REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF CONSTRUCTION
DEPARTMENT OF BRIDGE

DETAILED DESIGN STUDY
ON
THE BAGO RIVER BRIDGE
CONSTRUCTION PROJECT

DESIGN TECHNOLOGY TRANSFER
FINAL REPORT

MARCH 2018

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.
ORIENTAL CONSULTANTS GLOBAL CO., LTD.
METROPOLITAN EXPRESSWAY COMPANY LIMITED.
CHODAI CO., LTD.
NIPPON ENGINEERING CONSULTANTS CO., LTD.

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CHAPTER 1. INTRODUCTION

1.1 BACKGROUND

The Construction Project of Bago River Bridge (hereunder, the Project), contains prominent advanced structural technology such as steel cable-stayed bridge, steel box girder, precast PC box girder, steel pipe sheet pile foundation, which are new in Myanmar. Ministry of Construction (hereunder, MOC) conveyed their request to obtain such technologies both in design and construction to JICA.

Responding to the MOC's request, JICA and MOC discussed and agreed in June 2016 that the JICA Study Team (hereunder, JST) would train about ten MOC engineers for obtaining bridge design skills after the end of preparation of draft bidding documents in the design study of Bago River Bridge.

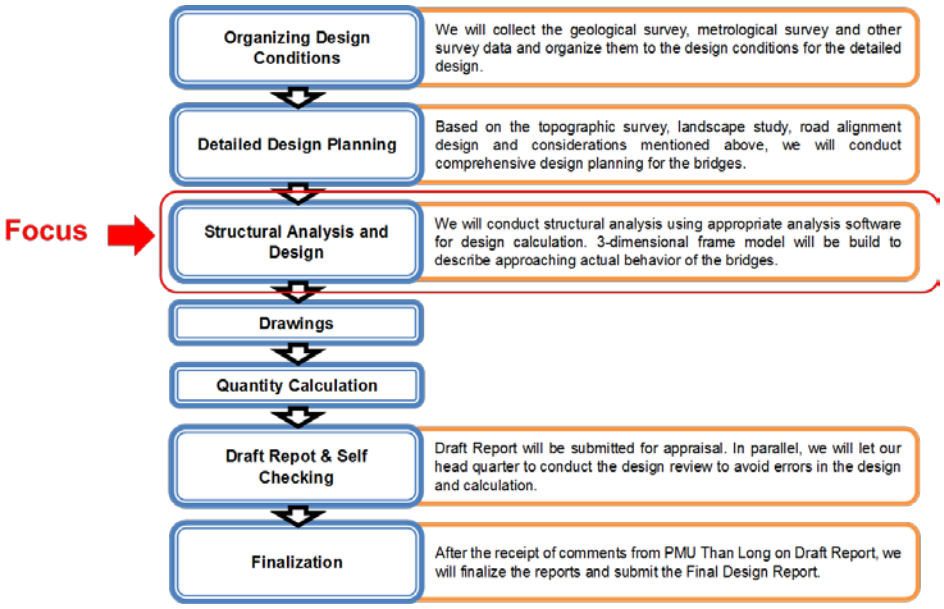
MOC and JICA also agreed that the MOC's engineers would learn project cost estimation methods, and the wind tunnel experiment by holding the corresponding seminars performed by the experts.

1.2 OBJECTIVES OF DESIGN TECHNOLOGY TRANSFER

Through the technical guidance to MOC engineers assigned as the trainees, the following outcome is expected:

- MOC engineers understand a series of the Services for detailed design of the bridges including the technical issues and solutions

Figure 1.2.1 shows the procedures of bridge design. Among the steps of the bridge design procedures, the step of "structure analysis and design" is the target of this design technology transfer since MOC has knowledge and experience in the other steps. In fact, MOC has planned, designed and constructed more than 40 major bridges with conventional structure types such as steel truss bridge, steel plate girder bridge and PC I-girder bridge with bored pile foundation and the other steps are common regardless of structure types.



Source: JICA Study Team

Figure 1.2.1 Series of Services for Detailed Design

CHAPTER 2. OUTLINE OF DESIGN TECHNOLOGY TRANSFER

2.1 SCOPE OF DESIGN TECHNOLOGY TRANSFER

Design Technology Transfer Program (hereunder, the Program) was planned for trainees coming from MOC design division to understand the flow of detailed design and to implement structural calculation to a certain extent by themselves. In the Program, several design lectures, basic practices and detailed practices by using structural analysis software were conducted. These lectures and activities covered each structural types of the bridge applied to the Project. In addition, seminars for wind tunnel test and for cost estimate were conducted.

2.1.1 Design Lectures & Basic Practices Stage

Several design lectures and basic practice related to the Project were conducted as the first stage of the Program. The first stage activities were conducted to all trainees.

a) Special Lecture for Bridge Design

b) Follow-up Lecture for Special Lecture

c) Lecture for Structural Analysis General

d) Lecture for Superstructure Design (Concrete)

e) Lecture for Superstructure Design (Steel)

f) Lecture for Foundation & Substructure Design

2.1.2 Detailed Practices Stage

Following the lectures and basic practice in the first stage, detailed practices were conducted as the second stage by using structural analysis software. For more effective practice, trainees were sorted into the following 4 different groups based on the available software.

a) Detailed Practice for Steel Cable-stayed Bridge

b) Detailed Practice for Steel Box Girder Bridge

c) Detailed Practice for PC Box Girder Bridge

d) Detailed Practice for Foundation & Substructure

2.1.3 Seminars

The seminars for wind tunnel test and for cost estimate which have been taken up in the Project were held as a part of the first stage activity of the Program.

a) Seminar for Wind Tunnel Test

b) Seminar for Cost Estimate

2.2 SCHEDULE OF THE PROGRAM

The schedule of the Program is summarized as below.

- The first stage activity of the program was scheduled from middle of October to latter of December 2017, in which design lecture and basic practices were conducted.
- At the beginning of the first stage, a pretest was conducted to grasp the knowledge of the trainees on bridge design.
- At the end of the first stage, examinations were conducted to evaluate the degree of understandings of the trainees.
- When the first stage completed, the trainees were sorted into 4 groups for the activity in the second stage.
- Activities in the second stage were scheduled from the beginning of January to the end of February 2018, in which detailed practices were conducted.
- At the end of the second stage, presentation for explaining the design practice was made by the trainees.

The overall and detailed schedule of design technology transfer program are indicated in Figure 2.2.1 and Figure 2.2.2.

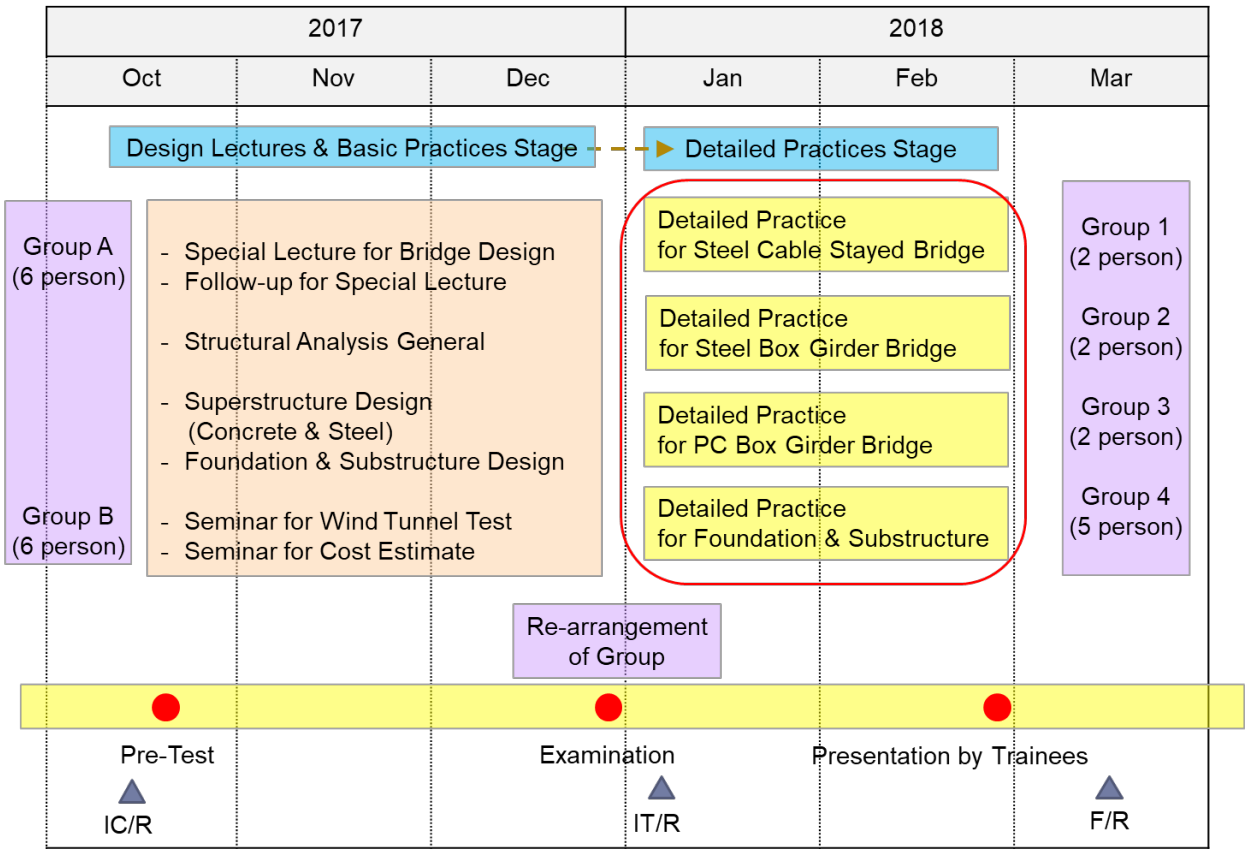


Figure 2.2.1 Overall Schedule of Design Technology Transfer Program

		OCT					NOV				DEC					JAN					FEB				MAR
	Week Number	1st	2nd	3rd	4th	5th	2nd	3rd	4th	5th	2nd	3rd	4th	5th	Grouping for trainees	1st	2nd	3rd	4th	5th	2nd	3rd	4th	5th	2nd
	Day (Monday-Friday)			16-20	23-27	30-3	6-10	13-17	20-24	27-1	4-8	11-15	18-22	25-29		1-5	8-12	15-19	22-26	29-2	5-9	12-16	19-23	26-2	5-9
Mon	Group A (6 person)			Special Lecture 1	Follow-up for Special Lecture 1	Super-structure Design 2	Structural Analysis General M 3	National Holiday	Special Lecture 5	Follow-up for Special Lecture 3	Follow-up for Special Lecture 4	Seminar for Wind Tunnel Test	National Holiday		Group 1 (2 person)		Detailed Practice for Cable Stayed Steel					National Holiday	Bridge M		
															Group 2 (2 person)		Detailed Practice for Steel BOX Girder						Bridge M		
	Group B (6 person)					Structural Analysis General M 3	Super structure Design 2								Group 3 (2 person)		Detailed Practice for PC BOX Girder						Bridge M		
															Group 4 (5 person)		Detailed Practice for Foundations &						RC Pier F		
Tue	Group A (6 person)			Special Lecture 2	Structural Analysis General M 1	Seminar for Cost Estimation 1	Structural Analysis General M 4	Structural Analysis General M 6	Special Lecture 6	Structural Analysis General M 7	Structural Analysis General M 9	Special Lecture 10	Special Lecture 14		Group 1 (2 person)		Detailed Practice for Cable Stayed Steel Bridge M								
															Group 2 (2 person)		Detailed Practice for Steel BOX Girder Bridge M								
	Group B (6 person)				Super structure Design 1		Super structure Design 3	Super structure Design 4		Super structure Design 5	Super structure Design 6				Group 3 (2 person)		Detailed Practice for PC BOX Girder Bridge M								
															Group 4 (5 person)		Detailed Practice for Foundations &RC Pier F								
Wed	Group A (6 person)			National Holiday	Structural Analysis General M 2	Seminar for Cost Estimation 2	Structural Analysis General M 5	Sub structure Design 3	Special Lecture 7	Structural Analysis General M 8	Structural Analysis General M 10	Special Lecture 11	Follow-up for Special Lecture 5		Group 1 (2 person)			Special Lecture for Structural Analysis	Detailed Practice for Cable Stayed Steel Bridge M			Presentation by Trainees			
															Group 2 (2 person)				Detailed Practice for Steel BOX Girder Bridge M						
	Group B (6 person)				Sub structure Design 1	Follow-up for Cost Estimation 2	Sub structure Design 2			Sub structure Design 5	Sub structure Design 6				Group 3 (2 person)				Detailed Practice for PC BOX Girder Bridge M						
															Group 4 (5 person)				Detailed Practice for Foundations & RC Pier F						
Thr	Group A (6 person)			Special Lecture 3	Sub structure Design 1	National Holiday	Sub structure Design 2	Sub structure Design 4	Special Lecture 8	Sub structure Design 5	Sub structure Design 6	Special Lecture 12	Super structure Design 7		Group 1 (2 person)		Detailed Practice for Cable Stayed Steel Bridge M					Special Lecture Additional	National Holiday		
															Group 2 (2 person)		Detailed Practice for Steel BOX Girder Bridge M								
	Group B (6 person)				Structural Analysis General M 1		Structural Analysis General M 4			Structural Analysis General M 7	Structural Analysis General M 9				Group 3 (2 person)		Detailed Practice for PC BOX Girder Bridge M								
															Group 4 (5 person)		Detailed Practice for Foundations & RC Pier F								
Fri	Group A (6 person)			Special Lecture 4	Super structure Design 1	National Holiday	Super structure Design 3	Super structure Design 4	Special Lecture 9	Super structure Design 5	Super structure Design 6	Special Lecture 13	Sub structure Design 7		Group 1 (2 person)		Detailed Practice for Cable Stayed Steel Bridge M					Ceremony at Nay Pyi Daw	National Holiday		
															Group 2 (2 person)		Detailed Practice for Steel BOX Girder Bridge M								
	Group B (6 person)				Structural Analysis General M 2		Structural Analysis General M 5	Structural Analysis General M 6		Structural Analysis General M 8	Structural Analysis General M 10				Group 3 (2 person)		Detailed Practice for PC BOX Girder Bridge M								
															Group 4 (5 person)		Detailed Practice for Foundations & RC Pier F								

Re-arrangement of Group

Design Lectures & Basic Practices Stage

Detailed Practices Stage

Pre-Test

Examination

Presentation by trainees

Source: JICA Study Team

Figure 2.2.2 Detailed Schedule of Design Technology Transfer Program

2.3 TRAINERS FOR EACH SUBJECT

The lecturers and the trainers for each subject of the Program are summarized in Table 2.3.1.

Table 2.3.1 Trainers for Each Subject

Stage	Subject	Main trainer in charge
Design Lectures & Basic Practices	Special Lecture for Bridge Design	Emeritas Prof. Nagai (Nagaoka University of Technology) Prof. Iwasaki (Nagaoka University of Technology) Dr. Tomoda (JST))
	Follow-up Lecture for Special Lecture	Mr. Tokumaru (JST) Ms. Xia (JST)
	Lecture for Structural Analysis General	Mr. Hayakawa (JST) Mr. Tokumaru (JST)
	Lecture for Superstructure Design (Concrete)	Mr. Ohyama (JST)
	Lecture for Superstructure Design (Steel)	Mr. Tanaka (JST)
	Lecture for Foundation & Substructure Design	Mr. Imada (JST) Mr. Takaoka (JST)
Detailed Practices	Detailed Practice for Steel Cable Stayed Bridge	Mr. Tokumaru (JST) Dr. Tomoda (JST)
	Detailed Practice for Steel Box Girder Bridge	Mr. Tanaka (JST)
	Detailed Practice for PC Box Girder Bridge	Mr. Oyama (JST)
	Detailed Practice for Foundation & Substructure	Mr. Takaoka (JST)
Seminars	Seminar for Wind Tunnel Test	Prof. Shirato (Kyoto University) Mr. Sano (JST)
	Seminar for Cost Estimate	Mr. Kuramochi (JST)

Source: JICA Study Team

2.4 TRAINEES OF TECHNICAL TRAINING

The trainees for the Program is as shown in Table 2.4.1. The group assignment for the detailed practice stage in the second stage is shown in Table 2.4.2. The groups were made for the detailed practice stage because of the efficiency of the activity and limitation of the software licences.

Table 2.4.1 Persons of Technical Training

Sr.No.	Name	Designation	Remarks
1	Daw Ei Htwe San	Deputy Director (Civil)	
2	Daw Nant Thar Hmwe	Deputy Director (Civil)	
3	Daw San Phyu Phyu Saw	Assistant Director (Civil)	
4	Daw Yu Yu Naing	Staff Officer (Civil)	
5	Daw Lai Mon Phyo	Junior Engineer (1) (Civil)	
6	Daw Kyi Thar Soe	Junior Engineer (1) (Civil)	
7	Dr. Hay Man Myint Maung	Junior Engineer (1) (Civil)	
8	Daw Htet Tint Wai	Junior Engineer (3) (Civil)	Attended till mid of Nov.
9	Daw Shwe Yamin Myat	Junior Engineer (3) (Civil)	
10	U Hein Zaw	Junior Engineer (4) (Civil)	
11	Dr. Khin Su Su Htwe	Professor (YTU)	Attended beginning only
12	U Phyo Hein Kyaw	Ph.D (Thesis) (YTU)	Attended beginning only
13	Daw Swe Hnin Aye	Junior Engineer (1) (Civil)	Assigned from Nov.
14	Daw Hnin Ei Ei Chaw	Junior Engineer (2) (Civil)	Assigned from Nov.

Source: JICA Study Team

Table 2.4.2 Group Assignment for Detailed Practice Stage in the Second Stage Activity

	Group	Name of Trainees	
a	Steel Cable Stayed Bridge	Daw Ei Htwe San	Daw Nant Thar Hmwe
b	Steel Box Girder Bridge	Dr. Hay Man Myint Maung	Daw Shwe Yamin Myat
c	PC BOX Girder Bridge	Daw Lai Mon Phyo	Daw Kyi Thar Soe
d	Foundation & Substructure	Daw San Phyu Phyu Saw	Daw Yu Yu Naing
		Daw Swe Hnin Aye	Daw Hnin Ei Ei Chaw
		U Hein Zaw	

Source: JICA Study Team

CHAPTER 3. SUMMARY OF CONTENTS OF LECTURES AND SEMINARS

3.1 DESIGN LECTURES & BASIC PRACTICE STAGE

3.1.1 Special Lecture for Bridge Design

3.1.1.1 Objectives of Special Lecture

Objectives of the special lecture were to study fundamental issues for steel cable-stayed bridge design through lectures and to learn necessary knowledges as a bridge engineer through exercises.

3.1.1.2 Outline of Special Lecture

A wide range of contents (i.e. history of bridge, structural mechanics, sectional design, cable-stayed bridge design, etc.) were explained in the special lecture.

3.1.1.3 Contents of Special Lecture

Special lecture has been conducted 14 times in total as shown schedule and contents in Table 3.1.1.

Table 3.1.1 Conducted Schedule and Contents of Special Lecture

Date		Lecture	Contents
Oct.	16th	1st lecture	1) Opening
			2) History of Bridge & Big Accidents
			3) Bridge General
	17th	2nd lecture	1) Slabs & Girder Bridge
			2) Truss & Arch Bridge
			3) Cable-stayed Bridge & Suspension Bridge
	19th	3rd lecture	1) Structural Mechanics
			2) Stress & Strain
			3) Cross-section Properties
	20th	4th lecture	1) Bending & Shear of Beam
			2) Girder Stress
			3) Axial Force of Truss Structure
Nov.	20th	5th lecture	1) Deteriorations of Road Infrastructure
			2) Maintenance of Road Infrastructure
			3) Monitoring of Bridge (ICUS Projects)
	21st	6th lecture	1) Influence Line of Girders
			2) Influence Line of Truss
			3) Design Method
	22nd	7th lecture	1) Buckling and Its Strength Design of Column
			2) Buckling and Its Strength Design of Beam and Beam Columns
			3) Buckling and Its Strength Design of Unstiffened and Stiffened Plates
	23rd	8th lecture	1) Connection (Bolt)
			2) Connection (Welding)
			3) Fatigue and Its Design
	24th	9th lecture	1) Design of Slab
			2) Design of Girder Bridges
			3) Design of Truss Bridges
Dec.	12th	10th lecture	1) Fundamental of Vibration 1
			2) Fundamental of Vibration 2
			3) Vibration (DVD)
	13th	11th lecture	1) History and Name
			2) Design Parameters and Selection 1

			3) Design Parameters and Selection 2
	14th	12th lecture	1) Estimation of Stress Resultants 1
			2) Estimation of Stress Resultants 2
			3) Exercises
	15th	13th lecture	1) Design and Erection of Cable
			2) Design of Girder
			3) Design of Tower
	16th	14th lecture	1) Erection of Girder and Tower
			2) Wind Resistant Design
			3) Limit Span of Cable-stayed Bridge

Source: JICA Study Team

In order to enhance the trainee's understanding, exercises were conducted and movies on showed as introduction. Documents used in each lecture are attached in the Appendix.

3.1.2 Follow-up Lecture for Special Lecture

3.1.2.1 Objectives of Follow-up Lecture

Follow-up lectures were conducted with the objectives of reviewing the lectures and seminars provided (i.e. the special lecture, the seminar for cost estimate and the wind tunnel and the lecture on PC Girder Supplement) and to check level of trainees' understanding.

3.1.2.2 Outline of Follow-up Lecture

Basically, exercises for the preceding special lecture were conducted at each follow-up.

3.1.2.3 Contents of Follow-up Lecture

Follow-up for special lecture were conducted 5 times in total as shown schedule and contents in Table 3.1.2.

Table 3.1.2 Conducted Schedule and Contents of Follow-up

Date		Program	Contents
Oct.	23rd	Follow-up 1	Exercises for Special Lecture (1st~4th lecture) (Second Moment of Inertia, Reaction Force, Moment, Axial Force, etc.)
Nov.	6th	Follow-up 2	Exervises for Cont Estimate Seminer (Cost Estimate of PC Girder, Bored Pile, Earthwork, etc.)
Nov.	27th	Follow-up 3	Exercises for Special Lecture (5th~9th lecture) (Influence Line, Moment under Live Load, Buckling of Column etc.)
Dec.	4th	Follow-up 4	Exercises for Special Lecture (5th~9th lecture) + PC Girder Supplement (Bolt, Weld, Moment of Slab, etc. + Calculation of PC Strand Loss)
Dec.	20th	Follow-up 5	Examination of Special Lecture (Reaction Force, Influence Line, Deformation of Truss, Bolt, Slab, etc.)

Source: JICA Study Team

The examination of special lecture was conducted to grasp trainees understanding, and the results are explained in Chapter 4.

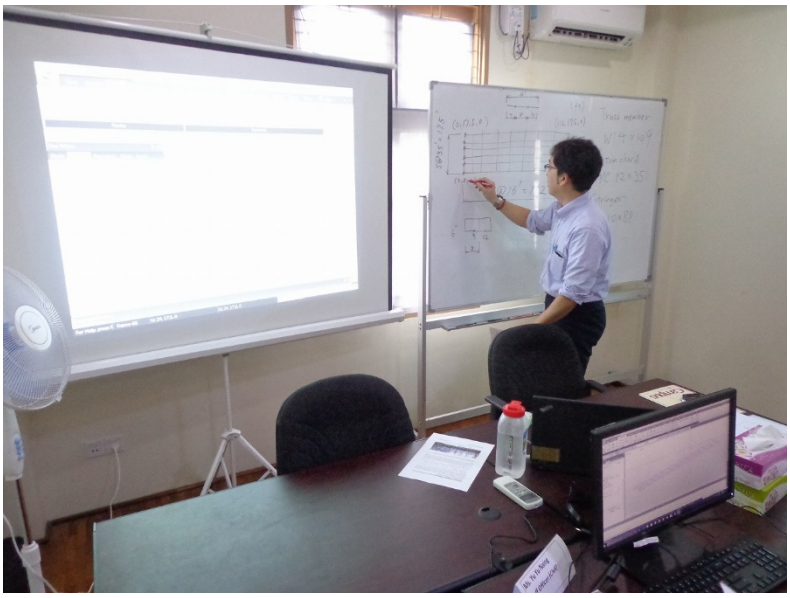
3.1.3 Lecture for Structural Analysis General

This lecture was planned to acquire the basic operational procedures of the structural analysis software, "MIDAS/Civil". Six desktop computers installing MIDAS/Civil were provided to the half of the trainees, and the instructors showed the actual operation procedures on the screen. Trainees were divided into 2 groups due to availability of desktop computers, and same contents of lecture were given to both groups.

Table 3.1.3 Contents of the lecture

Lecture	Contents
1	Introduction, Design of Simple Span Bridge
2	Design of Simple Span Bridge with Shaped Steel
3	Design of Truss Bridge, Modelling of Structural Models
4	Presentation
5	AASHTO LRFD Design with MIDAS/Civil, Tutorial
6	AASHTO LRFD Design with MIDAS/Civil, Lane Loading of Live Load
7	AASHTO LRFD Design with MIDAS/Civil, Prestressed Concrete Girder Design
8	Key Point for Calculating Cable Structures, Suspension Bridge and Cable Stayed Bridge
9	Practice of MIDAS/Civil (New Bayint Naung Bridge)
10	Practice of MIDAS/Civil, Presentation

Source: JICA Study Team



Source: JICA Study Team

Figure 3.1.1 Lesson by instructor

The English version of MIDAS/Civil is developed based on AASHUTO LRFD. Although the detailed design for the Project applied Specification for Highway Bridge (Japanese standard, JSHB), Japanese standard was not able to be lectured with MIDAS/Civil. Accordingly, the function of the live load calculation and the load combination with load factor and resistance factor were lectured in accordance with AASHTO LRFD.

In this program, the trainees were requested to make two presentations since it was observed that the trainees had never experienced any presentations. The trainees made 10 minutes presentations by using

Microsoft PowerPoint.

Table 3.1.4 Subject of presentations

Presentation	Contents
4th lecture	Calculation procedures and design results of steel truss bridge
10th lecture	Remodel and analysis results of New Bayint Naung Bridge

Source: JICA Study Team

Source: JICA Study Team

Figure 3.1.2 Presentation by trainee

Although any specific examinations were not carried out in this lecture, it was observed that the trainees understood how to operate MIDAS/Civil at the basic level of modelling, inputting parameters and loading, performing analysis and checking the calculation results.

3.1.4 Lecture for Superstructure Design (Concrete)

3.1.4.1 Objective of the Lecture

As the trainees are mainly the engineers of MOC, who will be supposed to take charge of project planning and project client, the training for superstructures (concrete) was carried out aiming to understand the outline of planning and design of concrete bridges.

3.1.4.2 Outline of the Lecture

In the lectures, the trainees learned the outline and basis of planning of concrete bridges (selection of structure type, erection method) and its design.

3.1.4.3 Contents of the Lecture

The lectures were composed of the contents shown in Table 3.1.5.

Table 3.1.5 Contents of Lecture (Superstructure Design (Concrete))

Items	Contents
1. History of Concrete Bridge	- Outline of history of concrete bridges - Introduction of historic bridges erected by precast segment method applied in Bago River Bridge
2. What is "Prestressed Concrete"?	- Introduction of principle and characteristics of prestressed concrete and structures using prestressed concrete
3. Planning of Prestressed Concrete Bridges	- Points of consideration on planning of prestressed concrete bridges
4. Structure Type of Prestressed Concrete Bridges	- Outline of structure type, applicable span length and erection method of prestressed concrete bridges - Characteristics of precast segment method and SBS erection
5. Basis of Design of Prestressed Concrete Bridges	- Outline of design of prestressed concrete bridges, determination of structural shapes and dimensions, determination of amount of prestressing, design of structural elements and points of consideration on design

Source: JICA Study Team

3.1.5 Lecture for Superstructure Design (Steel)

3.1.5.1 Objective of the Lecture

Steel bridges are made of steel plates which have high strength per unit area compared with other materials such as concrete, stone or bricks. Thus, steel plates can make a bridge lighter as well as they can secure strength. In addition, it is possible to choose more suitable type of structure that will be applied from long span up to short span since those are combined with fabricated member elements at a factory. In the light of this concern, the lecture aimed to enhance understanding of trainees on the aforementioned nature and capability of steel bridges.

3.1.5.2 Contents of the Lecture and Schedule

The design method based on thin plate steel structure was introduced after the special lecture regarding history of bridge, material strength and type of bridge, so that the trainees can understand suitable span length and structural outlines.

The steel bridge (especially with box girders) is consisted of thin steel plates, the linear stress theory and the buckling theory of stiffened plate that were introduced in the special lecture. For the review and exercise of those theories, the following contents were scheduled;

Table 3.1.6 Schedule and Content of the Lecture

Schedule			Content
11/14	Group A	1st	<u>Fabrication of Steel Bridge and Study Tour at Fabrication Factory</u> - Review about composed pieces of steel plate box - Purchasing Procedure of those pieces described on the drawings - What is the Mill-Sheet that certifies the quality? - Cutting Procedure and its Facilities for the delivered steel plates
11/15	Group B		- Sequential Procedure of fabricating steel box - The purpose of Trial Erection at the shop - The conditions of transportation from the shop to the site and those of site erection - In addition to the above lecture, the study tour to J&M Factory was done to see and review actual products fabricated at the factory.

11/28	Group A	2nd	Theoretical Relation between Section Properties and Stress - Hook's Law and Bernoulli Principal that are the basis of bridge design - Regarding equilibrium relation between all external forces and internal forces, the equation of internal forces and load was lectured. - In addition to the above, the differential equation of bending moment and deflection was lectured. - The lecture about physical meaning of geological moment of area or inertia, and he calculation exercise. - The primary design forces of different bridge type - The indeterminate reaction and bending moment of 2-span continuous bridge was explained by the integration method from the differential equation of deflection. - In addition to the above, the influence method was explained to calculate bending moment at every position as the more conventional method.
11/29	Group B		
12/5	Group A	3rd	The Buckling Theory that is most important on designing thin steel plate structure, and Practical Design Standard - What is the Buckling Phenomena - The relation between Allowable Stress and Radius of Gyration, Euler's Buckling and the Yield Stress - The Load Capacity curve of Column according to the yield stress and the initial distortion - The allowable Stress of compression column described on the JRA - The calculation exercise of the column - 2-dimendional buckling phenomena of unstiffened plate that is supported at 4 edges. - Buckling Coefficient relating to Load Capacity Curve and calculation of the Allowable Stress - Buckling Phenomena of stiffened plate supported at 4edges - Buckling Coefficient relating to Load Capacity Curve and calculation of the Allowable Stress - Aspect Ratio of stiffened panel and required stiffness of longitudinal stiffeners - Horizontal stiffeners arrangement and those stiffness - Calculation Exercise
12/8	Group B		

Source: JICA Study Team

3.1.6 Lecture for Foundation & Substructure Design

3.1.6.1 Objective of the Lecture

The objective of the lecture on substructure and foundation design was set to study fundamental issues for Cast-In-Placed pile (CIP Pile) and Steel Pipe Sheet Pile (SPSP) with Reinforced Concrete Pier (RC Pier), which have been applied in New Thaketa Bridge Project and Bago River Bridge Project and to learn necessary knowledges as a bridge engineer through lectures and exercises.

3.1.6.2 Contents of the Lecture

The lecture was held at 7 times in total including the mid-term examination. The schedule and content each lecture is summarized in table below.

Table 3.1.7 Schedule and Content of the Lecture

Schedule				Content
Oct.	25th	Group B	1st Lecture	Substructure and Foundation Planning Among the various types of foundation, spread foundation, caisson foundation, pile foundation, steel pipe sheet pile foundation, diaphragm wall foundation and deep foundation were briefly introduced. Some important issues for selection of foundation type were explained and a table of referenntial criteria of applicability of foundation type which is an appendx of Japanese Specifications for Highway Bridges (JSHB) was introduced. Then, the reason why pile foundation (CIP pile) and SPSP were selected in Bago River Bridge was explained with explanation of topographical, geological and environmental conditions including local scouring and liquefaction etc. One experiment to generate liquefaction was demonstated. At the Pre-Test, to select appropriate foundation type under some given conditions referring the table of referenntial criteria of applicability of foundation type, to judge liquefaction and to estimate ultimate bearing capacity were questioned and answer was explained.
	26th	Group A		
Nov.	8th	Group B	2nd Lecthre	Desing of CIP Pile Design of CIP pile including setting design conditions, structural stability, sectional force, stress verification of piles, connection between pile and footing were explained and some exercise were done to deepen trainee's understanding.
	9th	Group A		
	15th	Group A&B	3rd Lecture	
	16th	Group A&B	4th Lecture	Technical Feature and Construction Method of SPSP Firstly, to understand SPSP foundation, construction methodology of SPSP in New Thaketa Bridge Construction Project was explained with showing movies. Design of SPSP Design of SPSP including setting design conditions, allowable bearing capacity calculation, displacement and sectional forces calculated by finite-length beam on an elastic floor model, temporary cofferdam design, combined stress verification of piles, footing, and connection between pile and footing were explained and some exercises were conducted to deepen trainee's understanding.
	30th	Group A	5th Lecture	
Dec.	1st	Group B		
	6th	Group B	6th Lecture	Design of RC Pier Design of RC Pier including verifications at bottom of pier column and beam by calculation of minimum & maximum rebar content and stress due to bending moment, shear force and axial force were explained and some exercise were done to deepen trainee's understanding. And general rules of rebar arrangement based on the JSHB was introduced.
	7th	Group A		
	22nd	Group A&B	7th Lecture	Mid-term Examination To check the trainees understanding degree on the contents of above six times lectures, mid-term examination was conducted. Examination questions included verification method of CIP pile, judgement criteria of liquefaction, calculation of allowable bearing capacity, and calculation of sectional force worked on beam and verification of tension rebar.

Source: JICA Study Team

In this lecture, structural analysis was implemented by applying the Japanese standard of the design method namely JSHB. That is allowable stress method including seismic design by static analysis against Level-1 earthquake in accordance with JSHB.

The materials of the lecture are attached in the Appendix.

3.2 DETAILED PRACTICE STAGE

3.2.1 Detailed Practice for Steel Cable-stayed Bridge

3.2.1.1 Objectives of Detailed Practice

In the Lecture and Basic Practice Stage, bridge engineering and fundamental theories for bridge design were explained through "Special Lecture for Cable-stayed Bridge Design", "Structure Analysis in General", "Superstructure Design for Concrete", "Superstructure Design for Steel" and "Substructure Design". Therefore, objectives of this practice were learning design flow for a steel cable stayed bridge (structure type selection - static structure analysis – cross section calculation) as a specific design exercise.

3.2.1.2 Outline of Detailed Practice

The practice subject is the cable-stayed bridge of Bago Bridge. In the practice, 6 themes (Modeling, Cable Pre-stress, Parametric Analysis, Section Design, Seismic Design and Design Exercise) were covered.

3.2.1.3 Contents of Detailed Practice

Detailed practice has been conducted by following schedule and contents.

Table 3.2.1 Conducted Schedule and Contents of Detailed Practice

Theme and Schedule	Contents
Step1: Outline (8th Jan.)	[Object: Learn necessary study items for cable-stayed bridge design] - Explanation for contents of the practice and schedule - Outline of basic design and detailed design for cable-stayed bridge at Bago Bridge
Step2: Modeling (9th Jan. – 11th Jan.)	[Object: Acquire a modeling for cable-stayed bridge] - Node and element - Material properties - Section properties - Cable model - Design loads (dead load, live load, tempareture, wind, pre-stress) and load combination - Boundary conditions
Step3: Cable Pre-stress (12th Jan. – 15th Jan.)	[Object: Learn a cable pre-stress adjustment method] - Completion State: Smoothen of girder moment - Completion State: Tower moment ≒ 0 - Construction Stage: Final girder closing, moment at joints ≒ 0
Step4: Parametric Analysis [Cable, Girder, Tower] (15th Jan. – 26th Jan.)	[Object: Conduct parametric analysis and grasp a tendency of structure] - Girder rigidity (girder height and width) - Tower height - Cable arrangement - Cable number
Step5: Section Calculation (29th Jan. – 7th Feb.)	[Object: Create a section calculation sheet and learn evaluation methods by JSHB] - Calculation from stress resultants to stress - Allowable stress - Evaluation of stress and displacement - Combination of bending moment+axial force, bending moment+shear force
Step6: Seismic Design (8th Feb. – 9th Feb.)	[Object: Learn outline of seismic design by JSHB] - Outline of seismic design by JSHB - Input of seismic force
Step7: Design Exersice (13th Feb – 21st Feb.)	[Object: Conduct the Step2 ~ Step6 again, and grasp the design flow] - Explanation of design objects and conditions - Design exersice by the trainees - Preparation of analysis result report

Theme and Schedule	Contents
Step8: Summary (26th Feb. – 28th Feb.)	[Object: Learn how to summarize and explain analysis results] - Summary for the detailed practice - Presentation by the trainees

Source: JICA Study Team

In the lecture and basic design stage, the main object was "explain design technologies and knowledges to the trainees". Therefore, "to think, consider and conclude by the trainees" was set as one of the main objectives in the detailed practice.

Achievements and future issues were mentioned in Chapter 4.

3.2.2 Detailed Practice for Steel Box Girder Bridge

3.2.2.1 Objectives of Detailed Practice

The objective of this practice was to enhance understanding of the design steps, verification of the results, basic design theory of structural analysis and allowable stress. The actual profile of bridge design was applied to fulfill this objective.

3.2.2.2 Outline of Detailed Practice

2-span continuous girder bridge was applied as the actual profile bridge with the following procedures from the design condition to the determination of section profile and calculation off steel quantity was practiced.

On the first step, the trainees started to trace the calculation procedure including the calculation of load intensity and the calculation of section forces that was prepared by the lecturer. On the second step, the new model with a little modification from the preliminary model was provided. The trainees practiced to design by using the analysis software (MIDAS) as a trial design with the following design conditions and items;

The Practice Design Conditions

1. Bridge length 131m=2x0.5m(the end marginal length)+2@65m
2. Bridge width 15.2m=2@0.6m(curb width; Both edge)+4@3.5m(Carriageway)

The Design Items

1. Assumption of Dead Load Intensity
2. Number of Main Girder
3. Calculation of Section Forces without the analysis software
4. Analysis Grid Frame Model by using MIDS
5. Calculation of Section
6. Calculation of Stiffeners
7. Calculation of Spliced Joints
8. Making Section Composition
9. Making Material List Table
10. Camber Diagram

3.2.2.3 Contents of Detailed Practice

Table 3.3.2 shows schedule and contents of detailed practice.

Table 3.2.2 Conducted Schedule and Contents of Detailed Practice

Theme and Schedule	Contents
Step 1 : Orientation (01/08)	･The Explanation about Practice design model Span length is 2@50m and the width is 18.6m(4-lanes carriageways and 3.0m Footway)
Step2: Load Intensity and Distribution to each Girder (01/09 ~ 01/12)	･Load intensity of Line Load and Concentrated Load by using influence line 2-span continuous and 1-0 method ･How to calculate the Bennding Moment and Reaction at mid span and at mid Support by using Excel
Step 3 : Analisis by using Software（MIDAS） (01/15 ~ 01/19)	･ Creation of Grid Coordination and Menber Properties ･ Consideration about Stiffeners properties ･ Loading Method of AASHTO Loading
Step 4 : Verification of Analysis Results (01/22 ~ 01/26)	･ Confirmation of the discrepansy between Reaction due to dead load and whole intensity of dead load including the results of excel calculation ･ Confirmation of the discrepansy between Reaction due toAASHTO load and whole intensity of AASHTO load including the results of excel calculation
Step 5 : Trial Design of New Another Model (01/29 ~ 02/02)	･ Actual pactice design using the modified model Span length is 2@65m, Width is 15.2m 4-lanes carriageways ･ Both Calculations of Excel calculation and valculation based on MIDAS analysis
Step6: Calculation of Stiffeners and Spliced Joints (02/05－02/09)	･ How to determine the number of horizontal stiffener and thespacing of vertical stiffener relating to resitance of web buckling ･ How to ditermine the block length of main girder ･ How to calculate the joint forceand required high strength bolts and those arrangement
Step7: Creation of Section Composition (02/12—02/15)	･ Section Composition is the composition table of all plates dimensions and material grade that consits of maingirder. ･ Flange,web, longitudinal stiffener,horizontal stifener,vertical stiffener, cross beam and splice plate of each joint.
Step8: Creation of Material List Table (02/17—02/22)	･ All of materials shown on section composition are described on he material table, and weight of each material is calculated relating to every thickness and garade. ･ (02/22: Special Lecyure by Prof. Nagai)
Graduation Ceremony (02/23)	･ Graduation Ceremony was held at Nay Pyi Taw
Step9: Preparation for the Presentation of Practice Design (02/26-02/27)	･ The Procedure of Practice Design ･ Design Condition ･ Analysisi Model ･ Calculation Results shown on Section Composition including the excel calculation sheet.
Presentation of Practice Desig 02/28)	･ Presentation by using Powerpoint application

Source: JICA Study Team

In this design practice, almost whole procedures of steel bridge design including calculation of quantities were covered. However, it was observed that the understanding was not sufficient and it is necessary to continue the similar design practice.

3.2.3 Detailed Practice for PC Box Girder Bridge

3.2.3.1 Objectives of Detailed Practice

The training of detailed practice for PC box girder bridge was carried out aiming to understand the procedure and basic issues in actual calculation of detailed design of PC box girder bridges.

3.2.3.2 Outline of Detailed Practice

In the detailed practice, the trainees experienced the design calculation of PC box girder bridges including the items such as design for bending and design for shear, both on serviceability (at service load state) and on safety (at ultimate load state). In order to understand the practical issues for the design of PC box girder bridges, the training was carried out focusing on the design for longitudinal direction of a simple span box girder referring to "Basis of Design of Prestressed Concrete Bridge" described in Lecture & Basic Practice Stage, and analyses (calculation of sectional forces) of 4-span continuous girder and transverse box section have been carried out as well.

3.2.3.3 Contents of Detailed Practice

The detailed practice was composed of the contents shown in Table 3.2.3.

Table 3.2.3 Contents of Detailed Practice for PC Box Girder Bridge

Items	Contents
Review of the Lecture	- Reconfirmation of "Basis of Design of Prestressed Concrete Bridge" described in the Lecture
Study on Design Conditions	- Understanding and study on design conditions for the sample bridge to be designed
Design of Main Girder (Simple Span)	Preparation of analysis model - Cross-sectional properties, loading etc. Calculation of loss of prestress - exercise by hand calculation Preparation of drawings for calc. report - Structural outline, tendon arrangement, analysis model, loading … etc. Calculation of sectional forces - Hand calculation, analysis by software, cross-check - Summarization of sectional forces Design for bending - Hand calculation, analysis by software, cross-check - Service load state: stress due to loads, required prestress, check of resultant stress, check of tendon stress, tensile reinforcement - Ultimate load state: calculation of flexural resistance, calculation of ultimate moment, check safety ratio against bending failure Design for shear - Hand calculation, analysis by software, cross-check - Resistance against web crush at ULS - Diagonal tensile stress at SLS - Mean shear stress at SLS - Calculation of diaconal tensile steel at SLS - Resistance against diaconal tension failure at ULR - Calculation of longitudinal reinforcement for shear
Design of Box Section (Transverse)	- Analysis by software (calculation of sectional forces)
Design of Main Girder (4-span Continuous)	- Analysis by software (calculation of sectional forces considering construction steps by SBS erection)

Source: JICA Study Team

3.2.4 Detailed Practice for Foundation & Substructure

3.2.4.1 Objectives of Detailed Practice

The detailed practice for foundation and RC pier is aimed to obtain necessary design skills and know-how for targeted structural items as RC Pier, cast-in-place RC pile and Steel Pipe Sheet Piles mainly focused on design calculation by using structural design software (Forum8).

In accordance with the design of Bago River Bridge in the Project, Japanese Specifications for Highway Bridge (JSHB) is applied for the design standard. For seismic design, a static analysis against Level-1 earthquake is covered.

3.2.4.2 Contents of Design Practice

The software for design calculation used in detailed practice for foundation and RC pier are as follows.

- Pier 3D bar arrangement Ver.14 English Edition ("Pier design" by FORUM8 specially ordered edition)
- Foundation 3D bar arrangement Ver.2 English Edition ("Foundation design" by FORUM8 specially ordered edition)

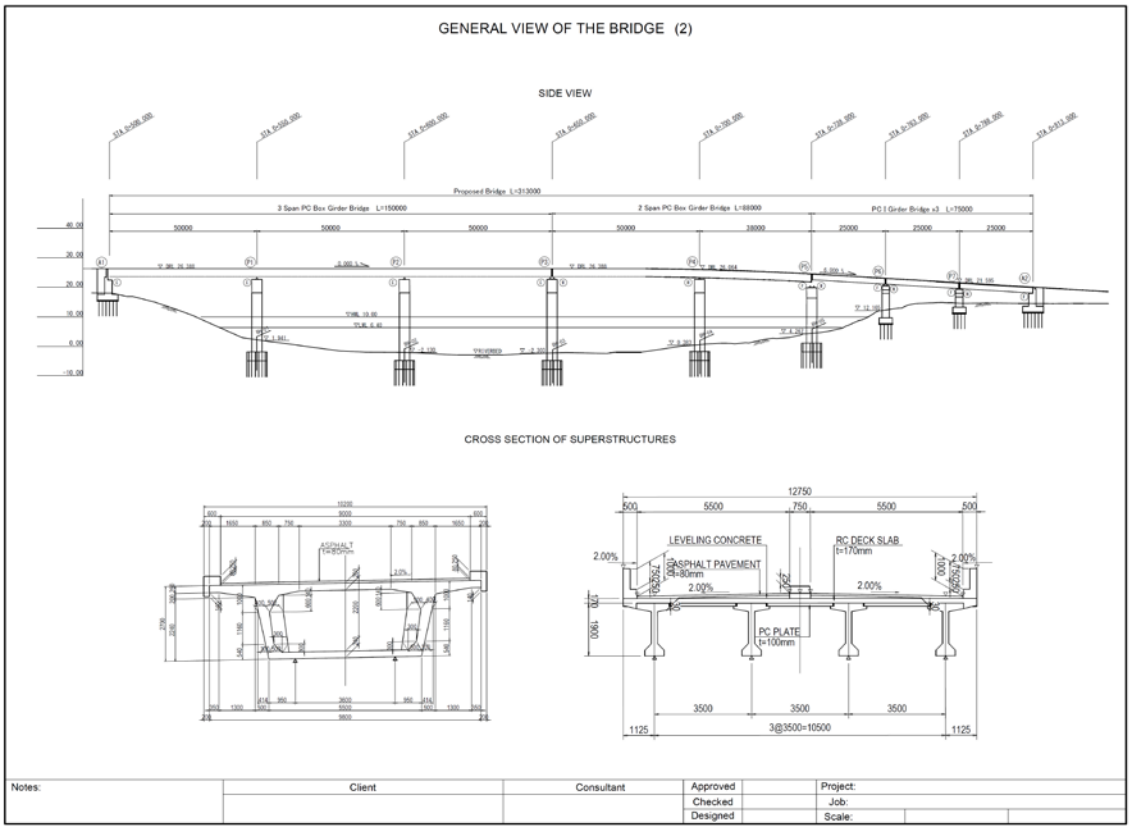
In the detailed practice for foundation and RC pier, operational practice for above software and two subjects of practical design work were conducted. The contents of the detail practice are summarized in Table below.

Table 3.2.4 Contents of the detailed practice for Foundation and RC Pier

Date		Title	Contents
January	8th	Operational practice for the design software [RC Pier]	Introduction, Operation guidance of the software
	9th		Data input practice (Beam, Column, Footing)
	10th		Data input practice / Check of calculation result (Summary sheet)
	11th		Check of calculation result (Stress verification for beam)
	12th		Check of calculation result (Stress verification for column)
	15th	Operational practice for the design software [Cast-in-place RC pile]	Data input practice (Design condition, Geotechnical condition, Pile layout)
	16th		Data input practice (Working force, Rebar arrangement of pile body / pile head)
	18th		Check of calculation result (Bearing capacity, stress on pile body)
	19th		Check of calculation result (Pile head, footing)
	22nd	Design subject [RC Pier + Cast-in-place RC pile]	A RC pier and cast-in-place RC pile was designed with design calculation by the software. For the design, following pre-conditions were distributed to trainees. Structural stability and member stress were verified by calculation. ・General View of the Bridge ・Geological log data ・Reaction force from Super-structure Through the design practice, following materials were made up by trainees. ・A comparison table for cast-in-place RC piles ・Rebar arrangement drawing for RC pier and Cast-in-place RC pile
	23rd		
	24th		
	25th		
	26th		
	29th		
	30th		
	31st		
February	1st		
	2nd		
	5th	Operational	Data input practice (Design condition, Geotechnical

Date		Title	Contents
		practice for the design software [Steel Pipe Sheet Pile]	condition, Pile layout)
	6th		Data input practice (Working force, Wales and struts, Top slab and Connection)
	7th		Check of calculation result (Bearing capacity, Wales and struts, Temporary cofferdam)
	8th		Check of calculation result (Steel pipes, Top slab, Pile head connection)
	9th	Design subject [RC Pier + Steel Pipe Sheet Pile]	A RC pier and Steel pipe sheet pile was designed with design calculation by the software. For the design, following pre-conditions were distributed to trainees. Structural stability and member stress for temporary cofferdam and permanent portion were verified by calculation. ・General View of the Bridge ・Geological log data ・Reaction force from Super-structure Through the design practice, following materials were made up by trainees ・A figure for installation procedure of temporary supports in SPSP ・General arrangement figure of SPSP
	13th		
	14th		
	15th		
	16th		
	19th		
	20th		
	21st		
	22nd		
	26th	Preparation of presentation	Preparation of presentation materials
	27th		Preparation/Practice of the presentation
	28th	Presentation	Conduction of presentation

Source: JICA Study Team



Source: JICA Study Team

Figure 3.2.1 General View of Bridge for design subject [RC Pier +Steel Pipe Sheet Pile]

3.3 SEMINARS

3.3.1 Seminar for Wind Tunnel Test

Professor Hiromichi Shirato of Kyoto University gave 2 series of seminars, (1) wind tunnel test for cable-stayed bridge of Bago River Bridge and (2) wind engineering.

(1) Wind Tunnel Test for Cable-stayed Bridge of Bago River Bridge

1) Objectives of Seminar

For introducing of the outline of the wind tunnel test for the cable-stayed bridge conducted in Kyoto University.

2) Contents of Seminar

The seminar was held in the morning on December 11th 2017. The contents of the seminar are itemized as follows;

1 Overview of Bago Cable‐Stayed Bridge

2 Wind Tunnel

3 Similarity rules

4 Equivalent mass

5 Items of wind tunnel tests

6 Wind tunnel tests of Bago Cable-stayed Bridge

7 Statistical analysis of wind speed record

8 Recommendations to cable vibration

9 Conclusion

(2) Wind Resistance of Structures (Wind Engineering)

1) Objectives of Seminar

The objective of the seminar was to introduce general knowledge of wind engineering and wind resistant design.

2) Contents of Seminar

The seminar was held in the afternoon on December 11th 2017. The contents of the seminar are itemized as follows;

1. Aerodynamics of structures

- Bluff body aerodynamics
- Aerodynamic Phenomena (Vortex-induced vibration, Galloping, Flutter, Gust response, Cable vibration)

2. Characteristics of natural wind and design wind load

- Frictionless wind balance
- Natural winds
- Annual maximum wind speed and return period
- Flow visualization

3. Wind Resistance Design Codes

- Lessons learnt from Tay Bridge, Tacoma Narrows Bridge, Ferrybridge Cooling Tower
- Wind resistance design procedures
- Examination of aerodynamic stability

Among the above-mentioned topics, Professor Shirato emphasized on necessity of wind speed recording in Myanmar for setting base wind speed for establishment of wind resistant design in Myanmar.

3.3.2 Seminar for Cost Estimate

3.3.2.1 Objective

A seminar for cost estimate was organized for the following purposes.

- To enhance understanding and importance of cost estimate from the view point of an employer
- To dedicate providing essential of Japanese cost estimate standards for maintaining / brushing up of Myanmar cost estimate standard

3.3.2.2 Outline of the Seminar

This seminar was held on 31st Oct. – 1st Nov. composed by 6 classes as a following schedule, Table 3.3.1.

Table 3.3.1 Seminar Schedule

Date	Program	Duration	Content
31st Oct.	Seminar for Cost Estimate 1	9:00 - 10:15	1.1 Introduction (Purpose of cost estimate, several methods of cost estimate, Japanese cost estimate standards)
		10:30 – 11:45	1.2 Breakdown Structure of Cost Estimate
		13:00 – 15:00	1.3 Exercise of Composing Structural Tree of Bridge Project
1st Nov.	Seminar for Cost Estimate 2	9:00 - 10:15	2.1 Exercise of cost estimate about Substructure (Ex. Bago bridge ramp)
		10:30 – 11:45	2.2 Exercise of cost estimate about Superstructure (Ex. Bago bridge ramp)
		13:00 – 15:00	2.3 Summary of Seminar

Source: JICA Study Team

3.3.2.3 Contents of the Seminar

1 Seminar for Cost Estimate 1

1.1 Introduction (Purpose of cost estimate, several methods of cost estimate, Japanese cost estimate standards)

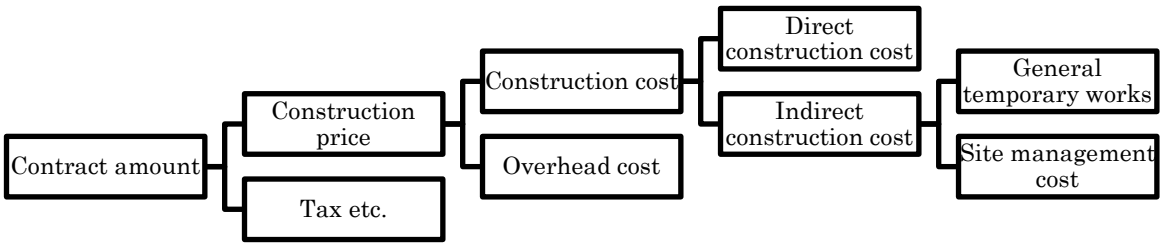
Making bid document is one of tasks of an employer. This class tried providing and enhancing of

mindset for importance of cost estimate as an employer's view to estimate bidding project cost to ensure quality of infrastructure. Besides, a role of the Engineer and a meaning of cost estimate in FIDIC were explained for international bidding.

To introduce cost estimate, Japanese cost estimate standards were explained with comparison between Myanmar's standards.

1.2 Breakdown Structure of Cost Estimate

Breakdown structure of cost estimate was explained based on Japanese standard. Mainly composition of contract amount was explained in every factor as shown in Figure 3.3.1.



Source: JICA Study Team

Figure 3.3.1 Breakdown Structure of Project Cost

1.3 Exercise of Composing Structural Tree of Bridge Project

A frame work of cost estimate was explained in "1.2 Breakdown Structure of Cost Estimate". This class provided actual exercises to build composing structural tree of bridge project for bridge part and approach road respectfully.

2 Seminar for Cost Estimate 2

2.1 Exercise of Cost Estimate about Substructure (Ex. Bago bridge ramp)

Exercise of cost estimate about a substructure part was executed by focusing on ramp bridge of Bago bridge project based on built tree from the previous class, "Exercise of Composing Structural Tree of Bridge Project". Prior to having exercise, the composition and point of Japanese standards were explained.

As checking understanding and progress of participants, noticed points were explained.

2.2 Exercise of cost estimate about Superstructure (Ex. Bago bridge ramp)

Exercise of cost estimate about superstructure part executed by focusing on Ramp bridge of Bago bridge project based on built tree from "Exercise of Composing Structural Tree of Bridge Project". Works from fabrication to erection of PC I girder were exercised in this class.

2.3 Summary of Seminar

The seminar for cost estimate was finished by summarizing of the works of this section into a grand table and Q&A session.

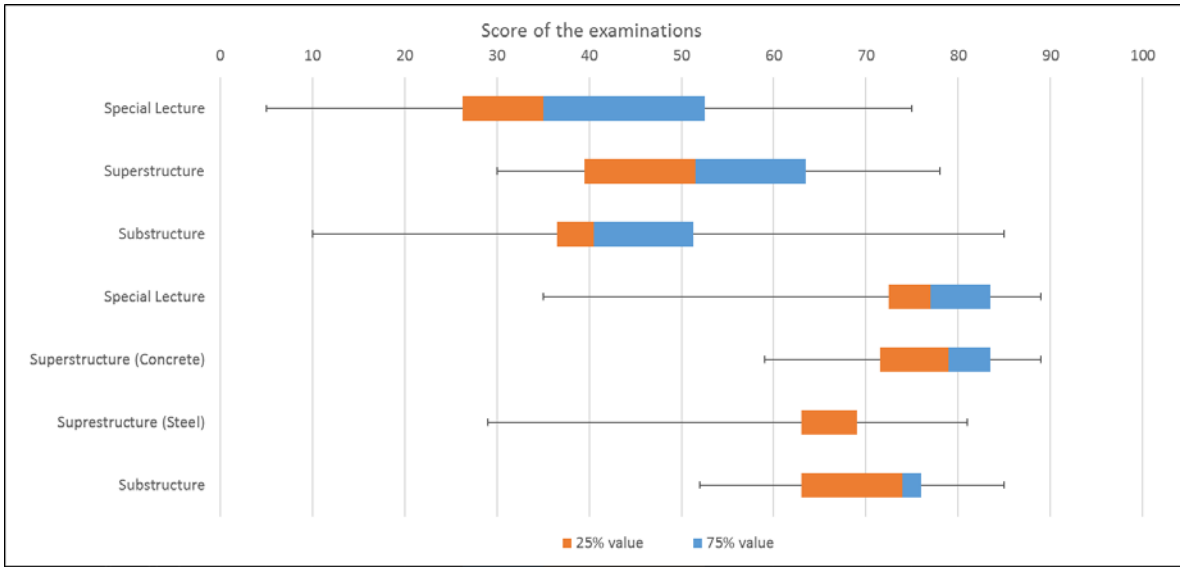
CHAPTER 4. INTERIM EVALUATION OF TRAINING ACHIEVEMENT

4.1 EXAMINATIONS

During the first half of the technology transfer program, two examinations were conducted for trainees. Three topics of pretests were carried out at the beginning of the lectures, and the subjects of pretests were related to the Special Lecture, Superstructure and Substructure respectively. Four subjects of interim examinations were asked for trainees to measure the learning effect of the technology transfer and to evaluate the adequacy for the coming specific design programs. These examinations were related to the Special Lecture, Superstructure of Steel, Superstructure of Concrete and Substructure respectively.

Figure 4.1.1 shows the result of the examinations. The full score of each examination was set to 100. The difficulties of all the examinations were determined to the same levels. The result of the pretest is among the 10 trainees from MOC, while interim examination is 11 trainees (new two MOC staffs were dispatched from MOC and one trainee was hanged up the program because of the childbirth).

The result of the examinations is indicated as Box-and-Whisker diagram, which expresses the range of top and lowest score as a line with whiskers at both ends, and box expresses the quartiles (25% of band) from the average mark. Orange-color box expresses the range of the score from 25% to50%, and Blue color from 50% to 75%.



Source: JICA Study Team

Figure 4.1.1 Result of the Pretest and Interim Examination

From this diagram, the following facts about the evaluation can be considered;

- The average score of the pretest was 42.0. Variation of the score was very wide, that meant the ability and learning level of the trainees was different.
- The average score of the interim examination was improved to 74.8. Variations of the score were reduced, which meant all the trainees could progress their ability equally.

It can be said that the trainees enhance their knowledge and ability about bridge design through the technology transfer. On the other hand, some of the trainees could not obtain a good score in a specific examination, which might be because of their background and achievement.

4.2 PRESENTATION BY TRAINEES

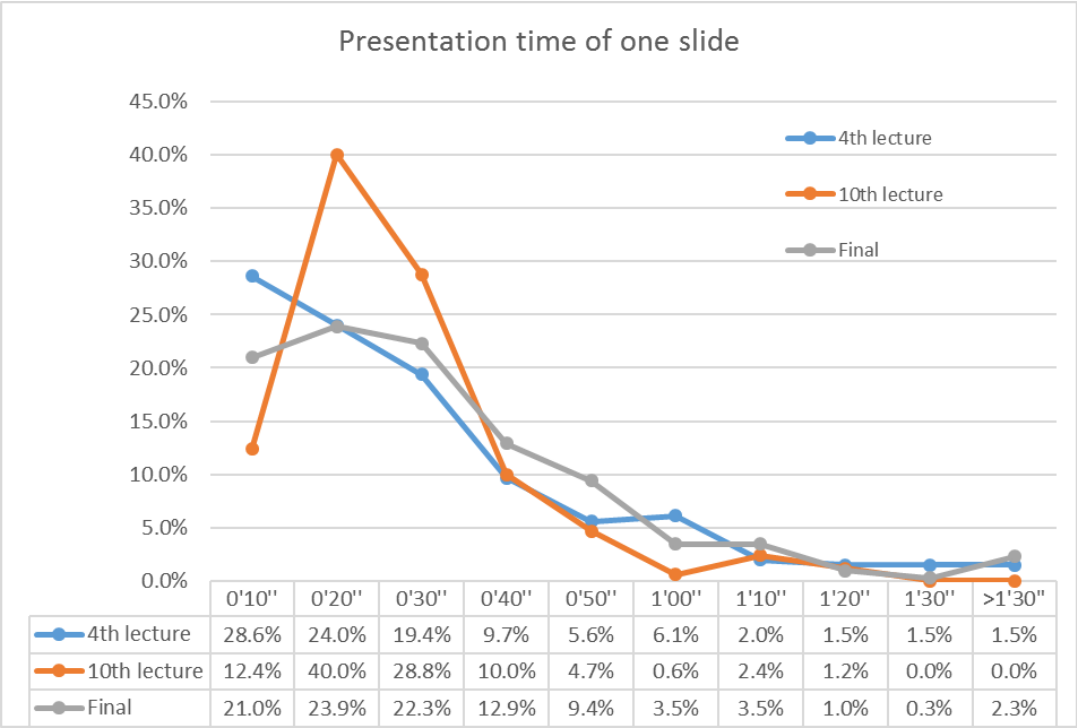
Presentations by the trainees were conducted three times, in which two times were performed in the lecture of Structural Analysis General, and another one was in the last lectures to explain about the Detailed Practice.

The purpose of the presentations in Structural Analysis General program was to adjust themselves to make a presentation because they had few experience of the presentation by their own until the Program. In the fourth lecture of Structural Analysis General, the lecturer explained the basic skills of the presentation and the trainees prepared the presentation with structural analysis of truss bridge. In the 10th lecture, the trainees were asked again to make a presentation about the structural result. The evaluation and scoring of the presentation was not conducted especially.

Figure 4.2.1 shows the time of presentation per one slide. It is generally said that one slide is better to be explained in one minute. Though the lecturer explained this information, some of the trainees explained very short period (less than five seconds) per one slide in explanation of the results of many slides of the structural analyses. In the 10th lecture, the ratio of the presentation time less than 10 seconds was decreased, which was advised by the lecturer. In the presentation of Detailed Practice, the presentation time of one slide became more levelling and was found that the trainees spent more times to explain one slides.

On the contrary, some trainee explained one slide of analysis result or conclusion in the long period (more than two minutes). The lecturer advised to divide description in one slide into some slides. This caused the ratio of the presentation time more than one and a half minutes decreased. However, in the presentation of Detailed Practice, some trainees intended to explain their achievements to spend more times in specific slides.

By the both subjective and objective reason, the presentation skills of the trainees could be progressed.



	0'10''	0'20''	0'30''	0'40''	0'50''	1'00''	1'10''	1'20''	1'30''	>1'30''
4th lecture	28.6%	24.0%	19.4%	9.7%	5.6%	6.1%	2.0%	1.5%	1.5%	1.5%
10th lecture	12.4%	40.0%	28.8%	10.0%	4.7%	0.6%	2.4%	1.2%	0.0%	0.0%
Final	21.0%	23.9%	22.3%	12.9%	9.4%	3.5%	3.5%	1.0%	0.3%	2.3%

Source: JICA Study Team

Figure 4.2.1 Explanation period in one slide

4.3 QUESTIONNAIRE OF THE LECTURE

4.3.1 Contents of the Questionnaire

The questionnaire to measure the impact of the Technology Transfer program was conducted for the trainees on 8th February 2018. The questionnaire was composed of the response alternative and asked 58 items in the Table 4.3.1. The questionnaire was asked as anonymous to the 11 trainees and the language used was English.

Table 4.3.1 Questionnaires

1. General impression of the lecture	
1	I could acquire the new knowledges for bridge design during the lecture.
2	I could acquire practical skills, new engineering experiences and technics during the lecture
3	I could change the way of viewing and thinking with acquiring the new technological knowledges.
4	I could strengthen my knowledge with reconstructing my experience and achievement.
5	I could enhance my motivation for the work by the Lectures' encouragement.
6	I could enhance my motivation for the work by the objective and contents of the Lecture.
7	This lecture will be advantageous for my work in the future.
8	This lecture will be effective for my work in short period.
2. Preparations	
9	I understood the objective and contents of the Lecture before lessons.
10	I understood the goal of the Lecture before lessons.
11	I expected I could enhance the attitude for the work, technical knowledges and engineering skills after the lessons.
12	My boss and colleagues expected that I could enhance the attitude for the work, technical knowledges and engineering skills after the lessons.
13	My boss, colleagues and I talked about the object and mission of the Lecture.
14	I studied about the object of the Lecture previously.
15	I think the level of the Lecture is appropriate for my experience and knowledge.
3. Contents of the lessons	
16	The contents of the lessons would achieve my objective of the work.
17	The level of the lesson was proper for me.
18	The volume of the lessons was proper for me.
19	The scope of the lessons was proper for me.
20	The order of the lessons was arranged for good understandings of the trainees.
21	The method of the lectures was effective for understandings of the trainees.
22	Special Lecture on Bridge Design and Structural Mechanics (by Professor Nagai (Senior)) was informative.
23	Special Lecture on Operation and Maintenance (by Professor Nagai (Junior)) was informative.
24	Special Lecture on Structural Analysis (by Professor Shirato) was informative.
25	Special Lecture on Structural Analysis (by Professor Iwasaki) was informative.
26	Structural Analysis General (by Hayakawa) was practical.
27	Superstructure Design (by Ohyama, Tanaka) was practical.
28	Substructure Design (by Imada, Takaoka) was practical.
29	Seminar for Cost Estimate (by Kuramochi) was practical.
30	Detailed Practice (by engineers) was practical.
4. Instruction by lecturers (general impression)	
31	Lecturers explained the objective of the lessons to the trainees.
32	Lecturers had adequate high degrees of professionalism for the lessons.
33	Lectures had many experience and related cases of the lessons.
34	Explanation of Lecturers were ingenuous (creative) and easy to understand.

35	Speaking speed of Lecturers are appropriate.
36	The trainees could receive proper answers from Lecturers.
37	Lecturers tried to communicate with the trainees.
38	Lecturers encouraged the mutual communications between the trainees.
39	Lecturers managed the time of the lessons.
40	I received the good impression from the attitude of the lessons of Lectures.
5. Training materials	
41	Distribution documents were helpful for me to understand the contents of the lectures.
42	Distribution documents will be useful for the actual works.
43	Videos could be helpful for the understanding of the lessons.
44	The contents of the video could easily be understood.
45	The presentation slides by Lecturers could easily understood.
6. Mutual learning	
46	I could acquire the useful information from not only Lecturers but also the trainees through the lessons.
47	I could learn something from other Trainees about the approach and attitude to the lessons.
48	This technology transfer was a good opportunity for the exchange of opinions among the trainees.
49	I and the other trainees could keep the good sense of purpose from the beginning to the end.
7. Environmental conditions	
50	Indoor condition (lighting, temperature, etc.) of the Lecture rooms were comfortable.
51	The area of room and desk were appropriate.
52	Desktop/laptop computer and software worked all right.
53	Space for relaxation is enough.
54	The place of the Project office is convenient for commuting.
8. Period of the lecture	
55	The duration of the Lecture is enough.
56	The hours of the Lecture (9:00AM to 3:00PM) is enough.
57	The period of the Lecture (from October to February) is good.
58	The numbers of each lesson are appropriate.

Source: JICA Study Team

4.3.2 Result of the Questionnaire

The questionnaire was the response alternative of 1 to 5. Although the 0 answer was returned, but no trainees returned to the 0 answer. Almost all the answer was more than 3.

The result of the questionnaire is shown in the next page.

Table 4.3.2 Answer of the Questionnaire

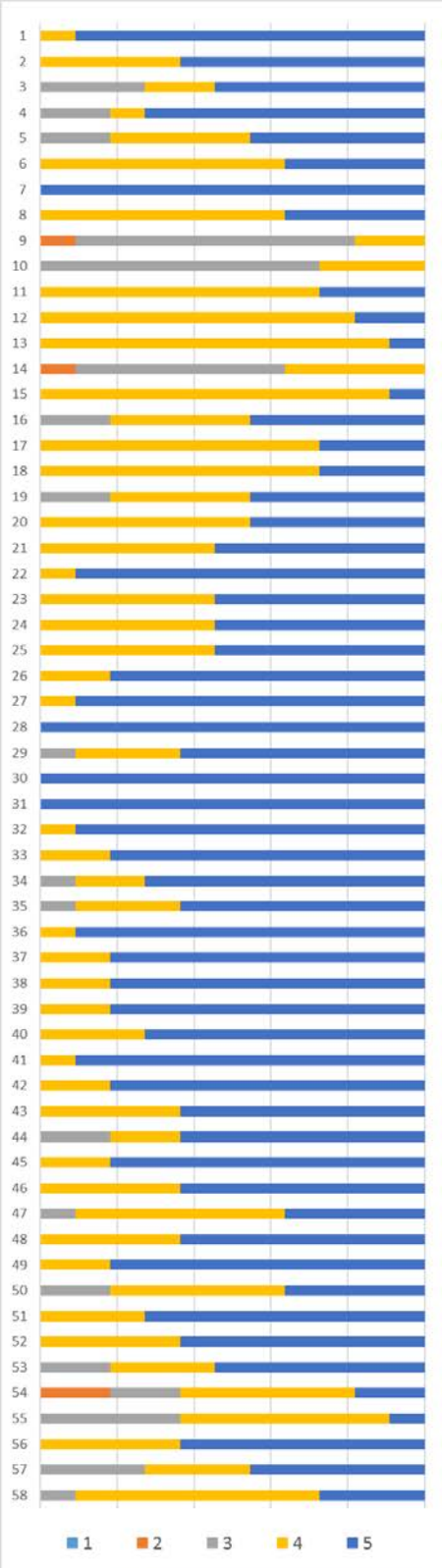
Answer No.	Answer
1	Never think so
2	Rather not think so
3	Between 2 and 4
4	Rather think so
5	Strongly think so
0	No answer

Source: JICA Study Team

Table 4.3.3 Result of Questionnaire

Q	1	2	3	4	5	Ave
1	0	0	0	1	10	4.909
2	0	0	0	4	7	4.636
3	0	0	3	2	6	4.273
4	0	0	2	1	8	4.545
5	0	0	2	4	5	4.273
6	0	0	0	7	4	4.364
7	0	0	0	0	11	5.000
8	0	0	0	7	4	4.364
9	0	1	8	2	0	3.091
10	0	0	8	3	0	3.273
11	0	0	0	8	3	4.273
12	0	0	0	9	2	4.182
13	0	0	0	10	1	4.091
14	0	1	6	4	0	3.273
15	0	0	0	10	1	4.091
16	0	0	2	4	5	4.273
17	0	0	0	8	3	4.273
18	0	0	0	8	3	4.273
19	0	0	2	4	5	4.273
20	0	0	0	6	5	4.455
21	0	0	0	5	6	4.545
22	0	0	0	1	10	4.909
23	0	0	0	5	6	4.545
24	0	0	0	5	6	4.545
25	0	0	0	5	6	4.545
26	0	0	0	2	9	4.818
27	0	0	0	1	10	4.909
28	0	0	0	0	11	5.000
29	0	0	1	3	7	4.545
30	0	0	0	0	11	5.000
31	0	0	0	0	11	5.000
32	0	0	0	1	10	4.909
33	0	0	0	2	9	4.818
34	0	0	1	2	8	4.636
35	0	0	1	3	7	4.545
36	0	0	0	1	10	4.909
37	0	0	0	2	9	4.818
38	0	0	0	2	9	4.818
39	0	0	0	2	9	4.818
40	0	0	0	3	8	4.727
41	0	0	0	1	10	4.909
42	0	0	0	2	9	4.818
43	0	0	0	4	7	4.636
44	0	0	2	2	7	4.455
45	0	0	0	2	9	4.818
46	0	0	0	4	7	4.636
47	0	0	1	6	4	4.273
48	0	0	0	4	7	4.636
49	0	0	0	2	9	4.818
50	0	0	2	5	4	4.182
51	0	0	0	3	8	4.727
52	0	0	0	4	7	4.636
53	0	0	2	3	6	4.364
54	0	2	2	5	2	3.636
55	0	0	4	6	1	3.727
56	0	0	0	4	7	4.636
57	0	0	3	3	5	4.182
58	0	0	1	7	3	4.182

Source: JICA Study Team



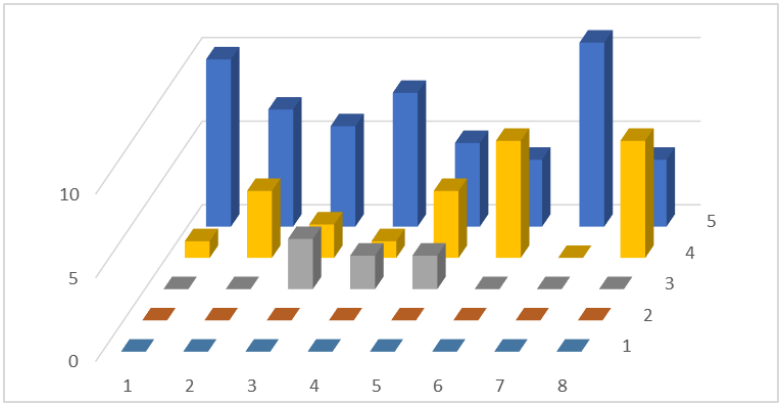
Source: JICA Study Team

Figure 4.3.1 Chart of the answer

4.3.3 Considerations of the Result

4.3.3.1 General impression of the lecture

These questions were intended to the direct impression to the lectures. Generally, the high reputations were acquired. Especially the question no.1 (acquire of new knowledge) and no.7 (expectation of the lessons to their future work) gained the high score, but the scores of no.3 (change of their thinking), no.4 (reconstruction of the knowledge), no.5 (encouragement by Lecturers), no.6 (increase of their motivation by the lecture), and no.8 (immediate effect of the lecture) were relatively low. It is assumed from the results that the trainees understood the Technology Transfer program was not urgent issue but be useful in the future. They seemed that they used this opportunity for a part of their work and highly motivated from the start of the lessons.



Source: JICA Study Team

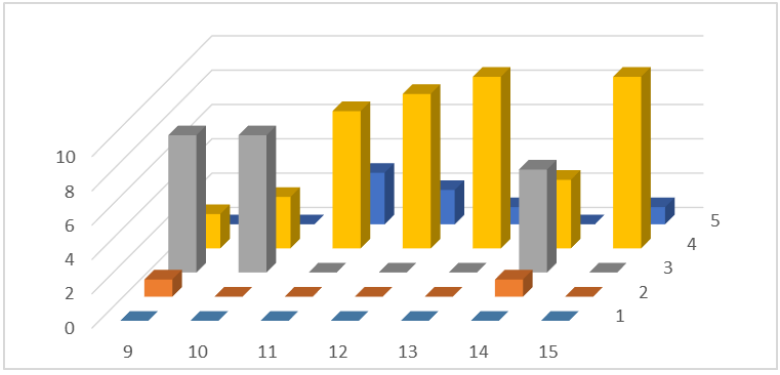
Figure 4.3.2 Results (1 to 8)

4.3.3.2 Preparations

These questions were intended to confirm what kind of preparations the trainees did before the lecture.

The results were relatively lower than other questions. No.9 (Objective of the Lecture), no.10 (Goal of the Lecture) and no.14 (preparations before the Lecture) had lower points among the questions.

The agenda of the contents was informed to MOC, while detailed contents and training materials were not given to the trainees before the lectures. There is another possibility that the trainees did not fully informed about the lecture in their organization.



Source: JICA Study Team

Figure 4.3.3 Results (9 to 15)

4.3.3.3 Contents of the lessons

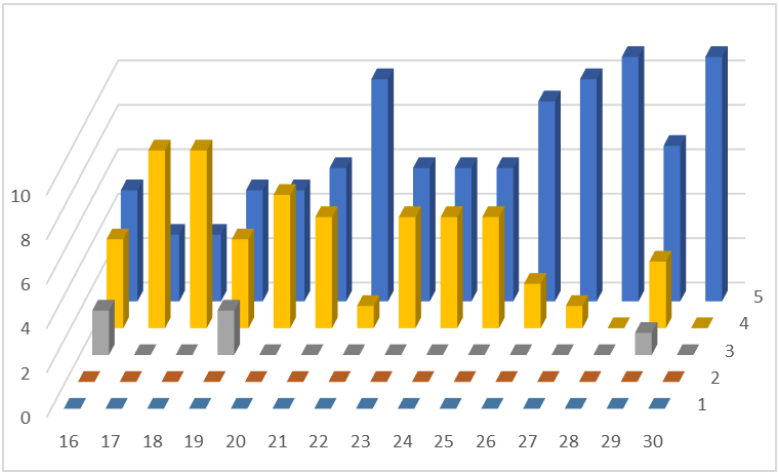
The questions of 16 to 19 were asked to confirm the levels and volumes of the lectures. The answers were

received enough points, while that was relatively lower than other answers.

JST prepared the detailed contents of the lecture. However, there was no step to confirm requests from MOC staff and the trainees to the lecture in the process of preparing the contents of the lecture.

The trainees thought that the question no.55 (the length of the lecture period) was not enough, which is supposed to be disgruntled by the balance between period of the lecture and field work

The special lecture by professors and basic lecture by lecturers was received higher marks. Detailed Practice also obtain the high votes.



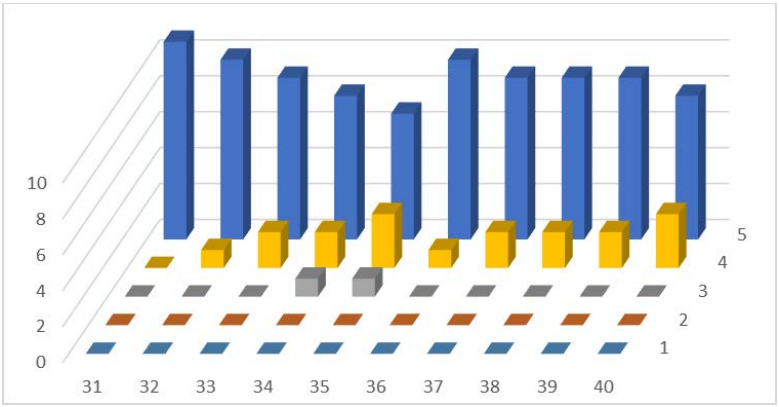
Source: JICA Study Team

Figure 4.3.4 Results (16 to 30)

4.3.3.4 Instruction by Lecturers (general impression)

The attitude of the lectures was asked, and trainees answered as almost good.

Since English was used in the lecture, question no.34 (difficulty level of the explanation) and no. 35 (speed of the explanation) was relatively low evaluation among the trainees. However, high scores were obtained in no.36 (reply from lecturers) and no.37 (communication between), the attitude of the lecturers was deemed as good and friendly.



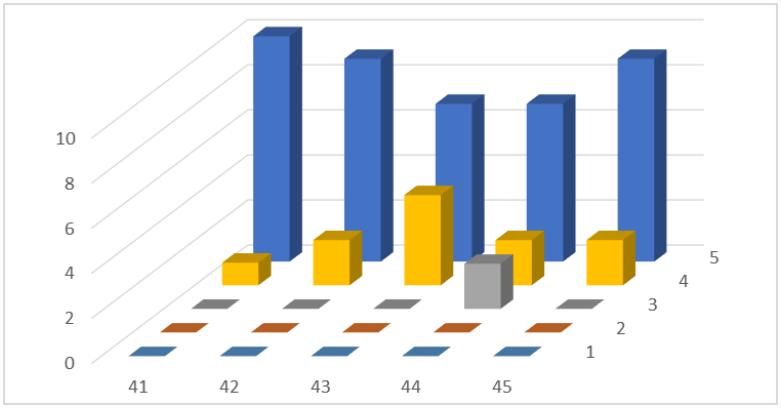
Source: JICA Study Team

Figure 4.3.5 Results (31 to 40)

4.3.3.5 Training materials

Almost all the materials were prepared by the lecturers, and the trainees appeared to satisfy training materials including distribution text and presentation slides.

Question no.44 (education video) means that the level of satisfaction by trainees was relatively low. Some of the video material was made only by Japanese language, which was not understand by the trainees. Video materials are not intended to explain to the MOC design team staff.

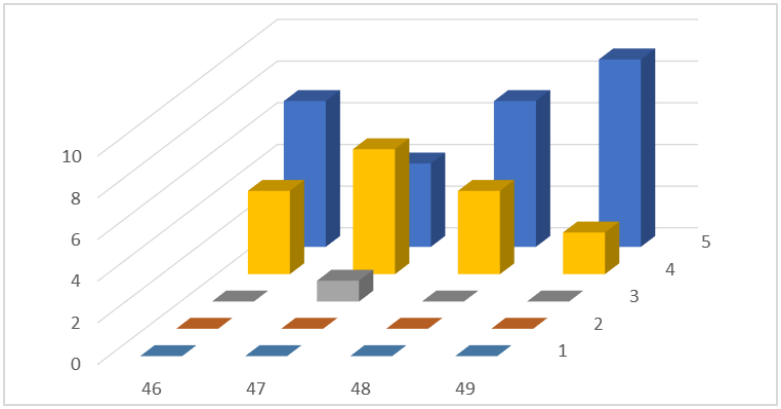


Source: JICA Study Team

Figure 4.3.6 Results (41 to 45)

4.3.3.6 Mutual learning

Although mutual learning was not a major objective of the Technology Transfer Program, high ratings were obtained. But the question no.47 (learning from the other trainees) was relatively low.



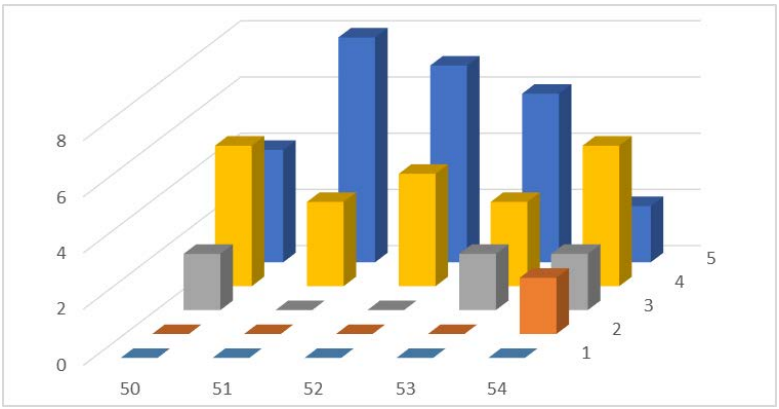
Source: JICA Study Team

Figure 4.3.7 Results (46 to 49)

4.3.3.7 Environmental conditions

Technology Transfer Program was carried out in the Project office of the Bago River Bridge prepared by JST. The office is three-story general building in Thaketa Township near Yangon-Thanlyin Bridge. The result shows that the room and space was not enough for the lecture. It was far from the center of the Yangon City and not convenient for commuting (question no.54).

The trainees satisfied the computer used in detailed design of Bago River Bridge.

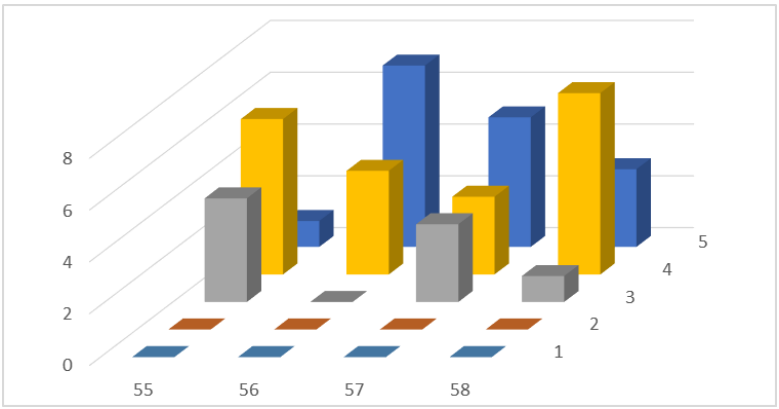


Source: JICA Study Team

Figure 4.3.8 Results (50 to 54)

4.3.3.8 Period of the Lecture

The score of the question about the period was relatively low. Although the period of the lecture as five months of duration (question no.55) and timing of implementation (October 2017 to February 2018, question no. 57) were prerequisite fixed condition, it was evaluated as the lower score. It might relate the busy period of the trainees from MOC.



Source: JICA Study Team

Figure 4.3.9 Results (55 to 58)

4.3.3.9 Conclusions

The result of the questionnaire reveals that the level of satisfaction by the trainees to Technology Transfer Program was high except the minor issues of “preparations” and “environmental conditions”.

4.3.4 Suggestions for the Further Training

The Technology Transfer Program by JST was considered as succeeded by obtaining high levels of satisfactory by the trainees and approval by officers from MOC.

It is suggested to use knowledge and skills obtained through the Program in the design works of MOC projects. MOC is also requested to continue capacity development of other staff by sharing knowledge and

skills obtained in the Program.

JST proposed in the Inception Report that evaluation of the capacity development shall refer to the Kirkpatrick's four level shown in Table 4.3.4. The four levels are used as the concept for evaluating the development of not only the individual skills but also the enhancement of the performance of organization. The questionnaire corresponds to the Level 1 of evaluation, which is "satisfactory of the participants", and examination is Level 2, "learning accomplishment".

Table 4.3.4 Kirkpatrick's four levels of learning evaluation

Levels of evaluation	Description
4. Results	Did the change in behavior positively affect the organization?
3. Behavior	Did the participants change their behavior based on what was learned?
2. Learning	What did the participants learn?
1. Reaction	Were the participants pleased with the program?

Source: "Techniques for Evaluating Training Programs" Kirkpatrick, D. L., 1975

JST planned the level and the goal of the Program with assumption of the trainees' capacity level, which can be said as "well-intended" program. JST could not expect this assumption might be correspond to the MOC's intension and direction or not. More effort shall be made to develop the organization's capacity.

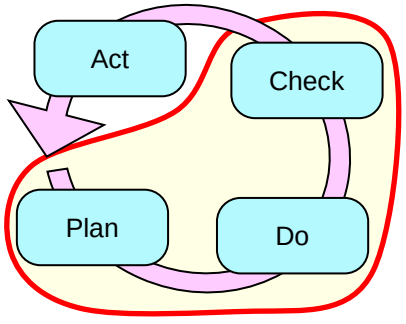
JST suggested the point for development below;

1) MOC shall plan the capacity development program of staff members with goal of the program and organization.

2) Similar questionnaire shall implement as this Technology Transfer to compare for discovery of the problem and improvement items.

3) Questionnaire shall implement not only for the trainees but the department which the trainees belong to.

Figure 4.3.10 shows the general PDCA cycle. In this Program P, D and C could execute but A (action) was not. JST expects that MOC shall improve the Program and applicate to the next new capacity development. Figure 4.3.11 shows the image of improvement of PDCA cycle.



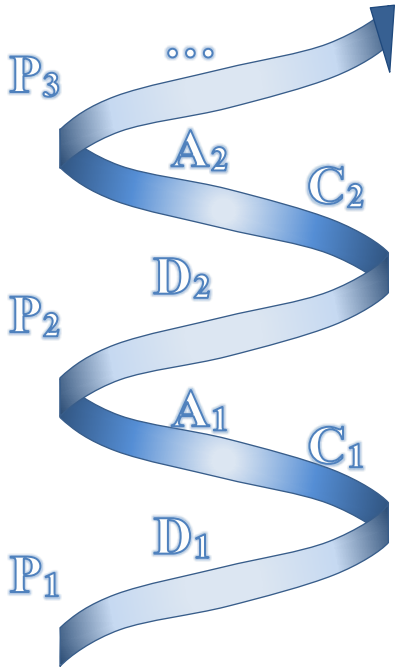
Source: JICA Study Team

Figure 4.3.10 Concept of PDCA cycle

Table 4.3.5 Description of PDCA cycle

Phase	Description
Plan	Clarification of the goal of the training Design of the training plan
Do	Implementation of the training
Check	Evaluation of the training
Act	Analyze of the evaluation Kaizen of the training plan

Source: JICA Study Team



Source: JICA Study Team

Figure 4.3.11 Image of improvement

4.4 ACHIEVEMENT OF THE TECHNOLOGY TRANSFER

First requirement of the contents of technology transfer by Permanent Secretary (at the time) was that the trainees could accomplish the detailed design of Bago River Bridge. JST appealed that because the design period was very limited and JST was not allowed to delay the Project schedule, so JST would conduct the program after the detailed design was finished. JST also explained that five months of technology transfer period including two months of detailed practice was not enough for full menu of the detailed design, and JST would conduct the essential part of the detailed design.

Table 4.4.1 shows the achievement of the Program and future assignment. This record will be utilized by MOC in self-practice or advanced lessons of detailed design in the future.

The main objective of the Detailed Practice was to design the structure with using structural analysis software. However, the software is made to calculate from any input and output some result even if the result is right or wrong. Engineers of JST emphasized that the designer should be careful about the result and should know the theoretical background of the design. Design theory and method were repeatedly explained in the Detailed Practice.

Because the design specifications of bridge are not formally established in Myanmar, JST applied AASHTO and/or Specifications for Highway Bridge (Japan) for Technology Transfer. Naturally it is desirable to apply technical standard of Myanmar as design practice, so the development of technical standard systems for Myanmar bridges are awaited.

Table 4.4.1 Achievements and assignments

	Achievement in the Program	Future assignment
Cable-stayed bridge	- Preparation of analysis model with using analysis program - Introduction of cable stress - Parametric analysis - Sectional calculation of member - Seismic analysis (static)	- Optimization of cable stress - Seismic analysis (dynamic) - Structural analysis during erection - Ultimate strength analysis - FEM analysis of stay cable anchorage - Elasto-plastic analysis

Steel box girder	- Calculation of dead load - Determination of number of main beam - Sectional calculation by 1-0 method - Sectional calculation by structural analysis program - Design calculation of stiffener - Design of splice plate - Design drawing of sectional configuration - Calculation of camber of beam	- Assumption of initial steel weight - Sectional calculation of transverse direction and torsional member - Design of diaphragm and vertical stiffener on support - Design of intermediate diaphragm - Design of concrete slab - Stress verification of connection point of crossbeam and main girder
PC box girder	- Calculation of cross-sectional forces (main girder and transverse box frame) - Design of main girder - Preparation of outline drawings (structural configuration, tendon arrangement)	- Check of transverse box frame elements, arrangement of transverse tendons and reinforcement - Study on tendon arrangement of main girder - Design of segment joints (SBS method) - Design of crossbeams - Design of deviators, anchorage blisters, web ribs, etc. - Preparation of detailed drawings
Substructure	- Understanding of the foundation design including cast-in-situ pile and steel pipe sheet pile foundation with using analysis program - Acquisition of the design concept of steel pipe sheet pile foundation considering construction procedures	- Evaluation of soil properties and modelling - Configuration of design load - Alternative design of foundation considering economy aspect - Design modelling of the foundation by construction method and procedure - Planning of the foundation considering the procurement of materials
General issues		- Design conditions (roadway composition, design loads, materials, etc.) - Structural plan (bridge length, span arrangement, girder height, cross section shape, etc.) - Calculation of road alignment - Design of bridge accessories (bearings, drainage, expansion joints, etc.) - Quantity calculation - Check and documentation

Source: JICA Study Team