

Ministry of Transport  
Myanma Port Authority  
Inland Water Transport  
The Republic of The Union of Myanmar

**The Project  
for  
Rehabilitation of Yangon Port  
and  
Main Inland Water Transport  
in  
The Republic of The Union of Myanmar  
(Follow-Up)  
  
Final Report**

February 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Nippon Koei Co., Ltd. (NK)

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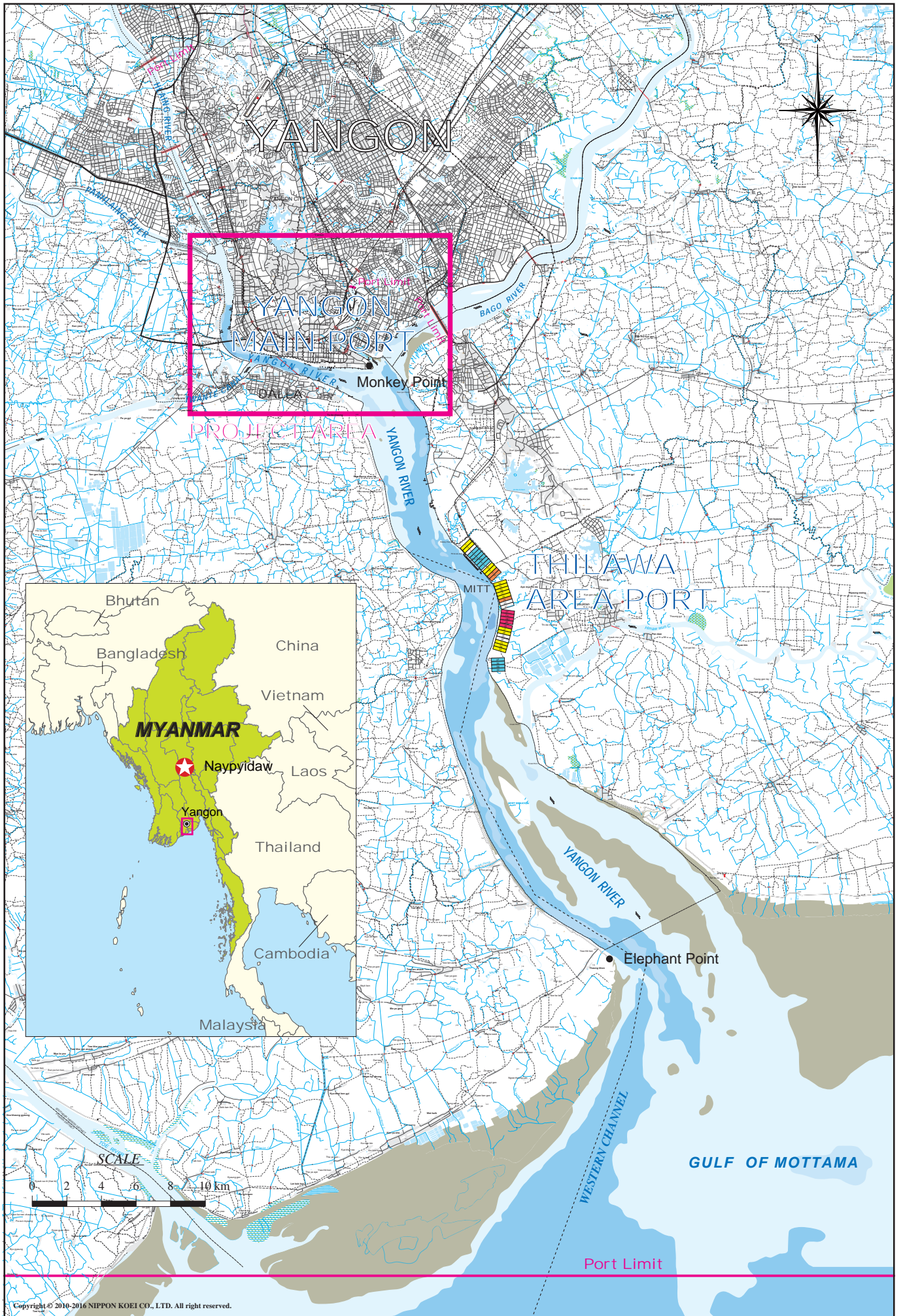
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LOCATION MAP OF YANGON PORT







The Project for Rehabilitation  
of  
Yangon Port and Main Inland Water Transport  
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the Republic of the Union of Myanmar  
(Follow-Up)

**Final Report**

Location Map of Yangon Port  
Location and Name of Port Facilities in Yangon Main Port  
Abbreviation

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### **ABBREVIATION**

ICB	Interlocking Concrete Block
IWT	Inland Water Transport
JB Press	Japan Business Press Co. Ltd
JFE	JFE Engineering Corporation
JICA	Japan International Cooperation Agency
MMU	Myanmar Maritime University
MOT	Ministry of Transport
MOU	Memorandum of Understanding
MPA	Myanma Port Authority
NK	Nippon Koei Co., Ltd.
ODA	Official Development Assistance
RC	Reinforced Concrete
US\$	United States Dollars

## CHAPTER 1 INTRODUCTION

### 1-1 BACKGROUND OF THE PROJECT

In Yangon Port, there are about 100 jetties and many of them are owned by Myanma Port Authority (MPA). However, there are many deteriorated jetties since the maintenance is not sufficient. In 2013, the Dalla Jetty has deteriorated significantly. As a result of the inspection and evaluation in order to verify the necessity of repairing, it was found that there is a high risk of immediate collapse if an earthquake occurs due to deterioration and that the structure is beyond repair. Therefore, it was decided to remove and construct a new jetty. The inspection and evaluation have been implemented by MPA and Inland Water Transport (IWT). Also, training and lecture have been carried out for the technical transfer.

Defect inspection was necessary one year after the completion of the construction of “The Pilot Project of Restoration of the Dalla Ferry Terminal Jetty at Dalla Side” under “The Project for Rehabilitation of Yangon Port and Main Inland Water Transport in the Republic of the Union of Myanmar”. Furthermore, follow-up of the technical transfer implemented in 2013 had been required for further improvement of the knowledge about the maintenance method and inspection of the reinforced concrete.

This Project (Phase 3) is the final compilation of the “The Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport in the Republic of the Union of Myanmar”. As the restoration project of the port that was affected by Cyclone Nargis, JICA Project Team commenced the services in February 2009, and completed the last Phase in February 2015. Please refer to Chapter 5 for the detailed the background.

### 1-2 OBJECTIVES OF THE PROJECT

The objectives of the Project are:

- Objective 1: To implement defect inspection and check whether there are construction defects one year after the completion of the construction of the Dalla Terminal Jetty.
- Objective 2: To achieve the maintenance capacity in Myanmar by illustrating the considerations of future maintenance with reference to the defect inspection result.

### 1-3 PROJECT AREA, SCOPE AND SCHEDULE

#### 1-3-1 PROJECT AREA

The Project area covers the jetties owned by MPA including the Dalla area in Yangon City.





Source: JICA Project Team

**Figure 1.1 Location Map of Yangon Main Port**

### 1-3-2 PROJECT SCOPE

The scope of work of the Project is composed of the following major items:

- Preparation and Discussion of the Inception Report
  - The inception report was prepared and submitted to JICA (Head Office) and the consultation was conducted with JICA (Myanmar Office), MPA and IWT.
- Implementation of Defect Inspection (Final Report: Chapter 2)
  - One year after the completion of construction of the Dalla Jetty Terminal, defect inspection had been implemented on December 23, 2015 to check whether there are construction defects. Then the defect inspection was summarized and reported to JICA after confirmation that the Contractor had completed the repair works, which the Contractor is responsible for.
  - Facilities to be inspected are the following:
    - Steel Structures: pontoon, movable steel bridge
    - Concrete Facilities: porter way, walkway, slipway, revetment, fence
    - Buildings: passenger terminal building, toilet
- Technical Transfer on Maintenance and Repairing (Final Report: Chapter 3)
  - The maintenance methods should be considered based on the defect inspection result, with reference to the repair method in Japan. Then, the optimal maintenance method of the Dalla Jetty Terminal had been proposed.
  - In 2013, technical transfer about the inspection and evaluation of the soundness of concrete was conducted for the engineers/staff of MPA and IWT. A follow-up training in order to enhance the level of the engineers/staff had been carried out in this Project.
- Public Announcement (Final Report: Chapter 4)
  - The Dalla Ferry Terminal is an important means of transportation for people commuting between Yangon and Dalla. In light of this situation, the information had been disseminated in Myanmar for the public announcement of the Project as a good example of Japanese official development assistance (ODA).
- Preparation of the Final Report



#### 1-4 COUNTERPART AGENCY

The counterpart agencies of the JICA Project Team are as follows:

- Myanmar Port Authority (MPA)
- Inland Water Transport (IWT)

#### 1-5 JICA PROJECT TEAM

The members of the JICA Project Team are shown in Table 1.2 below.

**Table 1.2 Team Members and Position**

No.	Position	Name
1	Team Leader Expert of Inland Water Transport Facilities	Mr. Kazuhisa IWAMI
2	Senior Marine Civil Engineer of Steel Structure	Mr. Toshihiro KATO
3	RC Maintenance Expert	Dr. Kimitoshi MATSUYAMA
4	Building Engineer	Mr. Kei SAWAMURA
5	Public Announcement	Ms. Mitsue TAMAGAKE

Source: JICA Project Team



## CHAPTER 2 DEFECT INSPECTION

### 2-1 SUMMARY OF PILOT PROJECT

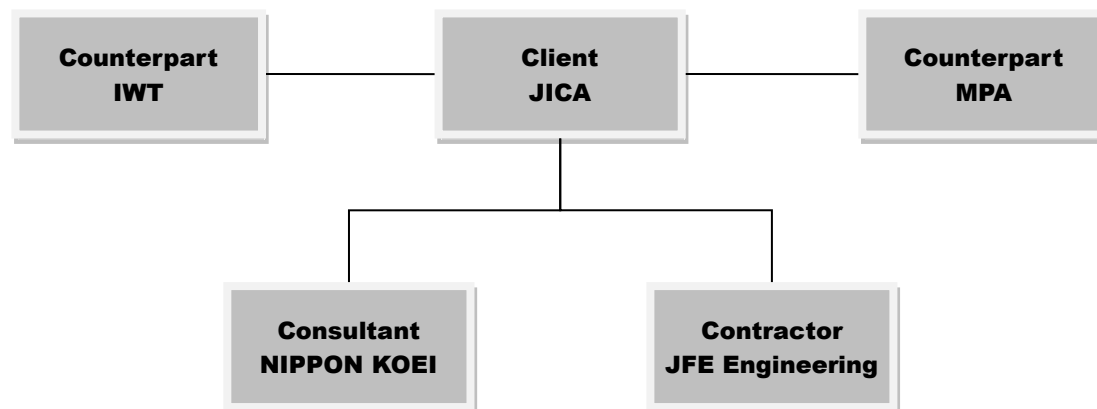
#### (1) Summary of Pilot Project as a Target of Inspection

The contract data of the Pilot Project are summarized as follows:

Name of the Project	:	The Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport in the Republic of the Union of Myanmar (Phase 2)
Name of the Pilot Project	:	The Pilot Project of Restoration of the Dalla Ferry Terminal Jetty ad Dalla Side
The Client	:	Japan International Cooperation Agency (JICA), Myanmar Office
The Consultant	:	Nippon Koei Co., Ltd. (NK)
The Contractor	:	JFE Engineering Corporation (JFE)
The Counterparts	:	Myanma Port Authority (MPA) Inland Waterway Transport (IWT),
Construction Duration	:	240 days (all the Works, except installation of the new pontoons and steel bridges) 270 days (whole of the Works)

#### (2) Implementation Structure of Pilot Project

The Project Implementation Structure is summarized in the following flowchart:



Source: JICA Project Team

**Figure 2.1 Project Implementation Structure**

JICA and JFE signed the contract on January 31, 2014 and JICA (Myanmar Office) issued a notice to proceed on February 1, 2014. The whole of the Works was completed on October 28, 2014 which was the 270<sup>th</sup> day from the date of the commencement of the Project. The facilities were handed over to MPA and IWT on November 15, 2014.

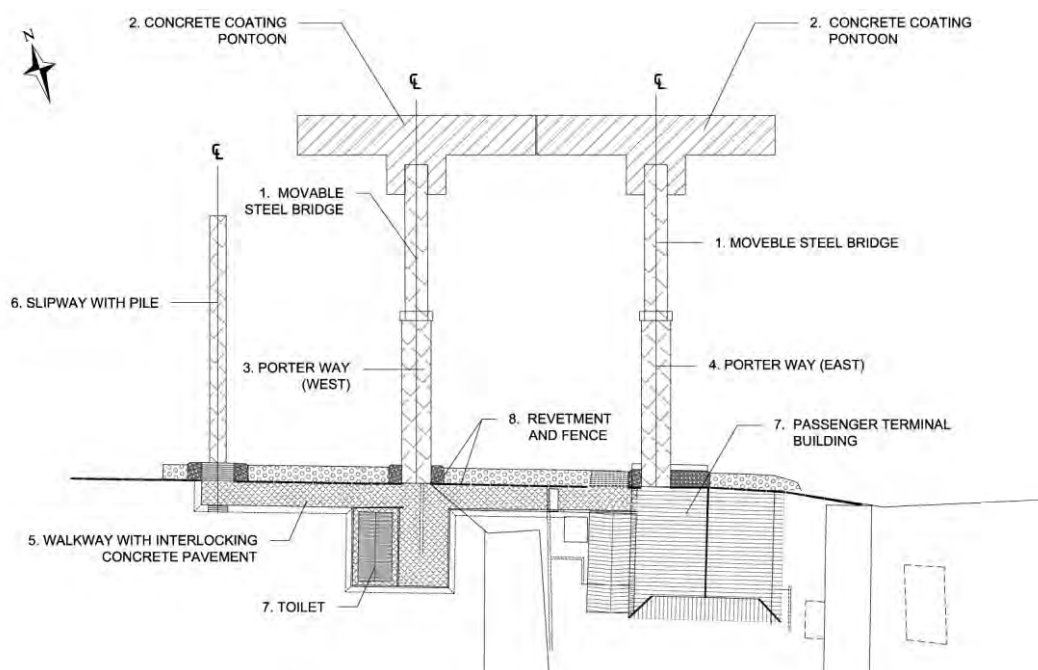
#### (3) Major Scope of Pilot Project and Owner

The scope of the Pilot Project and an owner of each facility have been summarized in the following Table 2.1 and Figure 2.2.

**Table 2.1 Major Scope of Pilot Project and Owner**

No.	Item	Dimension	Owner
1	Two moveable steel bridges	Truss Type Steel Bridge (Length: 22.78 m, Width: 3.25 m)	MPA
2	Concrete coating of two pontoons	Sides and tops of 2 nos. of steel pontoons	MPA
3	Porter way (West)	14 nos. of concrete piles (0.5 m x 0.5 m x 19.4 m) Concrete deck slab (24.85 m x 4.5 m x 0.3 m thick)	MPA
4	Porter way (East)	14 nos. of concrete piles (0.5 m x 0.5 m x 19.4 m) Concrete deck slab (25.45 m x 4.5 m x 0.3 m thick)	MPA
5	Walkway with interlocking concrete pavement	Length of pavement: 67 m (Area: 448 m <sup>2</sup> )	MPA
6	Slipway with pile	18 nos. of concrete piles (2.5 m x 38 m)	MPA
7	Passenger terminal building and toilet	Single storey building (18.5 m x 21.6 m)	IWT
8	Revetment and fence	Length: about 50 m and 70 m each	MPA
9	Demolition works	Existing porter way, terminal building, and existing toilet	-
10	Supply of materials for pontoons manufactured by IWT	Steel plate, welding rod, paint, anode	-

Source: JICA Project Team



Source: JICA Project Team

**Figure 2.2 Project Facilities**

#### (4) Utilization of the Facilities

The Photo below, taken from the slipway, shows that two pedestrian bridges are used simultaneously for embarking and disembarking. Therefore the usage situation was improved including the safety. Though the number of the passengers using the ferry boats has increased, and the travel time has decreased due to the following reasons:

- Embarking and disembarking times have decreased because of the two bridges and pontoons system.
- The navigation time has decreased because of the Japanese granted boats named Cherry.



Source: JICA Project Team

**Photo 2.1 Busy Terminal Operation**

## 2-2 IMPLEMENTATION OF DEFECT INSPECTION

### 2-2-1 SCHEDULE AND PARTICIPANTS OF DEFECT INSPECTION

The joint inspection to identify the defective facilities was carried out on December 23, 2015. JICA (the Client), NK (the Consultant), and JFE (the Contractor) carried out the joint inspection. MPA and IWT (Counterparts and Owners) attended as witnesses. The numbers of participant of each organization are shown in the following Table 2.2.

**Table 2.2 Numbers of Participants of Each Organization**

Organization		Number of Participants
JICA	Client	2
MPA	Counterpart and Owner	2
IWT	Counterpart and Owner	3
NK	Consultant	10
JFE	Contractor	4

Source: JICA Project Team

### 2-2-2 TECHNICAL TRANSFER OF DEFECT INSPECTION

The followings are explained to MPA and IWT on joint inspection.

- Procedure from the Construction Completion to Warranty Security Return
- Responsibility of Client, Consultant and Contractor
- Defects that are not attributable to the Contractor
- Defects that the Contractor shall repair
- Items to be inspected



## 2-2-3 STEEL STRUCTURES

### (1) Pontoons

The concrete coated surface is in good condition. No serious defects or damages occurred. Handrails, bollards, fenders, and anchor chains are in good condition.

Some bolt connections of fenders and pontoons became loose. About 5 cm of water was found inside the pontoon because rain water had leaked through the manhole hatch covers.



Source: JICA Project Team

**Photo 2.2 Two Pontoons**

### (2) Steel Bridges

The steel bridge structure, roof truss, and roofing of both bridges are in good condition. Some portions of the longitudinal beam floor had been rusty. Some timber planks of the timber floor had become loose.



Source: JICA Project Team

**Photo 2.3 Steel Bridges (East and West)**

## 2-2-4 CONCRETE FACILITIES

### (1) Porter Ways

The structure, roofing, and roof truss of both porter ways are in good condition. No serious defects or damages occurred after the completion of construction. Paint on the handrail had slightly faded because it was exposed to public use.



Source: JICA Project Team

**Photo 2.4 East Porter Way**

### (2) Walkway

The interlocking concrete block (ICB) walkway is in good condition. Concrete pavement beside the passenger terminal building is in good condition. Some ICB had sunk down at some places.



Source: JICA Project Team

**Photo 2.5 Walkway**

### (3) Slipway

The concrete structure of the slipway is in good condition. Small damages occurred along the edge of the slipway because of the berthing of small boats. Rubble stones for slope protection had been



washed away by tide and river flow at some places.



Source: JICA Project Team

**Photo 2.6 Slipway**

And the staircase at the slipway is in good condition. Passenger can pass through conveniently. Some nosing edge had been damaged because of the berthing of small boats during high tide. Also, some plaster damages had occurred at some thread surface and side wall.



Source: JICA Project Team

**Photo 2.7 Staircase at Slipway**

#### (4) Revetment

The revetment has firmly protected the slope of the riverbank. Some rubble stones had been taken away at the toe in some places. Small cracks have occurred in some places.



Source: JICA Project Team

**Photo 2.8 Revetment**

(5) Fence

The fence structure is in good condition. Some concrete blocks had been damaged that were probably hit by motorbikes or trishaws. Cracks had occurred at connection joints between the concrete column and the brick capping on the top of the concrete blocks.



Source: JICA Project Team

**Photo 2.9 Fence**

## 2-2-5 BUILDINGS

### (1) Passenger Terminal Building

#### a. Floor

The non-slip ceramic tiles are in good condition. No defects or damages were found. Passengers enjoy safe and pleasant environment. No serious slip injuries occurred after the completion of construction.

#### b. Wall

The acrylic emulsion paints on the cement mortar in both the interior and exterior walls are in good condition. The structure of the wall has the same condition before and after the completion of construction. Although the wall structure is in good condition, some defects (cracks) had occurred at the bottom of many windows. Crack lines occurred at every connection joint of the two

different materials.

c. Door and Window

The aluminium frames of the sliding windows, wooden frames of the swing wooden doors, steel frames of the rolled up shutter steel doors, and the iron concertina sliding door are all in good condition. One of the six glass window leaves became loose and moved out of frame because the frames of the window leaf were not strong enough to withstand the strong sliding movement. One of the mosquito nets at the window also became loose and out of frame. IWT kept the six window leaves and one mosquito net in the storage.

d. Ceiling

The aluminium frames and cement fiberboard are in good condition. However, some defects had occurred in the mineral fiber acoustic tile in some places.

e. Roof

The roof structure and roofing sheets appears to be in a good condition. The nailing points at the sheet lapped areas also appear to be in a good condition. Gutters and downspout are functioning well. Some brackets at the downspout became loose.

f. Ceiling Fans and Lighting

All ceiling fans and lighting are still effective and in good condition.

g. Lightning Rod and Cable

Metal rods mounted on top of the roof and conductor cables are in good condition.

h. Miscellaneous Items

The benches, diorama, revolving gate, and service counter are in good condition. Some handrail posts at the side of the portico (entrance porch) were broken due to the misuse by the passengers.



Source: JICA Project Team

**Photo 2.10 Passenger Terminal Building**

(2) Toilet

a. Floor

The non-slip ceramic tiles are in good condition. No defects or damages were found. Toilet users have a safe environment. No serious slip injuries occurred after the completion of construction.

b. Wall

The emulsion paints on the cement mortar in the exterior wall and on the waterproof gypsum board in the interior wall are in good condition. The ceramic tile on the cement mortar plaster is in good condition. The structure of the wall is strong and robust.

c. Door and Window

The aluminium frames of windows and wooden frames of wooden doors are in good condition except the locks at the toilet door which were loosened and damaged because of improper usage of the toilet users.

d. Roof

The roof structure and roofing sheets are in good condition. Nailing or screwing points at lapped areas of the roofing sheets are in good condition. Gutters and downspout are functioning well.

e. Exhaust Fans and Lighting

All exhaust fans and lighting are still effective and in good condition.

f. Toilet Accessories

Toilet cubicles, urinal bowls, sinks, mirrors, and other toilet accessories are almost in good condition. One water tap in the male toilet and one tap in the female toilet have stopped operation.

g. Water Pump

The compressor pump for pumping water from the tube well to the ground tank is in a good working condition. Whereas, the pump for raising water from the ground tank to the elevated tank is not working.

h. Wooden Fence

The wooden post and planks are in good condition.





Source: JICA Project Team

**Photo 2.11 Toilet (Male and Female)**

## 2-3 RESULT OF DEFECT INSPECTION

### (1) List of Facilities to be Inspected

The following facilities were inspected to determine whether they have defects (please refer to **Appendix 1** for more details):

#### a. Steel Structures

- West Porter Way Roof Truss
- East Porter Way Roof Truss
- West Steel Bridge
- East Steel Bridge
- Two Pontoons made by IWT

#### b. Concrete Facilities

- Slipway
- Fence
- Walkway
- West Porter Way
- East Porter Way
- Revetment
- Pontoon Coating Concrete

#### c. Buildings

- Terminal Building
- Toilet











### (2) Repair of Defects

The summary of the situation before and after the repair of the defects is shown in the following Table 2.3. For detailed contents of the repair of the defects, please refer to **Appendix 2**.



The Contractor commenced the repair works on 2 January 2016 and completed them in two weeks. Joint inspection was carried out on 21 January 2016 by NK and JFE with the presence of MPA and IWT to confirm the completion of the repair works. As a result of this inspection, it was confirmed that the Contractor had completed the repair works, which the Contractor is responsible for.

**Table 2.3 Situation Before and After the Repair of the Defects**

	Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
West Steel Bridge			Timber floor connection is loosed and mounted.
			Rust and Paint defected.
East Steel Bridge			Timber floor longitudinal member is mounted and cracked.
			Timber floor longitudinal member is mounted.
Pontoons			Steel angle is deformed and concrete is defected.

	Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
Slipway			Surface plaster defected.
			Concrete is defected.
Fence			Top portion of fence column is cracked and rebar is appeared. Top portion of fence column is cracked and rebar is appeared (Total 4 places).
			
Walkway			ICB paver blocks have been sunken and damaged. ICB are sunk and damaged.
			



	Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
West Porter Way			Pile cap bottom surface connection defected (Total 3 places).
			Edge of Porter Way slab (vertical surface) defected.
East Porter Way			Concrete surface is defected.
			Abutment concrete surface (vertical side) is defected.
Revetment			Some rubble stone in bottom portion are missing and crack appeared.
			Revetment is cracked base of Porter Way west.

	Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
Terminal Building			Ceiling 4 numbers need to repair.
			Ceiling one number need to repair.
Buildings (Crack line)			Crack line is occurred.
			
Buildings (Rain Water Down Pipe)			Downpipe brackets are damaged.

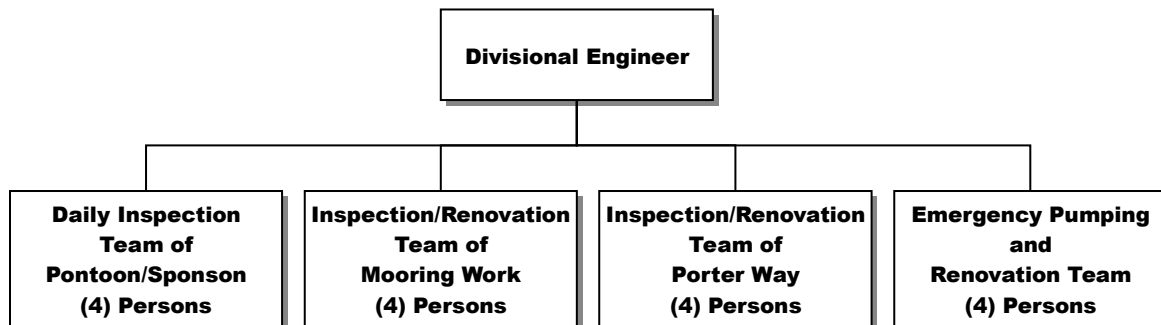
	Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
Toilet			Defected urinal bowl water tap and need to repair.
			Defected and need to repair.

Source: JICA Project Team

## 2-4 MAINTENANCE SYSTEM FOR THE FACILITIES OF PILOT PROJECT

### (1) Organization Chart of the Counterpart (MPA and IWT)

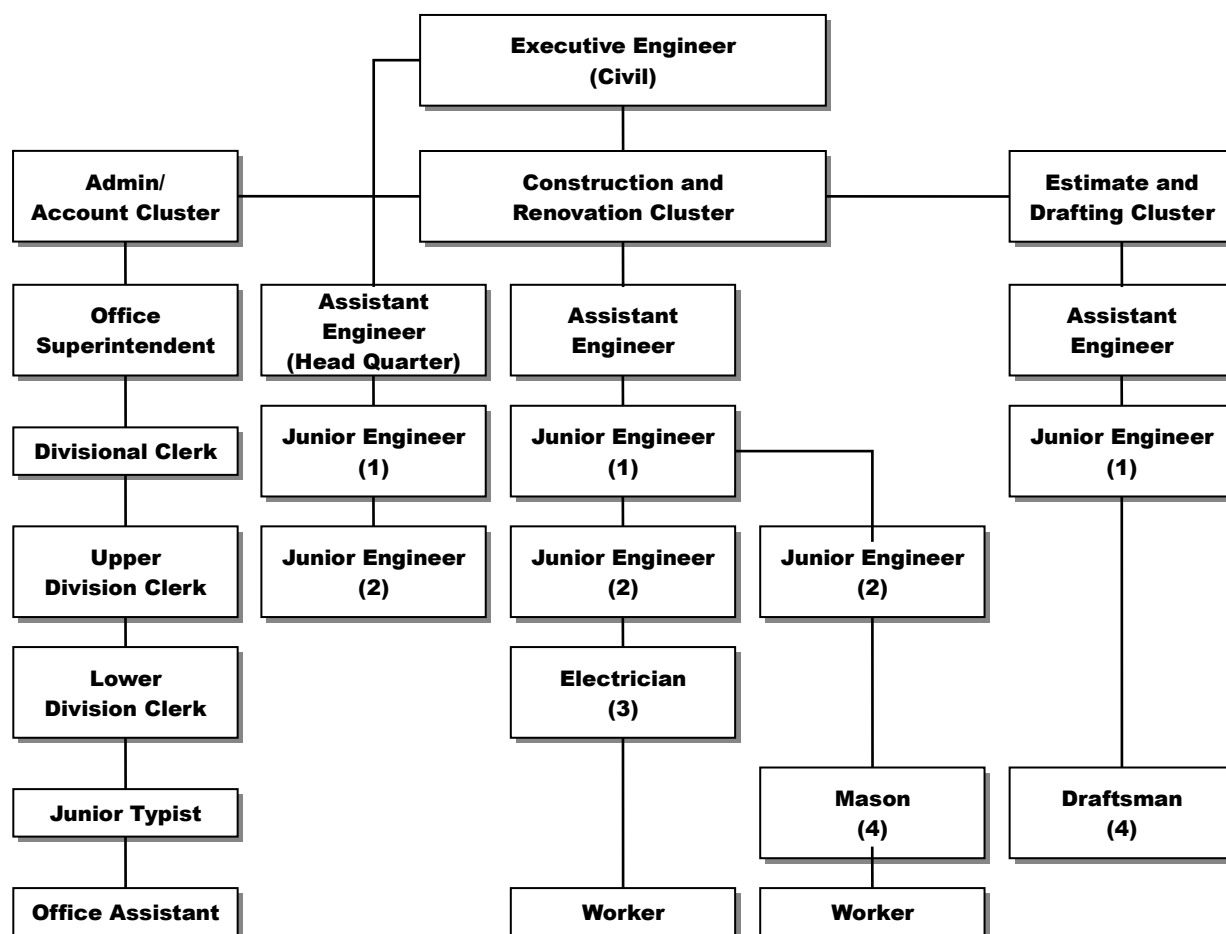
The organization chart of the MPA Maintenance Division, which is in charge of construction and maintenance for this Pilot Project, is depicted as follows. The Divisional Engineer participated in the Pilot Project as the representative of MPA during the construction stage.



Source: Prepared by JICA Project Team based on data from MPA

**Figure 2.3 MPA Maintenance Division**

The organization chart of the IWT Civil Engineering Department, which is in charge of construction and maintenance for this Pilot Project, is depicted as follows. The Executive Engineer participated in the Pilot Project as the representative of IWT during the construction stage.



Source: Prepared by JICA Project Team based on data from IWT

**Figure 2.4 IWT Civil Engineering Department**

The Executive Engineer participated in the Pilot Project as the representative of IWT during the construction stage.

## (2) Current Situation of Repair by the Counterpart (MPA and IWT)

After the completion of construction, the buildings, walkway, fence, and revetment were handed over to IWT, and the porter ways, steel bridges, pontoons, and slipway were handed over to MPA. However, both parties cannot carry out proper maintenance due to budget constraints and insufficient manpower allocation. For example, IWT can only use as much as US\$ 500 per year as budget for maintenance of its facilities on the Yangon River including the Dalla Ferry Terminal, Pansondan Terminal, and Delta branch office.

## (3) Recommendation for Effective Use

- The facilities shall be regularly inspected before minor damages result in major repair works. Especially, for the facilities used by many users such as Dalla Ferry Terminal, it is expected that each component of the facilities is carefully inspected regularly. Major repair may become necessary without the regular inspection, and may obstruct the passenger services severely.
- The owner should clean the facilities regularly or on a daily basis to enhance the environment around the facilities.

## CHAPTER 3 TECHNICAL TRANSFER ON MAINTENANCE AND REPAIR

### 3-1 SUMMARY OF THE TECHNICAL TRANSFER

In order for MPA and IWT to maintain the port facilities made from reinforced concrete properly, to have knowhow of the survey (soundness test) and repair of concrete are inevitable.

Technical transfer regarding these knowhow was conducted through on-site training and classroom lecture as summarized in Table 3.1. Further details are described in Section 3-3 and 3-4. And Section 3-5 presents the recommendation for the technical development regarding maintenance and repair for MPA and IWT.

**Table 3.1 Summary of the Technical Transfer**

On-site Training	Classroom Lecture
<ul style="list-style-type: none"> <li>• Visual inspection and sketches</li> <li>• Sound survey</li> <li>• Schmidt Hammer Test</li> <li>• Coring survey</li> <li>• Rebar detection</li> <li>• Repair of deteriorated concrete</li> </ul>	<ul style="list-style-type: none"> <li>• Properties of reinforced concrete and maintenance</li> <li>• Inspection and evaluation of RC</li> <li>• Results of inspection and evaluation of jetties</li> <li>• Repair and maintenance of RC</li> </ul>

Source: JICA Project Team

### 3-2 PRE-SURVEY

JICA Project Team surveyed the same jetties that were surveyed in 2013 in the previous Phase of the Project (The Project for Rehabilitation of Yangon Port and Main Inland Water Transport in The Republic of The Union of Myanmar - Phase 2). This was to check the conditions of the concrete aging during this elapsed time, and/or to see whether or not maintenance to the jetties was conducted by the counterparts. The results of the survey are summarized in this section.

#### 3-2-1 METHOD AND OBJECT OF THE SURVEY

JICA Project Team first confirmed the jetties that were repaired by the counterparts after 2013. Then the Expert of JICA Project Team (hereinafter “the Expert”) chose the jetties for the pre-survey, comparing the conditions of repair around 2013. The following six jetties were targeted on this survey.

- Nan Thi Da 3
- Nan Thi Da 4
- Sin Oh Dang 1
- Sin Oh Dang 2
- Hledan 2
- Kaingdon Jetty 1

The methods of the survey on the site were the visual inspection and the sound test using a hammer by the Expert. The result of the survey was reflected to the contents of the lecture as well as the selection of the site for on-site training. Also this result was used as the base information for the recommendation of maintenance management.



### 3-2-2 RESULT OF THE PRE-SURVEY

The conditions of the six jetties are as follows:

#### (1) Nan Thi Da 3

A part of Nan Thi Da 3 and its condition during the survey are shown Photo 3.1. There were no cracks and peeling off of the concrete surface. The repaired part was in good condition.



Source: JICA Project Team

**Photo 3.1 View and Survey of Nan Thi Da 3**

One of the slanted beams of Nan Thi Da 3 that was previously repaired was defective. The Expert suggested that this defect would be repaired as soon as possible.

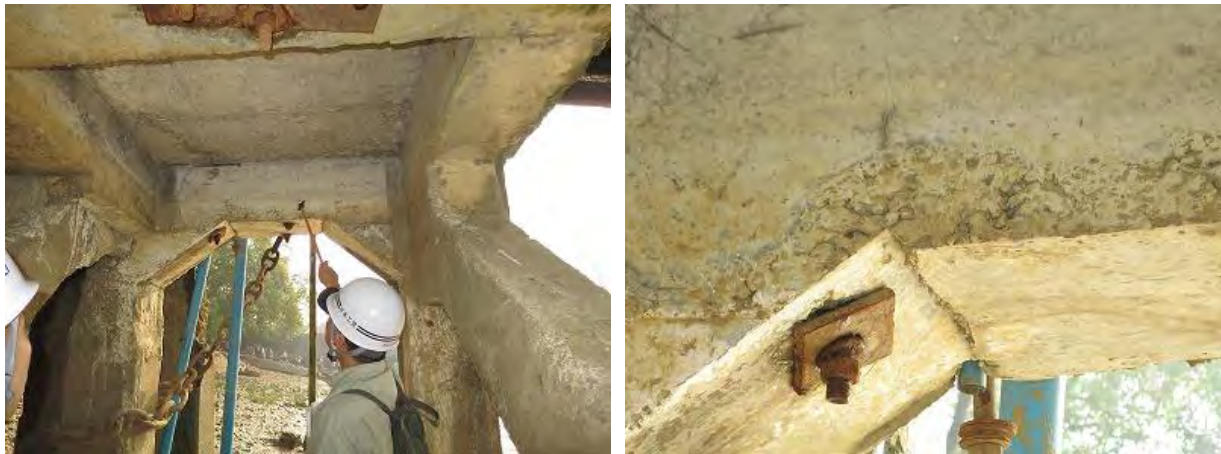


Source: JICA Project Team

**Photo 3.2 Defective Part of Nan Thi Da 3**

## (2) Nan Thi Da 4

A part of Nan Thi Da 4 and its condition during the survey are shown in Photo 3.3. There were no cracks and peeling off of the concrete. The repaired part was in good condition. There were rock pockets in a few parts but they were slight and they do not need to be repaired soon.



Source: JICA Project Team

**Photo 3.3 View and Survey of Nan Thi Da 4**

One part of Nan Thi Da 4 that was previously repaired has defective concrete cover and rebar. The Expert suggested that this defect would be repaired as soon as possible.



Source: JICA Project Team

**Photo 3.4 Defective Part of Nan Thi Da 4**



### (3) Sin Oh Dang 1

A part of Sin Oh Dang 1 and its condition during the survey are shown in Photo 3.5. The concrete cover of the underside of the repaired part was peeled off and the rebar was corroded.



Source: JICA Project Team

**Photo 3.5 View and Survey of Sin Oh Dang 1**

Other parts that were not repaired have peeled-off concrete cover and rebar corrosion. The underside has tensile stress so the Expert suggested that this part would be repaired as soon as possible. On the porter way, there are some exposed rebars. These rebars may not cause a structural problem but these are obstacles for carriage on the porter way. The Expert suggested that this part would be repaired soon.



Source: JICA Project Team

Note: Rebar exposure at the underside and on the Porter Way

**Photo 3.6 Damaged Part on Sin Oh Dang 1**

#### (4) Sin Oh Dang 2

A part of Sin Oh Dang 2 and a repaired part are shown in Photo 3.7. The repaired part, where new mortar was refilled, is in good condition.



Source: JICA Project Team

**Photo 3.7 View and Repaired Part of Sin Oh Dang 2**

There was a defective part on the support of the porter way. There were peeled-off concrete cover and rebar exposure. The Expert suggested that these parts would be repaired as soon as possible.



Source: JICA Project Team

**Photo 3.8 Damaged Part of Sin Oh Dang 2**



## (5) Hledan 2

A part of Hledan 2 and its condition during the survey are shown in Photo 3.9. A repaired part where new mortar was refilled is in good condition (no crack).



Source: JICA Project Team

**Photo 3.9 View and Repaired Part of Hledan 2**

There was a defective part at the underside of Hledan 2. There were peeled-off concrete cover and rebar exposure. The Expert suggested that these parts would be repaired as soon as possible.



Source: JICA Project Team

**Photo 3.10 Damaged Part of Hledan 2**

## (6) Kaingdon Jetty 1

A part of Kaingdon Jetty 1 and a repaired part are shown in Photo 3.11. The repaired part that was broken due to boat collision was reconstructed. There was no crack and it was in good condition.



Source: JICA Project Team

**Photo 3.11 View and Repaired Part of Kaingdon Jetty 1**

There were some repaired parts at the underside of Kaingdon Jetty 1. The refilled mortar in the repaired parts was damaged. These parts were just refilled with new mortar. There was no chipping off of deteriorated concrete and no anti-rust painting on the rebar.



Source: JICA Project Team

**Photo 3.12 Repaired Part of Kaingdon Jetty 1**

### 3-2-3 CONSIDERATION

#### (1) Condition of Repaired Parts

For the parts repaired after the previous technology transfer was conducted in 2013, there were no cracks and peeling off and they were in good condition. The repaired parts lasted for two or three years at least.

On the other hand, on the parts repaired before 2013, there were cracks, damaged concrete cover, and exposed rebars. Repair method by refilling with new mortar was simple.

It is important to chip off deteriorated concrete, put anti-rust paint on the rebar, and refill new mortar or concrete on it.

#### (2) Repair Range

Based on the results of the survey by the Expert, there were defective parts close to the repaired part. Some parts were defective members (no concrete and rebar). Therefore, the Expert suggested that the whole jetty would be checked and other deteriorated parts, if any, would be repaired at the same time.

### 3-3 ON-SITE TRAINING

#### 3-3-1 OUTLINE OF THE TRAINING

Outline of the training is summarized below:

Title of training	: Site Training on Maintenance of Reinforced Concrete Yangon Port Jetties
Date and time	: 22 December 2015, 8:30 to 12:00
Place	: IWT Meeting Room, Kaingdan Jetty 1 and Wadan Jetty 6
Trainees	: Total of six engineers from MPA and IWT (hereinafter “the Trainees”)
Trainer	: Expert of JICA Project Team with Myanmar assistant engineers (hereinafter “the Expert”)

**Table 3.2 List of Trainees**

No.	Name	Department	Designation
1	*****	IWT :Inland Water Transport	Assistant Engineer
2	*****	IWT :Inland Water Transport	Assistant Engineer
3	*****	MPA :Myanma Port Authority	Assistant Engineer
4	*****	MPA :Myanma Port Authority	Foreman
5	*****	MPA :Myanma Port Authority	Divisional Engineer
6	*****	MPA :Myanma Port Authority	Assistant Engineer

Source: JICA Project Team

#### 3-3-2 OUTLINE OF THE PROGRAM

The main program of the on-site training is as follows:

- Introduction of the Project and purpose of the training at the IWT Meeting Room
- On-site orientation
- Inspection of the concrete at the Kaingdan Jetty 1
- Repair of the deteriorated concrete at the Wadan Jetty 6
- Question and answer

Two jetties were selected for the training based on the results of the pre-survey shown in Section 3-2. The conditions of the two jetties are below:

**Table 3.3 Conditions of Jetties selected for On-site Training**

Jetty	Conditions	Remarks
Kaingdan Jetty 1	Many damaged parts. Repaired part is damaged again.	Please refer to Photo 3.13.
Wadan Jetty 6	Damaged part is good for the demonstration of repair.	Please refer to Photo 3.14.

Source: JICA Project Team



The condition of the selected jetties is shown in following Photo.



Source: JICA Project Team

**Photo 3.13 Overall and Repaired Part of Kaingdan Jetty 1**



Source: JICA Project Team

**Photo 3.14 Overall and Deteriorated Part (Rebar Exposure) of Wadan Jetty 6**

### 3-3-3 DETAILS OF ON-SITE TRAINING

#### (1) On-site Orientation

The outline of the on-site training was explained at the site by the Expert. The contents of the on-site training are the following:

- Visual inspection and sketches,
- Sound survey,
- Schmidt Hammer Test,
- Sampling of concrete core,
- Rebar detection, and
- RC beam repair.





Source: JICA Project Team

**Photo 3.15 On-site Orientation**

### (2) Visual Inspection and Sketches (Kaingdan Jetty 1)

The Expert explained about the deterioration and damages of Kaingdan Jetty 1 and how to carry out the visual inspection and sketches. The Expert showed how to use crack scale and draw cracks. After that, the Trainees tried to make sketches of crack and other deterioration. Most of the Trainees made sketches and became acquainted with it.

### (3) Sound Survey

The Expert explained about the sound survey using a hammer. The sound survey is being done to detect peeled off concrete covering. From the sound made by the hammer upon hitting the concrete surface, it is possible to judge the concrete cover conditions such as peeling off. After the explanation by the Expert, the Trainees tried the sound survey using a hammer.



Source: JICA Project Team

**Photo 3.16 Explanation of Sound Survey and Trial by the Trainees**

#### (4) Schmidt Hammer Test

The Expert explained the principle and method of the Schmidt Hammer Test. The Schmidt Hammer Test aims to measure the value of rebounding at the concrete surface and to calculate the concrete strength through a formula. The Trainees used the Schmidt Hammer Test and estimated the concrete strength of the jetty.



Source: JICA Project Team

**Photo 3.17 Explanation and Demonstration of the Schmidt Hammer Test**

#### (5) Sampling of Concrete Core

The Expert set a core drill in the pillar of the jetty and made a demonstration of core sampling. The Trainees operated the core drill for core sampling under the Expert's instruction.

Also the Expert explained about the method of the compressive strength test of the core sample.



Source: JICA Project Team

**Photo 3.18 Demonstration of Core Drilling and Participant's Operation**

#### (6) Rebar Detection

Before core sampling, rebar detection is needed to avoid cutting the rebar by core drill. Rebar detection is also needed for repairing structural design. The Expert explained the method of rebar detection and demonstrated the test by using the equipment as shown in Photo 3.19. The rebar detector is a non-destructive test, which uses radar system. The Trainees operated the rebar detector under the Expert's instruction.





Source: JICA Project Team

**Photo 3.19 Rebar Detector (Radar System)**



Source: JICA Project Team

**Photo 3.20 Demonstration of Rebar Detection and the Trainees' Operation of the Equipment**

### (7) Repair of the RC Beam

Cracks and rebar exposure occurred due to rebar corrosion at some beams at the Wadan Jetty 6. The Expert selected this jetty as a suitable site for the on-site training because the deterioration by rebar corrosion is popular in Yangon port.

The Expert removed the concrete covering and the rusted rebar, painted it with anti-rust paint, added a new rebar, and refilled new mortar. Time was limited to show how to repair the RC Beam during the training. Therefore, the Expert showed the repair process and explained the important points about the repair of the RC beam.



Source: JICA Project Team

**Photo 3.21 Condition of Deteriorated Jetty and Demonstration of Chipping**



Source: JICA Project Team

**Photo 3.22 Explanation and Demonstration about the Beam Repair**

## (8) Question and Answer

The Expert answered questions from the Trainees during the on-site training. The main questions from the Trainees are as follows.

- 1) How to make sketches of deteriorated concrete
- 2) How to use hammer for sound survey
- 3) Points to note about Schmidt Hammer Test
- 4) Rebar detection and core drilling
- 5) Depth of rebar detector
- 6) How to repair wide area

### 3-3-4 RESULT OF ON-SITE TRAINING

The Trainees actively studied and tried to carry out the tests. They understood that concrete survey and repair, which were explained by the Expert, are very useful to maintain the jetties. Since the Expert donated the test equipment of crack scale, Schmidt Hammer, and test anvil, the Trainees were determined to continue doing the test using these equipment. The on-site training was successfully and safely completed.



Source: JICA Project Team

**Photo 3.23 Expert and Trainees**

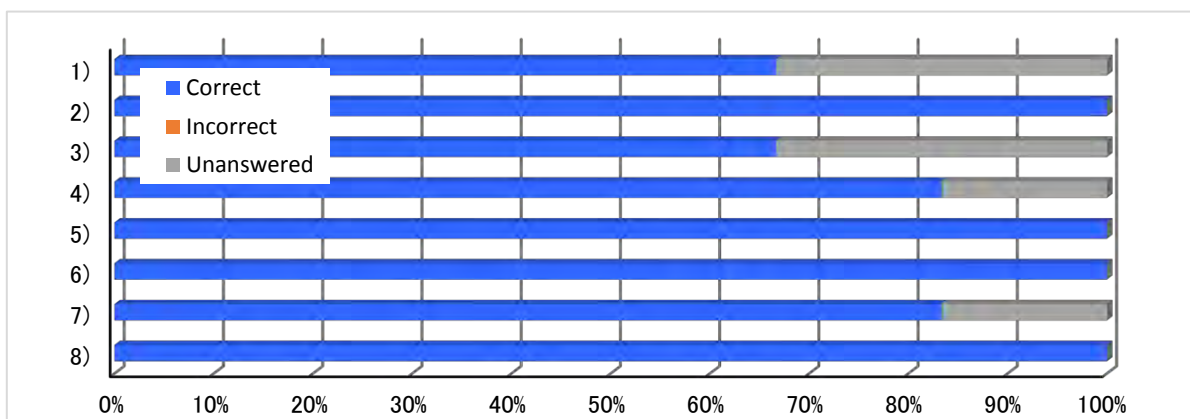
### 3-3-5 RESULT OF QUESTIONNAIRE SURVEY

The results of the questionnaire survey, which was conducted after site training, are shown below.

#### (1) Confirmation of Understanding of Site Training

Understanding of the site training has been confirmed through the following eight items. The correct answers for each item are shown in the figure below. It was found that almost all of the participants understood each item.

- 1) What characteristics does concrete have?
- 2) Why do you put rebar (reinforcing bar) into concrete?
- 3) Why does rebar not rust in good concrete?
- 4) Why will rebar rust in concrete under long time use and severe condition?
- 5) What damages will occur on reinforced concrete under long time use and severe condition?
- 6) How do you survey damages of reinforced concrete?
- 7) What do you need to take care when you repair damaged reinforced concrete?
- 8) Why do you need to maintain reinforced concrete structure for a long time?



Source: JICA Project Team

**Figure 3.1 Accuracy Rate for Questions (Understanding of Site Training)**

## (2) Contents of Training that the Participants Want in the Future

- How to use the checking equipment for inspection, such as hammer, by all engineers concerned with maintenance.
- Maintenance methods, except for the jetties, such as for buildings.
- Maintenance methods for deteriorated concrete facility.

## (3) Opinions about the Training from the Trainees

- It was a very good opportunity because we have acquired the knowledge and gained experiences related to maintenance of reinforced concrete structures.
- We were able to get not only knowledge about repair of damaged reinforced concrete structure but also experience during the site training.
- We got lots of beneficial knowledge about concrete structure from this training.

### 3-4 CLASSROOM LECTURE

#### 3-4-1 OUTLINE OF THE CLASSROOM LECTURE

Title of training	: Classroom Lecture on Maintenance of Reinforced Concrete Yangon Port Jetties
Date and time	: 24 December 2015, 9:00 to 12:00
Place	: Meeting Room at MPA Shipping Agency Department (Ahlone)
Number of participants	: Total of 36 from MPA and IWT (hereinafter “the Participants”)
Trainer	: Expert of JICA Project Team with Myanmar assistant engineers

**Table 3.4 List of Participants**

No.	Name	Department	Designation
1	*****	MPA :Myanma Port Authority	Chief Engineer
2	*****	MPA :Myanma Port Authority	Deputy Chief Civil Engineer
3	*****	MPA :Myanma Port Authority	Deputy Chief Civil Engineer
4	*****	MPA :Myanma Port Authority	Divisional Engineer
5	*****	MPA :Myanma Port Authority	Divisional Engineer
6	*****	MPA :Myanma Port Authority	Divisional Engineer
7	*****	MPA :Myanma Port Authority	Assistant Engineer
8	*****	MPA :Myanma Port Authority	Assistant Engineer
9	*****	MPA :Myanma Port Authority	Assistant Engineer
10	*****	MPA :Myanma Port Authority	Assistant Engineer
11	*****	MPA :Myanma Port Authority	Assistant Engineer
12	*****	MPA :Myanma Port Authority	Assistant Engineer
13	*****	MPA :Myanma Port Authority	Assistant Engineer
14	*****	MPA :Myanma Port Authority	Assistant Engineer
15	*****	MPA :Myanma Port Authority	Assistant Engineer
16	*****	MPA :Myanma Port Authority	Foreman
17	*****	MPA :Myanma Port Authority	Foreman
18	*****	MPA :Myanma Port Authority	Foreman
19	*****	MPA :Myanma Port Authority	Foreman
20	*****	MPA :Myanma Port Authority	Foreman
21	*****	MPA :Myanma Port Authority	Foreman
22	*****	MPA :Myanma Port Authority	Foreman



No.	Name	Department	Designation
23	*****	MPA :Myanma Port Authority	Foreman
24	*****	MPA :Myanma Port Authority	Foreman
25	*****	MPA :Myanma Port Authority	Foreman
26	*****	MPA :Myanma Port Authority	Senior Overseer
27	*****	MPA :Myanma Port Authority	Senior Overseer
28	*****	MPA :Myanma Port Authority	Senior Overseer
29	*****	MPA :Myanma Port Authority	Senior Overseer
30	*****	MPA :Myanma Port Authority	Senior Overseer
31	*****	MPA :Myanma Port Authority	Concrete Technician
32	*****	MPA :Myanma Port Authority	Foreman
33	*****	IWT :Inland Water Transport	Assistant Engineer
34	*****	MPA :Myanma Port Authority	Chief Concrete Technician
35	*****	MPA :Myanma Port Authority	Manager
36	*****	MPA :Myanma Port Authority	Supervisor

Source: JICA Project Team

### 3-4-2 OUTLINE OF THE PROGRAM AND DISPLAY

The main topics of the program are as follows:

- Properties and characteristics of RC
- Survey and diagnosis for RC
- Results of pre-survey and on-site training
- Repair and maintenance of RC
- Question and answer

Concrete materials, rebar corrosion, and survey equipment were displayed during the training. And the concrete materials that are used in Myanmar were confirmed by tour of the local concrete plant.

- Concrete material (cement, aggregate, and admixture)
- Model of rebar corrosion
- Equipment for RC survey (test hammer, Schmidt hammer, core drill, rebar detector)



Source: JICA Project Team

**Photo 3.24 Display of Equipment for Survey**

### 3-4-3 CONTENTS OF CLASSROOM LECTURE

#### (1) Orientation

Mr. Iwami, the Team Leader of the JICA Project Team, explained to the Participants about the Project and the purpose of the lecture.



Source: JICA Project Team

**Photo 3.25 Orientation**

#### (2) Lecture

The Expert explained the properties of reinforced concrete and maintenance. Then lecture was conducted about the survey method, diagnosis, technology of maintenance and also the results of the field survey at Yangon Port. The contents of the lecture are shown below.

- Properties of Reinforced Concrete and Maintenance
- Inspection and Evaluation of Reinforced Concrete
- Results of Inspection and Evaluation of Jetties in Yangon Port
- Repair and Maintenance of Reinforced Concrete



Source: JICA Project Team

**Photo 3.26 Explanation by Projector**



### (3) Explanation of Display

The Expert explained the materials of concrete (cement, aggregate, and admixture). The Expert also showed the model of rebar corrosion and explained the mechanism of corrosion.



Source: JICA Project Team

**Photo 3.27 Explanation of Concrete Materials and Corrosion Model**

During break time, the Participants inspected the display, which was very interesting for the Participants.



Source: JICA Project Team

**Photo 3.28 Participants at the Display**

### (4) Question and Answer

At the end of the lecture, the expert answered several questions from the Participants regarding the design for concrete structure under salt attack, how to maintain deteriorated jetties where the concrete cover has been peeled off and corroded.

And there were other specific questions regarding the actual problem, such as the maintenance method of the deteriorated building made from reinforced concrete.

## (5) Awarding Certificate

Finally, the Expert awarded certificates for completion of the lecture and crack scale to the Participants.



Source: JICA Project Team

**Photo 3.29 Awarding of Certificates to Participants**

### 3-4-4 RESULT OF CLASSROOM LECTURE

Many Participants took part in the lecture. They were very interested in concrete materials and survey equipment. They asked many questions about maintenance of concrete structures. In the classroom lecture, the topic of the Expert ranged from the basic of the concrete to the repair method of deteriorated and damaged concrete. The Expert, showing the illustrative cases, explained the practical methods extensively. It is hoped that the lecture will help them in the maintenance of the jetties.



Source: JICA Project Team

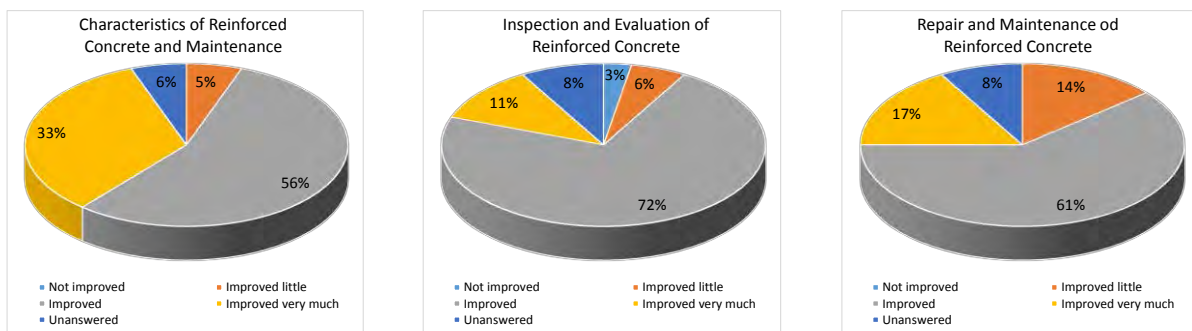
**Photo 3.30 Photo of All Participants**

### 3-4-5 RESULT OF QUESTIONNAIRE SURVEY

The results of the questionnaire survey, which was conducted after classroom lecture, are shown below.

#### (1) Ability Improved by the Classroom Lecture

Improvement of the following three items through the lecture was confirmed using four categories. The percentage of those who “improved” for each item is above half. Especially, the ratio of those who “improved very much” their ability on the “Characteristics of Reinforced Concrete and Maintenance” is over 30% and it seems that sufficient achievement has been obtained.

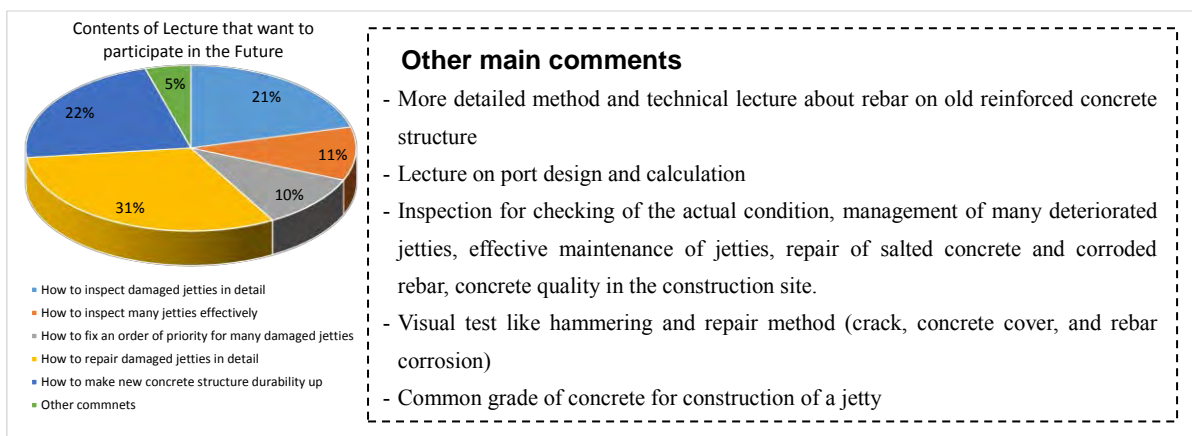


Source: JICA Project Team

**Figure 3.2 Ability Improved by the Classroom Lecture**

#### (2) Contents of Lecture that the Participants Want in the Future

The contents of the lecture that participants want in the future were confirmed through multiple-choice questionnaire. The topic which has the largest quantity of responses is “how to repair damaged jetties in detail”, and the topic with the second largest response is “how to make new concrete structure more durable”.



Source: JICA Project Team

**Figure 3.3 Contents of Lecture that the Participants Want in the Future**

#### (3) Opinions about the Lecture from the Participants

Out of the 36 people who attended the lecture, 25 people provided other comments on the lecture. According to the following main comments, it seems that almost all participants were satisfied with the lecture.

- Today's lecture is useful for me. I would like to invite you to hold lecture again.
- Please lecture more about repair and maintenance of marine structure made of reinforced concrete.
- We could obtain a lot of knowledge for the maintenance of reinforced concrete through this lecture.
- We would appreciate it if you could give us more knowledge and technique about repair and maintenance of deteriorated jetty.
- I'm satisfied with this lecture because I could learn much knowledge about the maintenance of reinforced concrete.

### 3-5 RECOMMENDATION FOR THE MAINTENANCE METHOD

#### 3-5-1 CURRENT SITUATION RELATED TO THE MAINTENANCE OF PORT FACILITIES

Through the implementation of defect inspection, on-site training, classroom lecture, and follow-up on the technical transfer implemented in 2013, the following matters related to maintenance management have been identified and are discussed below.

##### (1) Implementation of Defect Inspection

The concrete quality of the Dalla Ferry Terminal is generally good and initial defects such as cracks have not been found. Since filling defect of the concrete has been observed, repair has been implemented (for the detailed contents, refer to Chapter 2).

##### (2) Implementation of Pre-survey

The repair method used after 2013, for which technical transfer was done, was appropriate. However, the scope of repair was not sufficient since there were some areas that had been left unattended and had been damaged significantly. As for the areas that had been repaired before 2013, appropriate method was not used and there were some cases where the facilities had deteriorated again.

Although MPA conducts visual inspection regularly, detailed inspection in the lower part of the facilities such as the abutment or slab of the porter way has not been conducted enough. Furthermore, although recording is performed on the inspection, effective utilization of these data may also be recommended as a task in the future.

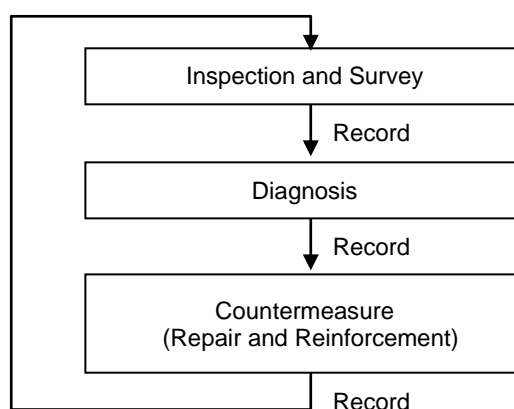
##### (3) Technical Transfer (On-site Training and Classroom Lecture)

For the engineers/staff from MPA and IWT, although their knowledge about concrete is enough to some extent, the technology related to maintenance (inspection, survey, diagnosis, and countermeasure) is inadequate.

Not only those with management posts such as Chief Engineer and Deputy Chief Civil Engineer, but also officials in charge of maintenance such as Assistant Engineer and Divisional Engineer and workers such as foreman and overseer have participated in the site training and classroom lecture. The positive attitude of trying to absorb new knowledge and skills has been observed in performing the actual maintenance in the field.

#### 3-5-2 RECOMMENDATION FOR THE MAINTENANCE METHOD

For proper maintenance management, it is important to repeat the cycle of "inspection and survey", "diagnosis", and "countermeasure". Also, recording and preserving each data are important. The flowchart for proper maintenance is shown in the figure below.



Source: JICA Project Team

**Figure 3.4 Cycle of Maintenance Management**

The recommendations for the implementation of proper maintenance management are discussed below.

#### (1) Implementation of Proper Inspection, Survey, and Recording

During the technical transfer (on-site training), the visual inspection and recording have been explained, and cracks and other deterioration were sketched by the participants. In addition, explanation and practical training for other survey methods (hammering, rebar detection, core sampling) have also been conducted.

It is very important to implement the inspection, survey, and recording continuously.

#### (2) Implementation of the Proper Countermeasure

During the site training at the Wadan Jetty 6, the explanation and practical training of the repair of cracks and rebar exposure due to rebar corrosion were carried out. Although this is an example of repair method for a typical damage observed in the site, technical transfer had also been conducted in 2013 such as for crack repair and concrete cover repair. Inspection, survey and Countermeasure are important and The JICA Project Team suggests to be implemented continuously.

#### (3) Establishment of Maintenance Management Method and Effective Operation

The following are necessary in order to establish the proposed maintenance management method (“Proper Inspection, Survey and Record” and “Proper Countermeasure”) and to operate it effectively:

- Standards and manual of inspection, survey, and recording;
- Standards and manual of the proper countermeasure and
- Continued implementation of training and lecture.

#### (4) Other Recommendation (Repair Material)

In Myanmar, there is a case in which the working time could not be secured sufficiently because of the sea level fluctuations or climate change. Therefore, it is desirable that the repair material that can be cured in a relatively short period (mortar and cement for the repair section) can be procured in Myanmar.



## CHAPTER 4 PUBLIC ANNOUNCEMENT

An expert of the Public announcement of the member of JICA Project Team accompanied the JICA, MPA, IWT, the other JICA Project Team, and the contractor and observed the defect inspection of the pilot project for restoration of Dalla Ferry Terminal Jetty. Inspection process was recorded, and interview to the participants of the inspection was conducted. The participants from MPA and IWT learned the importance of the inspection of the facilities as well as its design. Interview to the ferry passengers proved that the new ferry terminal had dramatically improved the convenience of the ferry service.

The Expert then covered the classroom lecture on the maintenance of reinforced concrete facilities and the on-site training on how to check the soundness of the facilities at the Yangon Port conducted by JICA Project Team. The lecture and training were held to improve the skills of MPA and IWT engineers/staff. The enthusiasm of the trainees indicates the importance of the appropriate training scheme to Myanmar.

The Expert will run an article in the “International Development Journal” this coming March regarding the above joint defect inspection and training including other various projects related to inland water transport facilities in the Yangon Port under JICA cooperation in the past eight years. It can reach many readers such as consultants, JICA staffs, researchers, and students or youngsters who want to be professionals in the field of international cooperation.



Source: JICA Project Team

**Photo 4.1 Situation of Interview**



Source: International Development Journal (January 2016)

**Figure 4.1 International Development Journal (January 2016)**

presence in Myanmar.

Furthermore, in two or three months, the article will appear on the online news site called “JB Press (<http://jbpress.ismedia.jp/>)” run by the Japan Business Press, Co. Ltd. in its website.

It is expected that a number of business persons will know about the projects.

The JICA Project Team is also asking for the cooperation of the editor of “MYANMAR JAPON”, a free paper magazine in Myanmar, to introduce the cooperation not only to the local people but also Japanese people living and working in Myanmar.

Three ferry boats are now being used to provide transport services between the central part of Yangon City and the Dalla District and more than thirty thousand people use them every day. These ferry boats were also donated under Japanese grant aid in 2014.

Both ferry boats and port restoration projects are very good examples of Japanese official development assistance (ODA) whose outcome can be directly seen by the Yangon people. Recalling these projects and calling the public attention at the time of the joint inspection are indeed important from the point of view of improving the Japanese

## CHAPTER 5 SUMMARY (OUTPUT AND EVALUATION)

### 5-1 BACKGROUND

On 2 and 3 May 2008, Cyclone Nargis struck the coastal areas of Myanmar and moved inland across the Ayeyarwady Delta, causing considerable human loss and damage to properties. The disaster caused widespread destruction of houses and vital infrastructures, including roads and port facilities. The facilities and fleets of inland water transport were also battered severely, paralyzing its operation and the distribution of basic human needs and commodities. As the restoration project of the port that was affected by Cyclone Nargis, “The Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport in the Republic of the Union of Myanmar” was commenced the services by JICA Project Team from February 2009 and it was completed the last Phase in February 2015.

The past phases of the Project covered the areas damaged by Cyclone Nargis: Yangon Port, four main inland waterways and hub ports in the Ayeyarwady Delta. The counterpart agencies to the JICA Team were MPA (Myanma Port Authority) and IWT (Inland Water Transport). MPA is responsible for providing terminal facilities and necessary services such as pilotage, water supply, fuel bunkering and cargo handling. IWT is responsible for providing inland transport services, including cargo and passenger transport, ship building and repair. The steering committee was established and chaired by the Vice Minister of the Ministry of Transport (hereinafter referred to as “MOT”). The member of the steering committee includes the representatives of MPA, IWT, Embassy of Japan, JICA Myanmar Office, and the JICA Project Team and the steering committee have been held four times.

The Project scope were as follows;

- Recommendation of Urgent Measure in Securing Safety Navigation in Yangon Port
- Preparation of Recovery Plan of Port Facilities in Yangon Port
- Preparation of Recovery Plan of Main Inland Waterways in the Project Area
- Capacity Development of Ship Crew and Navigation
- Capacity Development of Repairing Ships and Metal Structure
- Study of Tide Observation System Enhancement
- Study of Marine Disaster Risk Management Enhancement
- Social and Environmental Considerations
- Preparation and Implementation of Pilot Project

This Project (Phase 3) is the final compilation of the previous project (Phase 2) and it included the following services:

- Conducted the defect inspection after the 1-year defect notification period of the pilot project “The Pilot Project of Restoration of the Dalla Ferry Terminal Jetty ad Dalla Side”.
- Conducted pre-survey, on-site training and classroom lecture about inspection and repair method of the concrete facilities.
- Conducted seminar about ship and metal structure repairs at MMU.

Implemented programs from 2009 including this Project (Phase 3) are depicted in the following chart.

	Phase 1		Phase 2				Phase 3	
	2009	2010	2011	2012	2013	2014	2015	2016
[Training] Capacity Development of the Ship Crew and Navigation	Step-1 Ship maneuvering (1)	Step-2 Leading & Sector Light				Step-3 Ship maneuvering (2)		
[Training] Capacity Development of Repairing Ships and Metal Structures	Step-1 Arc Welding (Basic)	Step-2 Sustainable Arc Welding		Step-3 CO2 Welding & Test		Step-4 Pontoon Building		Lecture for Marine Engineering
[Study] Supplemental Study on Maritime Disaster Risk Management	Simulation of Nargis	Analysis of Future Cyclone & Tsunami (Yangon)		Analysis of Future Cyclone & Tsunami (Delta Area)				
[Study] Study of Tide Observation System	Installation of 2 ATG at MP & MITT	Analysis for 1 year's data		Analysis for confirmation for Yangon and Tide Analysis for Delta				
[Pilot Project] Restoration Work for the Dalla Jetty	Design (1) PQ (1)	Tender (1) Tender (2)		PQ (2) Relocation (Botahaung to Dalla)	Design (2) PQ & Tender (3)	Construction	Defect liability period	Defect Inspection Maintenance Technical Transfer
Steering Committee	▲ SC1 ▲ SC2				▲ SC3		▲ SC4	

Source: JICA Project Team

**Figure 5.1 Implemented Programs of the Project**

## 5-2 DEFECT INSPECTION

One year has passed since the completion of the construction of the Dalla Ferry Terminal Jetty, defect inspection was conducted to check whether or not there were defects, which were attributable to the workmanships of the Contractor. The defect inspection was summarized and reported to JICA upon confirmation of the completion of the repair works. The following facilities were inspected:

- **Steel Structures:** pontoon, movable steel bridge
- **Concrete Facilities:** porter way, walkway, slipway, revetment, fence
- **Buildings:** passenger terminal building, toilet

JICA Myanmar Office and JFE Engineering Cooperation signed the contract on January 31, 2014. The whole of the Works was completed on October 28, 2014 which was the 270th day from the date of the commencement of the Pilot Project. The facilities were handed over to IWT and MPA on November 15, 2014.

The facilities, one year passed since completion, are generally in good conditions. No major defects or damages were found except for the minor ones such as sinking of concrete blocks at pedestrian walkway.

The joint inspection to identify the defective facilities was carried out on December 23, 2015. JICA (the Client), NK (the Consultant), and JFE (the Contractor) are the inspection members, and MPA and IWT (Counterparts and Owners) attended as witnesses. Not only items to be inspected and judgment rule of the defects by the Contractor but also procedure before and after the defect inspection and responsibility of the Client, the Consultant and the Contractor are explained at the joint inspection.

The Contractor commenced the repair works on 2 January 2016 and completed them in two weeks. Joint inspection was carried out on 21 January 2016 by NK and JFE with the presence of MPA and IWT to confirm the completion of the repair works. As a result of this inspection, it was confirmed that the Contractor had completed the repair works, which the Contractor is responsible for.

The Dalla Ferry Terminal is now equipped with two bridges and porter ways. The embarking and disembarking ferry passengers do not cross at the same line, resulted in time saving and safety improvement. It is apparently observed that the number of passengers who choose the IWT ferry for commuting has increased. However, the maintenance management of the facilities by the counterparts (MPA and IWT) appears to be not efficient. Appropriate maintenances have not been carried out due to the lack of budget and work forces. For example, IWT can only use as much as US\$ 500 per year as budget for maintenance of its facilities on the Yangon River including the Dalla Ferry Terminal, Pansondan Terminal, and Delta branch office.

It is desirable that regular inspections of the facilities are carried out such that the minor damages will not become the major damages that require the major repair works. The regular inspections will reduce the maintenance cost, which will also result in reduction of life cycle cost of the facility. Especially, for the facilities used by many users such as Dalla Ferry Terminal, it is expected that each component of the facilities is carefully inspected regularly. Major repair may become necessary without the regular inspection, and may obstruct the passenger services severally.

MPA and IWT were not familiar about the international standard of defect inspection. They gained a better comprehension of the rule. The experience on the defect inspection in this Project will be useful for their future work.

### 5-3 RECOMMENDATION FOR THE MAINTENANCE METHOD

The pre-survey, on-site training and classroom lecture were conducted, with regard to the maintenance of RC structure.

As for the pre-survey, JICA Project Team first confirmed the jetties that had been repaired after the previous technical transfer conducted in 2013. Then the Expert of the JICA Project Team chose six jetties for the pre-survey, comparing the conditions of repairs before and after 2013. The methods of the survey on the site by the Expert were the visual inspection and the sound test using a hammer. The result of the survey was reflected to the contents of the lecture as well as the selection of the site for on-site training. Also this result was used as the base information for the recommendation of maintenance management.

During on-site training, inspection and repair of the RC structure were lectured. The contents of this training were visual inspection and sketches, sound survey, Schmidt Hammer test, sampling of concrete core, rebar detection and RC beam repair. The Expert answered questions from the Trainees during the on-site training. The main questions from the Trainees are “How to make sketches of deteriorated concrete”, “How to use hammer for sound survey”, “Points to note about Schmidt Hammer Test”, “Rebar detection and core drilling” and “How to repair wide area”.

Concrete materials, rebar corrosion, and survey equipment were displayed during the classroom lecture. The Expert introduced the technology of maintenance and explained the properties of RC concrete, the survey method, diagnosis, and the results of pre-survey and on-site training.

For the parts repaired after the previous technical transfer conducted in 2013, there were no cracks and peeling off and they were in good condition. On the other hand, on the portions repaired before 2013, there were cracks, damaged concrete cover, and exposed rebars. Repair method by refilling with fresh mortar was simple. It is important to chip off deteriorated concrete, put anti-rust paint on the rebar, and refill fresh mortar or concrete on it.

The Trainees actively studied and tried to carry out the tests. They understood that concrete survey and repair, which were explained by the Expert, are very useful to maintain the jetties. Since the Expert donated the test equipment of crack scale, Schmidt Hammer, and test anvil, the Trainees were determined to continue doing the test using the equipment. Understanding the contents of the on-site training has been confirmed from the result of the questionnaire survey. It was found that almost all the trainees were satisfied with the training.

During the classroom lecture, the Expert replied the questions from the Participants. One of the

interesting questions was the difference between normal and salt attack environments. The Participant understood their working environment, and was eager to solve the indigenous problem in Yangon. Over 30 staff of MPA and IWT participated in the seminars, and the level of the Participants ranged from foreman to director. Especially, the site level staff vigorously participated in the site training and classroom lecture. They understood the importance of the maintenance management, and were determined to apply the learned skills for their works. According to the questionnaire survey after the lectures, almost all the Participants answered that they had learned new technology and they were very satisfied with the lectures. Many Participants replied that they wanted “more detailed method of repair RC concrete” as the next subject of the lecture. The seminars in the Project are very useful, it is expected that the similar seminars are carried out in future.

Results of the defect inspection of the pilot project of Dalla Ferry Terminal and the pre-survey of six jetties in Yangon Port were taken into account, and the JICA Project Team proposed a practical maintenance management method for RC concrete referring to repair methods in Japan. Although MPA conducts visual inspection regularly, detailed inspection at the lower parts of the facilities such as the abutment or slab of the porter way has not been conducted. The effective use of the recorded data in the inspections is expected. Though the knowledge of concrete is sufficient for MPA and IWT technical staff, the knowledge of maintenance (inspection, survey, diagnosis, and countermeasure) appears to be insufficient. The level of the Participants to the site training and classroom lecture in this Project ranged from foreman to director, and Participants were very eager to learn new technologies. For proper maintenance management, it is important not only repeating the cycle of “inspection and survey”, “diagnosis”, and “countermeasure”, but also keeping the records. Thus, in the Project a technique for sketching concrete damages was lectured. In order to establish and apply the proposed maintenance management method (inspection and survey, diagnosis, countermeasure, and record) in Myanmar prevalently, the followings will be important:

- Standardization and manual preparation of inspection and survey, diagnosis, and record
- Standardization and manual preparation of countermeasure.
- Continuous implementation of training and lecture.

#### 5-4 PUBLIC ANNOUNCEMENT

An expert of the Public announcement accompanied the JICA, MPA, IWT, JICA Project Team, and the contractor and observed the defect inspection of the pilot project for rehabilitation of Dalla Ferry Terminal. Inspection process was recorded, and interview to the participants of the inspection was conducted. The participants from MPA and IWT learned the importance of the inspection of the facilities as well as its design. Interview to the ferry passengers proved that the new ferry terminal had dramatically improved the convenience of the ferry service. The Expert then covered the classroom lecture on the maintenance of reinforced concrete facilities and the site training on how to check the soundness of the facilities at the Yangon Port conducted by JICA Project Team.

The Expert will run an article in the “International Development Journal” this coming March regarding the above joint defect inspection and training including other various projects related to inland water transportation facilities in the Yangon Port under JICA cooperation in the past eight years. It can reach many readers such as consultants, JICA staffs, researchers, and students or youngsters who want to be professionals in the field of international cooperation. Furthermore, in two or three months, the article will appear on the online news site called “JB Press” run by the Japan Business Press, Co. Ltd. in its website. The JICA Project Team is also asking for the cooperation of the editor of “MYANMAR JAPON”, a free paper magazine in Myanmar, to introduce the cooperation not only to the local people but also Japanese people living and working in Myanmar.

It would be very important to announce publically the Japanese assistances to Yangon Port at the completion of the Project. The publication will increase the presence of Japan in Myanmar, which attract attentions of both Japanese and foreigners.



## 5-5 OUTPUT AND EVALUATION OF OTHER WORK

Since this Project duration was only 1.5 month, utmost cautions was necessary in the preparation stage, such as smooth purchase and import of equipment or close communications with the counterparts.

An associate professor of marine engineering at TOKAI University had a seminar on ship building at the Myanmar Maritime University (MMU). This was to enhance the contents of this Project. The number of the participant was 200 over, which was far exceeded the expected number of 60. The popularity of the seminar would be probably due to the success of the previous Phase 2 seminar on disaster prevention.

One of the outcomes of this seminar is that TOKAI University and MMU will make a MOU (Minutes of Understanding) for exchange program. Project Team is confident that this will contribute to the development of human resources in the ship building, which MPA and IWT has been anxious for.

During this Project (Phase 3), it was confirmed that the scopes of the JICA Project Team in the previous Phases have contributed to the increase of the capacities of the counterparts. Among the scopes are capacity development of Ship Crew and Navigation, Capacity Development of Repairing Ships and Metal Structure, Study of Tide Observation System Enhancement, Study of Marine Disaster Risk Management Enhancement, and Preparation and Implementation of Pilot Project.

An example of the improvement of the technical skill is inspection and repair of the concrete structure. This Project conducted advanced seminar in continuation to the seminar in 2103, and it was confirmed that the counterparts have sufficient basic skills for concrete inspection and repair. The JICA Project Team is confident that the counterparts will conduct regular inspections on the concrete structures by the method learned from the Project. The Team also hope that inspection methods learned from defect inspection, field study, or seminar, will be applied to the counterparts' new facilities, which will result in reduction of life cycle costs and in improvement of their financial status.

“The Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport in the Republic of the Union on Myanmar” started in February 2009, and this Project (Phase 3) is the last series of the Project. Total 43 expatriates were assigned to their specific areas. Due to this diversity, technical assistances were conducted interdisciplinary, and the JICA Project Team received a high evaluation from the counterparts, other related authorities, and MOT.

The JICA Project Team hope that the counterparts will maintain and transfer the skill and knowledge learned from the Project, and develop them by themselves.

## **APPENDICES**

- APPENDIX 1** Photos of the Facilities to be Inspected
- APPENDIX 2** Photos of the Repaired Items

## **APPENDIX 1**



### **Photos of the Facilities to be Inspected**

**APPENDIX 1**  
**PHOTOS OF THE FACILITIES TO BE INSPECTED**

**Date. 23th December, 2015**




**1. STEEL STRUCTURE**


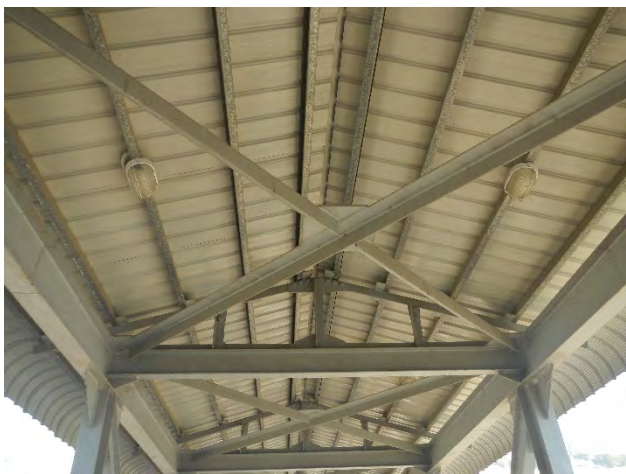

**1.1 Porter Way Roof Structure**

Inspected Photo	Remark
	West Porter Way Roof Structure
	East Porter Way Roof Structure






## 1.2 Steel Bridge



Inspected Photo	Remark
	West Steel Bridge  Structure Roofing Lighting
	Steel Bridge Roof Structure and Lighting (West Steel Bridge)
	Underneath of Steel Bridge (West Steel Bridge)

Inspected Photo	Remark
	<p>East Steel Bridge</p> <p>Structure Roofing Lighting</p>
	<p>Steel Bridge Roof Structure and Lighting (East Steel Bridge)</p>
	<p>Underneath of Steel Bridge (East Steel Bridge)</p>

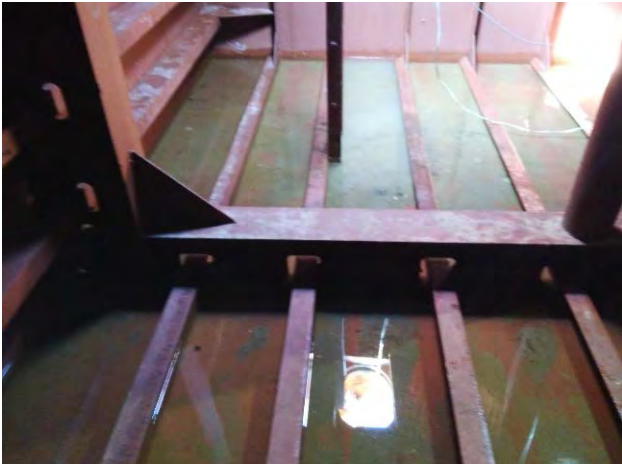

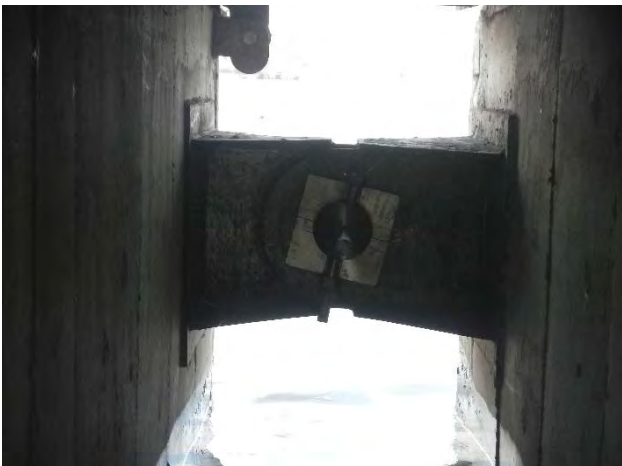
### 1.3 Pontoon Made by IWT

Inspected Photo	Remark
	<p>Pontoons made by IWT</p> <p>Pontoon Structure Hand Rail Stainless Steel Fender Bollard Manhole Cover Anchorage</p>
	<p>Outside of Pontoon</p> <p>Pontoon Structure Hand Rail</p>
	<p>Outside of Pontoon</p> <p>Pontoon Structure Bollard Stainless Steel Fender</p>



Inspected Photo	Remark
	<p>Outside of Pontoon Manhole Hatch Cover</p>
	<p>Outside of Pontoon Anchorage</p>
	<p>Inside Pontoon (West Pontoon)</p>



Inspected Photo	Remark
	<p>Inside Pontoon (East Pontoon)</p>
	<p>Pontoon Connection (Land Side)</p>
	<p>Pontoon Connection (River Side)</p>

## 2. CONCRETE FACILITIES

### 2.1 Slipway

Inspected Photo	Remark
	Stair Case at Slipway
	Top Surface of Slipway
	Side of Slipway

## 2.2 Fence

Inspected Photo	Remark
	Fence Column Capping Concrete block
	Connection at Column and Capping
	Concrete Block






### 2.3 Walkway




Inspected Photo	Remark
	Walkway around Terminal Building
	Walkway from East Porter Way to Slipway
	Walkway around Toilet



## 2.4 West Porter Way

Inspected Photo	Remark
	<p>Porter Way</p> <p>Pile Pile Cap Beam Slab</p>
	<p>Underneath of Porter Way (Pile, Pile Cap, Beam, Slab, Abutment)</p>
	<p>Slab of Porter Way</p>

## 2.5 East Porter Way




Inspected Photo	Remark
	<p>Porter Way</p> <p>Pile Pile Cap Beam Slab</p>
	<p>Underneath of Porter Way (Pile, Pile Cap, Beam, Slab, Abutment)</p>
	<p>Slab of Porter Way</p>

## 2.6 Revetment

Inspected Photo	Remark
 A photograph showing a concrete revetment wall on a steep, eroded embankment. The wall has a decorative lattice pattern. In the background, a covered walkway and a building are visible under a clear blue sky.	Revetment (between Slipway and West Porter Way)
 A photograph of a concrete revetment wall with a lattice pattern, situated on a dirt embankment. A stream or drainage channel is visible on the right side of the wall.	Revetment (between West Porter Way and East Porter Way)
 A photograph of a concrete revetment wall in front of a white building with a blue roof. The ground in front of the wall is covered with debris and trash.	Revetment (between East Porter Way and Fence Boundary)




**2.7 Pontoon Coating Concrete**

Inspected Photo	Remark
	<p>Concrete Coating of Pontoon by JFE</p> <p>Top Surface                      Longitudinal Side Surfaces                      Traverse Side Surfaces</p>
	<p>Top Surface</p>
	<p>Top Surface</p>






Inspected Photo	Remark
	<p>Longitudinal Side Surface (River Side)</p>
	<p>Longitudinal Side Surface (Land Side)</p>
	<p>Traverse Side Surface (Outer Side)</p>

Inspected Photo	Remark
	Traverse Side Surface (Inner Side)

### 3. BUILDING

#### 3.1 Terminal Building

Inspected Photo	Remark
	<p>Passenger Terminal Building</p> <p>Interior facilities Exterior facilities</p>
	<p>Interior Facilities (Ceiling, Lighting, Ceiling Fan)</p> <p>Passenger Waiting Area Passenger Service Office Manager's Office I-Pay Service Shop</p>
	<p>Interior Facilities (Doors)</p> <p>Passenger Waiting Area Passenger Service Office Manager's Office I-Pay Service Shop</p>

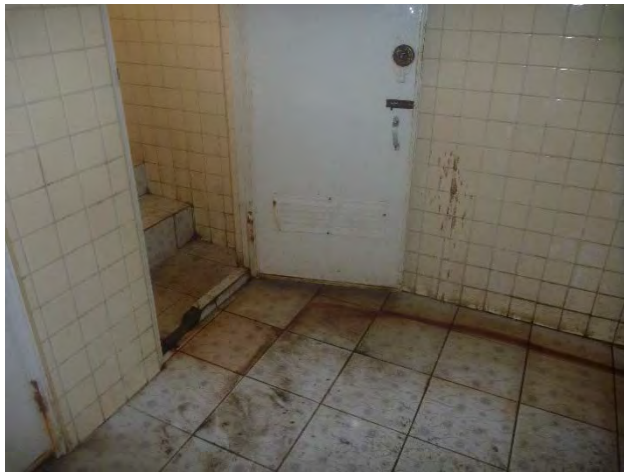

Inspected Photo	Remark
	<p>Interior Facilities (Window)</p> <p>Passenger Waiting Area Passenger Service Office Manager's Office I-Pay Service Shop</p>
	<p>Interior Facilities (Wall)</p> <p>Passenger Waiting Area Passenger Service Office Manager's Office I-Pay Service Shop</p>
	<p>Exterior Facilities</p> <p>Ventilation Louver Gutter and Downspout Roofing</p>



Inspected Photo	Remark
	<p>Exterior Facilities</p> <p>Wall Downspout</p>
	<p>Roofing</p>
	<p>Lightning Pole and Cable</p>

### 3.2 Toilet

Inspected Photo	Remark
	<p>Toilet</p> <p>Interior Facilities</p> <p>Exterior Facilities</p> <p>Wooden Fence</p>
	<p>Interior Facilities (Male Toilet)</p> <p>Ceramic Tile Wall</p> <p>Toilet Accessories</p>
	<p>Interior Facilities (Male Toilet)</p> <p>Ceramic Tile Wall</p> <p>Toilet Accessories</p>

Inspected Photo	Remark
	<p>Interior Facilities (Male Toilet)</p> <p>Ceramic Tile Wall Door</p>
	<p>Interior Facilities (Female Toilet)</p> <p>Ceramic Tile Wall Toilet Accessories</p>
	<p>Interior Facilities (Female Toilet)</p> <p>Ceramic Tile Wall Toilet Accessories</p>

Inspected Photo	Remark
	<p>Interior Facilities (Female Toilet)</p> <p>Door</p>
	<p>Exterior Facilities</p> <p>Wall Roofing Ventilation Louver</p>
	<p>Wooden Fence</p>










## **APPENDIX 2**

### **Photos of the Repaired Items**

## APPENDIX 2 PHOTOS OF THE REPAIRED ITEMS

### 1. STEEL STRUCTURE

#### 1.1 West Steel Bridge

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Timber plank is defected.
		Timber floor connection is loosed and mounted.
		Rust and Paint is defected.
		One number of light bulb is defected.

## 1.2 East Steel Bridge

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Rust and Paint is defected.
		Timber floor longitudinal member is mounted and cracked.
		Timber floor longitudinal member is mounted.
		All lights are not working.





## 2. CONCRETE FACILITIES





### 2.1 Slipway

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Surface plaster is defected.
		Surface plaster is defected.
		Concrete is defected, so rebar is come out.
		Concrete is defected.



Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
 A photograph showing a concrete surface with significant defects, including dark spots and exposed aggregate. Several people in light blue uniforms are visible in the background, observing the structure.	 A photograph showing the same concrete surface after repair. The surface is smoother and more uniform in color, with the rebar no longer exposed. A person's legs in blue pants are visible at the top of the frame.	Concrete surface is defected and rebar is exposed.






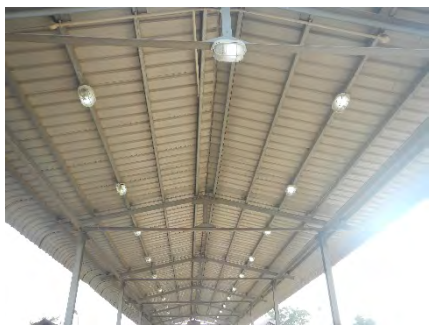
## 2.2 Fence

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		<p>Top portion of fence column is cracked and rebar is appeared.</p>
		<p>Top portion of fence column is cracked and rebar is appeared (Total 4 places).</p>

### 2.3 Walkway




Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		ICB paver blocks are sunken.
		ICB paver blocks are sunken and damaged.
		ICB are sunk and damaged.
		ICB are sunk and damaged.

**2.4 West Porter way**





Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		<p>Pile cap bottom surface connection is defected (Total 3 places).</p>
		<p>Edge of Porter Way slab (vertical surface) is defected.</p>
		<p>All lights are not working.</p>





**2.5 East Porter Way**

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		5 numbers of light bulb are defected.
		Concrete surface is defected.
		Concrete surface of abutment (vertical side) is defected.

**2.6 Revetment**









Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		<p>Some rubble stone in bottom portion are missing and crack appeared.</p>
		<p>Revetment cracked base of Porter Way west.</p>

## 2.7 Pontoon Coating Concrete





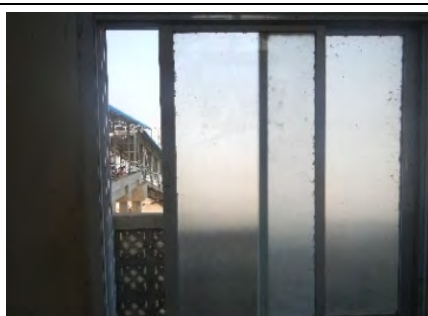


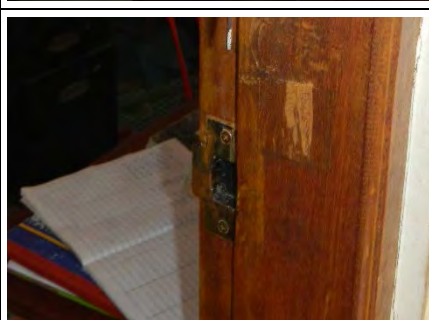

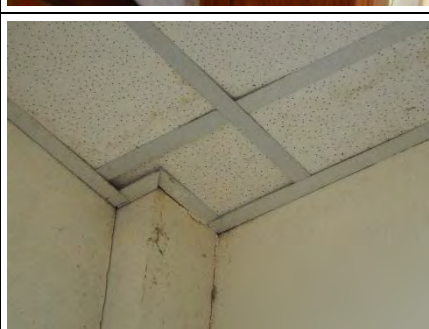
Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Steel angle is deformed and concrete is defected.

### 3. BUILDING

#### 3.1 Terminal Building

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
 A photograph of a ceiling tile that is missing, revealing a dark rectangular opening in the ceiling structure.	 A photograph of the same ceiling area after repair, showing a new white ceiling tile in place.	4 numbers of ceiling are defected.
 A photograph of a ceiling tile with a dark, moldy spot. A red circle highlights the affected area.	 A photograph of the same ceiling tile after repair, appearing clean and white.	
 A photograph of a ceiling tile with a dark, rectangular hole. A red circle highlights the hole.	 A photograph of the same ceiling area after repair, showing a new white ceiling tile in place.	Ceiling is defected.
 A photograph of a ceiling tile with a dark, rectangular hole. A red circle highlights the hole.	 A photograph of the same ceiling area after repair, showing a new white ceiling tile in place.	Ceiling is defected.



Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		<p>Door is defected (bottom of the door close to floor level and difficult to swing).</p>
		<p>6 numbers of glass window leaf are defected.</p>
		<p>Mosquito net leaf is defected.</p>
		<p>Door lock is defected.</p>
		<p>Ceiling is defected.</p>

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Brackets are loosed.
		
		Roof fascia is defected on one side .
		Lightning cable middle bracket is loosed.
		One number of lightning pole is loosed from bottom side.

### 3.2 Overall Defects

#### 3.2.1 Crack line

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Crack line is occurred.
		Crack line is occurred.
		Crack line is occurred.
		Crack line is occurred.


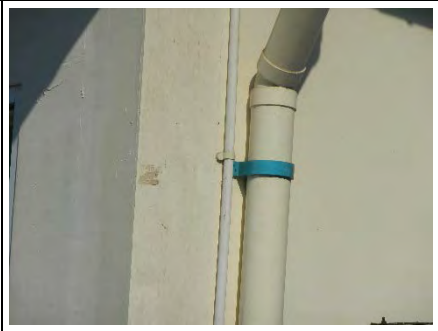
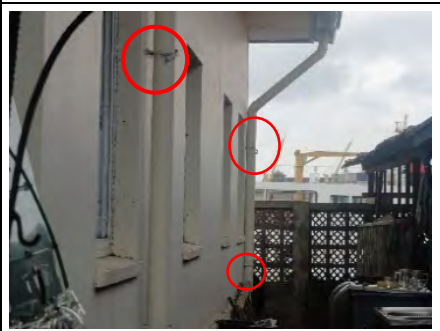


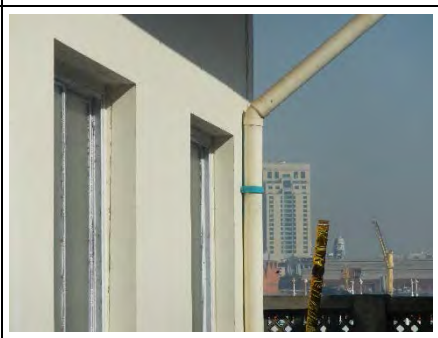


Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Crack line is occurred.
		Crack line is occurred.
		Crack line is occurred.
		Crack line is occurred.
		Crack line is occurred.






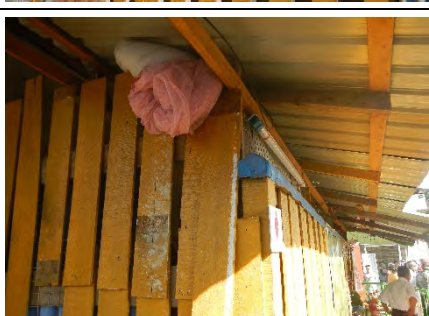
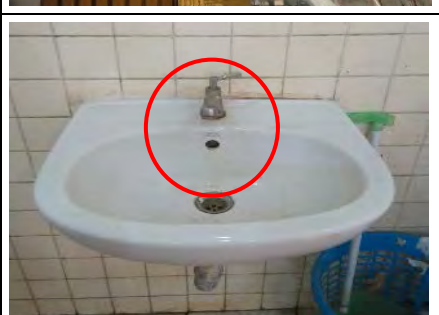


Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Crack line is occurred.

### 3.2.2 Rain Water Down Pipe

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
		Downpipe brackets are damaged.
		Downpipe brackets are damaged.
		Downpipe brackets are damaged.

### 3.3 Toilet

Defects Photo (23.12.2015)	Repaired Photo (21.1.2016)	Remark
 <p>A photograph of a urinal in a public toilet. The water tap on the urinal is circled in red, indicating it is defective.</p>	 <p>The same urinal is shown after repair. The water tap is now functional and is no longer circled.</p>	<p>Urinal bowl water tap is defected.</p>
 <p>A photograph of a transfer pump enclosure. The enclosure is made of metal mesh and is surrounded by debris and trash.</p>	 <p>The same transfer pump enclosure is shown after repair. The enclosure is now clean and free of debris.</p>	<p>One transfer pump is not working.</p>
 <p>A photograph of a building's roofline. The fascia board is circled in red, indicating it is defective.</p>	 <p>The same building's roofline is shown after repair. The fascia board is now intact and is no longer circled.</p>	<p>Roof fascia is defected.</p>
 <p>A photograph of a roof structure. A part of the roof is circled in red, indicating it is defective.</p>	 <p>The same roof structure is shown after repair. The defective part is now fixed and is no longer circled.</p>	<p>Part of roof is defected.</p>
 <p>A photograph of a white basin. The tap is circled in red, indicating it is defective.</p>	 <p>The same basin is shown after repair. The tap is now functional and is no longer circled.</p>	<p>Defected one number of basin tap and need to repair.</p>