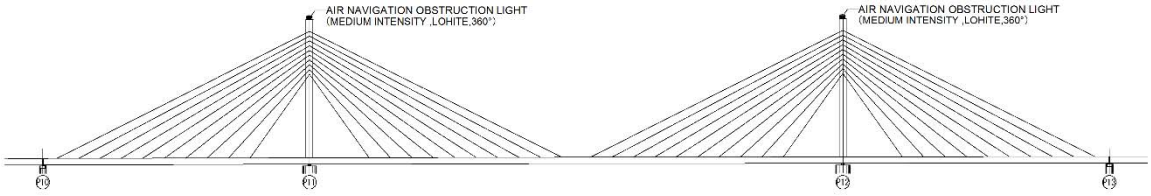
Source: Philips Product

Figure 6.5.1 Outside View of Type A

Table 6.5.2 ICAO Recommendation and Practice

Object	Height	Night Only Operation	Day and Night
Tower	45 m up to 105 meters	Plan B: 1 or 2 medium intensity lights Type B at the top. 3 low intensity lights Type B at intermediate levels at 120°	1 or 2 white medium intensity Type A at the top.
Recommendation		**1 white medium on top of pylon**	

Source: ICAO Annex 14



Source: JICA Study Team

Figure 6.5.2 Installation Location

6.5.2 Navigation Lateral Marks and Obstruction Lights

(1) IALA Lateral Marks System

The world has been subdivided in two regions as follows, where Myanmar is classified as Region A.

Table 6.5.3 Criteria for Lateral Marks

Region	Instrumentation	Location in Upstream Direction	Shape	Color	Light Rhythm
A	Port Hand	Left	Square	Red	Flashing
	Safe Water	Mid channel	Pillar or spar	Red and white vertical strips	Flashing
	Starboard Hand	Right	Triangular	Green	Flashing

Source: IALA Standard

Port Hand Safe Water Starboard Hand

Source: IALA Standard

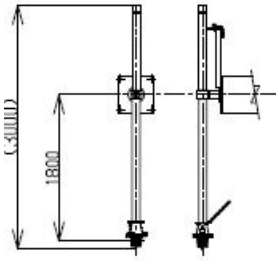
Figure 6.5.3 Lateral Marks Specified in IALA Standard

(2) Equipment to be Installed

The standards for navigation lights shall comply with the International Association of Marine Aids to Navigation and Lighthouse Authority (IALA).

Navigation lights (white/red/green colors) shall be installed at adequate locations on the project bridge together with signal plates. Six navigation lights per shipping water ways (SWW), three on the upstream side of the SWW, and the other three on the downstream side shall be installed on the Bago River Bridge.

Navigation Lights



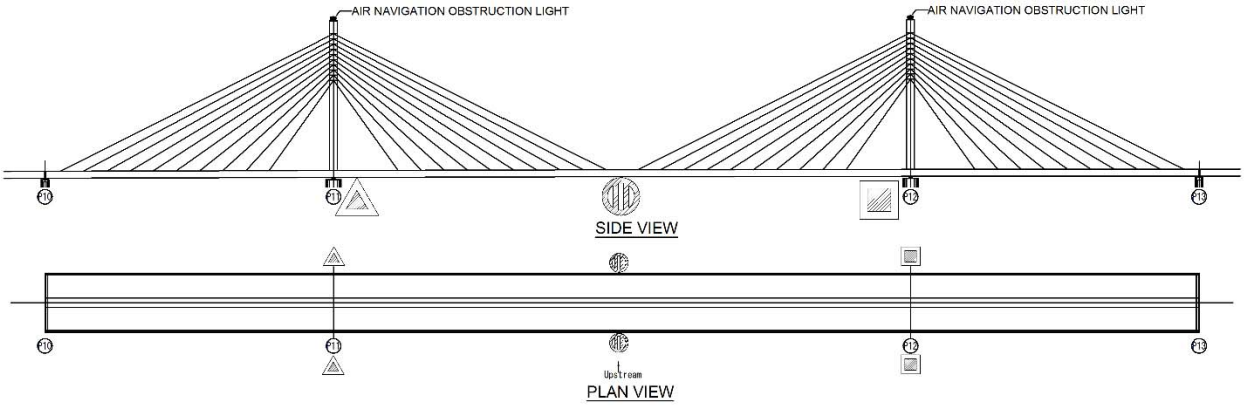
Location of Navigation Lights

Source: IALA Standard

Figure 6.5.4 Location of Navigation Lights

Navigation lights should be suspended below the bridge deck and supported on a hinged swing arm with retrieval chain and locking rod to allow the light to be swung up to deck level for maintenance.

Planned installation layout is shown in Figure 6.5.5.



Source: JICA Study Team

Figure 6.5.5 Layout of Navigation Lateral Marks

6.6 BRIDGE NIGHTSCAPE LIGHTING

6.6.1 Elements of Nightscape Illumination

In D/D, the color of illuminant was determined as white through the discussion with MOC. The following Figure 6.6.1 shows the perspectives:

Source: JICA Study Team

Figure 6.6.1 Perspective with Night Scape Illumination

6.6.2 Equipment to be Installed

The sets of equipment to be installed determined in D/D are shown in Table 6.6.1.

Table 6.6.1 List of Equipment to be Installed

Flood Lights Setting		Descriptions
Pylon	Height (H) of pylon above the road	H=58 m
	Pole location (L) from pylon	L=58/R=11m R: constant
	Top of lighting pole installed on median	4.5 m height
	Light-up on both sides of pylon	1,500 lx for pylon (steel box)
Pier	Distance from top of pier under main girder	5 m
	Light-up on both side of pier	100 lx

Source: JICA Study Team

6.7 LIGHTING PROTECTION SYSTEM (LPS)

LPS consists of air termination, conductors, and earth terminations. The components of LPS should be useable for tropical climatic areas. In order to counteract the effects of the lightning stroke current, electrical apparatus included in the bridge metal structures should be protected from electrical and magnetic fields on metal assemblies.

6.8 WIRING PLANNING

In consideration of the power distribution for long distance, LED single phase load and the voltage fluctuation, the power distribution system shall be 415 V/240 V on two feeder systems.

The lighting panel at site shall manage the 50% lighting operation by means of timer and photo cell.

Further, the voltage drop on distribution wiring should be in the range of the steady light-on, not to decrease remarkably the rated lumens and luminance efficiency.

(1) Electric Systems

The wiring cost should be for the most economical electric system, and the layout of the branch circuits for light control should be considered to influence the supply voltage, line voltage drop, and distance to each lamp.

The wiring cost can be reduced with higher supply voltage and line voltage drop by means of the single-phase three-wire system or three-phase four-wire system. Single-phase 240 V is widespread in Yangon. In the point of view of single-phase loads, three-phase four-wire system: 240 V/415 V is applicable for the electrical loads in long distances.

(2) Incoming Power Receiving Voltage

At the project site, the voltage fluctuation on 240 V lines is from 240 V to 140 V. The main distribution system should be equipped with an open-phase relay to protect 240 V equipment from the fluctuation. In B/D, considering the availability of incoming power line at the project area, 6.6 KV lines had been recommended for the project in the case of an emergency.

The incoming power receiving voltage was reviewed and determined, following the existing MV overhead lines due to availability.

Thaketa area: 11 KV lines

Thanlyin area: 6.6 KV lines

(3) Capacity of Emergency Generator

Each incoming power receiving point has an engine generator to back-up the power for 50% road lighting and the lighting of intersection.

Load list for the back-up by engine generator is shown below.

(4) Power Receiving Equipment

Electric power is required for the operations of electrical systems including toll plaza systems and road lighting. MV primary line extension from the nearest existing lines is considered and the primary voltage steps down to 415 V/240 V available for the project.

Regarding the power receiving equipment for toll operation building, the components of MV Incoming Power Receiving System are as follows:

(5) Power Transformer

The power transformer is applied to transfer power and to transform it in rated voltage, rated current, and rated frequency.

(6) Main Distribution Panel

The main feeder distribution system is a hub power distributor where the main distribution panel (MDP) distributes power by each circuit breaker (MCCB) to each lighting contactor panel (LPs).

(7) Lighting Control Panel (as Lighting Panel)

The lighting control panel is applied for the road lighting system if necessary for the reduction of number of luminaires. The lighting control panel is controlled by clock timer and photocell detector when the lighting power is assumed at 100% from 18:00 hours to 24:00 hours and 50% from 24:00 hours to 06:00 hours.

(8) Wire and Conduit

The results of calculation in D/D are shown in the following Table 6.8.1.

Table 6.8.1 Results of Calculation

Facilities	Power Distribution System	Number of Feeder	Electrical Load (VA) per Feeder	Cable Size	Voltage Drop (V)
River bridge	3 P, 4 W	2	2,400	XLPE 35 mm^2-4 C	8.4
Approach bridge-N	3 P, 4 W	2	1,120	XLPE 4 mm^2-4 C	2.5
Approach bridge-S	3 P, 4 W	2	900	XLPE 6 mm^2-4 C	3.5
On-ramp	3 P, 4 W	2	1,920	XLPE 25 mm^2-4 C	4.1
Flyover bridge	3 P, 4 W	2	1,760	XLPE 16 mm^2-4 C	8.9
Approach road-N	3 P, 4 W	2	1,600	XLPE 16 mm^2-4 C	6.6
Approach road-S	3 P, 4 W	2	960	XLPE 6 mm^2-4 C	4.0
AOL	2 P, 3 W	*1	2,400	XLPE 10 mm^2-3 C	14.2
Navigation light	2 P, 2 W	*1	1,000	XLPE 8 mm^2-2 C	10.0
Light-up	3 P, 4 W	2	24,000	XLPE 35 mm^2-4 C	20.0
Tollgate area light	3 P, 4 W	2	2,681	XLPE 8 mm^2-4 C	7.5
Shukhinthar IS	3 P, 4 W	1	2,571	XL 7 0 PE 8 mm^2-4 C	5.7
Yadanar IS	3 P, 4 W	1	706	XLPE 4 mm^2-4 C	1.3

Note: *: power supply only

Source: JICA Study Team

CHAPTER 7. CONSTRUCTION PLANNING

7.1 CONSTRUCTION PLANNING OF THE RIVER BRIDGE SECTION

7.1.1 Work Content and Tentative Construction Schedule

The Project works in the river bridge section are divided into two packages.

(1) Package 1

Package 1 includes the following work items, and erection and construction methods as shown in Table 7.1.1.

Table 7.1.1 Work Items and Construction Methods for Package 1

Work Items	Contents (Methods)
Steel cable-stayed bridge	Bent in side span and balancing cantilever method in center span
SPSP foundation	Driving steel pipe using two large crane barges
Precast continuous PC box bridge	Span-by-span erection using large erection girder
Fabrication of precast block	Short-line match casting method in large casting yard near the site
Ramp bridge (PC T-girder)	Casting T-girder near the erection site and erecting by crawler and track crane
Concrete placing for substructure	Concrete mixing plant ship

Source: JICA Study Team

(2) Package 2

Package 2 includes the following work items, and erection and construction methods as shown in Table 7.1.2.

Table 7.1.2 Work Items and Construction Methods Package 2

Work Items	Contents (Methods)
Steel continuous box girder	Bent erection using large crane barge
SPSP foundation	Driving steel pipe using two large crane barges
Precast continuous PC box bridge	Span-by-span erection using large erection girder
Fabrication of precast block	Short-line match casting method in large casting yard near the site
Concrete placing for substructure	Concrete mixing plant ship

Source: JICA Study Team

7.1.2 Major Materials to be Incorporated in the Works

(1) Package 1

Package 1 includes the following materials to be incorporated in the works as shown in Table 7.1.3 .

Table 7.1.3 Major Materials to be Incorporated in the Works for Package 1

Work Items	Contents (Methods)
Steel cable-stayed bridge	Steel plate, stay cable, and anchor and guess asphalt from Japan
SPSP foundation	Steel pipe φ1.2 m from Vietnam
Precast continuous PC box bridge	PC cable from Japan and cement and aggregate from Myanmar
Fabrication of precast PC block	Cement and aggregate from Myanmar
Ramp bridge (PC T-girder)	PC tendon from Japan and cement and aggregate from Myanmar

Concrete placing for substructure	PC tendon from Japan and cement and aggregate from Myanmar

Source: JICA Study Team

(2) Package 2

Package 2 includes the following materials to be incorporated in the works as shown in Table 7.1.4.

Table 7.1.4 Work Items and Construction Methods for Package 2

Work Items	Contents (Methods)
Steel continuous box girder	Steel plate and guess asphalt from Japan
SPSP foundation	Steel pipe φ1.2 m from Vietnam
Precast continuous PC box bridge	PC cable from Japan and cement and aggregate from Myanmar
Fabrication of precast block	Cement and aggregate from Myanmar
Concrete placing for substructure	Cement and aggregate from Myanmar

Source: JICA Study Team

7.1.3 Temporary Facilities

7.1.3.1 Outline of Temporary Construction Yard

(1) Package 1

Site-A in Figure 7.1.1 is proposed for construction yard, which is now a private land. It is confirmed that the possibility to use it for temporary facility yard will be on a lease basis. The reclamation area is approximately 49,000 m^2 and is used as construction yard for continuous PC box girder bridge and ramp to Star City. The reclamation level is 4.300 m considering a five-year return period based on the river hydrological study.

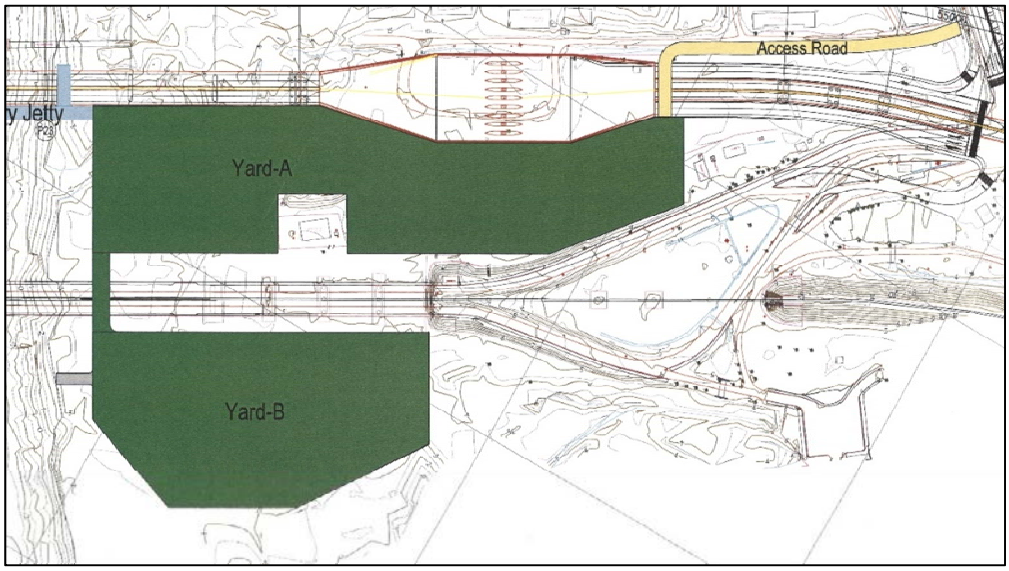
Source: JICA Study Team

Figure 7.1.1 Outline of Temporary Facilities for Package 1

(2) Package 2

Temporary facility yard for Package 2 is planned in two areas as shown in Source: JICA Study Team

Figure 7.1.2. Yards A and B owned by YRW are secured for temporary yard. For access road to the temporary yard, only one route is provided from the existing road. For approach to construction yard of bridge structures and erection area of superstructure in the river, temporary jetty should be provided for on-shore works using marine equipment such as crane barge and tugboat. Area of Yards A and B is approximately 25,000 m^2 and 18,500 m^2, respectively, with a total area of 43,500 m^2.



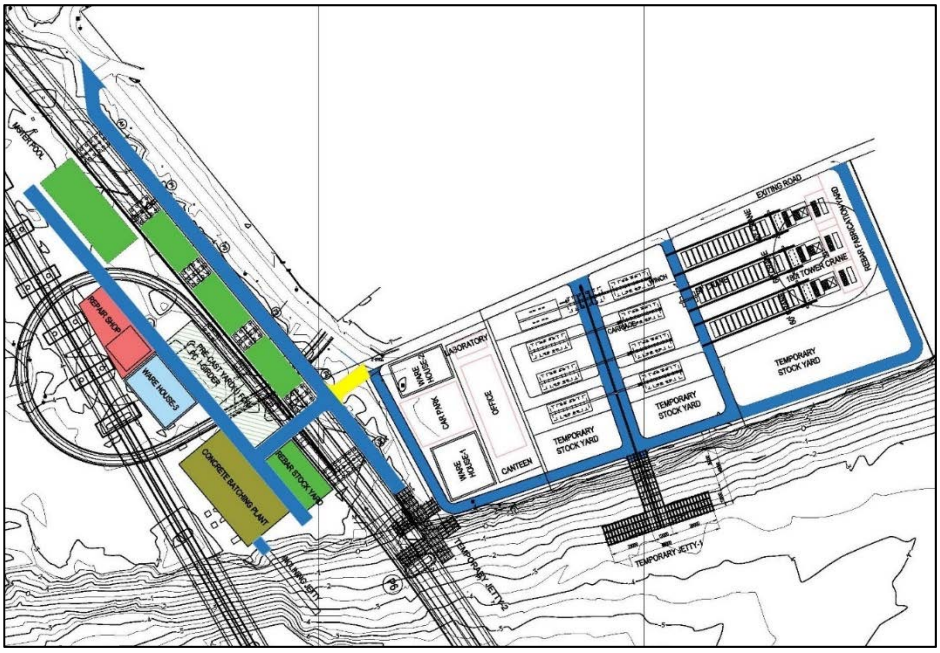
Source: JICA Study Team

Figure 7.1.2 Outline of Temporary Construction Yard for Package 2

7.1.3.2 Construction Facilities

(1) Package 1

Temporary construction facilities for Package 1 are planned in two areas as shown in Figure 7.1.3.

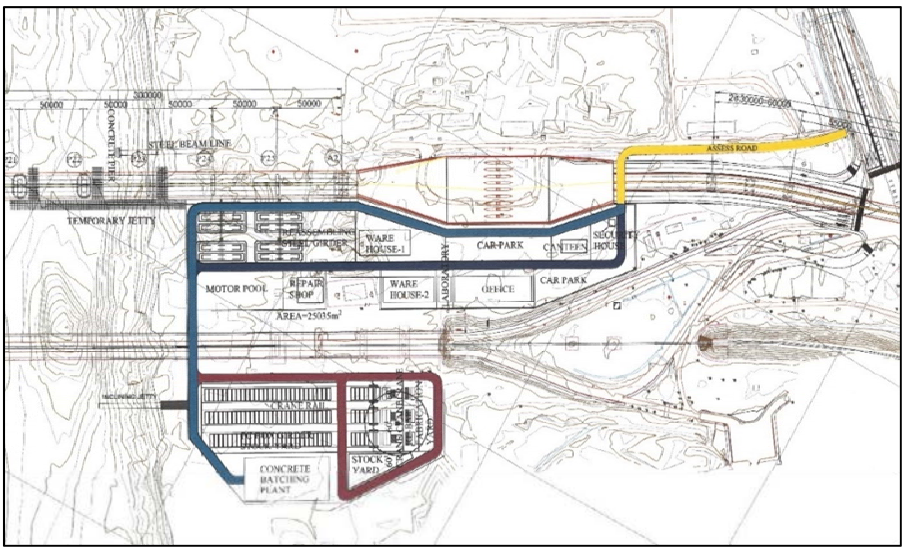


Source: JICA Study Team

Figure 7.1.3 Tentative Facilities of Construction Yard in Package 1

(2) Package 2

Construction Yard A is located near the construction site. It is situated in a limited area and is planned to be allocated with the following main facilities as shown in Figure 7.1.4 .



Source: JICA Study Team

Figure 7.1.4 Tentative Facilities of Construction Yard in Package 2

7.1.3.3 Temporary Facilities

(1) Temporary Construction Roads

Construction road in the yard is mainly 6.5 m in width for 2 lines and 5.0 m for single lines. Pavement is classified into three types considering soil and loading conditions.

(2) Temporary Jetty

A temporary jetty is provided each for Package 1 and Package 2 in order to construct foundations and substructures and/or loading and unloading steel girder blocks or segments. Steel members mostly consist of steel H-beam and steel slabs. A part of the jetty, is used for staging heavy equipment of 200 t crawler crane that is reinforced with high horizontal rigidity and floor beam.

(3) Concrete Batching Plant

Concrete batching plants are provided each for Package 1 and Package 2. The total concrete volumes for Package 1 and Package 2 are 58,800 m^3 and 32,600 m^3, respectively.

(4) Concrete Transportation in the River and Placing Facilities

Concrete placing method for structures in the river is considered in the following two plans:

Plan-A : Concrete Batching Plant Barge with a Capacity of 60 m^3/hr

Plan-B : Agitator Truck on Barge-pulling Tug Boat and Placing Concrete by 2.5 m^3 Bucket

(5) Reassembling Yard for Steel Girder Blocks

Reassembling yards in Package 1 and Package 2 are mainly used for reassembling steel girder blocks to erection segments, welding steel pipes used in SPSP to use bents for girder erection, and temporary stock pile. Steel girder blocks for cable-stayed and continuous steel box girder bridges are fabricated out of the construction yard and transported to the reassembling yard by barge. Loading steel blocks and pipes on the jetty is conducted by crawler crane and transported to the reassembling yard by trailer or carriage. Assembled erection segments on carriage are pulled out of the yard to the temporary jetty by winches jacks.

7.1.4 Road Works

7.1.4.1 Works for Soft Soil Treatment

Approach road for both Thanlyin and Thaketa side and toll plaza located on soft ground will require soft soil treatment. Considering construction period and cost, the treatment will be carried out through combination of deep soil mixing method and preloading method.

(1) Deep Soil Mixing Method

Approach road in the Thanlyin side located on soft ground requires improvement of clay, sandy clay, and silty sand layers. The improvement depth is 30 m in maximum for Package 1 and 20 m for Package 2. Deep soil mixing method is selected in consideration with deep improvement depth.

(2) Pre-loading Method

Preloading method is subdivided into: only preloading using surcharge; and preloading using surcharge and vertical drain considering time taken for consolidation of soft soil. For the soft soil area, where the time for consolidation is more than 16 months for Package 1 and 12 months for Package 2 including filling period in total construction period, preloading using surcharge method is applied to reduce cost. Filling material of surcharge is transported by barge from borrow pit 6.0 km upstream of the Bago River.

7.1.4.2 Works for Embankment and Retaining Walls

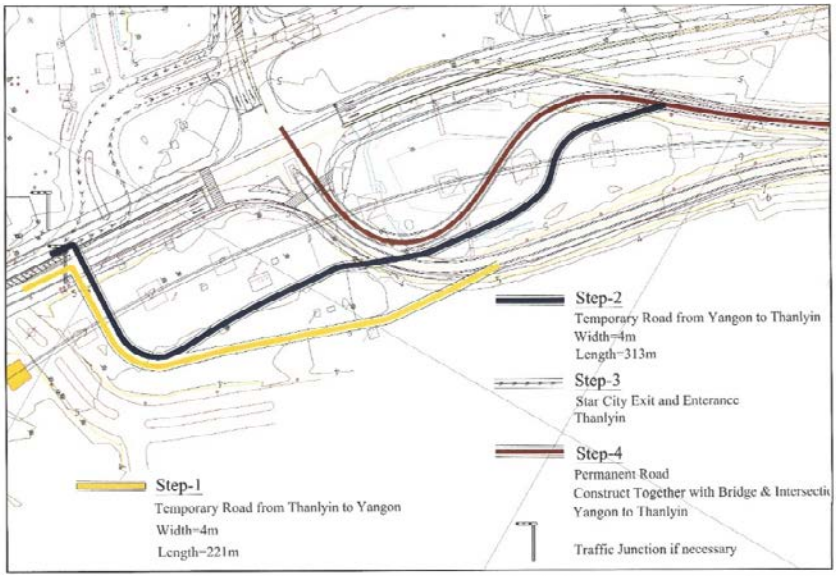
(1) Workable Day for Embankment

Workable day for embankment is approximately 178 days a year. However, in the rainy season from June to September, workable days are very limited, therefore, embankment works should be cancelled during this season in consideration of soil conditions.

7.1.4.3 Diversion of Existing Traffic during Construction

(1) Intersection at the Beginning Point for Package 1

Existing traffic at the intersection of the beginning point is mainly through Thaketa–Thanlyin Road and from Star City. During the construction of new intersection, these traffic flows are diverted into the following steps and as shown in Figure 7.1.5.

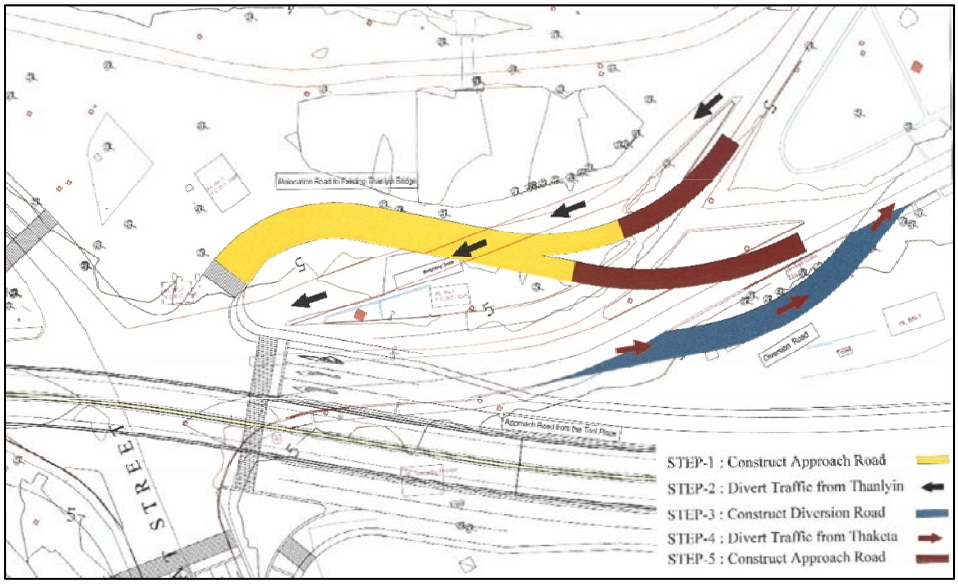


Source: JICA Study Team

Figure 7.1.5 Diversion of Existing Traffic during Construction of Intersection

(2) Approach Road to the Existing Thanlyin Bridge

The approach road is a new road to the existing Thanlyin Bridge after opening the new Bago Bridge construction. The construction is related to the schedule for improvement of intersection and construction of approach roads from the toll plaza. The process of construction is as per the following steps, and as shown in Figure 7.1.6 to maintain the existing traffic smoothly.



Source: JICA Study Team

Figure 7.1.6 Diversion of Existing Traffic during Construction of Relocated Road

7.1.5 Cable-stayed Bridge

7.1.5.1 Outline of Cable-stayed Bridge Works

(1) Alternative Study for Erection of Cable-stayed Bridge

Erection method for cable-stayed bridge is determined considering the points namely: Constructability, Construction period, Navigation Safety, Erection Cost and Technology Transfer.

Important factor is mainly to minimize construction period requested by MOC and maintain navigation traffic. Vertical bent + Balancing erection with segment is most recommended because construction period can be shortened and disturbance to navigation traffic is minimized.

In addition, detour navigation route will be secured in the Thaketa side.

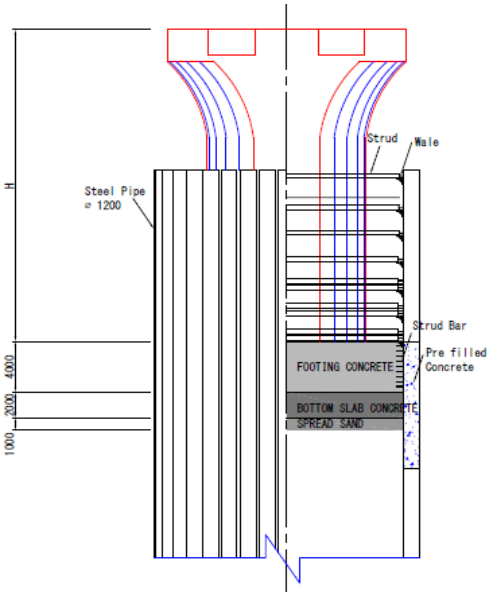
7.1.5.2 Foundation Works

(1) Maintenance of Navigation Route during Foundation Works

The foundation of cable-stayed bridge is planned to consist of steel pipe sheet piles (SPSP) with steel pipe of φ1.2 m to maintain the navigation route. The size of SPSP is large (15 m x 23 m) and steel pipe is as long as 60 m so that two large crane barges are required for the execution. For the security of navigation route, two crane barges of 350 t and 275 t are arranged in flow direction. Considering anchor setting temporarily in riverbed, a minimum of 120 m is secured for the navigation width.

(2) SPSP Foundation

All 6,220 t of steel pipes used for the SPSP foundation are fabricated based on JIS standards and Japanese fabricator in Vietnam. The SPSP foundation has an oval shape and measures 14.130 m x 22.820 m. Steel pipe pile is 1.20 m and 12-16 mm in thickness as shown in Figure 7.1.7. The maximum length is 62.0 m in Package 1 including temporary pipes for cofferdam and the total number of steel pipes including separation wall pipe is 184 for four foundations. The position of steel pipes is determined by using temporary guide-frame. Hydraulic vibration hammer is firstly used for driven steel pipes and finally it is driven into bearing stratum by using a diesel driven hammer. A driven steel pipe pile verifies the ultimate bearing capacity by impact loading testing (PDA).



Source: JICA Study Team

Figure 7.1.7 Configuration of SPSP Foundation

7.1.5.3 Substructure Works

(1) Concrete Plant and Transportation Method of Concrete

Concrete batching plant is provided near the riverside and ensures smooth access to the substructure in the river for both packages. Concrete agitator trucks on barge are the transporting method through inclined jetty.

(2) Concrete Placing Method in SPSP

Construction of concrete slab and pier structures is executed by using SPSP cofferdams, which is used for the top part of SPSP foundation. The false-work system is designed for dry constructability in the river. The concrete of bottom slab is placed by a concrete bucket of 2.5 m^3 attached to 100 t crawler crane on barge. During placing of the concrete in the SPSP, concrete agitator on barge and 100 t crawler crane on barge are arranged. After the SPSP is carried out in the dry and stud dowel welds on steel pipe to connect the pile cap, concrete is placed by the same method.

The reinforced concrete columns of pier are constructed by using a shuttering form with an integration of a working platform. A crawler crane with a capacity of 100-ton barge anchors on the cofferdam for material handling. Each typical pouring height is 3~4 m. In the construction planning, a 4-day cycle time for each lift is estimated.

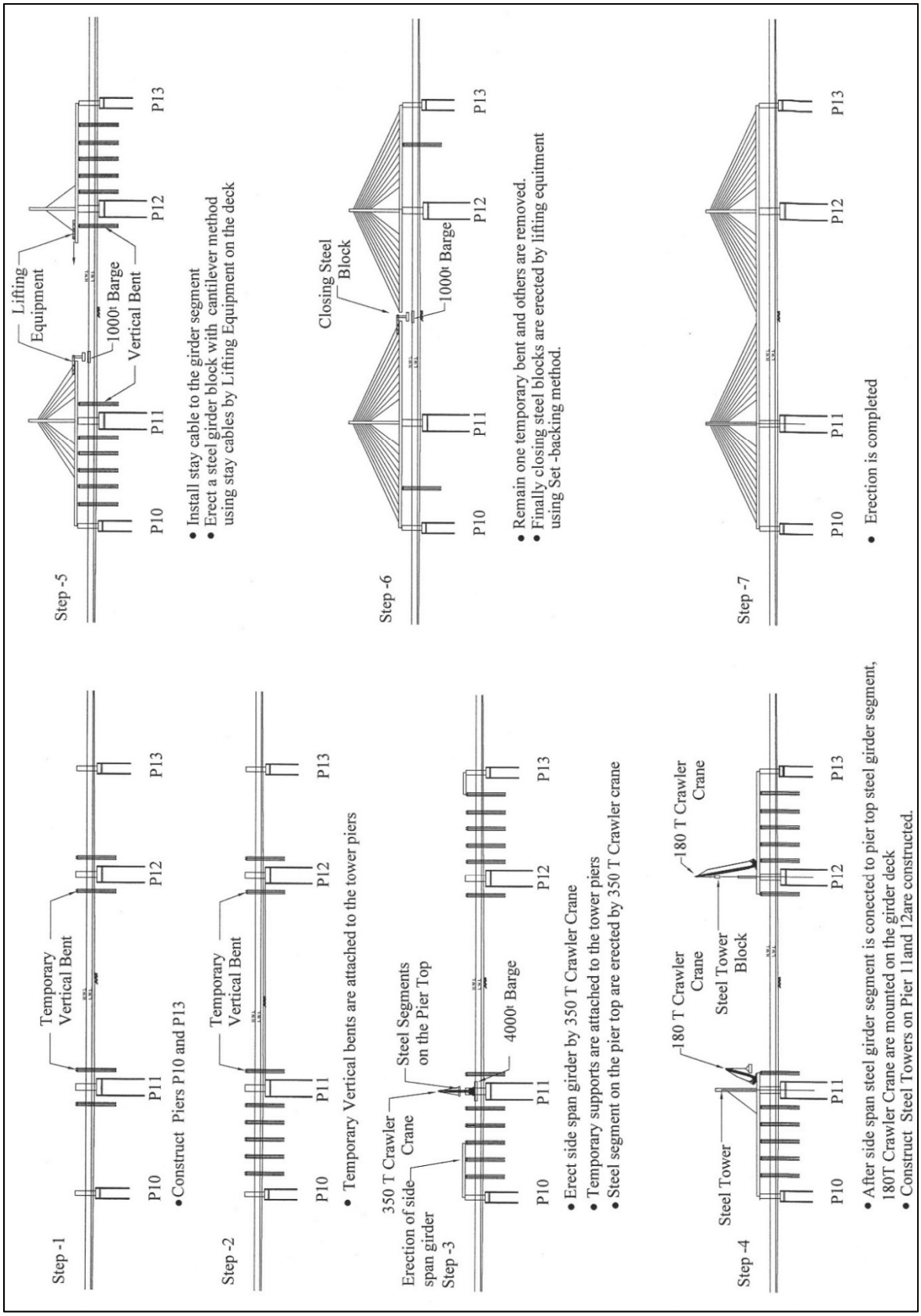
(3) Bracket for Scaffolding of Coping Concrete

After pier shaft concrete is completed, shuttering formwork is removed and then steel pipes above pile cap concrete are cut and removed. The removed pipes are connected and welded for reuse as temporary pile bents at side span of cable-stayed bridge. Brackets for scaffolding of a hammer head coping concrete are provided on pier column. The brackets consist of fabricated H-beam.

7.1.5.4 Superstructure Erection Works

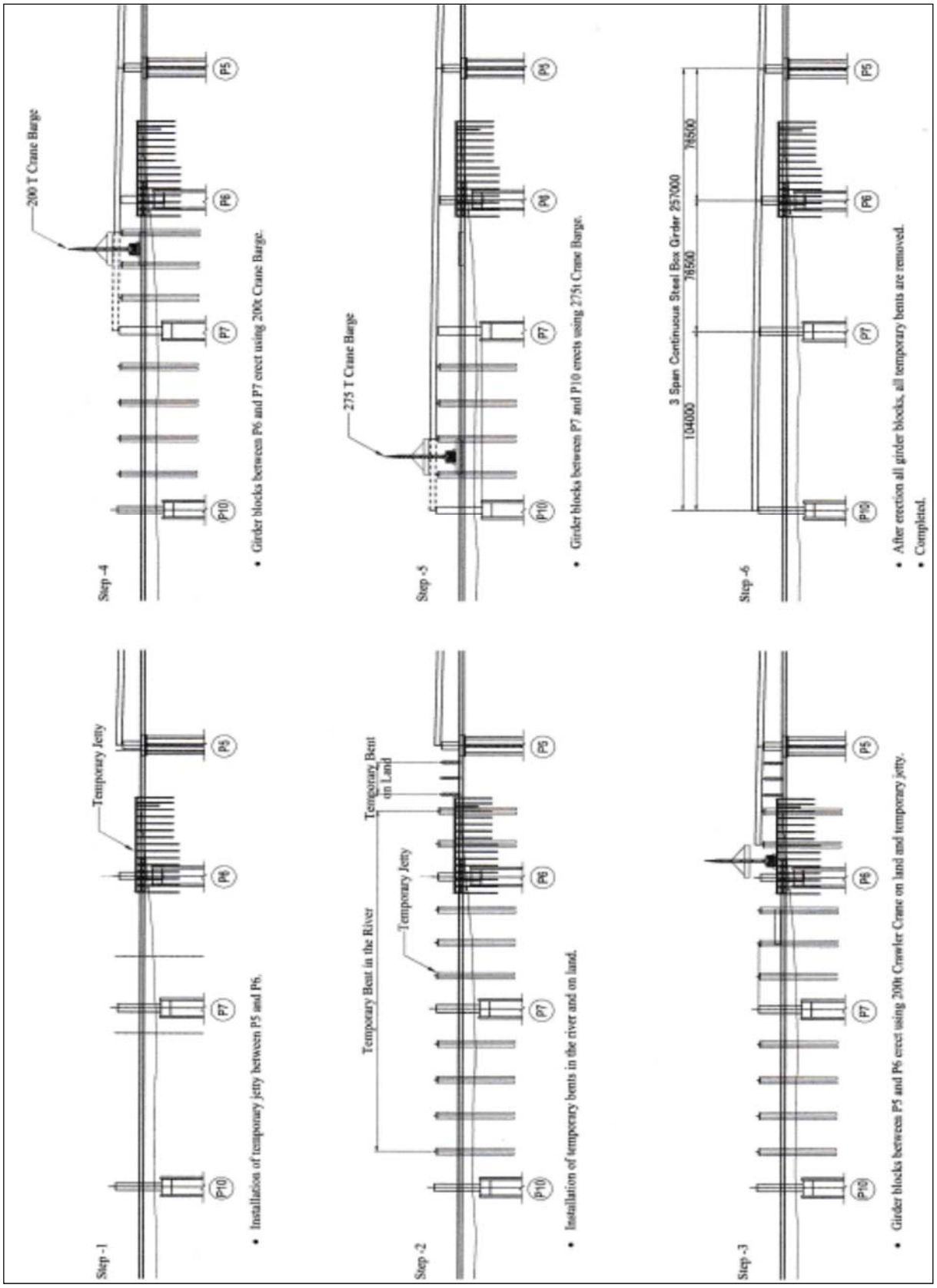
(1) Erection Sequence for Cable-stayed and Continuous Steel Box Bridges

Erection sequence for a cable-stayed and continuous steel box bridges are illustrated as shown in Figure 7.1.8 and Figure 7.1.9.



Source: JICA Study Team

Figure 7.1.8 Erection Sequence for Cable-stayed Bridge



Source: JICA Study Team

Figure 7.1.9 Erection Sequence for Continuous Steel Box Girder Bridge

7.1.6 Steel Box Girder Bridge

7.1.6.1 Outline of Steel Box Girder Works

(1) Alternative Study for Steel Box Girder Works

The erection of steel box girder bridge is executed using bent erection method considering the merit of construction period and erection cost.

7.1.6.2 Foundation Works

(1) Maintenance of Navigation Route during Foundation Works

Foundation of cable-stayed bridge is planned to consist of SPSP with steel pipe of φ1.2 m to maintain the navigation route. The size of SPSP is large (10 m x 17 m), and the steel pipe is long (60 m); therefore, large crane barges are required for the execution. For the security of navigation route, two crane barges of 200 t are arranged as shown.

(2) SPSP Foundation

All 8,700 t of steel pipes used for SPSP foundation are fabricated based on JIS standards and Japanese fabricator in Vietnam. The SPSP foundation is oval in shape and measures 30 m x 35 m. Steel pipe pile is 1.20 m and 12-16 mm in thickness. The maximum length is from 52.5 m to 57.0 m in Package 1 including temporary pipes for cofferdam and the total number of steel pipes including separation wall pipe is 216 for the six foundations. The position of steel pipes is determined by using temporary guide-frame. Hydraulic vibration hammer firstly uses for driven steel pipes and finally driven into bearing stratum using a diesel driven hammer. A driven steel pipe pile verifies the ultimate bearing capacity by impact loading testing (PDA).

(3) Construction Sequence of SPSP

Construction sequence of SPSP is the same as shown in the previous section.

7.1.6.3 Substructure Works

(1) Concrete Plant and Transportation Method of Concrete

Concrete batching plant is provided near the riverside and ensures smooth access to the substructure in the river for both packages. Concrete agitator trucks on barge are the transported through inclined jetty. The transportation distance from jetty to the farthest pier is approximately 750 m and the time cycle is 25 minutes. In case of 3-agitator on barge, capacity of 36 m^3/hr (15 m^3 x60/25=36 m^3/hr) is estimated as the maximum. Two sets of transporting barges are provided for concrete placement in the river, and a capacity of 60 m^3 /hr can be ensured in consideration of time cycle allowance.

(2) Concrete Placing Method

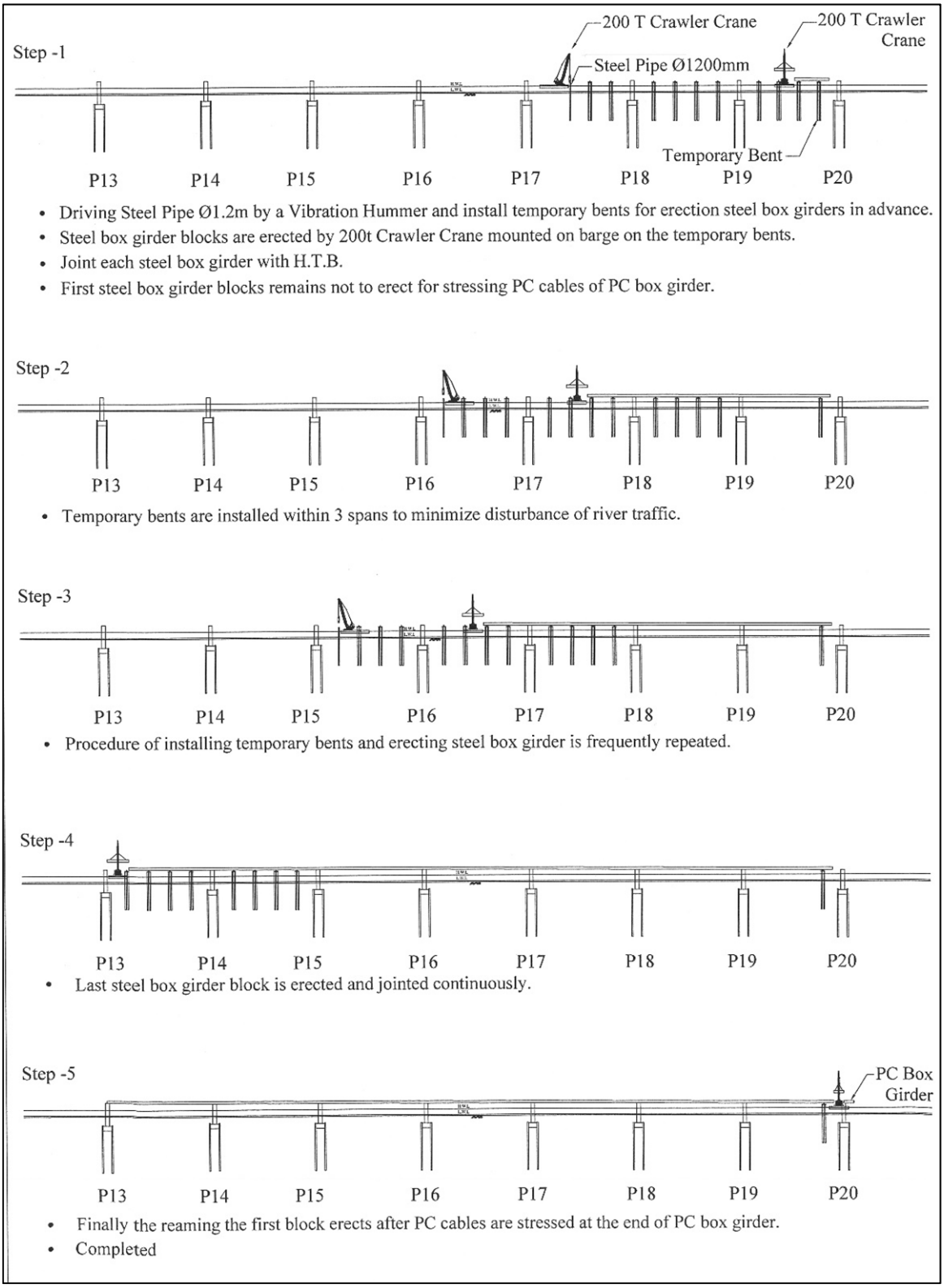
Construction of concrete slab and pier structures is executed using SPSP cofferdams, which is used for the top part of SPSP foundation. The false-work system is designed for dry constructability in the river. Concrete of bottom slab is placed using a concrete bucket of 2.5 m^3 attached to 100 t crawler crane on barge. During placing of concrete in the SPSP, concrete agitator on barge and 100 t crawler crane on barge are arranged in position. After the SPSP is carried out in the dry and stud dowel is welded on steel pipe to connect the pile cap, concrete is placed by the same method.

The reinforced concrete columns of pier are constructed by using a shuttering form with an integration of a working platform. A crawler crane with a capacity of 120 ton barge is anchored on the cofferdam for material handling. Each typical pouring height is 3~4 m. In the construction planning, a 4-day cycle time for each lift is estimated.

7.1.6.4 Superstructure Works

(1) Erection Sequence of Steel Box Girder

Erection sequence of steel box girder is illustrated in Figure 7.1.10.



Source: JICA Study Team

Figure 7.1.10 Erection Sequence for Steel Box Girder Bridge

7.1.7 PC Box Girder Bridge

7.1.7.1 Outline of Approach Bridge Works

Approach bridge consists of a precast continuous PC box girder using a span-by-span erection method. Package 1 has five spans with total length of 250 m while Package 2 has six spans with total length of 300 m. Bored piles and SPSP foundations support the piers.

7.1.7.2 Foundation Works

The foundation of the precast segmental approach bridge is composed of 94 bored piles with diameter of 1.5 m and 2.0 m in Package 1 and 50 bored piles with diameter of 1.5 m and 2.0 m in Package 2.

7.1.7.3 Substructure Works

(1) Cofferdam/ Excavation for Substructure

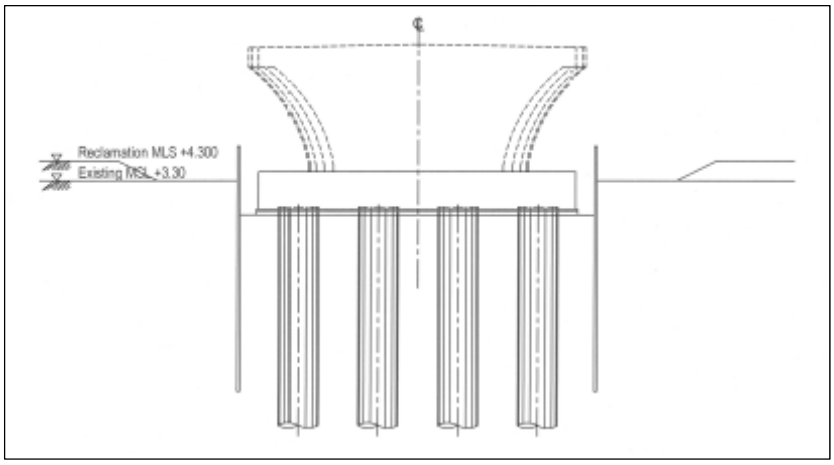
Excavation of substructure is relatively shallow, and hence cofferdam to be used consists of self-supporting steel sheet piles without waling members as shown in Figure 7.1.11. The structural excavation process is as follows:

Step 1: Cast-in-placed concrete piles is constructed on the reclamation revel MS +4.300.

Step 2: Outside area of steel sheet piles is excavated up to MS +3.300 to reduce lateral earth pressure.

Step 3: Inside area of steel sheet piles is excavated up to bottom of foundation.

Step 4: After completion of concreting, the excavated space is backfilled up to MS +4.300.



Source: JICA Study Team

Figure 7.1.11 Cofferdam for Pile Cap of Piers

(2) Concrete Placing Method

A concrete pumping equipment on MS +4.300 m is used to place concrete of sub-structure. The capacity of the pumping equipment is over 60 m^3/hr.

7.1.7.4 Fabrication of PC Box Segments

(1) Package 1

The PC box segments cast in a casting yard is located at the riverbank of the Thanlyin site.

One hundred seventy-two segments are fabricated in a period of seven months in Package 1.

(2) Package 2

The segments cast in a casting yard located at the riverbank of the Thaketa site. The yard belongs to MR, which is a favorable location to facilitate transportation of the heavy segments to the erection site.

In this project, 206 segments are fabricated in a period of nine months.

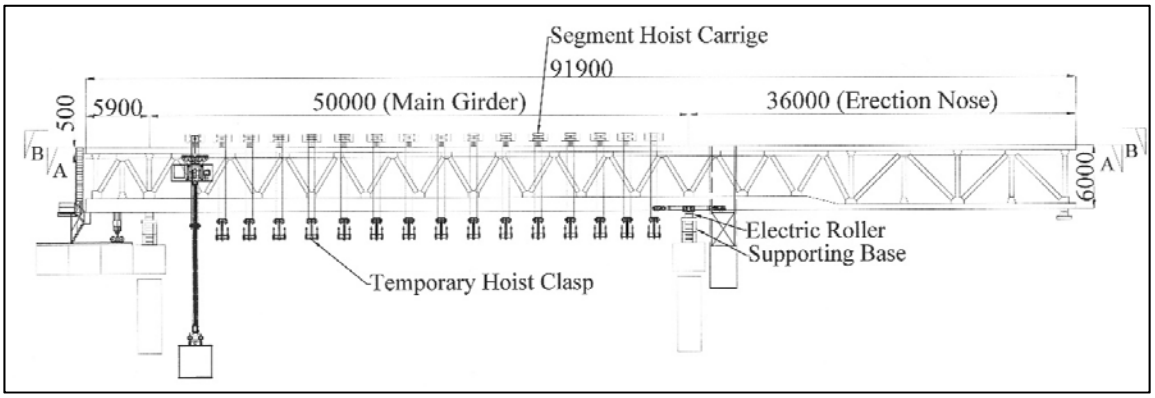
7.1.7.5 Superstructure Works

(1) Erection sequence for Approach Bridge

Erection sequences for Approach Bridge in Package 1 are illustrated as shown in Figure 7.1.13.

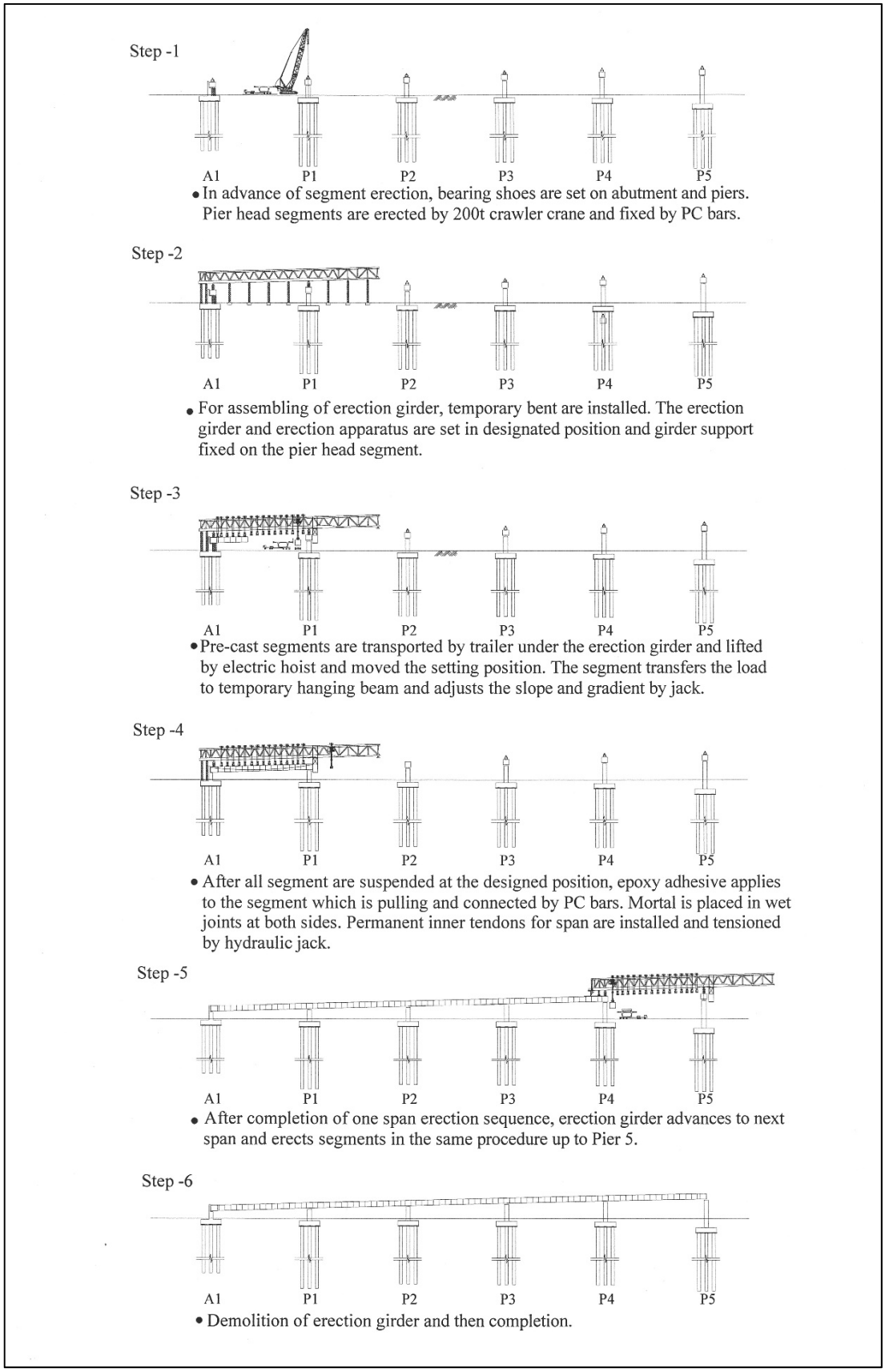
(2) Erection Girder

Erection girder for span-by-span method consists mainly of truss or box structure types. For the construction in foreign countries, the truss structure type is selected for span-by-span method considering transportation and easy fabrication and assembly. The erection girder planned for Package 1 and Package 2 is shown in Figure 7.1.12. Truss structure type is also preferred in high-wind region such as Myanmar due to low wind resistance.



Source: JICA Study Team

Figure 7.1.12 Image of Erection of Girder using Span-by-Span Method



Source: JICA Study Team

Figure 7.1.13 Erection Sequence for Approach Bridge in Package 1

7.1.8 On-ramp Bridge

7.1.8.1 Outline of On-ramp Works

On-ramp works consist of embankment and bridge portions. The embankment portion requires soft soil treatment before placing the embankment. The bridge portion is almost straight, which consists of 4-span PC I-girder with composite slab. Its foundation is a bored pile installed using a reverse circulation drilling method (RCD).

7.1.8.2 Foundation Works

Soft soil treatment is executed with the same method done for the approach road because of close similarity in soil condition.

7.1.8.3 Fabrication of PC I-Girders

Eight PC I-girders are fabricated near the erection site. Two fabrication beds are provided in parallel to the ramp bridge at the first span. Two I-girders are cast simultaneously for one span, and repeated for four times. PC I-girders casted at the first span and transported to the second span using a rail and winch installed parallel to the bridge line, and then continued to the fourth span. Moving distance is approximatly100 m.

7.1.8.4 Erection of PC-I-Girder

Two track cranes with lifting capacity of 200 t are ued to erect PC I-girders casted and transported in front of the erecting span. The erected I-girders connected with cross beam and precast PC boards, with the concrete slab placed on the PC boards. The PC board and slab act as composite section. As the number of the PC board in this package is small in quantities, it is considered to be imported or procured from local PC fabricator.

7.2 CONSTRUCTION PLANNING OF FLYOVER BRIDGE

7.2.1 Project Outline

The flyover section has approximately 600 m in length plus a 225 m long earthwork section, totaling an approximate length of 825 m. Moreover, there is an approximately 780 m long side road.

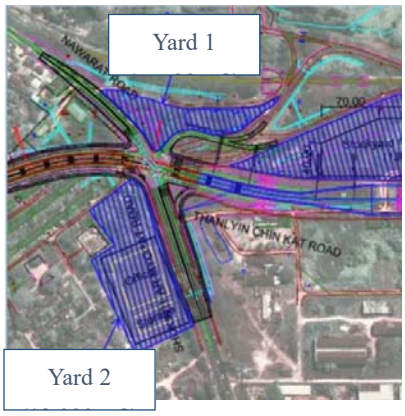
7.2.2 Temporary Installations

7.2.2.1 Temporary Access Road

The project is located in an existing road area; therefore, temporary access road is not required.

7.2.2.2 Temporary Yard Location

The flyover section is divided in three sections: steel bridge, PC bridge, and road section. Regarding the construction yard, two areas were identified in the B/D stage as shown in Figure 7.2.1. The Yard 2– from Myanmar Railways – with approximate 13,000 m^2 was selected as temporary yard facility.



Source: JICA Study Team

Figure 7.2.1 Temporary Yard Location

7.2.2.3 Steel Bridge Assembly

The erection of the steel bridge was planned using temporary bents and crane. After the PC girders erection, the space in the temporary yard can be used for storage of the steel girder blocks and for assembling the blocks. Since the steel sections are over the intersection, erection can only be done during night time when the girder is transported to the erection site by trailer.

7.2.2.4 PC Bridge Precast Elements

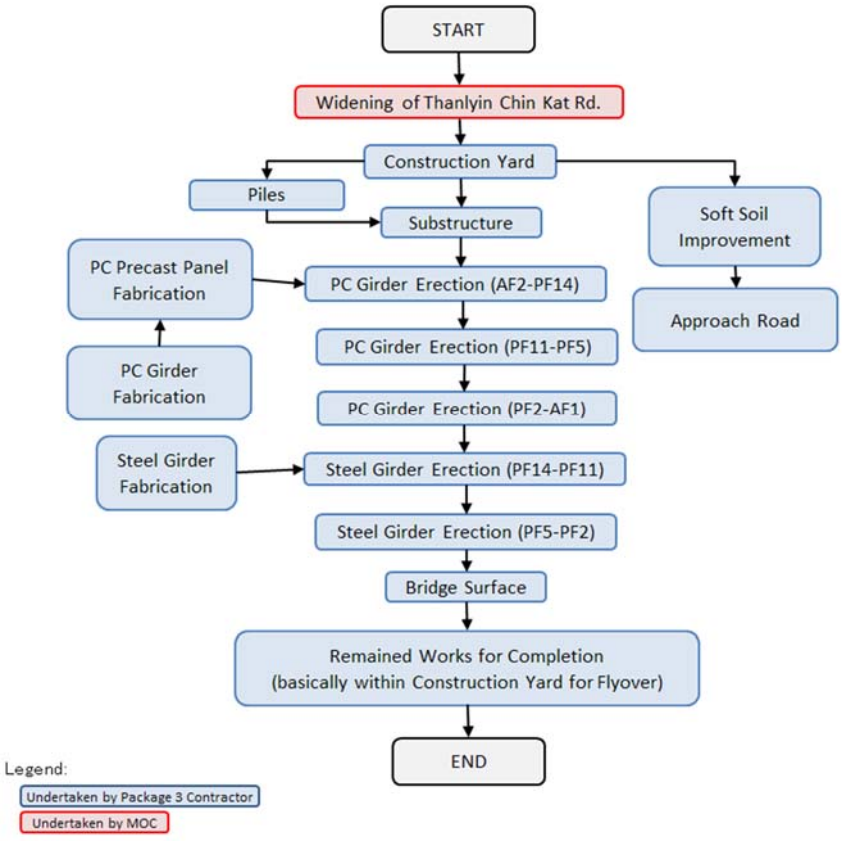
Precast elements such as the PC girder and PC panels were planned to be fabricated and stored in the temporary yard. Gantry cranes or truck cranes are necessary to move the materials during the fabrication. After the fabrication of all girders, these should be transported to the erection site by trailer.

7.2.3 Construction Site

The flyover construction site is the area between the abutment width plus 1.125 m as shown in Figure 7.2.3. The construction site shall be fenced with a temporary steel construction enclosure, except on the intersection area. The approach section is expected to be used as construction access during the pavement and bridge ancillary works. Furthermore, the space between the piers can be used for temporary storage of materials and equipment.

7.2.4 Outline of Construction Sequence

The main steps in the construction of the flyover section are shown in Figure 7.2.2.



Source: JICA Study Team

Figure 7.2.2 Construction Flowchart

7.2.5 Road Works

7.2.5.1 Weak Soil Treatment

The approach after the AF.2 abutment is composed of an embankment section. Since the space between the approach section and the side road section is very narrow, the embankment shall be confined with an L type retaining wall (H=0.0～1.5m) and after that with a reinforced earth wall, same as the AF.1 abutment section in the toll gate side. Differential settlement and lack of bearing capacity are expected in the approach section with embankment, due to a silty layer. Therefore, it is necessary to make a deep layer ground improvement; and thus, the alternative adopted is a cement deep mixing method (dual shaft type φ1200 mm), which is a relatively expensive improvement method.

7.2.5.2 Mechanically Stabilized Earth Wall and Embankment

The adopted retaining walls are the mechanically stabilized earth wall and L-type retaining wall cast in situ. The embankment material distribution/compaction is one of the most important procedures and controls the quality of retaining wall. In addition, to ensure the quality of the embankment it is necessary use an adequate soil material, compaction method, and control during construction (specifically, the compaction degree control shall be done as a standard).
Mechanically stabilized earth wall precast panels can be locally sourced or can be fabricated in situ.

① Foundation work

② Concrete panels erection

③ Reinforcement material installation

④ Earthworks (soil spreading, levelling, and compacting)

Repetition of steps ① to ④ until completion

7.2.5.3 Pavement

The pavement type adopted in the road/bridge sections is the concrete asphalt mix, which can be locally sourced from near asphalt plants.

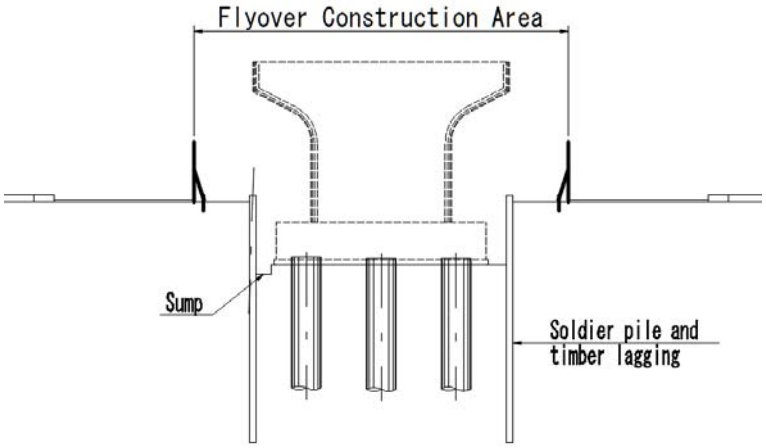
7.2.6 Bridge Works

7.2.6.1 Foundation

Considering economics, constructability, and other factors, the reverse circulation drilling method shall be adopted for the foundations. The designed pile diameter is 1500 mm as studied in Section 4.6.1.5. Since the construction site is enclosed by two detour roads, the available working space is limited; therefore, the pile construction shall be done with only one crane. Regarding the construction sequence, since the approach road is expected to be constructed first, the foundations should be constructed from AF.2 to AF.1 abutment. Substructure

(1) Structural Excavation

Structural excavations for the construction of piers/abutments have 3 m deep, and hence can be directly excavated by a backhoe. Considering the poor ground conditions and to guarantee traffic safety on the surrounding detour road, the excavation method adopted is the self-supporting excavation trench with soldier pile and timber lagging. However, for the footings with 4 piles that are smaller, it was considered to adopt open-cut method. On the longitudinal direction, the open-cut method was adopted since the excavation zone is inside the construction site area and is not influenced by local traffic. The water level is high so countermeasures against water inflow – i.e., sump excavation and drainage pump installation – might be necessary. The excavation cross section is shown in Figure 7.2.3.



Source: JICA Study Team

Figure 7.2.3 Excavation Cross Section

The soldier piles are expected to be used a few times, therefore, can be locally sourced and sold as recyclable scrap after use. Furthermore, the excavated soil has poor quality and need to be transported to a nearby dump area.

(2) Bottom Surface

A 20 cm crush stone layer plus a 10 cm concrete C18 layer shall cover the bottom surface to guarantee the stability of the rebar arrangement.

(3) Main substructure elements

The main substructure elements are divided in the footing, column, and pier head. Note that the column should be concreted from 2.5~3.0 m high steps. Ready mix concrete can be locally sourced and casted using a concrete pump.
Wooden formwork was adopted for the footing and abutment construction, since those elements are composed of plane surfaces. For pier columns and pier head, metallic formwork shall be adopted to guarantee the constructability and surface quality of the curved/variable sections of those elements.

7.2.6.2 Superstructure

The flyover section is planned over the existing road section and the only construction clearance to be preserved is at the intersections. Since this is a relative low bridge, the construction method adopted is crane erection. The side road is used by the cranes during the erection; therefore, the construction should be done only during night time when the traffic is restricted.

(1) Steel Box Girder

Raw materials for steel box girder are expected to be procured from Japan. Then the girders should be fabricated in Myanmar or near countries, assembled into a larger block in the construction yard. During night time, the block is transported to the site using a heavy load transport truck and erected in position using a 200 t crawler crane. The steel box girder superstructure is constructed in five steps: first, the two main box girders are set in place, after that the two external and the internal girder are installed.

(2) Steel Plate Girder

Similar to the steel box girder, the steel plate girder parts imported from Japan are assembled into a larger block in the construction yard. During night time, the block is transported to the site using a heavy load transport truck and erected in position using the 100 t crawler crane. The steel plate girder superstructure is also constructed in five steps: five main girders are installed one at a time.

(3) PC-I Girder

Post tensioned PC-I girder and the precast slab panels are fabricated and stored in a temporary yard. During night time, each girder is transported to the site using a heavy load transport truck. Since each girder weighs approximately 80 t; one 180 t crawler crane is not able to lift the girder due the lack of space, therefore, it is necessary to use two 180 t crawler cranes.

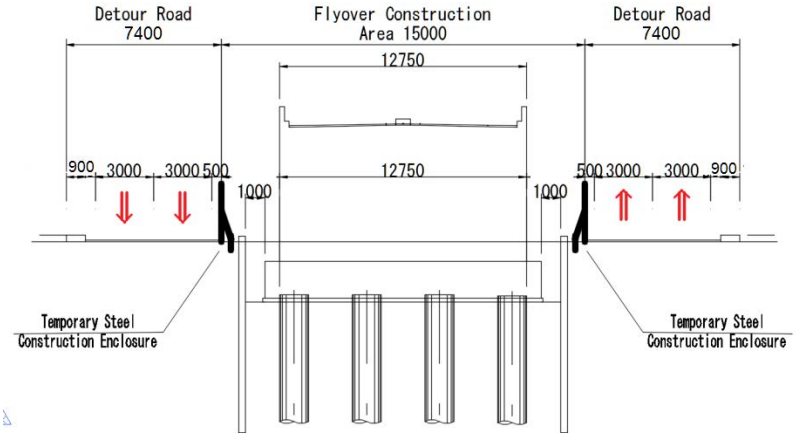
(4) Bridge Deck Works

The bridge deck work area can be accessed using the approach road side.

7.2.7 Traffic Diversion Plan

7.2.7.1 Thanlyin Chin Kat Road Diversion Plan

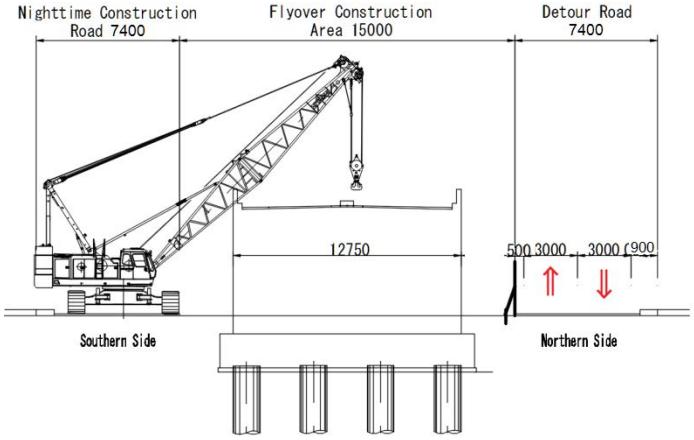
The construction site of the flyover section is located over the central area of an existing 4-lane road. The existing road shall be diverted in a similar position of the final configuration as the first step of construction. The detour road has the same four lanes as the existing road as shown in Figure 7.2.4. The construction site shall be fenced with a temporary steel construction enclosure and all temporary road access points shall have a flagman assigned in order to ensure traffic safety during the construction period.



Source: JICA Study Team

Figure 7.2.4 Detour Road Cross Section

During the erection of the bridge girders, the southern side of the detour road shall be used during the night time as construction road and yard. During this period, the traffic circulation shall be restricted to the northern side of the detour road as shown in Figure 7.2.5. The restriction from four lanes to two lanes shall be indicated by appropriate traffic signals, traffic cones and flagman in order to guarantee traffic/site safety.

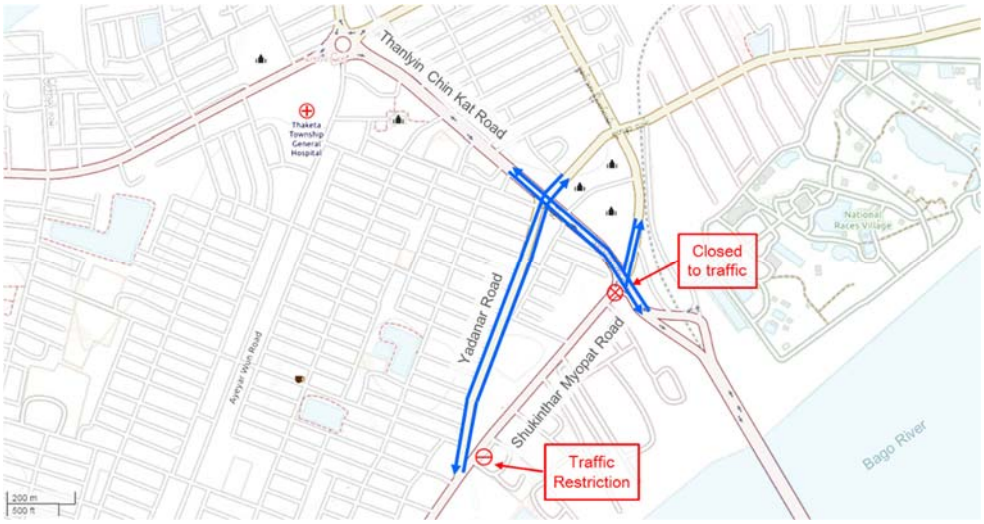


Source: JICA Study Team

Figure 7.2.5 Girder Erection Time – Detour Road Condition

7.2.7.2 Shukinthar Myopat Intersection Diversion Plan

The traffic to/from Shukinthar Myopat intersection shall be detoured and/or restricted during night time at approximately 1 week for steel box girder erection as shown in Figure 7.2.6.



Source: JICA Study Team

Figure 7.2.6 Steel Box Girder Erection – Shukinthar Myopat Intersection

7.2.7.3 Yadanar Intersection Diversion Plan

The traffic in Yadanar intersection shall be detoured and/or restricted during night time at approximately 1 week for steel plate girder erection as shown Figure 7.2.7.

Source: JICA Study Team

Figure 7.2.7 Steel Plate Girder Erection – Yadanar Intersection

7.2.8 Construction Schedule

The flyover section undertaken by Package 3 contractor is planned to be constructed within 26 months. To complete the project in the period proposed, it is necessary to have one team for ground improvement and foundation, three teams for substructure and one team for superstructure.

CHAPTER 8. STUDY ON SAFETY MEASURES DURING CONSTRUCTION

8.1 CONSTRUCTION SAFETY LAWS AND STANDARDS IN MYANMAR

Major laws and standards concerning vehicles, mandatory driver's license acquisition, penalties for traffic rules violation, compulsory insurance, car production method, vehicle inspection, license issuance, acquisition procedures, and signal lights are regulated by "Automobile Regulations (Motor Vehicle Law, enacted in 1964 and amended in 1989)" and other regulations.

The Road Transport Administration Department (RTAD) performs the enforcement of relevant regulations. Myanmar Traffic Police Bureau performs the enforcement of relevant laws and regulations. In addition, Traffic Rules Enforcement Supervisory Committee (TRESC) is established in each region. Traffic control is considered by actual situations in each region

The contractor shall at all time comply with all the existing statutes in Myanmar concerning safety, security, and health for the implementation of the works. Such statutes include, but are not limited to the following:

Table 8.1.1 Safety Regulations/Laws and Specifications

No	Enacted Laws	Available Version	Law No.	Notification No.
1	Motor Vehicle Law	RTAD		Revised 1989
2	Motor Vehicle Rules	RTAD		1989
3	The Highway Law	MOTC	No.24	2015
4	The First Amended Highway Law	MOTC	No.60	2015
5	The Second Amended Highway Law	MOTC	No.62	2015
6	The Amended Utilization of Roads and Bridge Law	MOTC	No.25	2014
7	The YCDC Rules and Regulations	YCDC	No.3	2001
8	The YCDC Law	YCDC	No.6	2013
9	The Law Relating to Private Health Care Services	MOL	No.5	2007
10	Accidents and Injury Prevention Law	MOL	No.53	2014
11	The Amended Law for Leave and Holiday Act	DOL	No.30	2014
12	The Amended Settlement of Labor Dispute law	DOL	No.40	2014
13	The Social Security Rules	DOL	No.15	2012
14	The Amended Law for Factories Act	DOL	No.12	2016
15	The Myanmar Fire Brigade Law	MFSD	No.11	2015

Source: JICA Study Team

-JICA Guidance for the Management of Safety for Construction Works September 2014.

-The Traffic Regulations, standards where the Association of Southeast Asian Nation (ASEAN) countries are referenced.

Table 8.1.2 Related River Laws and Regulations

No	Enacted Laws	Available Version	Law No.	Notification No.
1	The Conservation of Water Resources and River Law	MM/EN	8/2006	
2	The Conservation of Water Resources and River Rule	MM		14/2013
3	The Law of Inland Water Transport Board	MM	51/2014	
4	The Rule of Inland Water Transport	MM		158/2015
5	The Law regarding the Inland Water Vessels	MM	29/2015	
6	The Law Amending the Water Blockade Act	MM	26/2013	

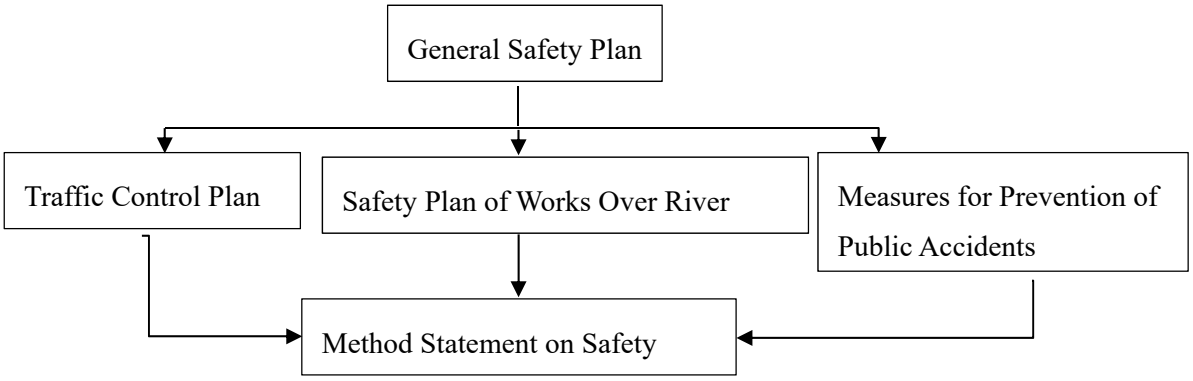
7	The Myanmar Port Authority Law	MM	21/2015	
8	The Law Amending the Lighting House Act	MM/EN	1/2016	

Source: JICA Study Team

-JICA Guidance for the Management of Safety for Construction Works, September 2014

8.2 COMPOSITION OF SAFETY PLAN

As for the Project, in addition to a comprehensive construction safety plan, to create safety plan for each item, the contractor must set up the framework for the construction safety plan before the tender/the beginning of construction to express his intention for safety working.



Source: JICA Study Team

Figure 8.2.1 Construction Safety Plan

8.3 GENERAL SAFETY PLAN

The general safety plan is positioned as the basic principle for safety management of the project at site and establishes basic policies on the general safety management and operation for the works at site.

- Basis Policies for Safety Management

The contractor shall determine the basic policies for safety management applied during construction (hereinafter referred to as the "Basic Policies") in accordance with the scope of work, the environment where the works perform under relevant laws and regulations of the recipient country, contract documents and other applicable documents or data incorporated into the contract. It is also necessary to describe the basic policies of the main office.

8.4 TRAFFIC CONTROL PLAN

The Project will comply with Myanmar traffic regulations in the construction area and public roads; and establish prevention measures of hazards in public areas and traffic accidents.

The employer / engineer will review the traffic safety plan submitted by the contractor from his perspective before issuing approval.

Since the items that constitute in the traffic safety plan as described below generally applied to all construction safety. The contractor shall incorporate all these items into his traffic safety plan.

8.5 SAFETY PLAN FOR WORKS OVER THE RIVER

The Bago River Bridge construction will comply with Myanmar water transport laws and regulations in waterways and river areas and will establish prevention measures of water-related disasters and construction accidents on the sea/river.

The employer / engineer will review the safety plan of construction works over river submitted by the contractor from his perspective before issuing approval.

Since the items that constitute in the safety plan of construction work over water as described below generally apply to all construction safety, the contractor shall incorporate all those items into his safety plan of construction work over water.

8.6 MEASURES FOR PREVENTION OF PUBLIC ACCIDENTS

The contractor shall prepare and undertake the work according to the measures for prevention of public accidents on safety that was prepared by themselves. Whenever the measures for prevention of public accidents on safety need to be amended in consideration of the latest site conditions, traffic situations, and natural environmental conditions and/or any other relevant particulars, the contractor shall update and maintain the documents for review and approval by the employer and the engineer.

Since the items that constitute in the measures for prevention of public accidents described below generally apply to all construction safety, the contractor shall incorporate all these items in his measures for prevention of public accidents.

8.7 METHOD STATEMENT ON SAFETY PLAN

The method statement on safety shall define a detailed plan to implement and manage safety in the Project and include specifications for the safe execution of works and safety measures for each type of work in accordance with the execution plans specifying the method or sequence of implementation.

The employer / engineer will review the method statement on safety plan submitted by the contractor from his perspective before issuing approval.

8.8 KEY POINTS OF CONSTRUCTION SAFETY PLAN (REQUIRED ATTENTION MATTERS)

8.8.1 Construction of Bago River Bridge

The Bago Bridge construction belongs to a contract of two packages. However, all information from relevant authorities such as weather conditions, precautionary, warnings, or information on strange/special vessels shall be shared and confirmed as well as joint meetings/inspections/patrols shall be carried out by both packages: Package 1 and Package 2.

8.8.2 Construction of Thaketa Flyover

In addition, there is an important and dense population area in Thaketa Flyover construction site. Hence, construction of the flyover while maintaining the existing transportation of Thanlyin Chin Kat Road, Yadanar Intersection, and Shukhinthar Intersection has high potential safety risks. Assuming all risks and identifying hazards and dangers in construction site in order to evaluate priorities based on a reasonable basis, the contractor shall implement appropriate mitigation measures from risks.

8.8.3 Approach Road and Tollgates

Approach roads and tollgates are near the right bank and left bank of the Bago River. In addition to consideration of Thaketa Flyover construction, safety measures and protective measures as well as in particular, flood safety measures in the area should be noted as follows:

CHAPTER 9. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

9.1 ENVIRONMENTAL CONSIDERATIONS

9.1.1 Review IEE Report and Approval by MONREC

Two IEE reports (i.e. IEE report for construction of Bago River Bridge and IEE report for improvement of intersections) prepared separately in F/S and Supplemental F/S were submitted from MOC to MONREC in the middle of July 2017. In parallel with submission of two IEE reports to MORENC, environmental conditions were updated to examine environmental impact based on the latest project description and surrounding environmental conditions.

It was verbally informed by MONREC at the end of May 2017 (and the official letter dated 3 August 2017) that construction of Bago River Bridge Project and improvement of intersections (the Project) is requested to conduct EIA. Accordingly, the Scoping Report was initially prepared covering all items stipulated in EIA Procedure (December 2015), which was submitted from MOC to MONREC in the middle of July 2017. Comments to the submitted Scoping Report dated 27 September 2017 were provided by MONREC. Received comments were reflected in to the Revised Scoping Report, which was submitted to MONREC on 25 October 2017.

Field survey was conducted in the rain season of 2016 and the dry season of 2017 based on the results of scoping to update IEE prepared during F/S and Supplemental F/S. The results of field survey were used for examination of environmental impact, and EIA report was prepared based on examination results. EIA report is composed of the result of examination on environmental impact and environmental management plan including mitigation measures and monitoring plan, and it was submitted from MOC to MONREC on 8 November 2017.

9.1.2 Environmental Survey

9.1.2.1 Survey Schedule

Field survey was conducted for two seasons, the first season (i.e. October to November 2016 as the rainy season) and the second season (i.e. January to February 2017 as the dry season), in and around the project area in order to update the environmental and social conditions confirmed at F/S and Supplemental F/S. Survey items in B/D and D/D are shown in the table below.

Table 9.1.1 Field Survey for Environmental Study

Field Survey Items	Location	Method Period	Parameters
Air quality	Five locations	・Rainy and dry seasons ・Continuous 24 hours at each location (1 weekday)	NO2、SO2、CO、PM10、PM2.5
Noise	–Same as above-	・Dry season ・Continuous 24 hours at each location (1 weekday)	Equivalent sound level (Leq)
Water quality	Five locations ※Crossing point at the river (3 points) Downstream (3 points)	・Rainy and dry seasons	Temperature、turbidity (NTU), pH, BOD5, COD, SS, DO, oil and grease, T. coliform, T. nitrogen, T. phosphorous, salinity
Bottom sediments	Same as above	・Dry season	As, Pb, Cr, Cd, Cu, Zn, Oil and grease
Soil	Five locations	・Dry season	Cd, pH, Cu, Zn, Pb, Mn, As, Fe and Cr
Flora and fauna	Vegetation on each side of the Bago River at the bridge crossing point	・Rainy and dry seasons ・Reviewing existing data ・Hearing to relevant institutions	Record of endangered species (IUCN Red List), breeding colonies, rare habitat, regional park, photos

Field Survey Items	Location	Method Period	Parameters
Inventory for affected trees along the road	Right-of-way (ROW) and construction yards	・Hearing survey ・Field survey (no. of trees to be cut) ・Reviewing existing information	No. of trees, species, tree height, diameter (Dbh), photos

Source: JICA Study Team

Note: BAN-1-5: Air and noise sampling points, BSW-1-6: Water and bottom sediment sampling points, Soil Pt-1-5: Soil sampling points

Source: JICA Study Team

Figure 9.1.1 Sampling Points for Pollution Parameters Measurement (Air, Noise, Water, Sediment, and Soil)

9.1.2.2 Evaluation of the Environmental Impact

Examination items to be caused by implementation of the Project were evaluated by classifying into six categories (i.e. social environment, natural environment, environmental pollution, health and safety, emergency risk and other). Possible impact to the examination items were evaluated at planning, construction and operation stages respectively with three levels (i.e. no impact, some positive/negative impact and significant positive/negative impact). Impact evaluation was not conducted to the decommissioning, closure, and post-closure stages since the road development project is not a life-limited development which is defined in the draft Administrative Instruction of Environmental Impact Assessment Procedure.

9.1.2.3 Environmental Management Plan

Mitigation measures which may avoid, minimize, eliminate and/or reduce the abovementioned negative impacts were examined in the planning, construction, operation and the whole stages respectively for environmental items evaluated as negative impact. In addition, the Environmental Management Plan (EMP) was prepared incorporating the mitigation measures and monitoring as well as the roles of implementing organization, responsible, and supervising organizations.

9.2 SOCIAL CONSIDERATIONS

The Project plans to use public land such as land owned by MOC or Myanma Railways (MR) in order to minimize social impact to be caused by land acquisition. However, there are some households occupying land inside the project area for living and/or for running a shop. The number of households required physical displacement has less than 200 people. Thus, Abbreviated Resettlement Action Plan (A-RAP) was prepared according to the JICA Guidelines for Environmental and Social Considerations issued in April 2010 (the JICA Guidelines) and the World Bank (WB) Operational Policy (OP) 4.12.

At the time of F/S and Supplemental F/S, the draft A-RAP was prepared although the results of Detailed Measurement Survey (DMS) namely census, socioeconomic survey and inventory of asset, and the public consultation meetings were not included since contacting possible Project Affected Households (PAHs) before approval of the Project by the parliament was regarded as not appropriate. Since the Project was approved by the parliament in December 2016, A-RAP prepared in F/S and Supplemental F/S were updated in this B/D and D/D by conducting DMS and holding public consultation meeting.

9.2.1 Updating A-RAP

9.2.1.1 Setting Cut-off Date and Eligibility

The Cut-off Date (COD) is the day to determine eligibility for entitlement of compensation due to relocation caused by the Project. Persons (or households) living or doing income generation activities inside a project area on the COD are eligible for compensation and persons (or households) who occupy the project area after the COD are not eligible for relocation assistance.

MOC and JICA Study Team examined the most appropriate COD for the Project, and concluded to set March 1, 2016, the first day of site reconnaissance for confirming the number and location of structures in the project area during Supplemental F/S, as the COD for the Project. It was explained to the public and stakeholders at the time of stakeholder meeting on November 12, 2016; and PAHs at public consultation meeting on December 17, 2016, and no objection was obtained.

9.2.1.2 Relocation Impact

DMS was conducted on February 23, 24, and 27, 2017, April 5 and 6, 2017, May 8, 2017, and June 9, 2017 at the project area in the bridge portion and intersection portion including candidate sites for construction yard jointly with the household head, Township representatives, MOC representatives and the Survey Team using a questionnaire in Myanmar language. DMS identified that 36 houses counting 165 people and 32 stalls occupied or used land inside the project area at the COD.

9.2.1.3 Supplemental Consultation Meeting

A total of two stakeholder meetings were organized for the Project at the time of F/S and Supplemental F/S, and project description and possible environmental and social impacts were explained to the stakeholders including people living in and around the project area.

Explaining and exchanging opinions about the compensation policy with PAHs and reflecting those opinions and comments to the A-RAP is essentially required action based on the JICA Guidelines. Therefore, MOC made an explanation on the compensation policy to PAHs by organizing the additional consultation meeting on December 17, 2016.

PAHs were classified into five groups based on the current structure conditions and features of possible impacts: 1) MR's Staff Apartment 2) Structures on Government Land, 3) Private fence, tea shop, hair salon, and beer shop, 4) Movable stall Group-1 and 5) movable stall Group 2. The additional consultation meeting was organized separately for each group.

9.2.1.4 Compensation Policy

Implementing the Project done not require acquisition of private land since all land to be used for the Project is confirmed as governed by the national authorities although some households occupied land in the project area without holding proper legal land title. Under this situation, the Project established key principles on relocation for aiming the objectives of this A-RAP:

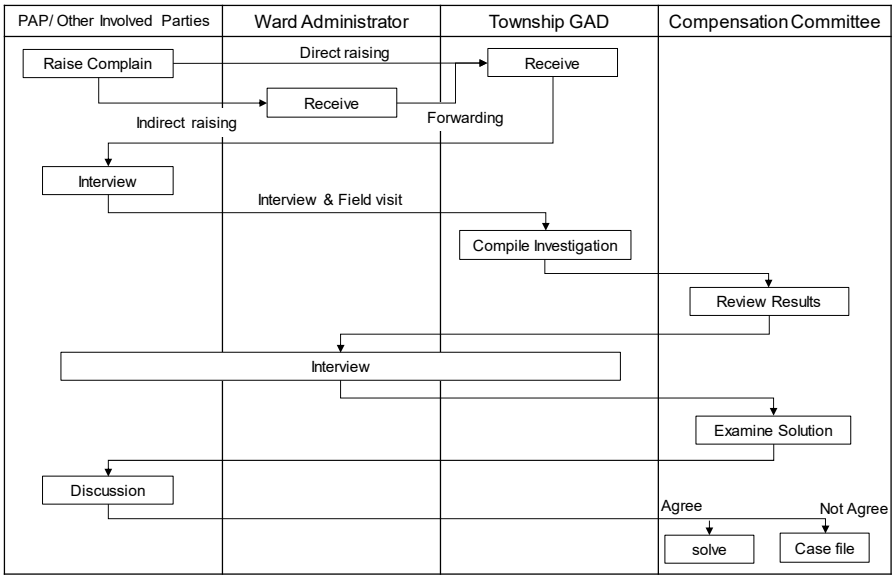
- Involuntary resettlement and loss of means of livelihood are to be avoided or minimized as much as possible by exploring all viable alternatives.
- People to be relocated will be provided sufficient compensation for loss of their own fixed property and income. Since land to be used by the Project belongs to the government or national authorities. Land compensation is not provided to people using land in the project area.
- Compensation is provided in full replacement cost in timely manner by holding consultation with people in the project area.

9.2.1.5 Institutional Structure for Implementing Relocation

According to the general relocation practice in MOC, relocation issues are handled by a compensation committee which is established for a project with the approval of a regional government such as YRG in the case of Yangon. For the Project, the Compensation Committee (the Committee) chaired by the Minister of Ministry of Electric, Technical, and Transportation in YRG was established with the approval letter from YRG in May 2017. The Committee is composed of several authorities: MOC, MR, YCDC, Ministry of Agriculture, Livestock and Irrigation, MPA, YESC, Myanmar Post, and Telecommunication and District Administrators.

9.2.1.6 Grievance Redress Mechanism

The grievance redress mechanism for land acquisition is stipulated in Land Acquisition Act 1894 and Farmland Rules 2012 although, there is no description of relocation not requiring land acquisition. Accordingly, MOC and the JICA Study Team examined the grievance redress mechanism applicable for the project referring to general practices in Myanmar to ensure: i) easy access of PAPs and other parties involved into relocation activities to appeal issues on relocation issues, ii) all complaints related to relocation are appropriately dealt with, and iii) taking adequate measures to solve the raised issues.



Source: JICA Study Team

Figure 9.2.1 Provisional Grievance Redress Mechanism

9.2.1.7 Monitoring

A project proponent is generally requested to implement internal monitoring (i.e., monitoring by a project proponent and other authorities to be included into relocation and compensation process) in the case of relocation scale less than 200 people. The Project will require relocation of less than 200 people, and therefore, internal monitoring is needed.

The purposes of internal monitoring are: i) to monitor progress and contents of relocation, ii) to identify problems which were not identified during A-RAP preparation, and iii) to assess compensation contents are sufficient. Monitoring items include the following elements:

- Timely and complete disbursement of compensation to each PAH in accordance with agreed conditions;
- Participation of PAPs into preparation and implementation of relocation;
- Information disclosure and consultation procedures;
- Effectiveness of grievance mechanism and raised issues; and
- Unforeseeable issues or additional measures to be taken.

Internal monitoring will be periodically conducted by PMU from the time of compensation payment until completion of relocation.

CHAPTER 10. HIV/AIDS PREVENTION PROGRAM

10.1 SCOPE AND IMPLEMENTATION STRATEGY

10.1.1 Objective

The main objective of the HIV/AIDS prevention program is to reduce potential negative social impacts associated with the implementation and operation of the Project. In order to achieve the main objective, the HIV/AIDS prevention program mitigates HIV risks and vulnerability to HIV/AIDS at the construction sites and surrounding communities by the following outputs:

- Reducing the risk of transfer of HIV between and among construction workers, their families, and the local community by raising awareness about HIV/AIDS.
- Ensuring that construction workers have access to condoms.
- Providing peer education program among the construction workers to be more effective in voluntary consulting about HIV/AIDS matters, more comfortable in receiving condoms from peer educators, and expected behavior changes.
- Providing HIV voluntary counseling and referring to NAP or INGO if necessary.
- Monitoring and evaluation of the program outcomes.

10.1.2 Components of HIV/AIDS Prevention Program of the Project

The HIV/AIDS prevention program of the Project will be implemented with three components mentioned as follows. These three components are commonly implemented for Packages 1, 2, and 3.

Component 1- HIV/AIDS education program to the construction workers and surrounding communities

In HIV/AIDS education program, the service providers (i.e., an entity approved to provide HIV/AIDS Prevention Program) will provide information about HIV/AIDS and STI risks and prevention, introducing behavior change, and promoting safe behavior to the construction workers and surrounding communities. The aim of the HIV/AIDS Awareness Program is to empower and increase the awareness of participants on HIV/AIDS, its impact, management, and availability of support systems. Furthermore, it is intended to encourage early testing and lifestyle changes that will thereby reduce and prevent further infection. For the effective implementation of the program, the participant is better not to be more than 50 persons in each session. Due to the instability of the workers' nature in the construction site, the program will be arranged every month throughout the construction period to cover all workers at least once. For the surrounding communities, the education program is tentatively arranged to organize once for every three months in each ward.

Component 2- Peer education program among construction workers

Peer education program is based on the idea that individuals are most likely to change their behavior if people they know and trust persuade them to do so. It helps to break down barriers by allowing people to discuss sensitive matters without fear. Team leaders or key persons respected in the team will be selected as peer educators and they will have an education level of high school and have an interest in helping others and good communication skills. Peer educators can disseminate information and supplies, organize skill-building sessions, and make referrals to other HIV/AIDS services. The service provider will design the content of peer education program. Tentatively, the peer education program will be organized four times per construction period including refresher courses. The peer educators will be supported by daily wages and additional necessary allowances.

Component 3- HIV voluntary counseling and testing for construction workers

The purpose of this component is to secure access to health services including HIV voluntary counseling

and testing in cooperation with NAP, other INGO in relevant township, and linking with other components in the HIV/AIDS prevention program for the Project with trust and confidentially. If a person with positive findings is found, that person will be suggested to be put to care at NAP or other INGO in relevant township without discrimination due to any reasons.

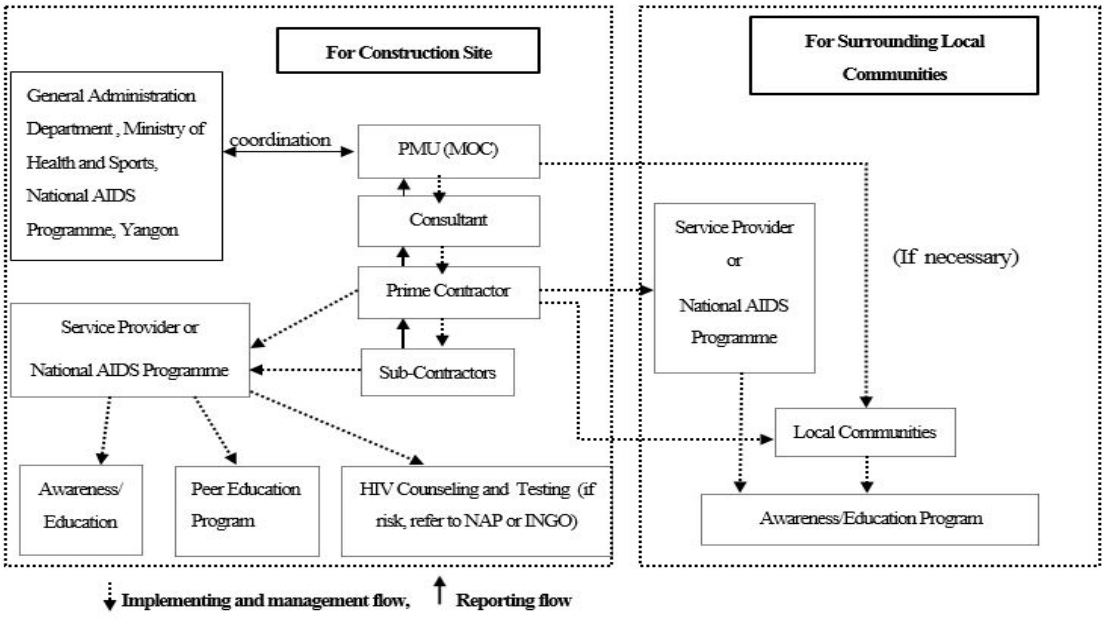
10.1.3 Implementation Structure

Before starting the construction work, the project management unit (PMU) of the Ministry of Construction (MOC) needs to coordinate with NAP of the Yangon Region and the General Administration Department of the respective township to get the co-operation in the implementation of the program.

The program implementation will be controlled by the PMU of MOC as part of construction. The PMU will assign the project consultant to control the quality of the program through participating in the preparation of HIV clause for the contracts, monitoring, and evaluation of the program. Based on the contract between a prime contractor and service provider, the service provider will operate the program on site. Therefore, service providers will be the responsible persons from NAP or other related NGO/INGO.

For the construction site, if the prime contractor divides and transfers the work to the sub-contractors, the sub-contractors need to follow the HIV/AIDS prevention program of the prime contractor and need to submit separate report to the prime contractor. The prime contractor needs to review and organize the reports of sub-contractors and submit the report to the consultant in accordance with the contract on a timely manner. After receiving the report from the prime contractor, the consultant will submit the report to the PMU of MOC.

The prime contractor has the main responsibility to implement the HIV/AIDS awareness and education program within the surrounding local communities. The prime contractor can request the consultant when the co-operation from the government ministries is necessary. The PMU has the responsibility to deal with the relevant ministries and government departments when the consultant is requested to get cooperation from the other relevant ministries and government departments. The implementation strategy of HIV/AIDS prevention program is shown in Figure 10.1.1 and the responsibilities of each organization are mentioned in Table 10.1.1.



Source: JICA Study Team

Figure 10.1.1 Implementation Strategy of HIV/ AIDS Prevention Program

Table 10.1.1 Responsibilities of Relevant Organization for Implementing HIV/AIDS Prevention Program

Organization	Responsibilities
PMU of MOC	1) Communicate with the relevant General Administrative Department and National Aid Program. 2) Monitor the implementation and effectiveness of the HIV/AIDS prevention program at the construction site and the surrounding local communities.
GAD	1) Responsible for co-operation of HIV/AIDS prevention program, especially in engagement with the surrounding local communities of the project.
Ministry of Health and Sports, National AIDS Program or Service Provider	1) Organize the HIV/AIDS awareness and education program both at the construction site and the surrounding communities. 2) Conduct the Peer Education Program for the construction workers. 3) HIV voluntary counseling and testing to the construction workers and referring to the relevant hospitals (if necessary).
Consultant	1) Monitor the implementation program of HIV/AIDS prevention program of the prime contractor. 2) Report the HIV/AIDS prevention program to the PMU. 3) Modify the implementing approach of HIV/AIDS prevention program, if necessary.
Prime Contractor	1) Conduct the HIV/AIDS prevention program of the project both at the construction site and the surrounding local communities as per contract. 2) Monitoring the implementing status of HIV/AIDS prevention program of the sub-contractors. 3) Submit the report of HIV/AIDS prevention program in timely as per contract to the consultant.
Sub-contractor	1) Conduct the HIV/AIDS prevention program of the project both at the construction site and the surrounding local communities as per contract. 2) Monitoring the implementing status of HIV/AIDS prevention program as per contract. 3) Submit the report of HIV/AIDS prevention program in a timely manner as per contract to the prime contractor.

Source: JICA Study Team

10.1.4 Implementation Schedule

The tentative implementation schedule of the HIV/AIDS program throughout the project period for all packages are mentioned in Table 10.1.2.

Table 10.1.2 Implementation Schedule for All Packages

Sr.	Component	Target Group	Package 1	Package 2	Package 3	Implemented Organization	Responsible Organization	Supervised Organization
1	Education/Awareness Program	Construction workers	Every month (~ 28 times per construction period)	Every month (~ 28 times per construction period)	Every month (~ 28 times per construction period)	National AIDS Programme or Service Provider	Contractor	Consultant/ PMU (MOC)
		Local Communities	2 times per year (~ 4 times per construction period)	Not necessary due to implementation in Package 1 and Package 3.	4 times per year in each ward and continue throughout the construction period. (Total- 8 times for 2 wards per year) (~ 16 times per construction period)			
2	Peer Education Program	Construction workers	2 times per throughout the construction period	2 times per throughout the construction period	2 times per year, and continue throughout the construction period (~ 4 times per construction period)	National AIDS Programme or Service Provider	Contractor	Consultant/ PMU (MOC)
3	HIV Voluntary Counseling and Testing	Construction workers	One time throughout the construction period	One time throughout the construction period	One time throughout the construction period	National AIDS Programme or Service Provider	Contractor	Consultant/ PMU (MOC)

**HIV/AIDS prevention program should be arranged within the working hours.*
Source: JICA Study Team

10.2 COST ESTIMATION

The total cost estimation of the HIV/ AIDS prevention program for all packages is USD 65,574.17: (Package 1 - USD 16,782.68, Package 2 - USD 14,227.61, and Package 3 - USD 34,563.88). The cost is estimated based on the estimated workers -700 persons, surrounding communities – 200 persons and peer educators – 10 persons for each package.

CHAPTER 11. OPERATION AND MAINTENANCE

11.1 TOLL COLLECTION PLAN

MOC determines rating to charge fees for access of toll bridges according to vehicle class by weight/ number of axes, etc., and also imposes penalty on overweight vehicles for extra weight. Thus, it is general to collect the toll fee and penalty mentioned above in the same tollgate.

Consequently, the collection of both toll fee and penalty also in the Bago River bridge should be in accordance with the regulation of MOC and make distinction between regular vehicles (non-large vehicle) and large vehicles like trucks, which needs to be weighed.

Given these facts, the following shows recommended toll collection system for the Project:

11.1.1 Toll Type

Flat Toll; Uniform tolls by vehicle class per entry, regardless of traveled distance on the toll road.

11.1.2 Toll Collection Method

Entry/Exit Collection; in consideration of one-time payment at integrated tollgate.

11.1.3 Extent of Toll Charging

Tolls are charged to all users. The toll roads should be physically designed not to let any users escape from paying the toll, and also to let large vehicles go through only exclusive lanes, equipped with truck scale.

11.1.4 Tollgate Allocation

Toll booths will be allocated according to the future traffic demand in order to prevent congestion at the tollgate.

11.1.5 Organization for Toll Collection

In general, the implementation body of toll collection is entrusted to the private sector entity, with toll collecting operations by MOC. Considering the fact, this section shows a recommended implementation structure:

- 8-hour shift, with three groups in turn
- Setup of personnel in one group:
  - 1 supervisor
  - 10 collectors (1 collector per lane)
  - 2 standby persons
- On-site staffs for administrative office along with tollgate
  - 1 responsible person/ 1 accountant/ IT engineer/ security guards and others

11.2 TRAFFIC MANAGEMENT PLAN

Traffic management is implemented in order to secure safe, smooth, and comfortable road traffic.

One of its important tasks is the traffic patrol to observe throughout the road traffic space, which detects not only sudden and unexpected accidents and fallen objects, but also minor differences (damages) in road structures.

Another important task is the traffic control, which directs and executes quickly and precisely the most appropriate measures, e.g., traffic regulation, contacts with parties concerned, and provision of information as occasion may demand, according to the ever-changing traffic conditions. To this end, cooperation with the teams related to O&M is also required.

In the Project, traffic management plan shall conform to the existing general practices of traffic management in Myanmar. To be specific, the model to realize safe and smooth road traffic will not establish a control department to integrate contractors of toll collection, maintenance, and enforcement, but entrust actions required in each task among contractors.

Besides, the Intelligent Transport Systems (ITS) technology (e.g., data collection, information provision, etc.) for efficient traffic management or its equivalent is appropriate to introduce when rising momentum for efficient road network because the independent introduction in the Project will provide limited effect.

11.3 MAINTENANCE PLAN

11.3.1 Basic Concept

With the aim of road safety, proper maintenance works are important to secure functions required for structures during their service life. A series of operations: plan, inspection, and repair should be implemented repeatedly during the maintenance period to maintain the structures in a proper state.

11.3.2 Considerations in Maintenance Works

The Bago River Bridge has several bridge types. Maintenance works require to understand their component parts, purposes, and functions of members.

11.3.2.1 Cable-stayed Bridge

Different from general bridges as it consists of particular parts such as main tower, cables, and it requires sensitive maintenance with understanding on their structural functions.

11.3.2.2 PC Bridge

As for corrosion, fracture and impaired tone of PC steel can reduce the safety of the structure and it requires maintenance to detect damages early in inspections and to maintain PC steel in good condition.

11.3.2.3 Steel Bridge

As the use of the steel bridge progressed, damages in steel materials such as fatigue crack, corrosion, and loss of bolts can reduce safety of the structure, it requires maintenance to detect damages early in the inspections and to maintain PC steel in good condition.

11.3.2.4 Substructure (foundation/ pier/ abutment)

It requires maintenance monitoring progress of damages in inspections, in light of ground stability, e.g., existence of scour at foundation, and attributes of RC structure, although it permits minor cracks, e.g., existence of earth pressure or excess load from superstructure.

11.3.2.5 Appurtenance

(1) Expansion Device

It requires maintenance to detect damages early in inspections and to maintain it in good condition; in order to keep functions to absorb expansion caused by changes in temperature and earthquake and consequently not to hinder passage of vehicles and humans.

(2) Bearing

It requires maintenance to detect damages early in inspections and to maintain it in good condition; in order to keep functions to transmit load of superstructure to substructure and absorb thermal contraction caused by temperature and earthquake.

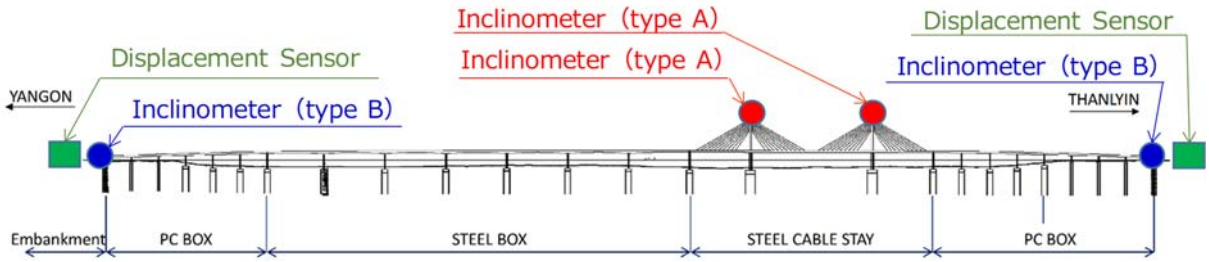
Additionally, as cable-stayed bridge employs rocking bearing because of negative reaction force generated at the end of piers, it is necessary to understand its required performances sufficiently.

11.3.3 Inspections

Type of Inspections can be classified into three types i.e., Daily, Periodic, and Emergency.

11.3.4 Simplified Monitoring

Since largely deformed bridges due to defective work and ground deformation are observed in Myanmar, this Study proposes to execute simplified monitoring in order to obtain historical data of deformation from the early stage of construction. Figure 11.3.1 shows arrangement planning of measuring devices.



Source: JICA Study Team

Figure 11.3.1 Arrangement Planning of Measuring Devices in Simplified Monitoring

11.3.5 Measurement with Laser Profiler

In order to figure out the entire behavior of cable-stayed bridge in periodic inspections, this Study proposes measurement with laser profiler.

11.3.6 Repair and Reinforcement Works

In these, it is required to identify cause of damage and to execute the corresponding repair. Moreover, it is important to decide repair timing considering progress of damages.

11.3.7 Personnel Organization for Implementation

Basically, it has the same implementation system as the one in the maintenance and management of other structures in Myanmar.

11.4 PROPOSED O&M STRUCTURE

Given the actual condition of O&M in Myanmar, and based on the hearings and consultations, the responsibility and assignment are summarized as follows:

Since in Myanmar, toll collection, entrusted through bidding, has been operated already under build-operate-transfer (BOT) and tender scheme, and there are several companies which have experiences in toll collection business. Appropriate toll collection services for the Project can be provided by experienced companies mentioned above through bidding procurement. Also, taking into account the requirements mentioned in development of toll road, at least, a general office shall be provided for the entrusted company.

On the other hand, although private business operators have experience in improvement and maintenance of roads on ground under BOT, the maintenance for large-scale bridges, like the Project, has been executed directly by MOC in practical terms. Therefore, it is realistic that MOC shall also take the initiative in the maintenance of the Project.

CHAPTER 12. COST ESTIMATE AND PROCUREMENT

12.1 POLICY OF COST ESTIMATE

12.1.1 Guidelines

The construction cost was estimated in accordance with the Japanese guideline and standard (specifically as shown Table 12.1.1), because there is no cost estimate standard for bridge work in Myanmar. New standards have a priority to be used. Some work items refer to conventional standards.

Table 12.1.1 Applied Standard and Manual for Cost Estimate

Japan International Cooperation Agency (JICA)
- Preparatory Survey for Grant Aid / Design and Cost Estimate Manual (Civil Engineering), 2016 - Preparatory Survey for Grant Aid / Design and Cost Estimate Manual (Equipment Procurement), 2016 - Preliminary Project Cost Estimate Guideline, 2008
Construction Research Institute
- Cost Estimate Standard for Civil Works (MLIT), 2016, 2013, 2012, 2011 - Cost Estimate Standard for Civil Works (MOC), 2000, 1999, 1993, 1992 - Cost Estimate Standard for Port Civil Works (MLIT), 2016 - Standard Specification of Cost Estimate for Civil Works (MLIT), 2016 - Construction Material Cost, April, 2017
Japan Construction Machinery and Construction Association
- Construction Equipment Depreciation Calculation, 2016 - Bridge Erection Works Cost Estimation, 2016

Source: JICA Study Team

12.1.2 Cost Estimate Base Time

This project cost estimation was executed in May 2017.

12.1.3 Currency Exchange Rate

Applied currencies are Myanmar Kyat (MMK) as local portion, Japanese Yen (JPY) as main currency, US Dollar (USD) as foreign portion from other countries except from Japan. According to the JICA guideline, exchange rate from USD to JPY was calculated based on TTS exchange rate of "The Bank of Tokyo-Mitsubishi UFJ Ltd" and exchange rate from USD to MMK was applied based on "The Central Bank of Myanmar". The applied exchange rates for this cost estimate were calculated the last three months average rate from February 1 to April 30, 2017 as shown in Table 12.1.2.

Table 12.1.2 Applied Exchange Rates

Currency	Exchange Rate
US Dollar (USD)	USD 1 = JPY 113.11 USD 1 =MMK 1358
Local Currency: Myanmar Kyat (MMK)	MMK 1 = JPY 0.0832

Source: JICA Study Team

12.1.4 Direct Construction Cost Factor

12.1.4.1 Labor Cost

Labor cost was collected in Myanmar through inquiry to contractors. Main laborers are assumed Myanmar citizens. The costs of organizers and specialists from other countries were estimated as indirect cost of "site management cost".

12.1.4.2 Lease Cost of Construction Equipment

Every ordinal construction equipment cost is collected in Myanmar through inquiry to machine lease companies.

Heavy equipment cost was applied based on "Construction Equipment Depreciation Calculation, 2016". For heavy equipment from other countries, shipping cost was estimated by inquiring freight company.

12.1.4.3 Material Cost

Every material cost was collected in Myanmar by inquiring of suppliers. Special material and products, hardly to be procured in the local market, unit rates were estimated based on inquiry and "Construction Material Cost, April 2017".

[redacted]

[redacted]

[redacted]

[redacted]

12.1.5 Construction Schedule Conditions

12.1.5.1 Rainy Season and Workable Period

Myanmar has a tropical monsoon climate. As winter ends, warm and moist air from the Indian Ocean is carried by southwest wind promoting a large amount of rain during the rainy season. During the dry season, there is clear weather for several days until the end of April. For schedule purposes, the rainy season was set up from June to August.

[redacted]

12.1.6 Indirect Construction Cost Factor

Mainly indirect construction cost is classified into three parts, i.e., site expenses (site management cost), general temporary work cost, and overhead cost. Those indirect construction costs were estimated according to the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) standard and JICA guidelines.

12.1.7 Price Escalation

Price escalation ratio for every currency was estimated in accordance with the "Preparatory Survey for Grant Aid / Design and Cost Estimate Manual (Civil Engineering)". Base data are from the "International Monetary Fund".

12.1.8 Physical Contingency

[redacted]

Table 12.1.3 Physical Contingency Amount

Currency	Amount(mil.)
Foreign Currency: US Dollar(USD)	[redacted]
Local Currency: Myanmar Kyat(MMK)	
Main Currency: Japanese Yen(JPY)	
Total (Converted to JPY)	

Source: JICA Study Team

12.1.9 Consultant Service

[redacted]

Table 12.1.4 Consultant Service Amount

Currency	Amount(mil.)
Foreign Currency: US Dollar (USD)	[redacted]
Local Currency: Myanmar Kyat (MMK)	
Main Currency: Japanese Yen (JPY)	
Total (Converted to JPY)	

Source: JICA Study Team

12.1.10 Dispute Board Cost (Eligible and Non-Eligible Portion)

Dispute board shall be set for every package. The cost is mainly going to be separated into Eligible (50%) and Non-eligible portion (50%) except for local portion. Applied "Dispute Board Cost" is shown in Table 12.1.6

Table 12.1.5 Dispute Board Cost

Currency	Amount			Total
	Package 1	Package 2	Package 3	
Total (Converted to JPY)	[redacted]			
Eligible Portion (Converted to JPY)				

Source: JICA Study Team

12.1.11 Tax (Non-eligible Portion)

Taxation is owned by the government (Non-eligible portion). Mainly "Commercial tax: 5% for total project cost" and "Import tax: 5% for foreign portion"

12.1.12 Interest During Construction (Non-eligible Portion)

The ratio is applied as same as the feasibility study.

- 0.01% for construction
- 0.01% for consultant

12.2 UPDATE OF PROJECT COST

The total project cost is shown in Table 12.2.1. Eligible portion amount was estimated [redacted] The details of "a base cost for eligible portion" is explained in the following sections:

Table 12.2.1 Updated Project Cost

[redacted]

Source: JICA Study Team

12.3 ANNUAL FUND REQUIREMENT

Expected annual fund requirement schedule, based on Loan Agreement amount, is shown in Table 12.3.1.

Table 12.3.1 Annual Fund Requirement (Not include Contingencies and Commercial Tax)

[redacted]

Source: JICA Study Team

12.4 UPDATE OF CONSTRUCTION COST

A total construction cost, including direct and indirect construction costs, of every package is shown in Table 12.4.1. Furthermore, a breakdown of the construction cost is shown in following sections in every package.

Table 12.4.1 Summary of Total Construction Cost

[redacted]

Source: JICA Study Team

12.4.1 River Bridge Section (Packages 1 and 2)

A breakdown of construction cost in packages 1 and 2 (river portion) is shown in this subsection and explained comparing to F/S amount.

12.4.1.1 Update of Construction Cost (Packages 1 and 2)

(1) Package1

1) Summary

Table 12.4.2 Summary of Civil Works Construction Cost (Package1)

[redacted]

*Bridge type was changed due to longer span arrangement for additional navigation
Source: JICA Study Team

2) Design Change Portion (3 spans Steel Box Girder)

The design change was executed due to the change of span arrangement for additional navigation in the approach bridge section. In an original design, a bridge type was “PC box girder” having a span with approx. 50m. On the other hand, in a changed design, the bridge type has been changed to “Steel box girder type” with maximum span of approx. 104m.

Regarding this change of superstructure type, a foundation type has also been changed from “Cast in bored pile” to “SPSP” for Pier Six. In addition, one pier has been omitted for longer span. Therefore, a total number of piers were reduced from three to two, and all of foundation type has been changed to SPSP.

Moreover, with this change of superstructure type, an asphalt pavement material type has been changed too for a steel deck.

From those design changes, a cost composition in each case “Original Design Portion” and “Changed Design Portion” is shown in Table 12.4.3 respectfully.

Table 12.4.3 Cost Composition of “Original Design Portion” and “Changed Design Portion”

[redacted]

Source: JICA Study Team

A cost comparison between “Original Design” and “Changed Design” is shown in the following Table 12.4.4.

Table 12.4.4 Cost Comparison of Approach Bridge between PC box girder and Steel Box Girder

[redacted]

Source: JICA Study Team

[redacted]

(2) Package2

1) Summary

Table 12.4.5 Summary of Civil Works Construction Cost (Package 2)

Source: JICA Study Team

12.4.1.2 Comparison of Construction Cost with F/S Amount (Packages 1 and 2)

A comparison of estimated costs between D/D and F/S is shown in Table 12.4.6 and Table 12.4.7 respectfully in each package.

For the difference based on comparison between D/D and F/S, description of reason due to cost change are listed in Table 12.4.6 and Table 12.4.7 too.

Table 12.4.6 Comparison of Construction Cost with F/S Amount (Package 1)

[redacted]

Source: JICA Study Team

Table 12.4.7 Comparison of Construction Cost with F/S Amount (Package 2)

[redacted]

Source: JICA Study Team

12.4.2 Flyover Section (Package 3)

12.4.2.1 Update of Construction Cost (Package 3)

Table 12.4.8 Summary of Civil Works Construction Cost (Package 3 / Yen Loan Portion)

Source: JICA Study Team

Table 12.4.9 Summary of Civil Works Construction Cost (Package 3 / MOC Portion)

Source: JICA Study Team

12.4.2.2 Comparison of Construction Cost with F/S (Package 3)

Table 12.4.10 Comparison of Construction Cost with F/S (Package 3)

[redacted]

Source: JICA Study Team

12.4.2.3 Description of Changed Cost from F/S (Package 3)

[redacted]

12.5 PROCUREMENT PLAN

The procurement plan is described in “Chapter 7 Construction Planning”, and furthermore, information is in “Cost Estimate Report” as appendix.

CHAPTER 13. CONSTRUCTION TECHNOLOGY TRANSFER

13.1 CONSTRUCTION OF RIVER BRIDGES IN MYANMAR

In this chapter, the Japan International Cooperation Agency (JICA) Study Team's proposal on construction technology transfer in the Project is introduced by reviewing the current situation of construction organizations for river bridge construction in Myanmar.

13.1.1 Construction Records of River Bridges

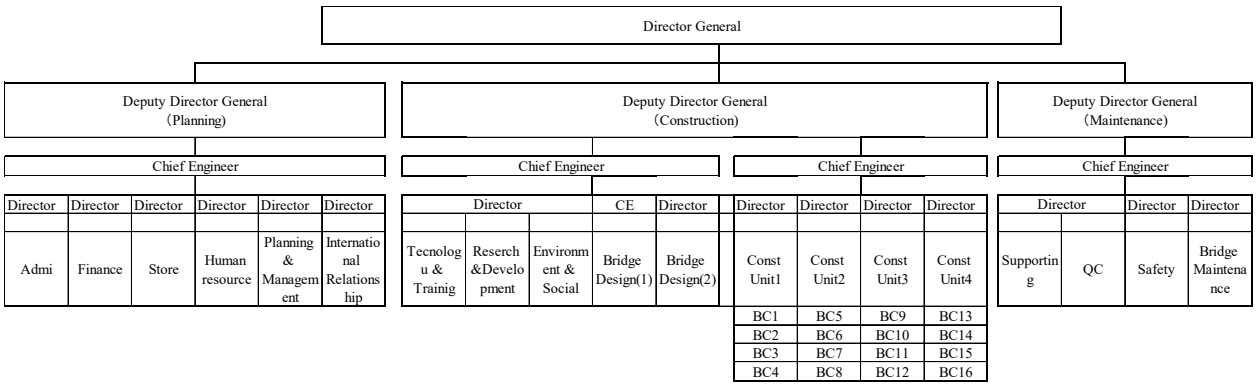
Although there are bridge construction companies in Myanmar which have experiences in bridge construction, these experiences are mainly on flyovers.

On the other hand, in the history of bridge construction in Myanmar, the Ministry of Construction (MOC) has implemented bridge construction over major rivers by its own construction units, such as the rivers of Ayeyarwady, Thanlwin, Sittaung, and Chindwin.

Although there are few private construction companies, such as Shwe Taung Development Co. Ltd., have experience in bridge construction over some major rivers, these private companies participated in the works as a subcontractor for foundation construction only. Therefore, it can be said that MOC is the only organization which has an experience as main construction unit in bridge construction over major rivers.

13.1.2 Organization of MOC's Construction Units

In the Department of Bridge (DOB) in MOC, there are four construction units which are organized under the Deputy Director General (Construction), Chief Engineer, and Directors as shown in Figure 13.1.1. Each construction unit has four bridge construction teams (BC) depending on the state/division and township.



Source: Department of Bridge, MOC

Figure 13.1.1 Organization of Department of Bridge (DOB)

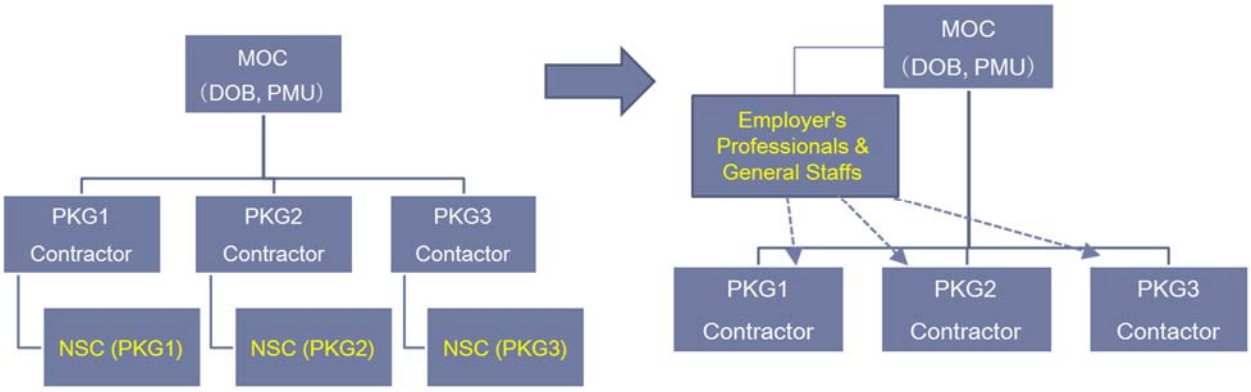
13.2 PROPOSAL ON CONSTRUCTION TECHNOLOGY TRANSFER

13.2.1 Participation of MOC Construction Unit

13.2.1.1 Contractual Role of MOC Construction Unit

It was notified that MOC is willing to let its Construction Unit (hereunder referred to as "the Unit") to participate in the construction works for its dignity and construction technology transfer. Since the Unit is the only organization that built more than 40 major bridges crossing big rivers, and similar situations will continue in the near future, it is desirable to transfer construction technology to the Unit.

It was also notified that the Unit will dispatch their engineers, supervisors, and labors, but not machines nor equipment. Other than the participation of NSC, there is another option of participation to the works as "Employer's Professionals and General Staffs (Option (b)) as shown in Figure 13.2.1 which is similar concept as "Employer's Equipment and Free Issue of Materials" in accordance with Sub-clause 4.20 in General Condition of Contract in FIDIC MDB.



(a) as "Nominated Subcontractor" (b) as "Employer's Professionals and Staffs

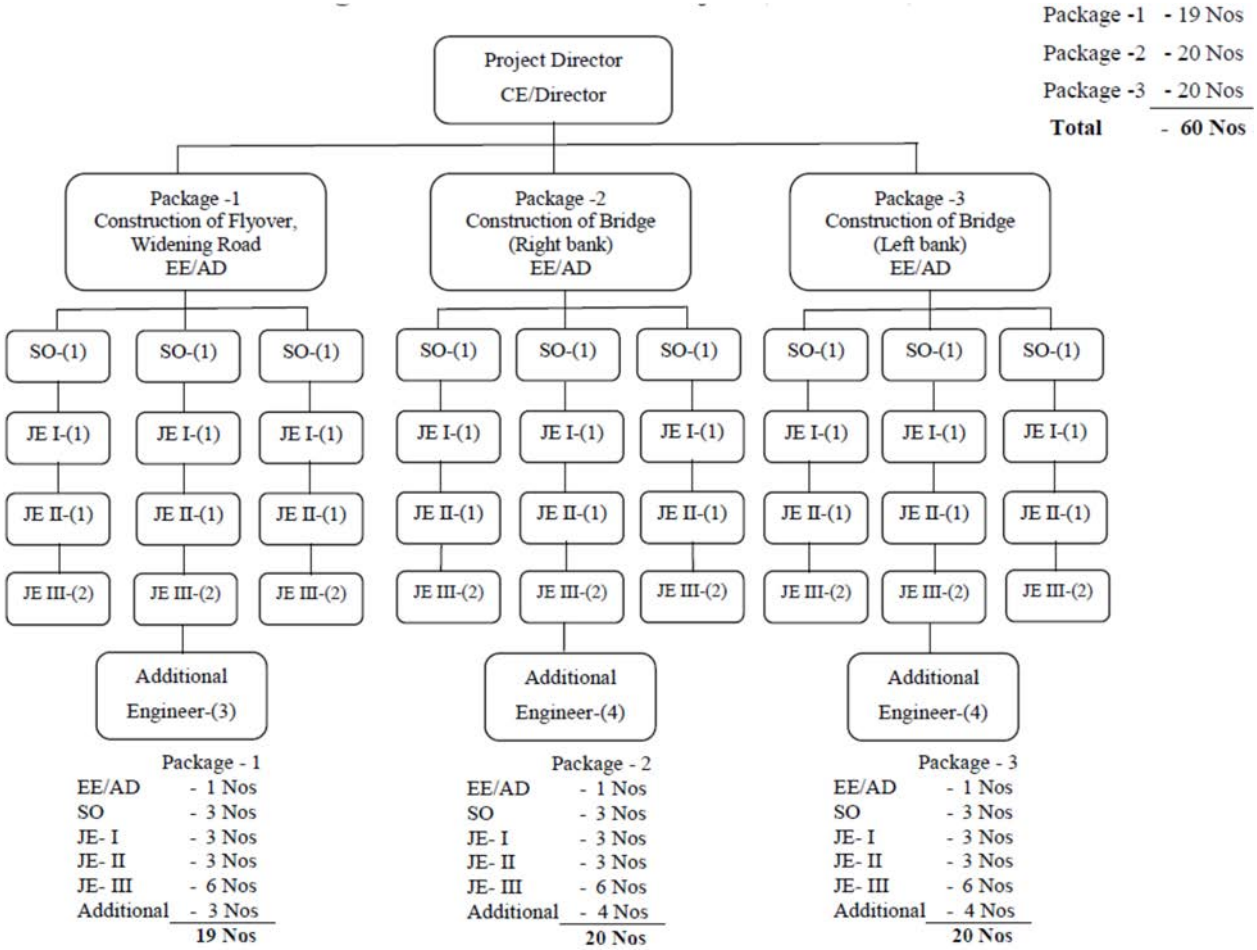
Source: JICA Study Team

Figure 13.2.1 Options for Participation of MOC's Construction Unit to the Works

MOC's participation as "Employer's Professionals and General Staffs" is more appropriate for construction technology transfer since MOC wishes to participate as practical on-the-job trainees for new construction technology and as physical workers for other conventional bridge construction works, while generally NSC takes limited and specific works. Therefore, Option (b) is recommended and MOC agreed on the definition of MOC Construction Unit as Employer's Professionals and General Staffs on May 25, 2017.

13.2.1.2 Organization of MOC Construction Unit in the Construction of Bago River Bridge

It was notified by MOC by MOC's letter, bridge/DDG/P2/2017-2018/015 dated May 15, 2017 that the engineers of MOC Construction Unit in the construction of Bago River Bridge will be about 20 in each package as shown in Figure 13.2.2. Junior engineers will play a role as foreman who leads skilled, semi-skilled, and unskilled labors.



Source: Department of Bridge, MOC Note: EE/AD: Assistant Director, SO: Staff Officer, JE: Junior Engineer

Figure 13.2.2 Organization of MOC's Construction Units in the Construction of Bago River Bridge

13.2.2 Issues on Participation of MOC in Construction

Below are the following issues on participation of MOC in the construction of Bago River Bridge:

- Conflict of interest
- Fairness in bidding process
- Responsibility of MOC on MOC's Construction Unit's errors
- Quality control

13.2.2.1 Conflict of Interest

For avoiding the risk of conflict of interest, the following measures will be taken:

- No salary for MOC's general staffs will be paid to avoid double payment
- No profit for MOC will be included in payment to MOC's Construction Units

13.2.2.2 Fairness in the Bidding Process

For securing fairness in the bidding process, the following measures will be taken:

- Detailed information on MOC's Construction Units, such as specialization and experiences of engineers, organization of engineers, and specialization and number of labors, is included in the bidding documents.
- Payment to MOC Construction Units will be categorized into provisional sum so that the cost is out of the price competition.

13.2.2.3 Responsibility of MOC on MOC's Construction Unit's Errors

When MOC's Construction Unit commits errors which cause loss or damage, MOC will be required to:

- Indemnify the contractor against loss or damage caused by MOC's Construction Unit;
- Grant an extension of Time for Completion without delay damages; and
- Pay the contractor additional cost incurred during extended period.

The Contractor will be entitled to:

- Request MOC to replace or reject the personnel whom the contractor judges as disqualified or inappropriate (with reasonable evidence).

13.2.2.4 Quality Control

For avoiding misuse of authority by personnel of the MOC's Construction Unit to give instruction to the consultant to pass over some errors in quality, the following will be included in the Technical Specifications of the Contract of Works:

> *The Engineer will at regular intervals inspect and test materials and completed work for compliance with the specified requirements, and where applicable, the various specified judgment plans will be applied. The testing frequencies and sample and lot sizes for routine testing shall be at the Engineer's discretion.*
>
> *All sections of completed work shall be submitted to the Engineer for routine inspection and testing, and the Contractor shall not cover up or construct any work on top of sections of completed work before being advised by the Engineer of the outcome of his tests and inspection. The Contractor shall arrange the submission of work for testing in a manner as will afford the Engineer reasonable opportunity for inspecting and testing.*

CHAPTER 14. PROJECT IMPLEMENTATION PLAN

14.1 LOAN AGREEMENT

The fund for the Bago River Bridge Construction Project (the Project) is financed by the Japan International Cooperation Agency (JICA) and the Government of the Republic of the Union of Myanmar (GOM).

The loan agreement of JICA and GOM for the Project was signed on March 1, 2017.

14.2 IMPLEMENTATION STRUCTURE

14.2.1 Implementation Agency

The Ministry of Construction (MOC) is "the Line Agency" and concurrently "the Employer' of the Project. The Department of Bridge (hereinafter referred to as “DOB”) is "the Employer's Representative" and concurrently "the Implementation Agency" managing the total implementation of the Project.

MOC consists of four departments under the ministry: Department of Bridge (DOB), Department of Highway (DOH), Department of Building, and Urban and Housing Development Department.

For the implementation of the construction project, the JICA Study Team recommended to DOB to establish an exclusive Project Management Unit (PMU). As recommended, PMU was established during the detailed design services and all the implementation works are being supervised by PMU consistently.

The Executing Agency will be the PMU under DOB and will be responsible for all project works as follows:

- Pre-construction works comprising engineering design, land acquisition, relocation/resettlement, and tender;

- Construction supervision;

- Traffic safety management during construction; and

- Operation and maintenance of civil works and equipment during defect liability period.

14.2.2 Demarcation among JICA, MOC, and YCDC

The design of the Project including river bridge, on-ramp, flyover, and Thanlyin Chin Kat Road under the flyover will be performed through a JICA grant. The construction of the Project will be financed by JICA excluding Thanlyin Chin Kat Road. After the construction, operation and maintenance of the bridge between the abutments will be conducted by DOB of MOC while the Department of Highway (DOH) of MOC or Yangon City Development Committee (YCDC) will be responsible for the approach road, the adjacent intersections, and connecting roads on Yangon side; and DOH will be responsible for the approach road, adjacent intersections and connecting roads on Thanlyin side including Thilawa Access Road.

14.3 IMPLEMENTATION PROGRAM

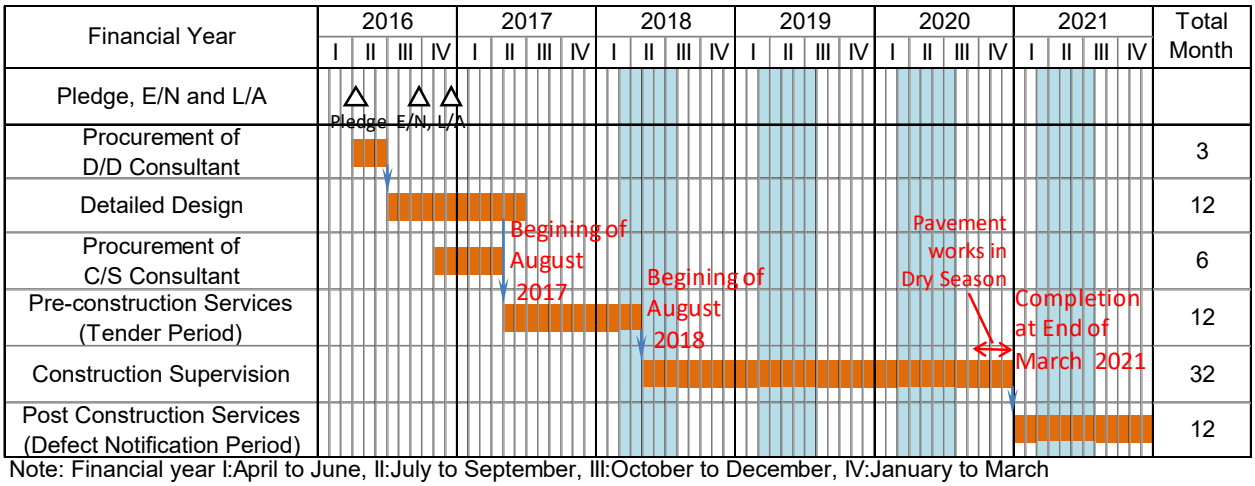
In this section, the implementation program of shortest scenario is introduced.

The implementation milestones and I/P are shown in Table 14.3.1 and Figure 14.3.1 respectively, assuming that common practice will be adopted.

Table 14.3.1 Implementation Milestones and Periods

Event/ Milestone	Period
Actions by the Governments	
Pledge by the Japanese Government	: July 2016
Exchange Note and Loan Agreement	: December 2016
Land Acquisition	: 17 months
Resettlement	: 17 months
Consultancy Services	
Procurement of D/D Consultant (by JICA)	: after Pledge
Detailed Design (by JICA)	: 12 months after Procurement
Procurement of C/S Consultant (by Myanmar)	: 9 months
Pre-construction Services (Tender Period)	: 12 monts
Construction Supervision	: 32 months
Post-construction Services (Defect Liability Period)	: 12 months
Construction	
Procurement of Contractor (by Myanmar)	: 12 months
Construction	: 32 months
Defect Liability Period	: 12 months

Source: JICA Study Team



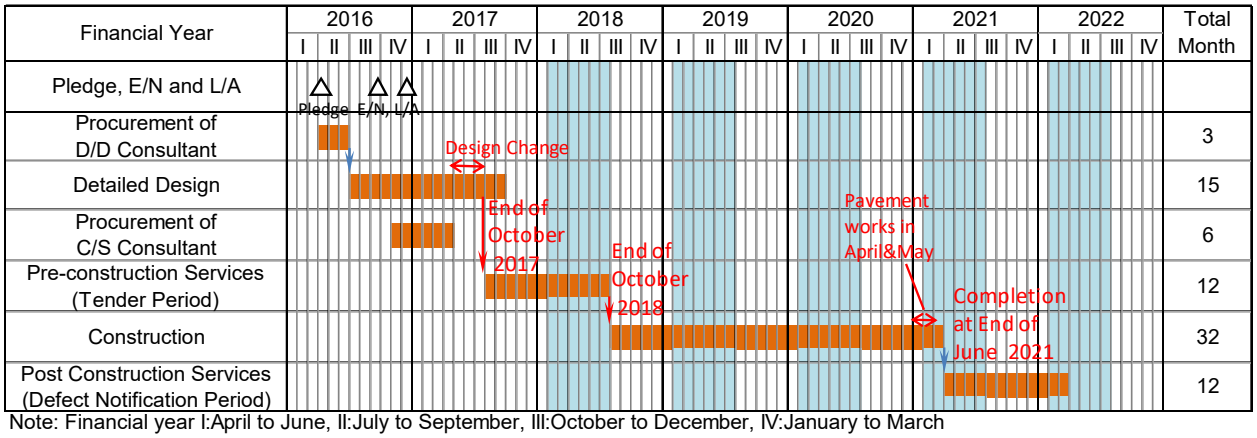
Note: Financial year I:April to June, II:July to September, III:October to December, IV:January to March

Source: JICA Study Team

Figure 14.3.1 Implementation Program with Shortest Scenario Assuming Commencement of Works: Beginning of August 2018

However, due to design change instructed by DOB in April 2017 for changing the span arrangement at the approach bridge on Thanlyin side, it is expected to be delayed for three months as shown in Figure 14.3.2 below. The detailed implementation schedule is shown in Figure 14.3.3.

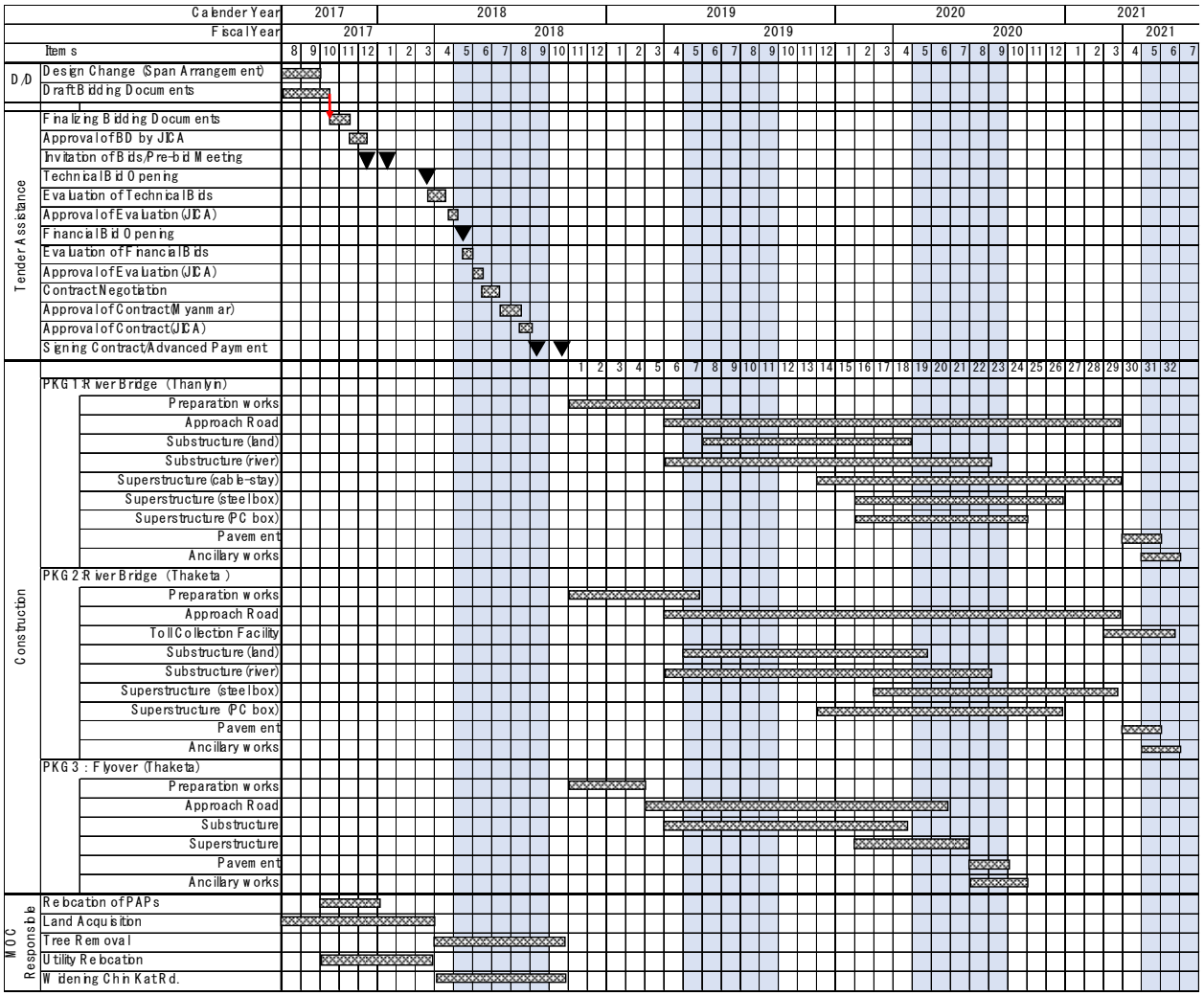
In this scenario, pavement works which cannot be implemented in the rainy season are expected to be in April and May. Therefore, it should be noted that a little more delay will result in much longer delay in waiting for the next dry season and the completion of the works might be after December 2021.



Note: Financial year I:April to June, II:July to September, III:October to December, IV:January to March

Source: JICA Study Team

Figure 14.3.2 Implementation Program Shortest Scenario Assuming Commencement of Works: End of October 2018



Source: JICA Study Team

Figure 14.3.3 Detailed Implementation Program with Shortest Scenario Assuming Commencement of Works: End of October 2018

CHAPTER 15. PROJECT PROMOTION

15.1 GENERAL

Considering the situation where the construction projects for transportation including the Project attracts a great deal of interest not only in Myanmar but also in Japan, the documents for promotion, promotion videos, perspectives and a magazine article were prepared.

15.2 PROMOTION VIDEO

A 7-minutes-long promotion video were prepared and submitted on September 14th, 2017, for explaining the objectives, components, features and effects of the Project. The video contains following stories;

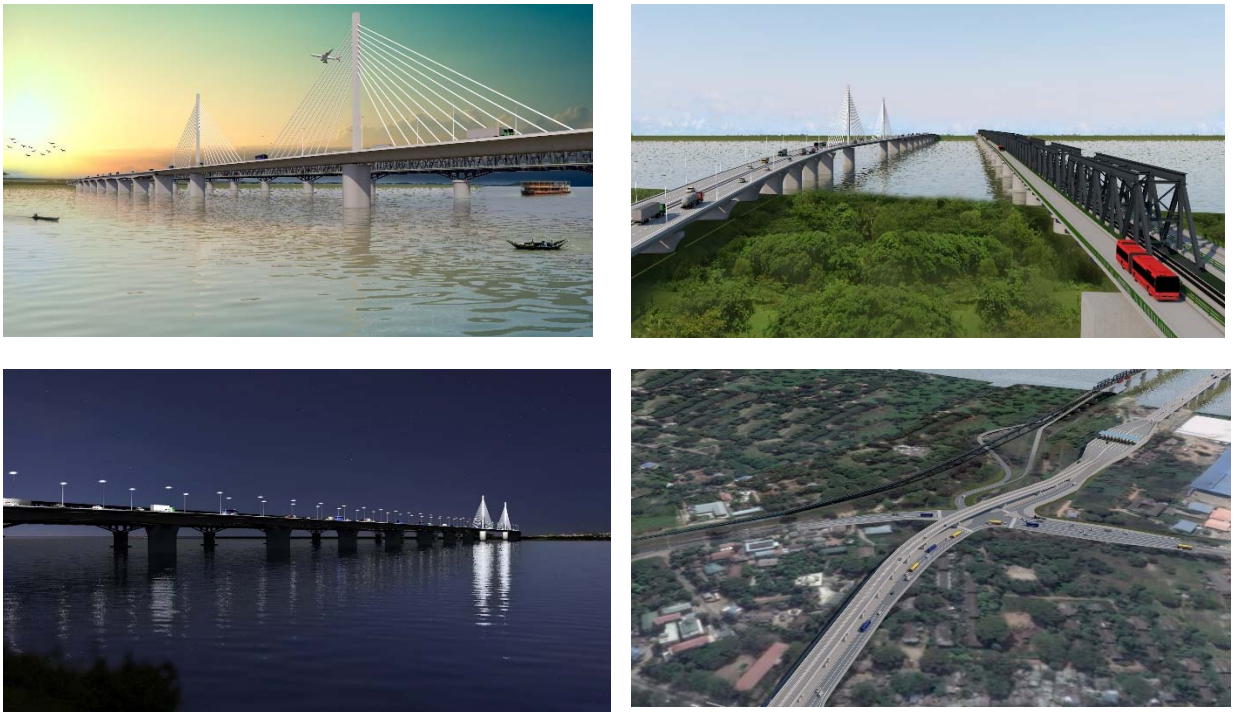
- Introduction of City of Yangon and issues on transportation network,
- Introduction of Bago River and issues on access between Yangon and Thilawa,
- Interview of a Thanlyin resident showing terrible traffic congestion for crossing Bago River at the exisiting Thanlyin Bridge,
- Interview of Vice Minister of MOC explaining necessity of a new bridge crossing Bago River
- Interview of President of MJTD (Myanmar Japan Thilawa Development Ltd) looking forward to construction of Bago River Bridge
- Major component of Bago River Bridge
- Construction technology and design features of Bago River Bridge
- CG perspectives of Bago River Bridge

The video was prepared with narration in the three languages, English, Japanese and Myanmar. The detailed storyboard in English is shown in Appendix 15.

15.3 CG PERSPECTIVES

Based on 2-D drawings of Bago River Bridge, a 3-D model were created for preparing perspectives of the completion image of the Project. For 3-D model creation, the application, Civil 3D®, was used. The application, Infraworks®, was used for finalizing the model with background image for presentation of perspectives and animation from bird-eye or driver's eye.

The samples of perspectives are shown in Figure 15.3.1



Source: JICA Study Team

Figure 15.3.1 Image Perspectives

15.4 PROMOTION PLAN

15.4.1 Promotion Plan in Myanmar

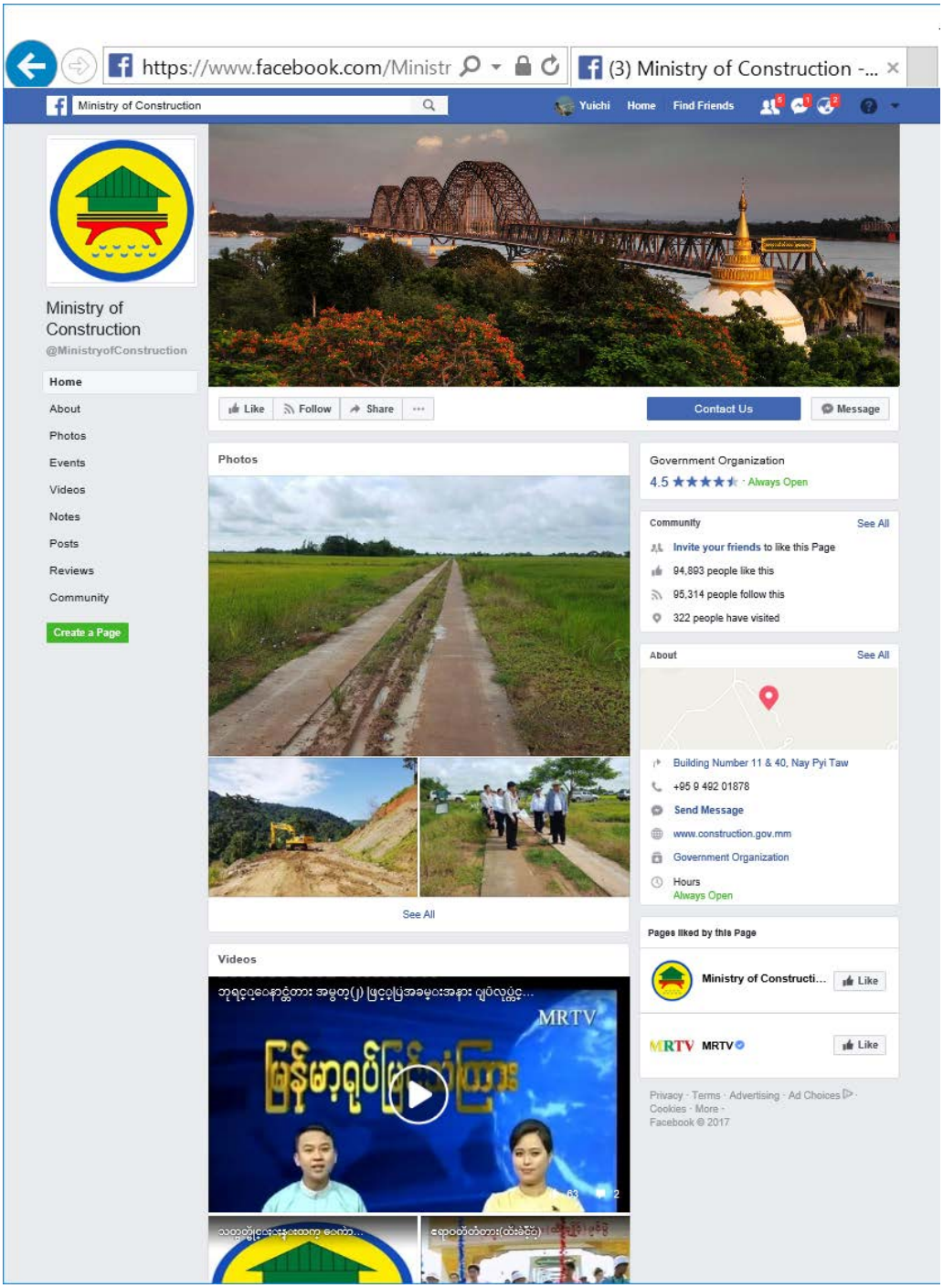
After introducing the contents of the promotion video to DOB of MOC on August 24, 2017, DOB agreed to upload the video in MOC's website, as shown in Figure 15.4.1. The video was submitted to DOB on September 21, 2017.

15.4.2 Promotion Plan in Japan

It was planned to post the promotion videos, both Japanese and English versions, in JICA's website. The promotion video was submitted to JICA on September 14, 2017.

In addition to promotion video, it was proposed to publish an article in a periodical specialized in international cooperation, such as "International Development Journal". The article would contain followings;

- Project Background and Objectives of the Bridge Construction,
- Interview of Vice President of MOC,
- Interview of President of MJTD,
- Structural Features and Components of the Project, and
- Implementation Plan.



Source: https://facebook.com/MinistryofConstruction/

Figure 15.4.1 MOC's Web Site