Republic of the Union of Myanmar

Myanma Railways, Ministry of Rail Transportation

PROJECT ON IMPROVEMENT OF SERVICE AND SAFETY OF RAILWAY IN MYANMAR

PROJECT PROGRESS REPORT

March 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO., LTD
ORIENTAL CONSULTANTS GLOBAL CO., LTD
SUMITOMO CORPORATION

Project on Improvement of Service and Safety of Railway in Myanmar Project Progress Report

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Project on Improvement of Service and Safety of Railway in Myanmar
Progress Report, March 2015

1. Preface

Since we started the Project in June 2013, about 21 months have passed and the Project has been implemented effectively under the close cooperation between MR officials concerned and JICA Expert Team.

We, JICA Expert Team, would like to express our sincere appreciation to MR officials concerned for their kindness extended to us during the execution of the Project.

This Progress Report deals with the major activities of the Project implemented around between December, 2014 and March of this year.

We should be grateful, if the members of the JCC would review the Report and provide us with the various advices.

2. Project Summary

2.1 Project background

The Republic of the Union of Myanmar has a totally non-electrified meter-gauge railway network spreading as long as 5,988 km. Most of the network is single-tracked, with double-tracked sections limited to (1) the Yangon–Mandalay section (approximately 620 km in length) crossing the central plain and (2) urban railway lines centering on the Yangon circular section. The yearly number of passengers is 53.2 million (or approximately 145,700 per day) as of fiscal 2013. The Myanma Railways (hereinafter referred to as MR) under the Ministry of Rail Transportation centralizes all aspects of its management, from construction, operation, and maintenance.

In recent years, MR and Ministry of Rail Transportation have come to recognize the importance of maintenance/repair of existing lines. In the past, however, MR invested more than a half of the budget in the construction of new railway lines, with only a small portion appropriated for the renewal of existing facilities and equipment. As a result, MR is now has crucial subjects how to recover the deteriorated safety level and passenger services. In concrete terms, facilities and equipment have extremely superannuated and machines, tools and materials are running short. Maintenance, and management have not been implemented appropriately in the past. As a matter of fact, 118 accidents including derailment and collision having occurred in fiscal 2011 in the Yangon–Mandalay section. There are a number of problems in the section, such as delays of train operation, lowered train speed and worsened ride comfort.

According to the data of MR, the status of the safety of train operation is as follows. From 2011 through 2012, 118 accidents occurred in the 620.4 km-long Yangon–Mandalay section, of which those attributed to tracks, rolling stock and others accounted for 50, 29 and 21%, respectively. This means that most of the accidents were caused by deteriorated tracks.

The status of services is as follows.
There are a number of factors that govern the service level, such as train speed, punctuality, comfort (ride comfort, cleanliness in the passenger room) and fare and charge. The scheduled speed between Yangon and Mandalay is as low as 39 km/h, with train speed limited at various points. The on-time operation rate of express passenger trains in the same section is as low as 41% during the past three years, with trains delayed 59% by improper track conditions and 22% by malfunction of rolling stock. This means that train delay is caused mostly by deteriorated tracks. Furthermore, trains vibrate excessively and passenger rooms are not clean. MR is required to eliminate these drawbacks and improve passenger services.

2.2 Circumstances having led to the project

With the above facts in the background, the government of Myanmar requested the government of Japan to implement a project of technical cooperation, namely "The Project on Improvement of Service and Safety of Railway." Based on this request, JICA delegated a detailed project planning study team in October 2012 and surveyed the present status of the railways around Yangon and in the suburbs of Naypyidaw and also had the consultations with MR.

According to the Record of Discussion (hereinafter referred to as R/D) signed on March 25, 2013, between President of MR and General Manager, JICA office in Myanmar, agreement was reached upon the detailed contents of the Project and cooperation of JICA to be extended thereto.

2.3 Purpose of the Project

Administration and maintenance ability is improved for the enhancement of service and safety of Myanma Railways.

3. Basic Plan of Project Implementation

3.1.1 Overall goal and Project purpose

Overall goal and Project purpose of this Project and expected outputs are as follows.

Overall goal and Project purpose	
1	Service and safety level of Myanma Railways is improved (Overall goal)
2	Administration and maintenance ability is improved for the enhancement of service and safety of Myanma Railways (Project purpose)

⇩

Expected outputs	
Output1	Based on accident analysis, issues are clarified for the enhancement of service and safety in the administration and maintenance process, and the improvement plan is drawn.
Output2	Technical Transfer of Track Maintenance Technology to improve the level of Service and Safety through implementation of the Pilot Project

3.1.2 Implementation plan

Implementation plans which accomplish the project purpose are as follows.

Implementation plan for Output1
To survey current situations of track, rolling stock, signal and telecommunication, and operation, and to establish system for collecting information in these various areas above.
To promote familiarization on the investigation and analysis method of accident cause based on the comprehensive factors of track, rolling stock, signal and telecommunication, and operation.
To conduct the investigation and analysis mentioned above with due consideration on hardware (facilities, equipments), and software (operational and maintenance standards, human errors etc.)
To provide recommendation based on the above analysis on necessary technical standards relating to operational and maintenance aspects to improve service and safety level
To draw up the improvement plan of railway facilities through discussion with the "Working Group of service and safety improvement"

Implementation plan for Output2
To draw up technology transfer plan of track maintenance through OJT in the Pilot Section.
According to the technology transfer plan above, to procure the necessary equipments and materials.
To conduct track maintenance (inspection, planning, work) jointly with MR staff, making use of the equipments and the materials.
To summarize points to be improved obtained during track maintenance operation mentioned above, and to feed back to the successive measures.
To revise the track maintenance manual based on the feedback above.
To conduct seminars, training for technical improvement of the track maintenance

3.1.3 Project Section

The site between Yangon and Bago in the Yangon is suburban area. At the beginning, technology transfer of track maintenance started for 30 trainees in the Pilot Section of 20km located in the section between Yangon and Bago. At present, accumulated number of trainees amounts to 300, and the various situations relating to technology transfer have been changed. Further, in order to implement the training efficiently, trainings are sometimes repeated in the same place, and also on Dagon or Thilawa line near Toegyaunggale Sta.

In this regard, we consulted with MR about various matters including the suitable change of the length of the Pilot Section.

3.2 Flow Chart of project implementation

The flow chart of the project implementation (Initial Plan) is shown in Figure3.1.

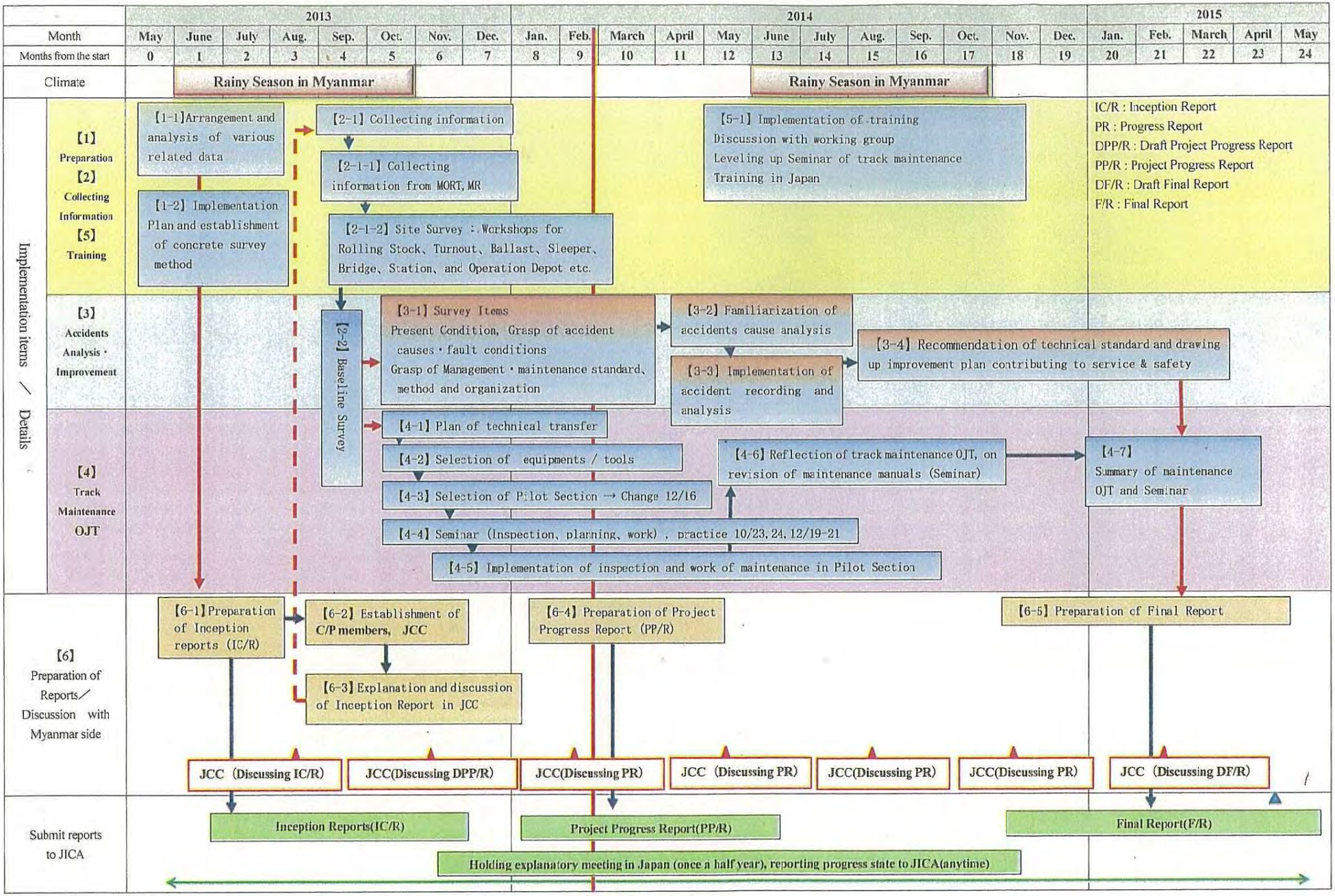


Figure 3.1 Project Implementation

4. Project implementation Organization

4.1 Structure of project implementation Organization

Based on R/D, a project implementation Organization was organized as shown in Fig. 4.1.

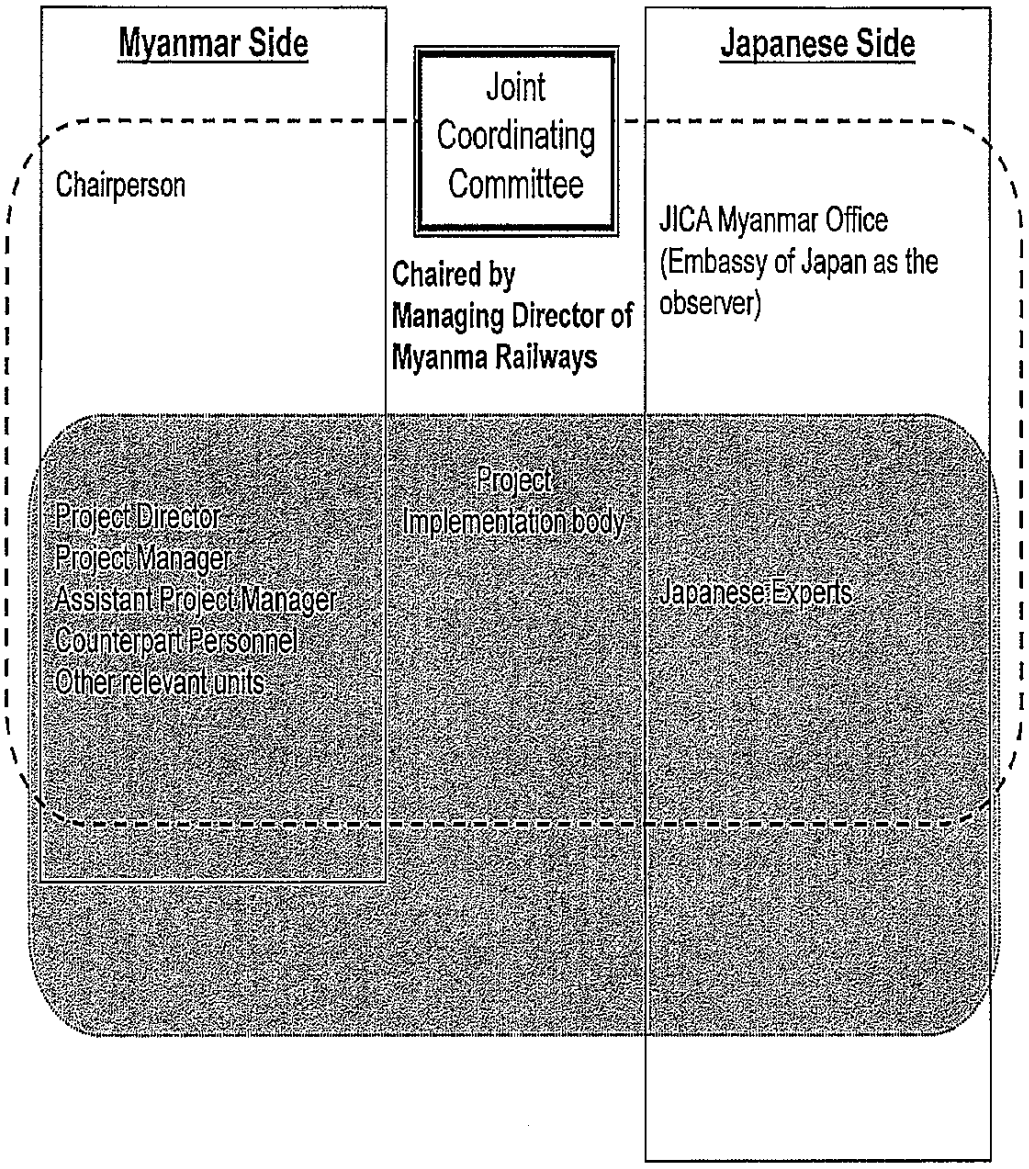


Fig. 4.1: Structure of project implementation Organization

This project is promoted as a scheme of "technical cooperation". Implementation organization consists of (1) Myanma Railways (MR) supported by the Ministry of Rail Transportation on the Myanmar side and (2) JICA and a tripartite consortium (JV) composed of Japan International Consultants for Transportation Co., Ltd. , Oriental Consultants Co., Ltd. , and Sumitomo Corporation. To ensure smooth implementation of the whole project, the Joint Coordinating Committee (JCC) was established as referred to later in 4.4.

4.2 Implementation body on the Myanmar side

MR plays a central role on the Myanmar side. To correspond to Japanese experts, a Counterpart Team was organized for this project. See Table 4.1. Project Director commands the general affairs and implementation of the project, while Project Manager manages the projects and directs technical affairs.

During the implementation of the Project, several experts locating at MR Headquarters at Nay Pyi Taw were added to the Counterpart Team, so that the analysis of accidents, low service level and discussion of countermeasures could be effectively executed under the cooperation of MR experts and JICA experts. The counterpart Team is finally established as shown in Table 4.1.

4.3 Implementation body on the Japan side

The JICA experts selected from the above tripartite consortium guide/advise the personnel on the Myanmar side and offer recommendations where necessary for the project. See Table 4.1 for the list of the JICA expert members.

During the implementation of the Project, the following replacement of Japanese experts was made due to inevitable circumstances.

(1) Signals/ Telecommunications	from Kiichi Takemura to Ryuhei Mitani (since October 25, 2013)
(2) Track Maintenance	from Kazuhiko Murao to Masato Wakatsuki (since October 28, 2013)
(3) Train Operation	from Hideharu Igarashi to Sunuji Morihara (since June 3014)

4.4 Estahlishment of Joint Coordinating Committee (JCC) and Its Functions

JCC is the committee to confirm the progress of the Project, discuss important matters and make decisions for the better implementation of the Project.

Managing Director of MR is the chairperson of the JCC. The members are listed in Table 4.2.

On Maynmar side U Saw Valentine, General Manager (Technical & Admin. Support) was changed to U Aung Win in Dec.2014 and U Aung Win, General Manager (Mechanical & Electrical) was replaced by U Win Oo in Dec.2014.

Corresponding to the replacement of Japanese experts as mentioned in the section 4.3, the JCC members on Japanese side were replaced as shown below.

(1) Signal/ Telecommunication	from Kiichi Takemura to Ryuhei Mitani
(2) Track Maintenance	from Kazuhiko Murao to Masato Wakatsuki
(3) Train Operation	from Hideharu Igarashi to Shunji Morihara

Originally it was planned to be held at least twice a year and when necessary arises.

However on the request of Myanmar side, it is planned to be held around once every 3 months.

Table 4.1 "Member of Administrative and Counterpart Personnel"

Field	Myanma Railways	Japanese Side (JICA Expert Team)
Project Director	U Saw Valentine/ U Aung Win, General Manager (Technical & Admin. Support)	Sadaaki KURODA (Leader)
Project Manager	U Tin Soe, General Manager (Civil)	Nobuyuki MATUO (Deputy Leader)
Railway Policy/ OM Improvement	U Kyaw Kyaw Myo AGM (Passenger)	Hiroshi KOMATSU
Track Maintenance	U Min Aung, AE (Civil) U Than Htay, DGM (Civil) U Maung Maung Than, AGM (Civil)	Masato WAKATSUKI Kiyoshi MIYAMOTO
Signalling & Telecommunications	U Han Nyunt, AGM (S&T) U Myint Lwin, DE (S&T)	Ryuhei MITANI
Rolling Stock	U Thet Lwin, DGM (M&E) U Aung Kyaw Naing, DME (M&E)	Makoto ISHIKAWA
Train Operation	U Zaw Pe Sein, AGM (Operationg) U Htay Myint Aung, DGM (operating)	Shunji MORIHARA
Structure	U Maung Maung Thwin, DGM (Civil) U Tin Win, DGM (Civil) U Zaw Min Oo (Ex. E (Civil))	Mitsuru TAKAMI (Coordination)
Procurement of Equpiment & Materials	U Win Htein, DGM (Supply) U Kyaw Naing Oo AM (Finance)	Yuichi TANIGUCHI

Table 4.2 JCC Personnel

Chairman U Thurein Win Managing Director of Myanma Railways			
Myanmar Side		Japanese Side	
Name	Position (Major)	Name	Position (Major)
U Saw Valentine/ U Aung Win	General Manger (Technical & Admin support)	Sadaaki KURODA	Leader of Japanese Expert Team (Track maintenance)
U Myint Wai	General Manager (Operation) for analyzing accidents	Nobuyuki MATUO	Deputy Leader (Maintenance planning)
U Aung Win / U Win Oo	General Manager (Mechanical & Electrical) for rolling stocks	Hiroshi KOMATSU	Railway Administration and Management Expert
U Tin Soe	Project Manager, General Manager (Civil)	Yuichi TANIGUCHI	Procurement of Equipment and Materials Expert
UThan Htay	Assistant Project Manager, Deputy General Manager (Civil)	Ryuhei MITANI	Signalling and Telecommunications Expert
U Khin Maung Thein	Assistant Project Manager, Deputy General Manager (Signalling & Telecommunications)	Makoto ISHIKAWA	Rolling Stock Expert
U Min Aung	Counterpart Personnel, Assistant Engineer (Civil)	Masato WAKATSUKI	Track Maintenance Expert
U Myint Lwin	Counterpart Personnel, Assistant Engineer (Signalling & Telecommunications)	Kiyoshi MIYAMOTO	Earth Roadbed Expert
Daw Thi Thi Nwe	Assistant General Manager (Finance)	Mitsuru TAKAMI	Coordinating Expert
Htaung Sian Kan	Deputy General Manager (Admin)	Shunji MORIHARA	Operation Expert
		Mitsuo HIGASHI	Railway Management Advisor
			Representative of JICA
			Representative of JICA
			Representative of Embassy of Japan : Observer

The first JCC was held on Aug. 28th, 2013 for authorization of Inception Report, and the 2nd JCC, originally planned to be held on Nov. 28th or 29th, 2013, but postponed with due consideration of various situations of MR, was held on 27th February, 2014 at Nay Pyi Taw. 3rd, 4th and 5th JCCs were held on the 29th May, on the 29th October, and on the 19th December 2014, respectively at Nay Pyi Taw.

4.5 Establishment of Working Group for Service and Safety Improvement

In the Record of Discussion(R/D) agreed between Managing Director of MR, U Thurein Win and Chief Representative, Myanmar office of JICA, on May 28th 2013, Appendix 1, Ⅱ.OUTLINE of the Project, 5.Activities(1-5) reads as follows: [To draw the improvement plan of railway facilities through discussion with Working Group for Service and Safety Improvement(tentative name)]

In this regards, MR and JICA Expert Team have established Working Group as shown in Table 4.3.

Table 4.3 "Member of Working Group for Service and Safety Improvement"

Field	Myanma Railways	Japanese Side (JICA Expert Team)
Project Director	U Saw Valentine/ U Aung Win, General Manager (Technical & Admin. Support)	Sadaaki KURODA (Leader)
Project Manager	U Tin Soe, General Manager (Civil)	Nobuyuki MATUO (Deputy Leader)
Railway Policy/ OM Improvement	U Kyaw Kyaw Myo AGM (Passenger)	Hiroshi KOMATSU
Track maintenance	U Min Aung, AE (Civil) U Than Htay, DGM (Civil) U Maung Maung Than, AGM (Civil)	Masato WAKATSUKI Kiyoshi MIYAMOTO
Signalling & Telecommunications	U Han Nyunt, AGM (S&T) U Myint Lwin, DE (S&T)	Ryuhei MITANI
Rolling Stock	U Thet Lwin, DGM (M&E) U Aung Kyaw Naing, DME (M&E)	Makoto ISHIKAWA
Train Operation	U Zaw Pe Sein, AGM (Operati) U Htay Myint Aung, DGM (Operating)	Shunji MORIHARA
Structure	U Maung Maung Thwin, DGM (Civil) U Tin Win, DGM (Civil) U Zaw Min Oo (Ex. E (Civil))	Mitsuru TAKAMI (Coordination)

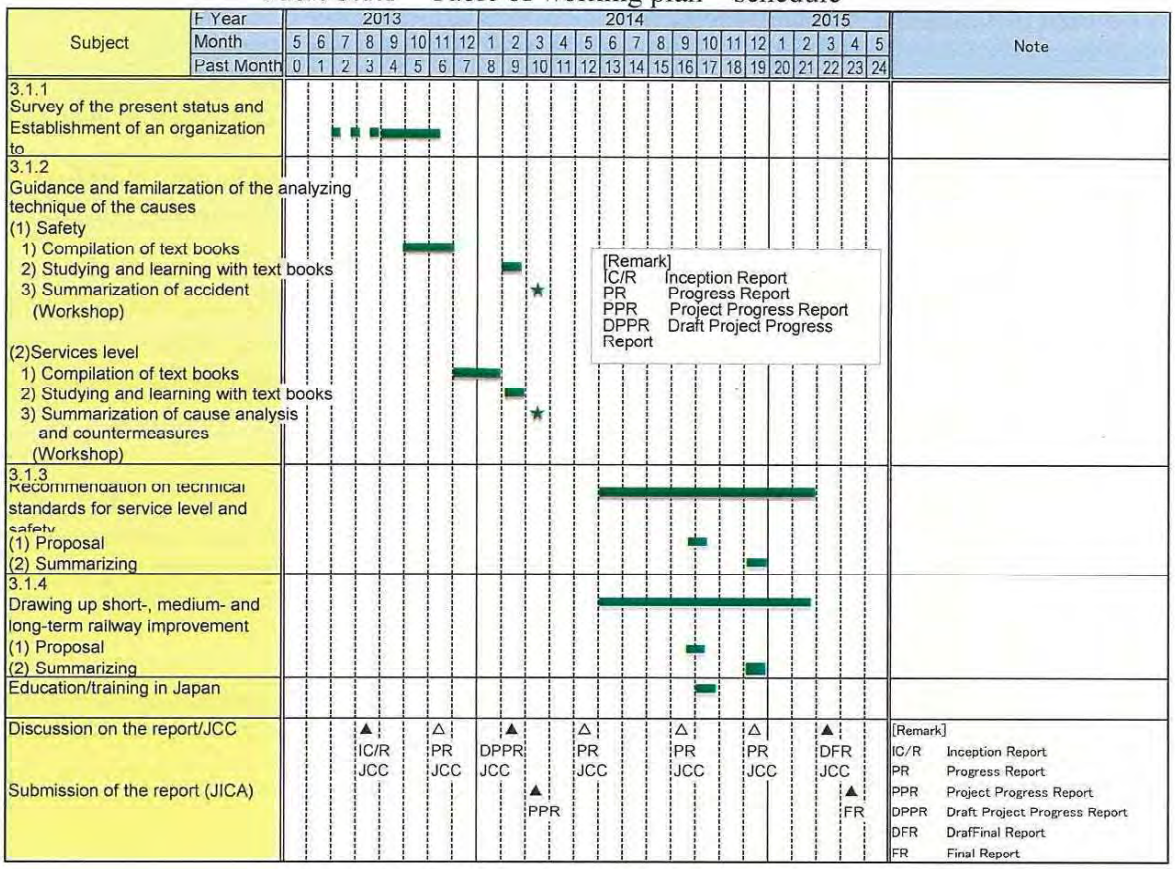
5. Reporting of the Progress of the Project

5.1. Recommendation of technical standard relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level

5.1.1 Preparation of a working plan

The Project is progressing as scheduled in Table 5.1.1

Table 5.1.1 Table of working plan schedule



5.1.2 Survey of the present status and establishment of organization to collect information

(1) With respect to an organization to collect information, the counterpart team was established as shown in Table 4.1 of this Report.
(2) Collection of relevant information relating to train operation and rolling stock.
Two experts visited MR headquarters and three rolling stocks workshops for facts finding in August and September, 2013.
(3) Present status of safety and service level of MR
Based on the answers to the Questionnaire from the JICA expert team to MR, the paper "Present Situation of Safety and Service Level of MR" was prepared, which is attached as Appendix 8-1 of the Progress Report March 2014.

5.1.3 Guidance and familiarization of the analyzing technique of the causes of accident and low service level

(1) Training program of cause analysis of accidents/ low service level and establishment of countermeasures

Training program, of which purpose is to guide MR staff and to make them be familiarized about the technique to analyze the cause of accident and low service level, and establishment of countermeasures, was held from Feb. 10 to Feb. 28, 2014 jointly by the MR and JICA in the meeting room of MR Headquarters.

19 experts (originally 20, but one expert was absent) of manager level (Track maintenance, Civil works, Signaling, Rolling stocks and Train Operation) of Divisions or Head office of MR participated in the training program.

The whole training program consists of there parts. The first part is class room lecture of the text book prepared by JICA experts. The second one is workshop. The third one is training of vibration measurement of rolling stock.

Further it should be mentioned that interview survey to investigate the customer's satisfaction level of MR's passenger transport was conducted following the training program.

Class room lecture of the text book was held form Feb.11 to Feb. 21 between 9:00 – 12:00 in the morning. Workshop was held from Feb. 11 to Feb.26, mainly between 14:00 – 16:00 in the afternoon. Training of rolling stock vibration measurement was implemented from Feb. 27 to Feb. 28.

(2) Class room lecture of text book

JICA experts explained, based on the text book, about the past accidents and countermeasures in the world mainly in Japan (for examples, derailment, train collision, level crossing, natural disaster and so on), and introduced the measures for improvement of the service level (for examples, increasing train speed, punctuality, riding comfort abilities, train protections and so on).

There were various discussions between JICA lecturers and MR participants. Major advices to MR by JICA experts based on the discussion are summarized in the Progress Report submitted to 3rd JCC held in May, 2014.

(3) Workshops

1) Items selected for presentation by MR experts

   The purpose of the workshop is to make MR experts be familiarized with analysis of causes of accidents and low service levels and establishment of countermeasures through making MR staff themselves analyze the causes of actual accidents or low service levels of MR and making themselves establish suitable countermeasures.

   In this regard, 25 items relating to accidents and low service levels (train delay and speed restrictions) were selected from the actual MR's events in 2012/ 2013, and MR experts by themselves tried to analyze the causes and to establish the appropriate countermeasures.

2) Discussion between MR experts and JICA experts on presentation by MR experts

   For each presentation of MR experts, JICA experts made comments on method of cause analysis and establishment of countermeasures presented by MR experts. JICA experts also presented advices to MR regarding major issues identified through discussion in the workshop.

   These comments and advices were prepared for each of all presentations which are classified according to kinds of items for presentation.

   Summary and details of them are given in Appendix 2-1of Progress Report, May 2014.

(4) Comments of training program by MR participants

In order to find out the major response of MR experts to the Training Program (the lectures by JICA experts and Workshop), the following four questions were asked to each MR participant.

Question 1 According to your opinion, what information/ matters/ Japanese examples were especially useful for improvement of safety and service level of MR?

Question 2 Are there any other information/ matters/ Japanese experiences you would like to know more?

Question 3 Do you think the way/ method by which JICA expert team organized the workshop was satisfactory to you?

Question 4 Do you have any advice how to improve the way/ method of workshop?

The answers to each question by MR participants are shown in Table2.4 of the Progress Report, May 2014.

(5)Training for measurement of train vibration

In order to make MR experts familiarize how to apply the vibration measurement of train to control of track maintenance and improvement of vehicle performance, JICA experts instructed measurement and analysis of actual Train Vibrations on Feb. 27, and 28th. Trainings were implemented by using the device [Digital Vibration Measurement Device W0031]. Trainings included 1) how to use the device to measure the vibration and how to analyses the measured data, 2) measurement of actual MR's express train, and 3) analysis of the measured data.

The details of the training of measurement of train vibration are presented in [Vibration Measurement Report] included as a part of the Progress Report, May 2014.

(6) Investigation of Customer's Satisfaction Level of MR passenger transport

In order to investigation customer's satisfaction level of MR passenger transport, interview survey was conducted on March 4 to 7 2014, between Yangon Station and Nay Pyi Taw Station on Yangon-Mandalay Trunk Line.

Myanmar Railway passengers were targeted excluding foreign travelers, and they were interviewed on the running trains. In case of a group trip, only one passenger of the group was interviewed.

3 kinds of train and class, "Express Upper", "Express Ordinary" and "Local", were targeted and at least 120 passengers were sampled for each train kind/class.

For interviewing, a questionnaire consisting of 20 questions was prepared.

Subjective Evaluation items (Q1~16) were scored and the difference of evaluation by Train kind and passenger class was analyzed The survey items (Q17~20) were for investigating the fundamental properties of passengers such as gender, age, purpose of travel and occupation.

The boarding sections of passengers were plotted on the graph for each train.

The details of the interview survey and the result of the analysis of the answers to the questionnaire are summarized in the Progress Report, May 2014.

5.1.4 Recommendation on technical standards relating to administrative and maintenance aspect to improve the service level and safety

5.1.4.1 Introduction

The training program and workshop for familiarization of cause analysis of accidents and low service level and for conducting these cause analysis and establishing counter measures together with MR experts were held from Feb. 10 to 28, 2014 at Nay Pyi Taw. In this training program and workshop, major technical standards of MR relating to safety and service level in the field

of track, rolling stock, signal/telecommunication, train operation and structure, were discussed between MR experts and JICA experts. Taking this opportunity, JICA Experts collected the relevant major technical standards relating to safety and service level in the respective engineering fields.
JICA Expert Team made reviews on these collected technical standards and proposed recommendations on these technical standards as shown in Appendix1[Report of Proposals of Recommendation on Technical Standards of MR and Short-, Medium-, and Long Term Railway Facilities Plan] (Herein after referred to as "Report of Proposals") attached to Progress Report September 2014.

5.1.4-2 Some Major Technical Standards Having Been Reviewed by JICA Experts

They are listed in the Following Table 5.1.2.

Table 5.1.2 List of Technical Standards/ Regulations Reviewed by JICA Experts

	A-Rolling stock
1	Diesel Electric Locomotives and Diesel Hydraulic Locomotives Maintenance Instruction Schedule
2	Diesel Electric Locomotives and Diesel Hydraulic Locomotives Maintenance Instruction Schedule (Elecgrical)
3	Examinatin and repair of C & W stock
4	Technical Specifications for 1200 Horse Power Diesel Hydraulic Locomotive
5	Technical Specifications for Meter Gauge 1200/2000 Horse Power for Hillsection Diesel Electric Locomotives for Plain Section
6	Technical Specirications for Meter Gauge 2000 Horse Power Diesel Electric Locomotives
7	Technical Specifications for In-Service Diesel Elctric Locomotives
8	Technical Specifications for YDM4 Class Locomotive (1000mm Gauge)
9	Technical Specifications for Meter Gauge 2000HP Diesel Electric Locomotives
10	General Technical Specifications for Meter Gauge Bogie Passenger Coaches
11	General Technical Specifications for Meter Gauge Bogie Freight Wagons
12	General Technical Specification for Design, Supply and Domestic Manufacturing of Meter Gauge Bogie
13	General Technical Specifications for Meter Gauge Bogie Passenger Coache Type BDTEZ
14	Technical Specifications for Meter Gauge Bogie Ballasted Hopper Wagons
15	Paticular Technical Specification for Meter Gauge Four-Axle Bogie Welll Wagon for Container
16	Technical Specification for Meter Gauge Bogie Day Upper Class Passenger Coarch
17	Technical Specification for Meter Gauge Bogie Covered Wagon Type - GBHV
18	Technical Specification for Meter Gauge Bogie Sugercane Cum Material Wagon Type - SMBV
19	Technical Specification for Meter Gauge Bogie Material Wagon Type - MBHV
	B.--Track
1	Manual of the Engineering Department Chapter IV Permanent Way I (material,tool,theory)
2	Manual of the Engineering Department Chapter V Permanent Way II(construction, and maintenance)
3	Track Specification
4	Manual of the Engineering Department Chapter XXII Technical Appendices
5	Manual of the Engineering Department Chapter IX Miscellaneous
	C--Structures,Building,Ststion Machinery,Safety Precaution
1	Manual of the Engineering Department Chapter XII Safety Precaution
2	Manual of the Engineering Department Chapter VI Bridges
3	Manual of the Engineering Department Chapter III Formation
	D-Signalling and Telecommunications
1	TRAIN SIGNALLING INSTRUCTIONS for the Double and Single Lines by Electric Block Instrumentsand by Telegraph or Telephone
2	Manual of the Engineering Department-Chapter VIII-Signal andTele-communication No.1
3	General Rules for all open lines of railway in Burma Parts I&II together with the subsidiary rules
	E--Train Operation
	General Rules for all open lines of railway in Burma Parts I&II together with the subsidiary rules
1	Chapter 1 Preliminary
2	Chapter II Signals
3	Chapte III working of Trains General
4	Chapter IV Accidents
5	Chapter XIII The Following Trains System

5.1.4-3 Details of the major recommendations/comments on Technical Standards.

The details of the recommendations/comments are presented in the Appendix I, [Report of Proposals] attached to Progress Report, September 2014. Report of Proposal was submitted to the workshop and discussed by the members of Working Group for Service and Safety

Improvement. Summary of discussion for these recommendations are presented in Appendix-2 [Summary of Discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, and Long-term Railway Facilities Improvement Plan] attached to Progress Report Dec. 2014.Later a set of Questions relating to the Workshop were sent to JICA experts. The answers prepared by JICA experts are attached as Appendix 8-1 of this Report.

5.1.4-4 Revision of the Report of Proposal

The Report of Proposal was revised as required according to the discussion mentioned in 5.1.4-3 above, and Revised Report is attached to the Progress Report, Dec. 2014 as Appendix-1 [Revised Report of Proposal of Recommendation on Technical Standard of MR and Short-, Medium-, and Long- Term Railway Facilities Improvement Plan]

5.1.4-5 Summarizing Workshop

Revision of the report of Proposals was very limited, so JICA Experts made several presentations relating to improvement of service and safety of MR in addition to explanation of Revised Report of Proposals. The agenda and timetable are as shown in the following Table 5.1.3 and 5.1.4.

Table 5.1.3 Agenda

1. Explanation of Revision of the Last Report of Proposals
2. Railway Development in Japan
3. Running Performance of Rolling Stock
4. Supervision of Construction Work
5. Maintenance Work for Civil Engineering Railway Structure
6. Supplementary Lecture on ATS etc.

Table 5.1.4 Timetable

Month / Day	Dec 15	Dec 16	Dec 17	Dec 18	Dec 19
Day of the Week	Mon	Tue	Wed	Thu	Fri
Morning	9:30-12:00 Explanation of Revised Report of Proposal by Dr. S. Kuroda, Mr. M. Takami.	9:30-12:00 Lecture No.2 Running Performance of Rolling Stock by Mr. M. Ishikawa	9:30-12:00 Lecture No.4 Maintenance Work for Civil Engineering Railway Structure by Mr. M. Takami	9:30-12:00 General Discussion	5th JCC
Afternoon	13:30-15:30 Lecture No.1 Railway Development in Japan by Dr. S.Kuroda	13:30-15:30 Lecture No.3 Supervision of Construction Work by Mr. N. Matsuo	13:30- Lecture No.5 Supplementary Lecture on ATS etc. by Mr. R. Mitani		

Summary of discussion made during summarized workshop is attached as Appendix 8-2 of this Report.

5.1.5 Drawing up of short-, medium-, and long-term railway facilities improvement plan

5.1.5-1 Introduction : the principles for drawing up short-, medium-, and long-term railway facilities improvement plan

In drawing up short-, medium-, and long-term railway facilities improvement plan (hereinafter referred to as RFIP) from the viewpoint of upgrading safety and service of MR, the following

principles are adopted,

(1) RFIP focuses on the rehabilitation and modernization of the existing lines.
(2) Railway facilities plan relating to new line construction and improvement of international transport will be excluded.
(3) RFIP will focus on improvement of facilities relating to upgrading safety and service, but exclude the improvement of facilities relating to economic development of the area along the lines, railway business expansion, or revenue increase such as development of ICD, freight yard, connection to sea ports.
(4) The railway projects proposed by Myanmar Development Cooperation Forum which took place on Jan.19 and 20, 2013 will be duly taken into consideration.
(5) "Survey Program for National Transport Development Plan in the Republic of the Union of the Myanmar" prepared by JICA (June 2014) will be duly taken into consideration.

5.1.5-2 Proposal of short-, medium-, and long-term railway facilities improvement plan

(1) Introduction

In drawing up RFIP, the principles described in 5.1.5-1. Introduction have been duly taken into consideration. Further the following preconditions or policies have been assumed.

1) In MR railway network, Yangon – Mandalay line and Yangon Transit System (Circular line + Danyingon ~ Hlawga+ Mahlwagon ~ Ywathagyi + Thilawa line) have been defined as "Most Important Lines".
2) Mandalay – Myitkyna line, Yangon – Pyay line, Yangon-Pathein line and Yangon – Dawei line have been defined as "the Next Important Lines".
3) All other lines have been defined as "Other Lines".
4) As indicated in the Inception Report,

Short term corresponds to	2015 – 2018
Medium term corresponds to	2018 – 2025
Long term corresponds to	2025 – 2045

(2) Short-, medium-, and long-term railway facilities improvement plan

Details of improvement plans are explained in Appendix 1 [Report of Proposal] attached to Progress Report September, 2014.The Report of Proposal was submitted to the workshop and discussed by the member of working group for Service and Safety Improvement.
Summary of discussion for the proposed plan is presented in Appendix-2
[Summary of Discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, and Long-term Railway Facilities Improvement Plan] attached to Progress Report Dec. 2014.

5.1.5-3 Revision of the Report of Proposal

The Report of Proposal was revised as required according to the discussion mentioned in 5.1.5-2 above, and Revised Report is attached to the Progress Report, Dec. 2014 as Appendix-1 [Revised Report of Proposal of Recommendation on Technical Standard of MR and Short-, Medium-, and Long- Term Railway Facilities Improvement Plan]

5.1.5-4 Summarizing Workshop

Revision of the Report of Proposals was very limited, so the agenda and timetable of summarizing workshop was the same as those for Recommendation on Technical Standards.
Summary of discussion made during summarized workshop is attached as Appendix 8-2 of this Report.

5.1.6 Education/ training in Japan

Schedule of training in Japan was proposed by JICA Expert Team to MR in August, 2014,

which MR reviewed and agreed with on the condition that Railway Museum is desirable to be included.
As a result, the schedule of training in Japan was finalized as shown in Table 5.1.5. The 11 participants as shown in Table 5.1.6 were nominated by MR.
Details of the training in Japan are summarized in Appendix 3 [Workshop Report of the Institutional Management Improvement Course in Japan] attached to Progress Report, Dec. 2014

Table5.1.5 Schedule of Training in Japan (Institutional Management Improvement Course)

No.	Date	Time	Lecture/ Visit	Content	Lecturer	Location of Training	Stay at
1	Oct. 19 (Sun)	6:50 ~		arrival at Narita			JICA Tokyo
2	Oct. 20 (Mon.)	9:00 ~ 14:00	Lecture	Program Orientation	JIC/JICA	JICA Tokyo	JICA Tokyo
		14:00 ~ 15:30	Lecture	Outline of Railway Transport in Japan	MLIT	JICA Tokyo	
		15:30 ~ 17:00	Lecture	Outline of JR East	JIC	JICA Tokyo	
3	Oct. 21 (Tue)	9:30 ~ 10:00	Lecture	Orientation	JIC	JICA Tokyo	JICA Tokyo
		10:00 ~ 12:00	Lecure	Outline of railway development in Japan	JIC	JICA Tokyo	
		13:00 ~ 15:00	Lecure	Management & technorogy of JRE to ensure safe railway transport	JIC	JICA Tokyo	
		15:00 ~ 17:00	Lecture	Management and technology of JRE to ensure comfortable/ convenient railway transport	JIC	JICA Tokyo	
4	Oct. 22 (Wed)	7:30 ~ 10:00	trip	Tokyo – Shinshirakawa – Training Center			JICA Tokyo
		10:00 ~ 11:30	Lecture	Outline of staff training of JRE	JEPS	JRE Training Center	
		11:30 ~ 12:00	Visit	Museam of railway accident	JEPS	JRE Training Center	
		12:00 ~ 15:00	trip	Shinshirakawa-Tokyo			
		15:00 ~ 17:00	Visit	Tokyo monorail	Tokyo monorail	Hamamatsu-cho	
		17:00 ~ 18:00	Trip				
5	Oct. 23 (Thur)	9:00 ~ 10:00	trip	(Tokyo – Keiyo Line)			JICA Tokyo
		10:00 ~ 14:00	Visit	High speed Track Inspection Car(East-i)	JRE, NSG	Keiyo Line	
		14:00 ~ 15:00	trip	Tokyo- Omiya			
		13:00 ~ 16:00	Visit	Railway museum	JIC	Omiya	
		16:00 ~ 17:00	trip				
6	Oct. 24 (Fri)	8:30 ~ 9:30	Trip	Tokyo – Kunitachi			JICA Tokyo
		9:30 ~ 12:00	Visit	Railway Technical Researchi Institute RTRI	RTRI	Kunitachi	
		12:00 ~ 13:30	trip	Kunitachi – Tokyo freight terminal			
		13:30 ~ 17:00	Visit	Tokyo Freight terminal	JRF	Shinagawa	
		17:00 ~ 18:00	trip				
7	Oct. 25 (Sat)		Holiday	Free			JICA Tokyo
8	Oct.26 (Sun)		Holiday	Free			JICA Tokyo
		14:30 ~ 19:30	trip				
9	Oct. 27 - (Mon)	7:00 ~ 12:00		Free			Akita
		13:00 ~ 14:00	Lecture	Outline of Akita Branch Office	JRE	Akita Branch office	
		14:00 ~ 15:30	Vist	Akita General Training Center (AGTC)	JRE	AGTC	
		15:30 ~ 17:30	Visit	Riding train on Oga line	JIC	Akita Branch office	
10	Oct. 28 (Tue)	9:30 ~ 12:30	Visit	Akit aGeneral Rolling Stock Center (AGRSC)	JRE	AGRSC	Akita
		13:30 ~ 15:00	Vist	Akita rolling Stock Center (ARSC)	JRE	ARSC	
		15:00 ~ 16:30	Vist	Train Control Center	JRE	Akita Branch office	
		16:30 ~ 17:00	Lecture	follow-up orientation	JIC	AGTC	
11	Oct. 29 (Wed)	9:30 ~ 11:00	Visit	Akita Track maintenance Technical Center (ATMTC)	JRE	ATMTC	Akita
		12:30 ~ 13:00	Trip	Akita – Oga Line			
		13:00 ~ 15:00	Visit	Oga line	JRE/JIC	Oga Line	
		15:00 ~ 18:00	Lecture	Natural Disaster Prevention system	JIC	Oiwake Traing Center	
12	Oct. 30 (Thur)	9:00 ~ 10:00	Lecture	Akit Station in General	JRE	Akita Station	JICA Tokyo
		10:00 ~ 12:00	Visit	Various Station Facilities	JRE	Akita Station	
		13:00 ~ 14:00	Visit	Non-Railway Business Station Plaza etc.	JRE	Akita Station	
		14:00 ~ 18:00	trip	Akita – Tokyo			
13	Oct. 31 (Fri)	9:30 ~ 11:00	Lecrue	Question and Answers	JIC	JICA Tokyo	JICA Tokyo
		11:00 ~ 17:00	Presentation and Wrap up	Opinion/ comments on Trainonig Program by MR trainees, Wrap up meeting	JIC/JICA		
14	Nov. 1 (Sat)	11:00		Leave Narita			

JEPS = JR East Personnel Service, RTRI = Railway Technical Research Institute

Table 5.1.6 The List of Trainees for Institutional Management Improvement Course

No	Name	Rank
1	U Win Naing	Deputy General Manager (Carriage)
2	U Htay Myint Aung	Deputy General Manager (Operation)
3	Daw Kyi Kyi Nwe	Assistant General Manager (Finance)
4	U Lwan Thu	Executive Engineer (Civil)
5	U Maung Maung Tin	Manager (Supply)
6	U Aung Chan Myint	Manager (Commercial)
7	U Myint Lwin	Executive Engineer (Communication)
8	U Aung Wai Soe	Assistant Manager(Inspection)
9	Daw Khin May Than	Assistant Manager (plan & News)
10	U Nyo Aung	Assistant Engineer (Electric)
11	U Aung Myint	Assistant Manager (Planning)

5.1.7 Major issues to be tackled with , good schemes for better implementation, lessons obtained through implementation

(1) To implement the project more effectively, the Counterpart Team and Working Group for Service and Safety Improvement were strengthned by including both the MR experts stationed at Yangon, and those stationed at Nay Pyi Taw as shown in Tables 4.I and 4.3.

(2) With respect to guidance and familiarization of the technique to analyse the present status and causes of accidents and poor services, the Training program and the Workshop were programmed and implemented as described in the section 5.1.3. Through implementation of the training program and the workshop, the following have been found out to be the items for recommendation.

  (a) Repetition of the training program and the workshop so that MR experts could be more familiarized with the relevant techniques.

  (b) In analyzing the causes of accidents/ low service levels by MR experts, theoretical analysis seems to be insufficient. In this regard, a small research unit consisting of a few selected able experts in the field of track, civil engineering structures, rolling stock and signaling/ telecom is recommended to be established, and these experts should be trained so that they can execute theoretical analysis of the causes of accidents/ low services.

  (c) Strengthening of educational institutes.
  In MR, there are currently two educational institutes: RTTC located at Ywataung Locomotive Workshop for upgrading the technical skills of locomotive maintenance staff and CITC belonging to Ministry of Rail Transportation and located at Meiktila for upgrading engineering staff in the fields of track, rolling stock, operation and signaling/ telecom.
  The training facilities/ equipments in these Institutes are sometimes out-of-data and insufficient.
  These Institutes should be modernized to cope with the coming modernization of MR.

(3) With respect to recommendation on Technical Standards of MR relating to administrative and maintenance aspect to improve service level and safety, relevant recommendations were proposed by JICA experts as described in the section 5.1.4. Through the process of proposing these recommendation, the following were found out to be major issues and relevant suggestions.

  (a) Many ones of the current Technical Standards of MR are out of date, not well organized systematically and very simple, They should be updated, systematically organized deleting duplications, and adequately detailed.

  (b) In this regard, technical cooperation for updating and revising Technical Standards of MR could be a meaningful one in the coming years.

(4) With regard to drawing up short-, medium-, and long-term railway facilities improvement plan, it is described in the section 5.1.5.
  Through implementation of this activity, the following have been considered to be some meaningful suggestions by JICA Experts.
  In view of the budget constraint, in drawing up the plan, railway lines to be improved should be prioritized from the socio-economic and political viewpoints.
  Regarding giving priority to the lines from the viewpoint of socio-economy, "Survey Program for National Transport Development Plan in the Republic of the Union of Myanmar" prepared by JICA (June, 2014) should be adequately referred to.

5.1.8 Extent of achievement of target

This project is the project of technology transfer and consists of two subprojects: namely

(1) Recommendation of technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level

and
(2) Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project

In this section, extent of achievement of target of the subproject (1) above will be described.
This subproject consists of the following:
(1) Preparation of working plan
(2) Survey of the present status and establishment of an organization to collect information
(3) Guidance and familiarization of the analyziling technique of the causes of accidents and low service level, and establishment of countermeasures.
(4) Investigation of customer's Satisfaction Level of MR passenger transport
(5) Recommendation on technical standards for service and safety
(6) Drawing up short-, medium-,and long-term railway facilities improvement plans.
(7) Education/training in Japan

These all items were implemented as scheduled in Table 5.1.1. In this regard, the target of this subproject can be said to be almost achieved. However it should be noted that complete achievement of technology transfer takes time and needs continuous efforts by MR staff and continuous cooperation between MR staff and Japanese railway experts.

5.1.9 Recommendation Addressed to Achievement of Overall Goal
The following are the items, the pursuit of the implementation of which will contribute to further upgrading the safety and service level of MR.

(1) Repetition of the training program and workshop similar to those provided by the Project, to further promote the relevant technology transfer
(2) Updating and revising the current Technical Standards so as to match the technical development and modernization of MR.
(3) .Modernization of Training Institutes, RTTC and CITC, with respect to training facilities/ equipments, curriculum etc.
(4) Establishment of a research unit by which fundamental theoretical analysis of track structure, and rolling stock such as calculation of stress, deformation, vibration, and fundamental measurements of technical data such as vibration, stress, deformation, relevant forces, temperature are implemented.
(5) Establishing the priority of each railway line from the socio-economic point of views, with due consideration on the recommendation of "Survey Program for National Transport Development Plan in the Republic of the Union Myanmar" prepared by JICA (June 2014), and implementing the modernization of each line step by step based on the established priorities.

So it is hoped that MR staff try to continue expanding and deepening the relevant knowledge and experiences of Japanese railways introduced by JICA experts in this sub project.
Further it is hoped that technical cooperation between MR staff and Japanese railways experts will be continued through the projects of modernization of Yangon- Mandalay line and Yangon circular line, etc. and taking advantage of the opportunity of these cooperation, technology transfer of this subproject should be further deepened and promoted.

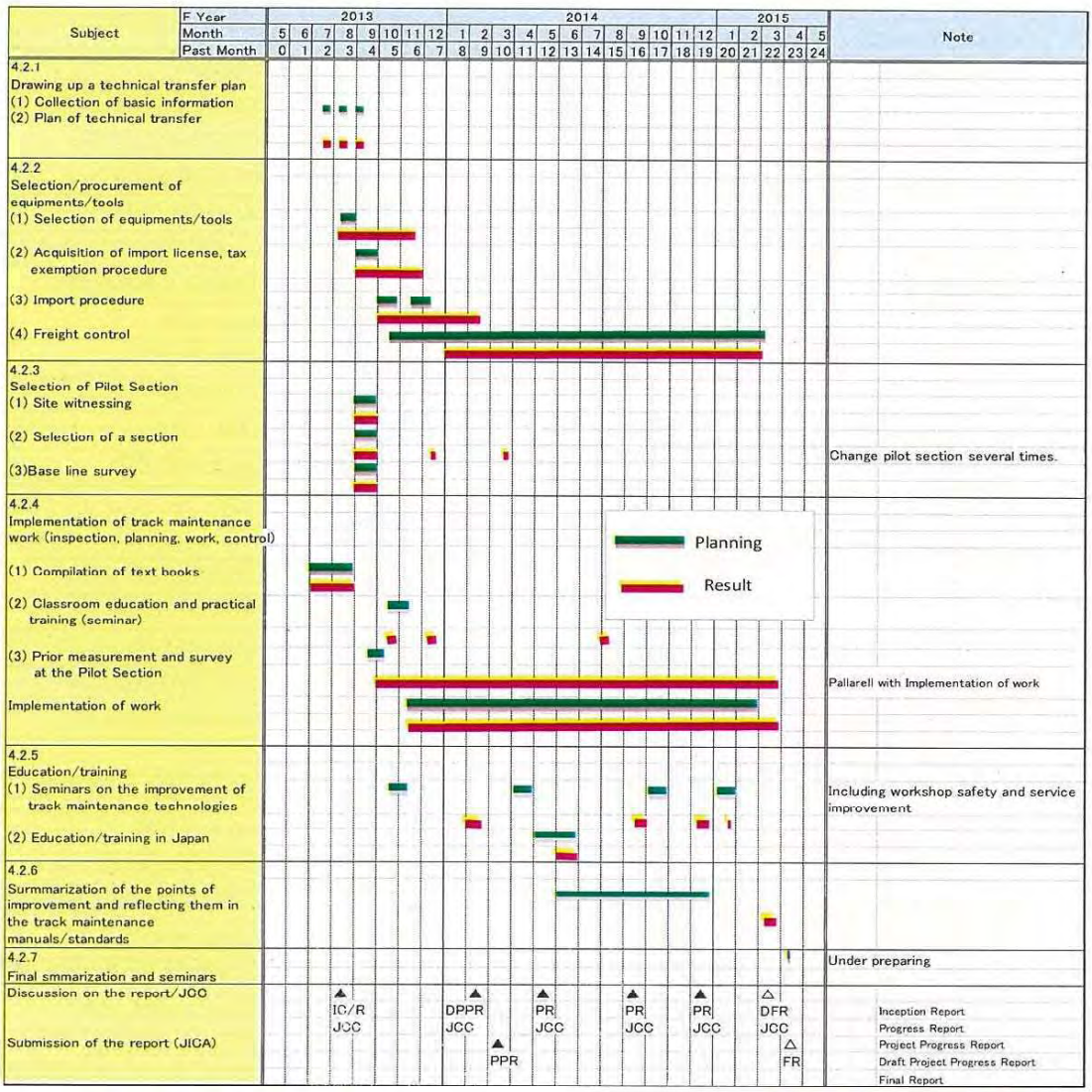
5.2 Technology Transfer of Track Maintenance Technology to improve the level of Service and Safety through Implementation of The Pilot Project

5.2.1 Drawing up a plan for technology transfer

The system of track maintenance work currently in practice in Myanmar is a version of the old-fashioned system implemented in the past in Japan. Through this Project, track maintenance workers of MR received education/training of basic track maintenance works, while aiming at a mechanized maintenance system to use large-scale maintenance machines. This means a conversion from the current gang system to a larger sized maintenance depot system or a re-construction of maintenance system. Bearing in mind this long-term vision, we prepared a plan for technology transfer focused on the track maintenance OJT for two years.

See Table 5.2.1 for the schedule of technology transfer.

Table 5.2.1 The schedule of technology transfer



5.2.2 Procurement of the required equipments / tools

Table 5.2.2 summarizes the required equipments / tools, which were procured by the Japan side.

Table 5.2.2 List of the required equipments / tools

No.	Item	Unit	Manufacturer
1	Analog standard gauge	5	KANEKO CO., LTD.
2	Instrument detection for track	5	GIDOU GIKEN
3	Mesuring instrument for rail wearing depthe	2	HARADA SEISAKUSYO
4	Gap gauge	5	TRSUKO NAKAYAMA CO., LTD.
5	Taper gauge	5	KANEKO CO., LTD.
6	Thermometer for rail	5	KANEKO CO., LTD.
7	Square for rail	5	KANEKO CO., LTD.
8	Trackmaster	1	KANEKO CO., LTD.
9	Mesuring instrument for train swing	1	SHINYEI TECHNOLOGY CO.,LTD
10	Cloth measuring tape (30 m)	5	YAMAYO SOKUTEKI CO., LTD.
11	Steel measuring tape (30 m)	5	YAMAYO SOKUTEKI CO., LTD.
12	Square	5	TETUYU KOGYO CO., LTD
13	Slate pencil , Chalk	4	NIHON HAKUBOKU KOGYO CO., LTD.
14	Tie tamper	1	SHIBAURA ELRTEC CORPORATIO
15	Beater	18	ISHI TEKOU CO., LTD
16	Shovel	18	TONBO KOGYO CO.,LTD.
17	Bar	35	ISHI TEKOU CO., LTD
18	Spike hammer	13	ISHI TEKOU CO., LTD
19	Panpuller	18	HOSEN KIKI SEIBI CO.,LTD
20	Jack for rail	40	NICH CO., LTD.
21	Equipment for ballast tamping	5	HITACHI KENKI KAMINO CO., LTD.
22	Generator	1	SHIBAURA ELRTEC CORPORATIO
23	Generator	5	HONDA MOTOR CO., LTD.
24	Shovel	9	TONBO KOGYO CO.,LTD.
25	Dump shovel	9	KATOU SEISAKUSYO CO., LTD.
26	Shovel with blade divided into multiple	9	KATOU SEISAKUSYO CO., LTD.
27	Hoe with blade like nail of wild goose	9	KYOUWA CO., LTD.
28	Hand screen	15	IRIE KOUGYO CO., LTD.
29	Hoe with blade of traiangle	9	IRIE KOUGYO CO., LTD.
30	Wooden maul	9	KONDO KASHIZAI MOKOUSYO CO., LTD.
31	Basket made by bamboo or plastic	9	SEKISUI KAGAKU KOGYO CO., LTD.
32	Jack traverser	10	TOKO SANGYO CO., LTD.
33	Rail sawing machine	3	TETUYU KOGYO CO., LTD
34	Rail boring machine	3	KOBORI TEKOUSYO CO., LTD.
35	Core cutter	10	KOBORI TEKOUSYO CO., LTD.
36	Rail bending machine	1	RIKEN KIKI CO., LTD.

37	Rail joint expandor	1	TETUYU KOGYO CO., LTD
38	Sleeper replacing machine	1	HOSEN KIKI SEIBI CO.,LTD
39	Rail carrying machine	9	YOSHIIKE KAKEN KIKI CO., LTD.
40	Rail carrying tongs	9	YOSHIIKE KAKEN KIKI CO., LTD.
41	Shovel	18	TONBO KOGYO CO.,LTD.
42	Single open ended spanner	9	ISHI TEKOU CO., LTD
43	Chisel	5	ISHI TEKOU CO., LTD
44	Rail fork	5	NICH CO., LTD.
45	Disc grinder	5	HITACHI KOUKI HANBAI CO., LTD.
46	Power wrench	5	MAKITA CO., LTD.
47	Low joint maintenance machine	1	L. GEISMAR
48	Spanner for joint bolt	9	IIJIMA KIKOU CO., LTD.
49	Rail grinding machine	1	YOSHIIKE KAKEN KIKI CO., LTD.
50	Swager for back bolt	1	NIPPON POP RIVETS AND FASTENERS LTD
51	Hydraulic lining machine	5	TETUYU KOGYO CO., LTD
52	Low roller	7	HOSEN KIKI SEIBI CO.,LTD
53	Chisel with handle	3	ISHI TEKOU CO., LTD
54	Spanner for bed plate / rail brace	7	IRIE KOUGYO CO., LTD.
55	Adz	9	ISHI TEKOU CO., LTD
56	Hand hammmar	9	TORASUKO NAKAYAMA CO., LTD.
57	Spanner for huck bolt	9	IIJIMA KIKOU CO., LTD.
58	Engine Drilling Machine	13	NIKOU TANAKA ENJINYARING CO., LTD.
59	Drill 22mm	13	NIKOU TANAKA ENJINYARING CO., LTD.
60	Gouge	9	KAKURI SANGYO
61	Electric saw	5	HITACHI KOUKI HANBAI CO., LTD.
62	Boring machine	3	MAKITA CO., LTD.
63	Sleeper carrying tongs	9	KATOU SEISAKUSYO CO., LTD.
64	Pad remover	9	ORUHA CO., LTD.
65	Light track trolley	5	YOSHIIKE KAKEN KIKI CO., LTD.
66	Gas cutting machine	2	YAMATO SANGYO CO.,LTD
67	Rail lifting machine	3	TOKO SANGYO CO., LTD.
68	Spanner	2	TOPU KOGYO CO., LTD.
69	Track jack	9	TETUYU KOGYO CO., LTD>
70	Low elasticity pad	20	NIHON ESURAITO CO., LTD.
71	Track shim	20	TETUDOU YOUHIN CO., LTD.
72	Huck bolt	40	KONDO TEC CO., LTD.
73	Brushcutter	4	HONDA MOTOR CO., LTD.
74	Chip cutter for Brushcutter	4	HONDA MOTOR CO., LTD.

5.2.3 Selection of Pilot Section

In the 46.5 mile section (74.8 km long) between Yangon and Bago, we planned track maintenance as a means of technical transfer in the approximately 20 km-long Pilot Section, which was to be selected through a site survey to allow experiencing maintenance of different track structures, such as defective, sound, straight and curved tracks, turnouts in station yards and bridges, so that the effect of technical transfer was readily obtainable.

Japan side proposed the pilot section consisting of Pilot Section 1 and Pilot Section 2 at the 1st JCC. This was selected by the reason that there are many types of tracks and structures such as straight line, curve, turnouts and bridges, etc in Pilot Section 1 and the vehicle vibration acceleration values were big according to the results of vibration measurement in Pilot Section 2.

We proposed the Pilot Section by the formal letter which was agreed by the Myanmar side, and the Myanmar side wanted to start the track maintenance practice in Pilot Section 2 earlier than that in the Pilot Section 1 because Pilot Section 2 had very bad track conditions.

After that, there was a request of early start of track maintenance practice in the section from 12km200m to 14km550m between Toekyaungkalay Sta. and Ywathargyi Sta. from Myanmar side on 11th December in 2013. Thereby, the order of track maintenance practice in the Pilot Section was changed from 16th December in 2013.

At the beginning, technology transfer of track maintenance started for 30 trainees in the Pilot Section. At present, accumulated number of trainees amounts to 300, and the various situations relating to technology transfer had been changed. Further, in order to implement the training efficiently, trainings were sometimes repeated in the same place, and also on Dagon line. In this regard, we consulted with MR about various matters including the suitable change of the length of the Pilot Section.

Trainees of MR change every month. We show divisions of trainee and members till now (Table 5.2.3). We have educated about 300 trainees who are belonging to all divisions in Myanma Railways.

Table 5.2.3 Divisions of trainee and members till now

	Date From	Date To	Division	Number	Remark
1	25.10.2013	12.5.2014	(7)Yangon (6)Bago	24 6	
2	12.5.2014	12.6.2014	(7) Yangon (5)Taunggu (7)Yangon (8)Mawlamying (9)Hinthada	10 6 5 4 5	To perform the chainging of trainees
3	12.6.2014	12.7.2014	(7) Yangon (2)Ywataung (3)Mandalay (10)Pakauku	10 8 8 7	To perform the chainging of trainees
4	12.7.2014	12.8.2014	(7) Yangon (1)Myitgyinar (4)Kalaw (11)Bagan	10 6 7 7	To perform the chainging of trainees

5	12.8.2014	12.9.2014	(7) Yangon (5) Taunggu (8) Mawlamying (9) Hinthada	10 6 6 8	To perform the chainging Of trainees
6	12.9.2014	13.10.2014	(7) Yangon (2) Ywataung (3) Mandalay (6) Bago	10 6 6 8	To perform the chainging Of trainees
7	13.10.2014	12.11.2014	(7) Yangon (9)Hinthada (8)Mawlamying (5)Taunggu	10 7 7 6	To perform the chainging Of trainees
8	12.11.2014	11.12.2014	(5)Taunggu (2)Ywataung (3)Mandalay (10)Pakauku	10 8 9 7	To perform the chainging Of trainees
9	9.1.2015	6.2.2015	(7) Yangon (4)Kalaw (9) Hinthada (11)Bagan	10 7 7 7	To perform the chainging Of trainees
10	9.2.2015	4.3.2015	(7) Yangon (1)Myitgyinar (6)Insein (10)Pakauku	10 6 7 7	To perform the chainging Of trainees
11	9.3.2015	Untill now	(7) Yangon (4)Kalaw (5)Taungu (11)Bagan	10 6 7 7	To perform the chainging Of trainees
Total				348	

We educated 1st group for half year and many kinds of program. From 2nd group, trainees change every month. So we are programing training schedule to master many things about track maintenance for short term.

5.2.4 Implementation of track maintenance (inspection, planning, work and control)

(1) Compilation of text book

To use for classroom education and practical training, we compiled a text book in three parts, each covering the fields of (1) safety of work, (2) track maintenance work and (3) track inspection.

We implemented practical training and maintenance work based on this text book and compiled, (1) standards and (2) manuals, for track maintenance work, after modifying, adding or deleting contents of the text book based on review of track maintenance training.

(2) Classroom education and practices (seminars)

Before implementing actual track maintenance work on the Pilot Section, we had seminars on the particulars related to track maintenance such as inspection, planning and work for the workers to be assigned to the Pilot Section. This was the first classroom education and an important step to assess the level of local staff, which would significantly contribute to the work progress control in the future.

Before starting the maintenance work in the Pilot Section, we performed practical training on track maintenance (inspection and work) on non-commercial tracks. As safety is one of the most important concerns for track maintenance workers, we also educated them on safety in practicing track maintenance work, with (1) wearing protectors and other protective equipment and (2) deployment of security guards (train watchmen) subject to prior negotiation with MR. However, we proposed at least wearing protective shoes, helmets and safety vests.

Regarding classroom education and practical exercises, we selected an inspector and three to four works from each gang; implemented education in the classroom in the morning and practical exercises using working tools in the afternoon, for about one month in consideration of the combinations of work category and associated job and the number of object trainees. As a part of base line survey, track irregularities (5 items), train vibration accelerations (Vertical and lateral), average speed in the Pilot Section were measured.

(3) Implementation of prior measurement and surveys of the Pilot Section

Before implementing track maintenance work for tracks used for commercial services in the Pilot Section, we measured track levels (transit measurement at curves) to calculate the amount of rail lift and the volume of ballast for the total length of the Pilot Section. Furthermore, we patrolled the total length to (1) visually checked the conditions of track structure/materials and (2) surveyed the workload required and the volume of materials in each 100 m-segment to draw up a working plan.

(4) Implementation of inspection, planning and work in the Pilot Section

Based on the working plan for each 100 m-segment compiled according to the results of prior measurement and surveys, we implemented in turn education and training for the inspector and workers of each track maintenance gang. In the course of this education/training for a particular gang until the track maintenance work in the range of track section in its charge completes, inspectors and workers for other gangs were expected to observe, witness and help the work in progress when necessary in order to make these gang-wise separated operations yield an extended effect over the whole Pilot Section.

For this education/training, in principle, we used the intervals between trains during the daytime. Based on the experience in practical training, time-consuming work was shifted to the time zone when tracks were not used for commercial purposes.

See the items 1) to 11) below for the scheduled track inspection and maintenance work. The contents which we were implementing for technology transfer of track maintenance included the following.

1) Ballast compacting work (use of hand tie-tampers, beaters or shovels)

①Inspection of track irregularities and conditions

② Correction of track irregularities

2) Ballast sieving

① Inspection of ballast

② Execution of work

3) Rail renewal work

① Inspection of rail

②Rail renewal work

4) Rail joint work (rework on rail clearance (rail joint clearance), correction of rail joint depression)

①Inspection of rail joint

②Clearance correcting work

③ Fail joint correcting work

5) Track realignment work

① Inspection of track displacement

② Irregular alignment correcting work

6) Turnout maintenance work

① Inspection of turnout

② Repair and renewal of turnouts

7) Inspection and maintenance of bridge sections

① Inspection

② Maintenance work

8) Correction of track gauge

① Inspection

② Correction work

9) Welding of rails (preparation of long-rails and a measure to strengthen rail joints)

→ Welding equipments were not so good. So we changed rail junction program from welding to fastening with bolts.

10) Improvement of formation

① Inspection of ballast and roadbed

②Although a standard width of formation was specified in Myanmar, we found through site surveys that sufficient widths were not maintained. To fully exert the effect of aforementioned ballast compacting work, we guide MR to expand the width of formation where it is insufficient.

11) Control and evaluation of track conditions

As the indexes to control and evaluate track conditions, we adopted the normal convention, or the values of five track irregularities (track gauge, longitudinal/cross levels alignment and distortion of track), which can be measured by simple means (track gauge, threads and tops, etc.) or simplified measuring instruments (track masters).

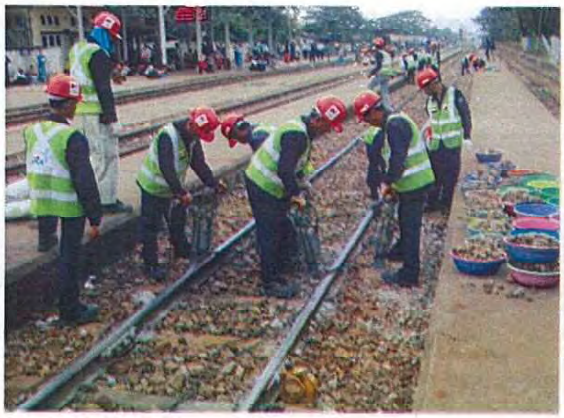
For the purpose of track control, set threshold values for maintenance for track irregularity items that guarantee the safety of running trains, measure irregularities periodically and provide maintenance services within the pre-set time length in case the value of an item had exceeded the threshold value.

To maintain appropriate track conditions after providing maintenance services and aim at extending the maintenance periodicity, also set the standard values of measurement items to judge whether the maintenance services were appropriate.

To evaluate track conditions, measure track irregularities at constant intervals and count the number of the points where the threshold value has been exceeded. Judge whether the track conditions were appropriate thereafter by the changes in the number of defective points. If the track maintenance is improved by such an evaluating system, it is thought that the points where a threshold value was infringed would decrease.

We also discussed a method to assess track conditions by measuring train rolling acceleration at a constant periodicity, though this measurement included the influence of rolling stock performance. In this case as well, set and measure the threshold value of vibration (vertical/lateral vibration acceleration measured with rolling tops, etc.) and correct the points where the threshold value had been violated. If the track maintenance is improved by this evaluating system, it is thought that the overall level of train rolling acceleration (amplitude) will decrease, followed suit by the number of the points where a threshold value is infringed.

Regarding the above paragraphs 1) to 11), we would discuss improvement measures, renew the essentials of track maintenance work after completion of the above procedures and made efforts thereafter to disseminate the renewed version of the essentials of maintenance work.



Ballast compacting work (Tie Tamper)

Ballast compacting work (Rammer)

Conveying Ballasts

Measuring Track

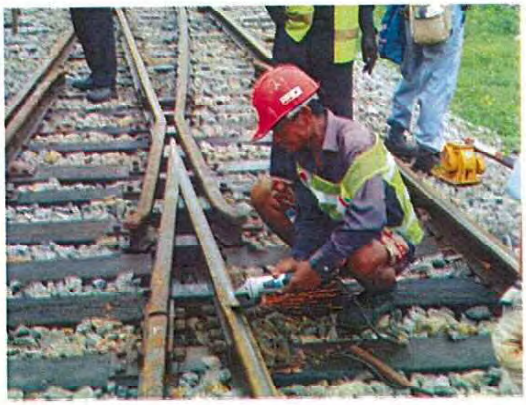
Screening Ballasts

Taking down 50N Rail

Rail Joint Work

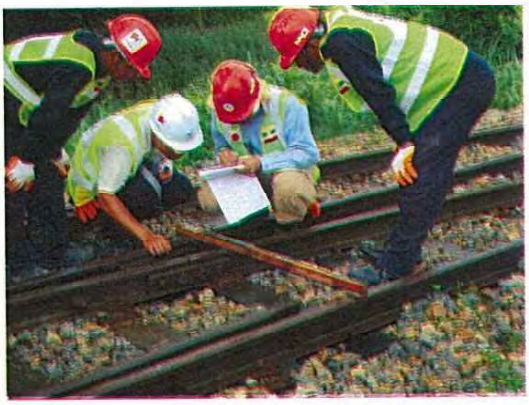
Remending Alignment

Maintenance of turnout①



Maintenance of turnout②

Track Maintenance on the Bridge



Correction of track gauge

Strengthen rail joint

Improvement Formation

Replace sleeper

Surveying

5.2.5 Education/training

In Myanmar, a rainy season starts every year at the end of May. As the track maintenance work in a rainy season is apprehended to adversely affect track beds, we implemented education/training twice from June to July, 2014.

(1) Seminars to improve track maintenance technologies

We assessed the level of track maintenance technologies of MR employees and compiled appropriate text books. Thereafter, we hold seminars to improve track maintenance technologies for those participated in the maintenance.

(2) Education/training in Japan

We implemented a two-week education/training program twice in Japan each for approximately 11 trainees including some MTT operators, in which education/training on track technologies (centering on lectures and practical training) were performed under the cooperation of JR East and Japan Railway Track Consultants, at the Integrated Education/Training Center (Shin-Shirakawa) and JR East. MTT operators were included in the above program to prepare for introduction of MTTs into track maintenance in the future.

We discussed the detailed contents of curriculum so as to reflect the level of MR engineers, and also discussed with MR about suitable timing of training in Japan.

Outline of Education/Training in Japan

①Period of Program

1st Group Jun.6.2014 to Jun.21.2014

2nd Group Jun.22.2014 to Jul.5.201

②Trainees List (Total 22persons)

1st Group Jun.6.2014 ~ Jun.21.2014

No.	Name	Position	Division
1	Mr. Ye Htut	Assistant Engineer (Civil)	Nay Pyi Taw
2	Mr. Kyaw Lwin	Assistant Engineer (Civil)	Division(3)
3	Mr. Saw Naing	Permanent Way Inspector (1)	Division(3)
4	Mr. Aung Swe	Permanent Way Inspector (1)	Division(6)
5	Mr. Han Tin Soe	Permanent Way Inspector (1)	Division(8)
6	Mr. Win Nyunt	Permanent Way Inspector (2)	Communication,Meiktila
7	Mr. San Yu	Permanent Way Inspector (2)	Division(1)
8	Mr. Chit Ko Ko	Permanent Way Inspector (2)	Division(2)
9	Mr. Than Naing	Permanent Way Inspector (2)	Division(3)
10	Mr. Aung Thein Win	Permanent Way Inspector (2)	Division(6)
11	Mr. San Naing	Permanent Way Inspector (2)	Division(6)

2nd Group Jun.22.2014 ~ Jul.5.2014

No.	Name	Position	Division
1	Mr. Soe Myint Aung	Assistant Engineer (Civil)	Division(4)
2	Mr. Aye Nyeub Swe	Assistant Engineer (Civil)	Division(3)
3	Mr. Han Thein	Permanent Way Inspector (1)	Division(11)
4	Mr. Kyaw Thu Ya	Permanent Way Inspector (1)	Katha-Bahmo
5	Mr. Moe Kyaw Aung	Permanent Way Inspector (2)	Yangon-Pathein
6	Mr. Kyaw Htet Zaw	Permanent Way Inspector (2)	Division(6)
7	Mr. Aye Min Aung	Permanent Way Inspector (2)	Division(11)
8	Mr. Kyaw Tun Linn	Permanent Way Inspector (2)	Division(2)
9	Mr. Aung Aung	Permanent Way Inspector (2)	Division(5)
10	Mr. Hla Htay Win	Permanent Way Inspector (2)	Division(4)
11	Mr. Thaung Tun Aye	Permanent Way Inspector (3)	Division(5)

Outline of the Curriculum

No.	Content	Type	Time (h)	Lectures
1	Summary of Japanese Track maintenance Technology and present state of track in Myanma	Lecture	1:00	NSG
2	Technology standards and Rules of Track Maintenance	Lecture	3:00	NSG
3	Tamping Machine and Ballast Regulator	Lecture	1:30	Kotsu transport Construction & Engineering Corporation
4	Turnout (Structure , inspection . Maintenance)	Lecture	3:00	NSG
5	Past Train Accident caused by Track Conditions and its Countermeasure	Lecture	2:00	JIC
6	Track structure and Track work , Track material	Lecture	6:30	NSG
7	Track material (Rail , Fastening , Sleeper , Turnout)	Lecture	2:30	NSG
8	Tokyo Operation Control Center	Visit	2:00	JRE
9	Tokyo Rail Center (Factory welding , Long Rail wagon)	Visit	2:30	JRE
10	Turnout Factory	Visit	3:00	SUMIHATSU
11	Sleeper Factory	Visit	2:30	ABE NIKKO KOGYO
12	Ballast Factory	Visit	2:00	Seeds
13	General Education Center Museum of the History of Railway Accidents	Visit	2:00	JEPS
14	Tamping Machine and Ballast Regulator	Practice	2:30	Kotsu transport Construction & Engineering Corporation
15	Track inspection , Track maintenance work	Practice	4:00	NSG
16	Replacement of Rail and Sleeper , Adjustment of joint gaps	Practice	7:00	NSG
17	Question and answer Review and presentation	Lecture	3:00	NSG , JIC

JRE:East Japan Railway Company , JEPS:JR-East Personnel Service , NSG:Japan Railway Track Consultants

5.2.6 Summarization of the points of improvement and reflecting them in the track maintenance manuals/standards

We summarized the points of reflection through the whole of maintenance work and compiled the maintenance manuals to meet the present status of the track maintenance in Myanmar in consideration of the local organizations, working conditions and climates. The essentials of maintenance manuals would be easy to use, while including the steps of work and handling of machines/materials for track maintenance.

5.2.7 Final summarization and seminars

In closing the above technical transfer course on track maintenance work, we will open seminars for the trainees participated in the program and track maintenance members for other sections selected through consultation with MR. As this is the final step for MR employees to receive technology transfer, which is expected to evolve as a model shop to every section of the country in the future, we will avail ourselves of this opportunity to totally wipe unknowns out of MR members regarding the whole of track maintenance work.

5.3 Others

5.3.1 Cooperation and assistance by the government of the counties other than Japan in the field of railways

The contents of assistance, amounts of funds and conditions of loans and other matters regarding the assistance (ODA) extended by the governments of the countries other than Japan in the field of railway are given below (As of Dec. 2014)

Country Name	Detailed Contents of cooperation	Amount of Grant or Loan	Repayment Period	Grace Period	Commitment Fee	Management Fee	Interest Rate per Annum
India	Procurement of the locomotives and machineries in 2010	USD 60 million	10 years	5 years	0.50%	0.50%	1.75%
	Procurement of rolling stocks, spare and up-gradation of three railway workshop in	USD 86.31 million					
	To establish the new railway line from existing terminal stations to border towns on both sides i.e. Jiribum-Moreh in Indian and Kalay-Tamu in Myanmar.	Discussion is ongoing					
China	Procurement of rail, locomotives, passenger coaches, spare parts in1992.	US$ 20 million Loan had been paid	10 years	5 years	-	-	2%
	Procurement of rail 30,000 tons in 1993	US$ 15.6 million Loan had been paid					
	Procurement of 10 locomotives, 30 passenger coaches, spare parts for wagons, Machineries in 1993	US$ 30 million Loan had been paid					
	Procurement of passenger coaches, wagons, brake vans, container crane and bogies in 1993.	US$ 5 million Loan had been paid.					
	Procurement of rail 55,000 tons in 1994.	US$ 31.68 million Loan had been paid.					
	Procurement of locomotives, passenger coaches, wagons, wheels and machineries, equipments for tunnel construction in 1995.	US$ 35 million Loan had been paid.					
	Procurement of locomotives, passenger coaches, wheels, dumpers and spare parts in 1996.	US$ 50 million Loan had been paid.					
	Procurement of rail 35,000 tons and 4 locomotives in 1997.	US$ 50 million Loan had been paid.					
	Project of New Loomotive Manufacruring Workshop and New Carriage Manufacturing Workshop	US$ 91.787 million China loan					
Yugoslavia	Procurement of 402 wagons and spare parts in 1996	US$ 28 million Loan had been paid					
Republic of Korea	Procurement of 60 passenger coaches, 10 brake vans and spare parts in	US$ 20 million	25 years (EDCF)	15 years (EDCF)	-	-	0.01% (EDCF)
	Procurement of 100 passenger coaches by EDCF	US$ 45 million Pledged by ROK					

5.3.2 Existing Situations and Issues to be Improved of RTTC and CITC

5.3.2.1 Visit of RTTC and CITC by JICA Expert Team

JICA Expert Team consisting of Kuroda (Leader), Ishikawa (rolling stock expert), Morihara (Train Operation expert), Mitani (Signalling & Telecom. expert) and Takami (Civil Engineering Structure expert) visited CITC at Meiktila on Dec. 22nd 2014 and RTTC at Ywataung on Dec 23rd, 2014., and surveyed the existing situations of those educational institutes to identify the major issues to be improved, which will become the basis of future cooperation by advanced railways.

5.3.2.2 RTTC

The existing situations are described in detail in the Appendix 8-3, "Existing situations of RTTC and the Answers to the Questionnaire".
Major issues to be improved are described below. (It should be noted that RTTC is the training institute for upgrading the technical skills of the staff working for diesel locomotives)

(1) RTTC was established with the cooperation of GTZ of Germany, and mainly machineries for training, preparation of curriculum, training of teachers were offered by GTZ. The RTTC started the training activities in 1981. Installation of machineries for training was executed about 30 years ago, so they should be modernized. Now GTZ is under consideration for upgrading the RTTC, but not yet decided. It is recommended that RTTC should be upgraded with due consideration on modernization of MR.
(2) Further the following can be mentioned for consideration.
   (a) Facility
   Dormitory of RTTC consists of one large room and very old. It is recommended to divide the one large room into small units for several number of trainees so that their privacy can be secured and they can study individually at the night time.
   (b) Equipments/ Machineries
   When a new system is introduced, a mockup for the new system shall also be provided to make trainees to be familiarized with the system.
   Mockup shall also have a function to simulate the failure of locomotives intentionally and trainees should find out how the failures have happened and learn the procedure to repair them.

5.3.2.3 CITC

The existing situations are described in Appendix 8-4, Existing Situations of CITC. Future upgrading plan by CITC and some recommendations by JICA experts for modernizing CITC are given below.

(1) Future upgrading plan of CITC.
The CITC has the future upgrading plan as shown below.

Future plan of the CITC

a) To conduct more training courses annually.
b) To review and upgrade the training curriculums using currently in the courses.
c) To collect the skilled instructors and training aids to be more effective for the training courses.
d) To cultivate the technical know-how instructors.
e) To promote trainer of the training program (ToT)
f) To implement the effective training courses by upgrading the existing personnel strength.

g) To promote the scholarship program domestic and foreign countries for the instructors will be extended for the sake of receiving advance teaching techniques and applying effectively in real life situation.

Reviewing and Upgrading the Training Curriculums

a) In line with the modern technologies, some of the subjects have been reviewed and submitted. The submitted subjects are upgraded in cooperation with Myanmar Railways (MR).

b) Some of the case study and research paper are requiring more attractive and practical

Lectures, classrooms and practice facilities to motivate the trainees are necessary.

c) Recruitment of excellent new expert and engineers will be trained in near future due to the development of Myanmar market oriented economy.

d) To aspire the teaching and training aids to be more effective for the training courses.

e) To cultivate the technical know-how instructors.

f) To implement the effective training courses by upgrading the existing personnel strength.

g) To cooperate with donor partner just like JICA.

Requirements of the CITC for Training Aids

Sr No	Description	Unit	Qty	Remark
1	Desktop Computer Class Room 40 Sets, Furniture Fully Equipped Accessories	1-Lot	40- Nos	
2	Locomotive Driving Simulator(Full Cab)	1-Set	1-Nos	
3	Multimedia Class Room PC 30 Sets+ Furniture + Fully equipped Audio,Video Accessories	1-Lot	30-Nos	
4	Training for Automotive Vehicles (Saloon,Wagon,Van)	7-Nos	7-Nos	
5	Digital Ultrasonic Flaw Dector	1-Nos	1-Nos	
6	On Board Diagnosis Machines Fully Equipped and Accessories	1-Set	1-Nos	

(2) Some recommendations by JICA Experts

(a) Track

Now MR is going to modernize Yangon – Mandalay line and Yangon Circular line, and is required to introduce the new technologies such as long-welded rail, application of large

scale track maintenance machines, track maintenance to cope with the train speed up to 100km/h.

In this regard, lectures relating to these new technologies, and training equipments for trainees to be trained for these new technologies, in the laboratories and on the practical training track, should be provided.

(b) Rolling stock

When a new system is introduced, a mockup for the new system shall also be provided to make trainees to be familiarized with the system.
Mockup shall also have a function to simulate the failure of locomotives intentionally and trainees should find out how the failures have happened and learn the procedure to repair them.

(c) Signalling & Telecom.

-) It can be praised to hand over the text used in training to a student after the completion of training. This practice should be continued.

-) The practice to take notes of the contents of the lectures and other important things taught should be tried to be established in CITC. This practice should also be applied to the field workers. In this regard, CITC is advised to deliver memo notebooks to the trainees.

-) Training course of signaling for Junior Engineers is also necessary. Further, it's necessary to establish a curriculum for dealing with every equipment including Interlocking.
Signal equipment and train protection system are used only in the railway. CITC is advised to issue qualification for the persons who completed the training for these equipments.

-) Electronic Interlocking will be introduced to MR from now on. It is necessary to understand its operation mechanism by training. It is also necessary to understand the operation mechanism of Relay Interlocking by training. Understanding the operation mechanism of these equippments will contribute to life prolongation of these equipments.

-) All signal training equipments in CITC are of old types. However, these old types are still used on local railway lines. Then CITC should repair these old type training equipments so that they can be used as training equipments.

-) The electric switch machine and the track circuit should be installed in CITC as signal practical training equipments. The maintenance of the electric switch machine and the track circuit becomes very important for MR after its modernization. The training of these equipments should be fully provided..

-) Many construction laborers are needed for modernization projects of MR by Japanese ODA and Grant aid. CITC is advised to give relevant trainings to these construction laborers.

(d) Train Operation

We inspected "CITC", and the comments on points that we are concerned about in comparisson with the present conditions of the education institutes of the Japanese railway company are given below..
We would be happy, if MR could refer to the comments for improving CITC in the future..

	Points which we are concerned about	Comment
1	The area of the desk is small. 	In the training center of Japan, the trainee places a textbook, a reference book and a notebook on a desk and while referring to each of them, he listens to the lectures.
2	The inside of the classroom is dark.	The visual information that a person can recognize decreases in the dark. In Japan, necessary illumination corresponding to kinds of work is specified by a law.
3	Teachers give the lecture mainly by writing the lecture contents on the blackboard. 	As for the demerit of the lecture method to write lecture contents on the blackboard, the following is thought about. ・Loss of the time when a teacher writes them on the blackboard ・When letters are small or dirty, trainees are hard to read ・Fear of wrong letters or omitted letters In Japan, a teacher often prepares lecture contents in large size caracters in advance and displays them in front of trainees in the classroom. The above-mentioned demerits can be canceled by doing so, and efficient and effective lectures become possible.
4	There are some handling apparatuses of the train operation such as signal panels and so on. However, most of them are used only for display.   	In Japan, many railway companies install apparatuses handled on-site in the training center and utilize them for handling skill education.

5	All teachers of the skill education are on-site leaders.	Some Japanese railway company educates trainees not only about the knowledge but also about the operation skill in the training center. The trainees can learn knowledge and the operation skill of the constant level by doing so. Further the burden of on-site leaders can be reduced.
6	The passing standardsof the knowledge test is more than 50%.	Some Japanese railway company makes passing standard a little more severe for ensuring train operation safety. When a trainee becomes unacceptable in the reexamination, he is made to leave from the training center in consideration of his unfitness.
7	Each on-site leader judges the passing of the operation skill test of the trainees, but there is not the clear passing standard.	Some Japanese railway company establishes the passing standard of the skill test clearly for evaluating a trainee. A fair skill evaluation is made possible by doing so and what parts of a training course a trainee cannot yet understand can be made clear. In addition, the uniform evaluation is possible even if an evaluator is changed.
8	It cannot be said that quantity of the meal is enough.	Some Japanese railway company evaluates meals as very important in developing the health and the energy of the trainees. Therefore the company offers meals to trainees in consideration of a nourishment aspect and quantity.

(e) Civil Engineering Structure

1) Course

① There are no training courses for maintenance of civil engineering structures except bridge. They should be established for maintenance of tunnels, earth structure and other civil engineering structures.

② For the bridge maintenance course, trainees should learn several types of bridges, such as concrete bridge, and steel bridges. But these trainings are not held in any places including CITC, Mahlwagon bridge depot, and the field. These training courses should be held at least in one place.

2) Equipment

① In the CITC, there are some track equipments for training. A bridge, "Baily pin" structure, is installed on the practical training line. But this structure is a minor type on operating line of MR. Then it is considered that training using such a type would not be effective. It should be replaced with other ones that are major type of bridges in MR, such as Deck girder.

② It is advised to install necessary equipments for practical training of bridge maintenance in CITC..

6. Concluding remarks

As it is well known, the Project consists of two sub project:

(1) Based on accident and low service level analysis, recommendation on technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level

(2) Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project

We would like to express our thanks to MR for the kind and earnest cooperation for execution of the Project up to now, and sincerely hope that the execution of the Project has contributed to some extent to the improvement of safety and service level of MR.

Appendix

Appendix-1 PDM

The original PDM is given as Annex 1 of Record of Discussion (R/D) signed on March 25, 2013 between the Managing Director of MR and General Manager of JICA Office in Myanmar.
It was modified as given in Table 6.1 of Chapter 6 of the Inception Report. Essence of modification of the original PDM is given in Appendix 1- PDM of Progress Report March 2014.
Modified PDM is shown as follow

Annex 1
PDM

Table 6-1 Modification of PDM (Incepition Report)

Project Design Matrix
The Project on Improvement of Service and Safety of Railway — Project Implementation Period : 2013 to 2015
Excuting Agency:Myanma Railway(MR) ,Ministry of Rail Transportation — Project Site: Yangon — (24months)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Service and safety level of Myanma Railways is improved.	①Number of annual accidents on Yangon-Mandalay line decreases compared with the pesent and past records. ②Number of speed ristricted locations on Yangon-Mandalay line decreases compared with their present number. ③Journey speed on Yangon-Mandalay line increases compared with the present journey speed. ④Punctuality of express passenger trains on Yangon-Mandalay line is improved compared with the present situation. ⑤Satisfaction level of clients is enhanced. ⑥Number of passenger	·Statistics on safety ·Reporting of accidents cause analysis and discussion of countermeasures are executed. ·Satistics on operation ·Interview/questionnaires to clients ·Satistics on operation	
Project Purpose Administration and maintenance ability is improved for the enhancement of sevice and safety of Myanma Railways.	①Accident cause analysis and countermeasures to prevent the similar accidents, and means to improve service levels are established and executed ,and inherited by MR ②Administrative and managerial capacity of track maintenance is improved and improved level is kept by MR	·Reflection on organization,management/ operation rules;facilities renewal plans ·Utilization,modification of administration management manuals ·Actual results of maintenance execution, such as the record of maintenance	·Administration staff members are not relocated drastically ·Technical staff members are not relocated drastically
Output			
1. Issues are clarified for the enhancement of service and safety in the administration and maintenance process, and the improvement plan is drawn.	1-1 System for collecting information of track, rolling stock, signal and communication, and operation is established. 1-2 Safety issues are listed based on the investigation and analysis of cause of accident. 1-3 Service issues are listed. 1-4 Service and safety improvement plan is drawn so as to tackle the issues.	1-1 Related management document(s) of System for collecting information 1-2 Listed issues 1-3 Listed issues 1-4 Service and safety improvement plan	·The Government support to the Myanma Railways, especially financial support is secured.
2. Technical capability is improved through emergency track maintenance to improve the level of sevice and safety.	2-1 Technical transfers are made effectively at each measure (targeted numbers of technical staff:30 persons). 2-2 Working manual of emergency track maintenance is prepared. 2-3 Proper equipment and materials are procured both qualitatively and quantitatively. 2-4 Counterpart personnel acuired necessary proficiency through seminars(3 times), trainings(3 times) for technical improvement on the rail maintenance and others.	2-1 Record of technical transfers 2-2 Set of Working manual 2-3 Inventory list of equipment and materials 2-4 Record of seminar and training	

Table 6-1 (continued) (Inception Report)

Annex 1

Activities	Input (Japanese side)	Input (Myanmar side)	Preconditions
1. Preparation of Railway Service and Safety Improvement Plan 1-1 To conduct current situation survey regarding track, rolling stock, signal and communication, and operation, and establish system for collecting information. 1-2 To promote familiarization on the investigation and analysis method of accident cause based on the comprehensive factors of track, rolling stock, signal and communication, and operation. 1-3 To coinduct the investigation and analysis mentioned above. 1-4 To provide recommendation based on above analysis on necessary technical standards to improve service and safety level. 1-5 To draw the improvement plan of railway facilities through discussion with the "Working Group for service and safety imprivement(tentative name) " **2. Enhancement of Technical Capabilities of Track Maintenance** 2-1 To draw the technology transfer plan. 2-2 To procure the necessary equipment and materials. 2-3 To conduct emergency track maintenance. 2-4 To summarize betterment point(s) obtained during emergency track maintenance operation, and to feedback to the successive measures. 2-5 To draw the working manual of emergency track maintenance. 2-6 To conduct seminars, trainings for technical improvement on the rail maintenance and others.	**1. Dispatch of Japanese Experts** Fields of Experts(several person) ·Railway OM improvement ·Technical Standards ·Track Maintenance ·Procurement of Equipment and Materials/Project Coordination **2.Counterpart training in Japan** ·Railway Institutional Management Improvement: 11person ×2weeks ·Track Maintenance: 22person (11p×2×2weeks) **3.Equipment** Necessary handy equipment of emergency track maintenance, such as Tie Tamper. **4.Expense** ·For research, travelling, training, the other activities for Japanese experts	**1. Assignment of Counterpart** ·Project Drector: 1person ·Project Manager: 1person ·Railway Polocy/OM Improvement: 1person ·Rail Maintenance: 1person ·Procurement of Equipment and Materials: 1person ·Others: As approproate **2.Provision of facilities for the Project implementation:** ·Project office (in the Myanmar Railways, Lower Myanma Regional Office) ·Working tools and furniture for Project Office ·Internet connection in the Project office **3.Joint Coordination Committee(JCC)** ·Establishment of JCC **4.Expense** ·Local cost for personnel ·Cost for office rent and quipment. ·Expense for the pilot project,such as gravels,sleepers,rail materials and others. ·Other expenses: For research,travelling,training,the other activities for counterpart personnel **5.Others** ·Status guarantees of Japanese experts, ID card for access into the Myanma Railways properties. ·Access to the necessary statistical data and related information ·Other necessary local cost	Natural Disaster does not hit the railway facilities fatally.

Appendix3 Detailed implementation plan

As shown in Table5.11 and 5.2

Appendix6 Records of procurement of the required equipment/tools

As shown in Table 5.2.2

Appendix 4 Record of JICA Expert dispatching

Appendix 4-1

Appendix5 Record of training in Japan

5.1 Track Maintenance Course (2 times)
A) Period
1st time: From 8th Jun 2014 to 21th Jun 2014: 14days
2ndtime: From 22nd Jun 2014 to 5th Jul 2014: 14days

B) Trainee
1st time: 11 trainees

No	Name	Title
1	Mr. Ye Htut	Assistant Engineer (Civil)
2	Mr. Kyaw Lwin	Assistant Engineer (Civil)
3	Mr. Saw Naing	Permanent Way Inspector (1)
4	Mr. Aung Swe	Permanent Way Inspector (1)
5	Mr. Han Tin Soe	Permanent Way Inspector (1)
6	Mr. Win Nyunt	Permanent Way Inspector (2)
7	Mr. San Yu	Permanent Way Inspector (2)
8	Mr. Chit Ko Ko	Permanent Way Inspector (2)
9	Mr. Than Naing	Permanent Way Inspector (2)
10	Mr. Aung Thein Win	Permanent Way Inspector (2)
11	Mr. San Naing	Permanent Way Inspector (2)

2nd time: 11 trainees

No.	Name	title
1	Mr. Soe Myint Aung	Assistant Engineer (Civil)
2	Mr. Aye Nyeub Swe	Assistant Engineer (Civil)
3	Mr. Han Thein	Permanent Way Inspector (1)
4	Mr. Kyaw Thu Ya	Permanent Way Inspector (1)
5	Mr. Moe Kyaw Aung	Permanent Way Inspector (2)
6	Mr. Kyaw Htet Zaw	Permanent Way Inspector (2)
7	Mr. Aye Min Aung	Permanent Way Inspector (2)
8	Mr. Kyaw Tun Linn	Permanent Way Inspector (2)
9	Mr. Aung Aung	Permanent Way Inspector (2)
10	Mr. Hla Htay Win	Permanent Way Inspector (2)
11	Mr. Thaung Tun Aye	Permanent Way Inspector (3)

5.2 Railway Institutional Management Improvement Course

A) Period

From 8th October 2014 to 1st November 2014: 14 days

B) Trainee, 11 trainees.

No	Name	Title
1	U Win Naing	Deputy General Manager (Carriage)
2	U Htay Myint Aung	Deputy General Manager (Operation)
3	Daw Kyi Kyi New	Assistant General Manager (Finance)
4	U Lwan Thu	Executive Engineer (Civil)
5	U Maung Maung Tin	Manager (Supply)
6	U Aung Chan Myint	Manager (Commercial)
7	U Myint Lwin	Executive Engineer (Communication)
8	U Aung Wai Soe	Assistant Manager (Inspection)
9	Daw Khin May Than	Assistant Manager (Plan & News)
10	U Nyo Aung	Assistant Engineer (Electric)
11	U Aung Myint	Assistant Manager (Planning)

Minutes of Discussion

1st JCC for " The Project on Improvement of Service and Safety of Railway in Myanmar"

1. DATE 28 August, 2013 10:00am~12:00am

2. PLACE Meeting Room of Myanma Railway Head Quarter

3. ATTENDANTS

3.1 Myanmar side

Myanma Railways

GM (Inspection)	Mr. Ba Myint
GM (Operating)	Mr.MyintWai
Deputy GM (Mechanical)	Mr. Thet Lwin
Deputy GM (Goods)	Mr. Thura Aung Myo Myint
Deputy GM (Civil)	Mr. Maung Maung Thwin
Deputy GM (Planning)	Mr.Htaung Sian Kan

3.2 Japan side

JICA Transportation and ICT Division 1
Transportation and ICT Group
Economic Infrastructure Department Mr. K.Imia (Adviser), Mr.T.Chokki
JICA Southeast Asia Division 4
Southeast Asia and Pacific Department Mr.T.Kon(Adviser), Mr. A. Fukuyama
JICA Myanmar Office Mr. M.Morikawa(Project Fomulation Adviser)
JICA Expert Team Dr.S.Kuroda(Leader:Track maintenance),
Mr.N.Matsuo(Sub-leader:Maintenance Planning),
Mr.H.Komatsu(Operation maintenance),
Mr.Y.Taniguchi(Procurement of equipment and material),
Mr.K.Miyamoto(Track maintenance 2),
Mr.Ishikawa(Rolling Stock),
Mr.H.Igarashi(Train Operation),
Mr.M.Takami(Coordination),
JICA Railway management
Adviser Mr.M.Higashi
Observer JICA Study Team (MYT-PLAN) Mr.J.Shibata(Project Manager),
Mr.I.Numata(Train Operation)
Sumitomo Corporation Asia Pte.Ltd.NayPyi Taw Office
Mr.M.Yamato(General Manager)
Interpreter Mr.YeTunOo

4. SUBJECT Explanation and Discussion of Inception Report(IC/R)

5. HANDOUTS Inception Report(IC/R)
Power Point document for explaining Inception Report
Three kinds of letters
- JICA Expert Team Schedule until October
- Selection of the Pilot Section
- Additional Questionnaire

List of members of JICA Expert Team with face photos

6. GREETING S BY JICA

Before the start of explanation and discussion of IC/R, Mr.Chokki of JICA Headquarters gave an opening address and at the same time delivered the following comment and request for the Project.

(1). This Project is not a Yen loan project, but a technical cooperation project aiming at technology transfer.

(2). We should be grateful, if MR could kindly arrange smooth import of related equipments/tools from Japan, and prepare track materials such as rail, ballast etc.,necessaryfor track maintenance OJT in proper timing.

7. MAJOR SUBJECTS

7.1 Presentation of IC/R

IC/R was presented and explained by Dr.Kuroda , leader of JICA Expert Team, and it was accepted by MR in principle.

7.2 The following three letters were explained by Dr.Kuroda.

(1) The letter proposing the Pilot Section and requesting confirmation of it by MR

(2) The letter describing the working schedule of JICA experts in August, September and October and requesting the arrangements necessary for JICA experts activities.

(3) The letter requesting provision of relevant information requested by the additional Questionnaire.

7.3 Major Points of discussion

(1) MR : ① MR will be responsible for clearance of necessary equipments/tools to be provided by Japan side for the Project.

: ② MR has already prepared necessary track materials to be used for on-the-job training of track maintenance. JICA experts should make checking the ballast whether right size or not before start the project.

: ③ Working schedule of JICA experts in August, September and October has already been confirmed. MR will suitably deal with it.

(2) MR When was the vibration of vehicle running on the proposed Pilot Section measured?

JICA Expert : It was measured in March, 2013.

MR : In the period from March to August, any specific renewal work has not been executed, accordingly the measurement in March does not raise any specific problems.

(3) MR: JICA Expert Team is proposing the Pilot Section, and is requesting MR to confirm the proposal. Are there any possibilities to modify the proposal?

JICA Expert: Pilot Section is selected with due consideration on the kinds of track maintenance work technology to be transferred to MR staff. Difference of opinions between MR and JICA Expert Team, if any, can be adjusted in the first week of September, during which preparatory work such as driving in the posts is carried out.

MR: We would like to have the discussion in the first week of September on the location of the Pilot Section. JICA experts and MR staff will survey the proposed Pilot section together using the rail car.
At that time, please check the size of ballast.

JICAExpert: Please provide us with the specification of ballast.

MR: We will do.

(4) MR: Does proposed Pilot Section include both the up line and the down line?

JICA Expert: It includes both lines.

(5) MR: How many trainees will be involved in job training of pilot project?

JICA Expert: Members of gangs are planned to be trained.
Number of trainees will be about 30. With respect to details, we would like to discuss with MR. We are also planning to make use of the training center of MR.

(6) MR: Is welding work technology included in the kinds of maintenance work to be transferred to MR staff? We would like to get training of welding technology.

JICA Expert: Yes, it is included. Thermit welding is used by MR, so if the quality of Thermit welding used by MR has some problems, we will investigate the problems and make recommendations.

(7) MR: In the period of 1st week of September during which discussion on the location of the Pilot Section will be held, we would like to request JICA experts to examine the equipments/tools possessed by MR gangs.

JICA Expert: Yes, we do. As one countermeasure to improve rail joint portion, we would like to propose one design of fishplate of rail joint.

(8) MR: With respect to equipments /tools to be imported from Japan, tax and import license fee exemptions can be assured. Schedule of technology transfer of track maintenance has already been informed to the relevant track maintenance organizations. The answers to the Additional Questionnaire are being prepared and will be completed soon.

(9) MR: Which rail will be used in the pilot project, new or existing rails?

JICA Expert: It will be confirmed while implement the project.

Sept 5, 2013 **Nay Pyi Taw**

U Thurein Win
Managing Director
Myanma Railways

Dr. S.Kuroda
Leader of JICA Expert Team

Minutes of Discussion

2nd JCC for "The Project on Improvement of Service and Safety of Railway in Myanmar"

1. DATE — 27 February,2014 10:00~12:30am
2. PLACE — Meeting Room of Myanma Railways Headquarters
3. ATTENDANTS

3.1 Myanmar side

Managing Director	U.Thurein Win
General Manager(Technical&Admin.Support)	U.Saw Valentine
General Manager(Civil)	U.Tin Soe
General Manager(Mechanical and Electrical)	U.Aung Win
Deputy General Manager(Planning)	U.Htaung Shan Khan
Deputy General Manager(Civil)	U.Than Htay
Deputy General Manager(Finance)	Daw.Thi Thi Nwe
Railway Policy Advisor	Mr.M.Higashi

3.2 Japan side

JICA Transportation and ICT Division 1
Transportation and ICT group
Economic Infrastructure Department Mr.T.Chokki

JICA Expert Team
Dr. S.Kuroda(Leader:Track maintenance),
Mr. N.Matsuo(Sub-leader:Maintenance planning),
Mr. H.Komatsu(Operation maintenance),
Mr. Y.Taniguchi(Procurement of equipment and material),
Mr. K.Miyamoto(Track maintenance),
Mr.R. Mitani(Signal&telecom)
Mr. M.Ishikawa(Rolling Stock),
Mr. H.Igarashi(Train Operation),

Observer — Sumitomo Corporation Mr.M.Yamato (General Manager)

Interpreter — Mr. Ye Tun Oo

4.SUBJECT — Explanation and discussion of Progress Report

5.HANDOUTS
(1). Progress Report(PR)
Power Point Document of PR for explanation
(2.)Text Book for Training Program of Cause Analysis of Accidents/Low Service Level and Establishment of Countermeasures

(3) Article in the Journal of Japan Railway Civil Engineering Association introducing" The Project on Improvement of Service and Safety of Railway in Myanmar "

(4) Photo List of Members of JICA Expert Team (The newest version)

6.OPENING GREETING

6.1 U.Thurein Win ,Managing Director ,Chairman of JCC

- At the beginning of the last year, in the top meeting between Myanmar and Japan, the Japanese Government agreed upon the cooperation with the Myanmar Government in the field of railway transport. Since then, Yen loan projects, free aid projects, and technical cooperation projects have been planned and programmed.

Technical cooperation of "the Project on improvement of Service and Safety of Railways in Myanmar" is the first realized technical cooperation in the field of railways.

This Project was initiated according to ROD agreed upon between MR and JICA in March 2013.

According to this Project, the following various cooperations have been promoted.

* 74 items,610 quantities of track maintenance equipments/tools have been provided to MR.
* 11 track maintenance related staff of MR have been trained for two weeks recently in Japan.
* 20 officers of MR have been trained in the training program focused on accidents analysis, and safety and service level improvement.
* At present, track maintenance training is being executed with the use of modern Japanese track maintenance equipments/tools in the section between Thingangyun and Ledaunggan.

On the Myanmar side, we are making every efforts in the smooth acquisition of visas for JICA experts, in exemption of import tax for track maintenance equipments/tools imported from Japan to Myanmar country, provision of working offices in Nay Pyi Taw and Yangon for JICA experts, and so on.

In the first JCC, we could have active and fruitful exchange of views regarding the smooth execution of the Project. It is sincerely hoped that in the 2nd JCC, we could have active and suhstantial discussion in the same way as in the first JCC.

Last but not the least, we ,MR, express the sincere appreciation to JICA experts for their cooperation with MR in improvement of safety and service level of MR.

6.2 Mr.Chokki 、 JICA Headquarters

It is our pleasure that the whole track maintenance equipments/tools offered by JICA have arrived at the Pilot Project site.

In this regard, we, JICA ,appreciate very much MR for their efforts in smooth import of these equipments/tools .With the arrival of these equipments/tools, full-dress track maintenance training will be executed soon.

It is our pleasure to inform our MR colleagues that the activities of technology transfer of track maintenance in the Pilot Section have been introduced in an article of a well-known journal of railway engineering in Japan.

Today, in the 2nd JCC,JICA expert team will present the Progress Report describing the status of the progress of the Project.

We should be grateful, if JCC members could kindly examine the Progress Report and provide the various advices for smooth and effective execution of the Project.

7. Presentation of Progress Report

Progress Report was explained by Dr.S.Kuroda, Leader of JICA Expert Team, and Mr.N. Matuso, Deputy Leader of JICA Expert Team, and it was accepted in principle.

8. Major Points of Discussion

(1) MR: ① Track maintenance is very important for safe train operation. However, MR is in shortage of skilled track maintenance staff.

Measurement of track conditions by instruments is very important. We expect JICA experts to train the young MR staff with respect to measurement of track conditions with use of measurement tools.

② MR have 200 sets of tie-tampers although their performances are not good. Is it possible to make use of them with the suitable modification such as replacement of parts?

③ "Finger pointing and confirmation" is a splendid method for ensuring the precise work.

④ We are very happy that JICA provided us with a train vibration measuring device. Is it possible to evaluate the track conditions between Nay Pyi Taw and Mandalay by measuring the vibration of

train with this device? If we could find the locations of bad track conditions by vibration measurement, we can efficiently repair the track.

⑤ In reviewing the track maintenance manual, kindly discuss with MR staff concerned, so that the revision could be made with due consideration on MR's practical situations.

JICA Expert: With respect to ② above, it may not be practical to use MR tie-tampers with replacement of parts. We have been informed that MR have 10 sets of tie-tampers similar to Japanese ones. We would like to propose a plan to suitably combine these 10 MR tie-tampers and JICA tie-tampers for track tamping.

Regarding ④ above, we would try to comply with the request. However, kindly inform us of your request of measurement one week in advance. With respect to ⑤ above, we would try to comply with your request.

(2) MR: MR needs vehicles to comply well with the tack condition. MR's vehicles have frequent failures and there are many problems with respect to bogies etc. Kindly teach us what kinds of vehicles MR should have.

MR is now planning to purchase new DEMUs. Kindly advice us what types of suspension should these DEMUs have.

In the Yangon – Mandalay line, there are 400 vehicles, and MR have to replace 3200 pieces of spring coils every year, namely replacement of 8 spring coils per vehicle per year.

It means that ¼ of 32 spring coils installed in one vehicle are replaced every year. It is a very bad situation.

MR would like to find out suitable spring coils to comply with the track condition.

JICA Mr.Chokki: The Project is the technology transfer project focused on track maintenance technology and improvement of safety and service level through the accidents/ low service level analysis. With respect to cooperation with MR in the field of rolling stock, JICA would like to do it by other separate projects. However, provision of relevant information can be made through rolling stock engineer of the Team , through Text Book used in the Training Programme,etc.

(3) MR: Regarding the cost of this Project, whether it should be or should not be

put in the Myanmar Railways budget .

JICA Mr.Chokki : This questions will be answered after getting the idea from JICA Headquarters in Tokyo.

(4) MR: How MTTs and tie-tampers can be used properly?

JICA Expert: MTTs are used in the track maintenance of the long section. Tie-tampers are used for the tamping of turnouts or for spot maintenance.

(5) MR: What kinds of trainees should be selected for October training in Japan?

JICA Expert: We are now training 20 middle class management experts (such as divisional officials) of track, train operation, rolling stock and signaling & telecom in the "Training Program of Cause Analysis of Accidents/Low Service Level and Establishment of Countermeasures." MR officers of the similar levels are recommended for training in Japan. One DGM level senior management officer is advised to be included in the trainees as a leader.

(6) MR: In case of measurement of train vibration, not only the track conditions but also vehicle conditions will have effect on magnitude of vibrations. Accordingly good conditioned vehicle should be selected for measurement of train vibration.

JICA Expert: We agree with the opinion. We are now measuring the train vibration to confirm the effect of track maintenance once per two weeks. We are trying to chose the similar vehicles for measurement of vibration.

9. JICA Mr.Chokki's comments:

① With respect to ballast supply for track maintenance, we appreciate very much MR for their efforts in supplying the required amount of ballast with proper timing.
We should be grateful if MR could kindly continue the proper and timely supply of ballast so that the track maintenance training could be executed smoothly.

② With respect to working hours for training in the season after the middle of March and allowances for overwork of MR staff.
In the season after the middle of March. It becomes very hot in the Yangon Area. The government and the media warn that the people

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should not be outside their houses from 10 A.M. to 4 P.M. ,if going out is not necessary.

With the condition of this situation, in order to keep the health of workers in good conditions, we are planning to set the working hours from 7 A.M. to 11 A.M., instead of the current working hours from 8 A.M. to 12 A.M.

The MR workers participating in the training program must do the other maintenance work of duty in the evening or at night, in addition to the work for training.

This situation puts a big burden on them. We should be grateful if MR could kindly consider some suitable allowances for the trainees to comply with their overwork.

MR: We will consider the matter suitably.

10. Closing speech by the Chairman

It is a pleasure that there have been many substantial exchange of views on various matters in this JCC.

From now on, MR would like to continue their efforts in cooperating with the Project as much as possible.

March 5, 2014 Nay Pyi Taw

U Thurein Win
Managing Director
Myanma Railways

Dr. S.Kureda
Leader of JICA Expert Team

Minutes of Discussion

3rd JCC for "Project on Improvement of Service and Safety of Railways in Myanmar"

1.Date and time 29 May 2014 9:30~12:30

2.Place Meeting Room of Myanma Railways Headquarters

3. Attendants

3.1 Myanmar side

Myanma Railway

U Thurein Win	(Managing Director)
U Saw Valentine	(General Manager –Technical & Admin Support)
U Myint Wai	(General Manager –Operation)
U Tin Soe	(General Manager –Civil)
U Aung Win	(General Manager –Mechanical & Electrical)
U Ba Myint	(General Manager –Inspection)
U Aung Myint Hlaing	(Deputy General Manager –Passenger)
UHtaungSianKan	(Deputy General Manager –Planning)
U Than Htay	(Deputy General Manager –Civil)
DawThiThiNwe	(Deputy General Manager –Finance)

3.2 Japanese Side

JICA Myanmar Office	Mr. Win KoKo (Program Assistant)
JICA Expert Team	Dr. S. Kuroda (Leader: Track Maintenance)
	Mr. N. Matsuo (Deputy Leader: Maintenance Planning)
Observer	Mr. M. Yamato (General Manager: Nay Pyi Taw Office Sumitomo Corporation)
Interpreter	Mr. Kyaw Soe Thu

4. Subject: Explanation and Discussion of Progress Report

5. Handouts

(1) Progress Report (PR) (JICA Expert Team)

(2) Power Point Document of PR for explanation (JICA Expert Team)

(3) Report for Technical Transfer Training in Yangon –Bago Line Pilot Project by JICA (Civil Engineering Dept. Myanma Railways)

6. Opening Speech by U Thurein Win, Managing Director, Chairman of JCC

The Pilot Section was selected in the last September, and since then the track maintenance training

has been implemented under the cooperation of JICA.

The 1st and the 2nd JCC were held in August 2013 and in February 2014 respectively, and now we are going to hold the 3rd JCC.

It is our pleasure that two groups of eleven members each are going to visit Japan for track maintenance training.

We would like to express our gratitude to JICA and JICA Expert Team for their assistance in recommendation on technical standards and drawing up railway facilities improvement plan based on cause analysis of accidents/low service level, and in technology transfer of track maintenance.

7. Greeting by Dr. Kuroda, Leader of JICA Expert Team

I must report with regret that Mr. A. Sanjo, senior representative of JICA Myanmar Office cannot attend the Meeting due to some inevitable reason, although he was scheduled to attend the Meeting.
If MR has some specific requests to JICA, they will be recorded in the minutes of the Meeting and will be reported to JICA.

On this opportunity, we, JICA Expert Team would like to express their appreciation to U Thurein Win, Managing Director and the officials concerned for their assistance extended to the Team.

8. Presentation of Progress Report

Progress Report was presented by Dr. S. Kuroda, Leader of JICA Expert Team and Mr. N.Matsuo, Deputy Leader of JICA Expert Team.

9. Presentation of Report for Technical Transfer Training In Yangon —Bago Rail Line Pilot Project by JICA

The Report was presented by U Tin Soe, General Manager (Civil). In the presentation, U Tin Soe made the following requests to JICA.

*Kindly continue the train vibration measurement by the measurement device on Yangon —Mandalay line (the up line of Yangon —Pyinmana section has already been measured).

*Kindly arrange so that Dr. Osanai visits Myanmar more often to give training of track maintenance to MR staff concerned.

10. Major Points of Discussion

(1)MR: ①Measurement of track irregularities by inspection device is very significant. Supplying track with ballast of specified volume is also important. We are now supplying the track between Yangon and Pyinmana with the ballast of 280000 m^3/ year in these two years.

②We would like to request JICA to provide us with training of maintenance of long welded rail track.

③Kindly explain the meaning of unification of level crossings.

④ What is the opinion of JICA Expert Team about the size of ballast of MR?

JICA Expert:

*With respect to ②above.

It will be reported to JICA.

*With respect to ③ above.

It means that several small size level crossings locating close to each other are unified to one level crossing which will be equipped with sufficient protection devices.

*With respect to ④ above

The maximum ballast size specified by MR standards is larger than that by JR standards. It can be observed that stones larger than the maximum size specified by MR standards are used in the track. Generally the excessively large stones are difficult to be filled under the sleeper.

Further it can be observed that grain size distribution of ballast is not well controlled by MR. If the various sizes of stones are appropriately mixed, the settlement characteristics of the track will be improved. We will later submit the size distribution standards of JR Group together with the comparison with that of MR.

(2). MR: ①JICA has already provided us with one train vibration measuring device.

Kindly provide MR with one more train vibration measurement device

② By the presentation of JICA expert, it can be well understood that there are many issues regarding braking system and spring coil system. Kindly provide us with training of rolling stock maintenance.

③ How should MR improve vibration system of the truck, in order to improve riding comfort?

④ Continuous braking system is designed for vehicles, accordingly the sentence on the 5th line from the bottom on page 13 of PPT should be replaced by the following sentence.

"The vehicle should be fully equipped so that....."

Should MR replace vacuum braking system with compressed air braking system?

⑤ Thermit welding can be executed while it is raining?

⑥ Kindly provide us with training on cause analysis of accidents and low service level and establishment of countermeasures for MR officials in the various fields including civil, track, rolling stock, operation, signal/telecom.

JICA Expert:

*With respect to ①&② above.

They will be reported to JICA.

*With respect to ③ above.

Damper system should be improved. More details will be explained later after consultation with the rolling stock expert of our Team.

*With respect to ④above.

Continuous braking system is arranged for vehicles in design. However, continuous brake is actually not working in the vehicles. In case continuous brake is not working, brake distance of the train will become long, and train speed cannot be raised so much.

In case of vacuum braking system, the maximum braking force is only one atmospheric pressure, accordingly the brake distance of the train equipped with vacuum braking system becomes longer than that of the train equipped with compressed air pressure braking system. Compressed air braking system should be adopted for increasing train speed.

*With respect to ⑤above.

Thermit welding should not be executed while it is raining.

*With respect to ⑥ above.

It will be reported to JICA.

(3).MR:①Please explain the JR rule about train speed slow down during the track maintenance work.

② There occur many accidents on illegal level crossings. What should we do?

We would like to know more about level crossing accidents prevention. We will ask the questions by e-mail. Kindly answer the questions.

JICA Expert:

*With respect to ① above.

In JR, the time during which trains are operated and the time during which track maintenance works are carried out are separated from each other. The kinds of track maintenance works which will be carried out while trains run, but accompanied by train speed slow down are limited to specific preparatory works specified by the regulation.

*With respect to ② above.

In case some illegal level crossing are necessitated by the neighborhood residents, they should be leveled up to the legal ones, and should be equipped with appropriate protection devices. In case the ones are not so much necessitated by the neighborhood residents, they should be abolished.

If you have some questions about level crossing issues, please send us your questions by e-mail. We would like to try to answer your questions as much as possible.

11. A list of requests to JICA made by MR during the discussion are given as follows.

*Kindly continue the train vibration measurement by measurement devices on Yangon–Mandalay line. (The up line of Yangon–Pyinmana section has already been measured)

*Kindly arrange so that Dr. Osanai visits Myanmar more often to give training of track maintenance to MR staff concerned.

*Kindly provide MR staff concerned with training of maintenance of long welded rail track.

*Kindly provide MR with one more train vibration measurement device.

*Kindly provide MR staff concerned with training of rolling stock maintenance.

*Kindly provide training of cause analysis of accidents and low service level, and establishment of countermeasures to MR officials in the fields of civil ,track, *rolling stock, signal/telecom and operation.*

12. Closing speech by U Thurein Win, Managing Director, Chairman.

I appreciate the attendants on the 3rd JCC meeting for their earnest discussion. MR would like to do its best in cooperating with the Project.

In case JICA has some specific requests regarding implementation of the Project, kindly inform us of these, which MR would try to comply with as much as possible.

June 3, 2014 Nay Pyi Taw

UThurein Win
Managing Director
Myanma Railways

Dr.S.Kuroda
Leader of JICA Expert Team

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Minutes of Discussion

4th JCC for "The Project on Improvement of Service and Safety of Railway in Myanmar"

1. DATE 29 Sept. 2014 13:30~15:30
2. PLACE Meeting Room of Myanma Railways Headquarters
3. ATTENDANTS

3.1 Myanmar side

Managing Director	U Thurein Win
General Manager(Technical&Admin.Support)	U Saw Valentine
General Manager(Civil)	U Tin Soe
General Manager(Mechanical&Electrical)	U Aung Win
General Manager(Finance)	U Maung Maung Lwin
Deputy General Manager(Planning)	U Sai Thaw Lin
Deputy General Manager(Operating)	U Htay Myint Aung
Deputy General Manager(Civil)	U Maung Maung Thwin
Deputy General Manager(Civil)	U Than Htay
Deputy General Manager(Signalling&Communication)	U Khin Maung Thein
Assistant General Manager(Planning)	U Thein Myint
Assistant General Manager(Civil)	U Maung Maung Than
Assistant General Manager(Operating)	U Zaw Pe Sein
Manager(Passenger)	U Arkar Min Thu
Assistant Engineer(Civil)	U Zaw Ye Myint
Assistant Engineer(Civil)	U Min Aung
Assistant Manager(Planning)	U Than Htun Aung

3.2 Japan side

JICA Head Office	Mr. K.Imai, Mr. K.Kuramoto
JICA Myanmar Office	Mr. M.Morikawa
JICA Expert Team	Dr. S.Kureda(Leader:Track maintenance), Mr. N.Matsuo(Sub-leader:Maintenance planning), Mr. H.Komatsu(Operation maintenance), Mr. R. Mitani(Signal&telecom), Mr. M.Ishikawa(Rolling Stock) Mr. M. Takami(Coordinator)

Observer Sumitomo Corporation Asia & Oceania Pte, Ltd.
Mr.M.Yamato (General Manager Nay Pay Taw Office)
U Tun Tun Kyaw

Interpreter U Kyaw Soe Thu

4.SUBJECT Explanation and discussion of Progress Report

5.HANDOUTS (1)Project Progress Report(ppt digest)
(2) Project Progress Report(file)
(3)Appendix·1.Report of Proposals of Recommendation on Technical standards of MR and Short·,Medium·, and Long·Term Railway facilities Improvement Plan
2.Minutes of Meeting, August 11, 2014,at NayPyiTaw
3.Workshop Report (in Japan)

6.Agenda

6.1 Opening Speech by Chairman U.Thurein Win ,Managing Director

This project is the first technical support by JICA, and one year has passed since commence of the training in the pilot section between Yangon and Bago.

This JCC is the 4th one.

Workshops in Japan have already been implemented for 2 groups, and we are arranging to dispatch one more group in October.

We highly appreciate JICA for supporting safety and service level improvement of MR.

We will continue to cooperate with JICA Expert Team.

6.2 Speech by Mr. Imai, JICA Head Quarter

The progress of the Project up to now was explained by Managing Director of MR.

Today, we will explain the present circumstances of the Project.

I have been informed that technical level of MR staff is improving. Improvement of their ability is the basis of safety and management upgrading of MR.

Please listen to reporting of the Project by JICA Expert Team.

After the Project reporting, I would like to talk about another topic.

6.3 Presentation of Progress Report by JICA Expert Team (Leader S.Kuroda & Deputy Leader N.Matsuo)

6.4 Discussion by all JCC members

(1) MR

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This Project will be completed in May 2015. In case the Project is continued further beyond May 2015, kindly include the training for rolling stock and signal. If some trainings can be added to this Project, please consider to add the trainings for rolling stock and signal.

JICA

Regarding the request for formulation of another technical cooperation project for rolling stock and signal similar to the present Project, we cannot answer it here at this moment. We will convey your request to Japanese government.

(2) MR

We would like to have a training of more detailed track maintenance. (Advanced training course)

JICA

We understand the significance of advanced training course. However, the training of fundamental track maintenance technologies is very important.

Besides the track maintenance technology under the ongoing training, technologies for soft ground improvement and level crossing track improvement are also considered to be the fundamental ones for track maintenance.

In this context, if we add the trainings for soft ground improvement and level crossing track improvement to the ongoing training for track maintenance, it can be considered that JICA's technology transfer of track maintenance to MR will be almost achieved.

In this regard, we would like to recommend that in addition to the current training for track maintenance, trainings for soft ground improvement and level crossing track improvement should be implemented, and for completing the trainings, a summarizing training should be implemented on a certain appropriate line. As for this line, we consider that Thilawa line is most suitable, because the line has not so many number of train operations allowing sufficient time for training and includes the suitable locations for recommended training.

This recommendation is based on the professional experiences of railway technical cooperation.

(3) MR

(a) The ongoing training of manual based track maintenance is very useful for MR. However, we would like to request JICA to extend the training for mechanized track maintenance and managing large sized track maintenance machines. Mechanized track maintenance is effective for executing the maintenance of the track stretched over a

long distance.

We have a plan to outsource the track maintenance work. In case of outsourcing the mechanized track maintenance work, MR itself must have the knowledge about details of mechanized track maintenance.

We are also wishing that the current trainees become the trainers for other MR staff.

(b)We would like to learn the bridge maintenance technology.

Kindly consider to provide us with a short (2～3 months) bridge maintenance training course for a selected small group.

(c)We are now going to have many LWR installation projects.

Kindly provide us with a training for LWR technology.

JICA

(a)We understand the various needs of MR. We also understand the significance of mechanized track maintenance. However, soft ground improvement and level crossing track improvement are the most fundamental track maintenance technologies.

With respect to the outsourcing of track maintenance work, it is considered that the most important thing is that MR staff can judge whether the contractor has completed the contracted work precisely as required by the contract.

(b).As for the training for bridge maintenance, we must examine whether the current JICA Expert Team can manage the training. We may need another group of JICA experts.

From tomorrow, we are going to have the workshops for manager level staff.

Upgrading the level of staff at site is also very important. As mentioned above, we would like to request MR to consider our recommendation that in addition to the ongoing training of track maintenance, trainings for soft ground improvement and level crossing track improvement should be implemented and a summarizing training should be implemented on Thilawa line.

Kindly give your response to our recommendation by Oct.15 to JICA Yangon Office.

(4) MR

We would like to request for a training of locomotive, rolling stock and DMU.

We have questions about 5 items of recommendation on technical standard which were explained in Progress Report.

JICA Expert Team

We will discuss them fully at the workshop starting from tomorrow.

4

(5) MR

The workshop of accident prevention held in February was very useful. We would like to have another one.

Signal equipments of MR are very old. We would like to request for workshop about new signal technique.

JICA

We are planning to hold signal workshop as a part of OCC Project.

7 Closing speech

U Thurein Win, Managing Director, MR

We appreciate various fruitful discussions in the JCC. Please consider the various requests of MR.

Mr. Imai , JICA Headquarters

We appreciate many significant discussions of JCC members.

Please consider the recommendation made by JICA fully.

October 2nd , 2014 Nay Pyi Taw

U Thurein Win
Managing Director
Myanma Railways

Dr. S.Kuroda
Leader of JICA Expert Team

5

Minutes of Discussion

5th JCC for "The Project on Improvement of Service and Safety of Railway in Myanmar"

1. DATE 19 Dec. 2014 10:30~13:00
2. PLACE Meeting Room of Myanma Railways Headquarters
3. ATTENDANTS

3.1 Myanmar side

U Saw Valentine	Advisor
U Maung Maung Lwin	G.M (Finance)
U Htaung Sian Khan	D.G.M(Planning)
U Than Htun Aung	D.G.M(Inspection)
U Maung Maung Thwin	D.G.M(Civil)
U Win Naing	D.G.M(Mechanical)
U Nyi Nyi Swe	D.G.M(Commercial)
U Aung Myint	D.G.M(Electrical)
U Han Nyunt	A.G.M(Signaling)
U Kyaw Soe Lin	Manager(Operating)
U Phyo Htet Kyaw	Manager(IR)
U Than Htun Aung	Assistance Manager
Mr. M.Higashi	Advisor

3.2 Japan side

JICA Myanmar Office	Mr. A.Sanjyo (Senior Representative)
JICA Expert Team	Dr. S.Kuroda(Leader:Track maintenance),
	Mr. N.Matsuo(Sub-leader:Maintenance planning),
	Mr. H.Komatsu(Operation maintenance)
	Mr. S.Morihara(Operation)
	Mr. R. Mitani(Signal&telecom),
	Mr. M.Ishikawa(Rolling Stock)
	Mr. M. Takami(Coordinator)
Observer	Sumitomo Corporation Asia & Oceania Pte, Ltd.
	Mr.Y.Taniguchi (Nay Pay Taw Office)
	U Tun Tun Kyaw
	Ms. M.Saito (JICA Trainee)
Interpreter	Sonny

4.SUBJECT Explanation and discussion of Progress Report for 5th JCC

5.HANDOUTS (1)Project Progress Report(ppt digest)

(2) Project Progress Report(file)

(3)Appendix-1 Revised Report of Proposals of Recommendation on Technical Standards of MR and Short-,Medium-, and Long-term Railway Facilities Improvement Plan

2 Summary of Discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, and Long-term Railway Facilities Improvement Plan.

3 Workshop Report of the Institutional Management Improvement Course in Japan

6 Opening Speech by Chairman U Saw Valentine

The Project is the first technical corporation by JICA for MR, and about one year has passed since the technology transfer of track maintenance started in October, 2013 in the Pilot Section located between Yangon and Bago. Up to now, four JCCs have been held, and we are now holding 5th JCC.

JICA has provided MR with trainings in Japan 3 times. Technology transfer of track maintenance has been executed with the use of modern maintenance equipment/ tools, and it has contributed to improvement of track maintenance technology of MR.

MR appreciates very much for the cooperation of JICA and JICA experts for improving safety and service level of MR

MR would like to cooperate as much as possible for effective implementation of the Project.

7 Presentation of Progress Report by JICA Expert Team (Leader S.Kuroda & Deputy Leader N.Matsuo)

8 Discussion by all JCC members

(1) MR

- We would like to request for JICA Expert Team to make various advices to MR on what is necessary for MR based on the recognition of the current situation of MR.
- In the last JCC, we requested the training for track maintenance, bridge maintenance and rail welding. This time we would like to request JICA to consider the cooperation with respect to the following items.

① Training for rolling stock maintenance, how to install sanitation system in coaches, training for DMU and DEMU maintenance.
② Training of maintenance of signaling
③ Train protection system at level crossing
④ Training facilities of CITC and RTTC
⑤
   a Training of track maintenance by use of large sized maintenance machines
   b Advice on the procedure of outsourcing the track maintenance work
   c Updating the track maintenance manual based on the current situation of MR
   d Continued training for track maintenance of Yangon – Mandalay line and Yangon Circular line.
   e Training of maintenance of bridge (upper structure and sub structure)
   f Training for rail welding
⑥ Training for new systems (OCC, ATS etc), and training for modernized train protection system at level crossing
⑦ Advice for planning an appropriate railway network connecting Yangon ports, Thilawa Special Economic Zone, Dry Port

(2) JICA

We know that 6 items for cooperation were requested by the letter dated Oct, 16, 2014. These requests are now under examination by JICA. Today, further, there were many requests which belong to the category of technical cooperation and also to other categories.

Kindly provide JICA with a letter in which the requests should be described, and the requests should be limited to the ones belonging only to the category of technical cooperation, but excluding such requests as construction of buildings, provision of large sized machines/ equipment ; and then put the order of priority on the requests. Also please exclude such requests as could be implemented under the on-going Project.

Kindly provide us with the letter as soon as possible.

(3) MR

The request for provision of equipment necessary for improving RTTC and CITC should be kindly considered. MR would issue the letter.

S.K.

(4) JICA

We are waiting for receiving the letter.

JCCs have already been held 5 times during this one year and half. There are no other projects such as this Project for which JCCs are held with such frequency. It means that MR officials are very earnest in implementing this Project. JICA would like to pay his respect to the earnestness of MR.

(5) MR

It is important to teach the public how to make use of railway facilities and trains safety and properly. Kindly provide MR with advices on how to educate the public on this matter based on the Japanese experience.

(6) JICA Expert Team

JICA's Grant AID Project Team gives the following aid for signaling & telecommunications in MR.

① Concentrated Electronic Interlocking device for Yangon and Pazundaung stations

② Centralized Train Monitoring System for Yangon – Pyuntaza sections

③ Automated level crossing alarm facilities for Kyan Sit Thar Level Crossing.

Related with this aid, we think we can meet needs of MR to some extent through work of soft component. However we cannot afford to revise the current technical standards.

(7) MR

Modernized signaling system is going to be introduced in the section between Yangon and Mandalay. Kindly give an advice to us about the maintenance organization chart.

(8) JICA Expert Team

Strengthening the organization to cope with electrifying and modernizing the signal and telecommunication facilities was experienced lastly more than 40 years ago in Japan. With respect to an appropriate organization for MR case, we would like to make suitable advices based on Japanese experiences after receiving the questionnaire.

(9) JICA Expert Team

At the beginning, technology transfer of track maintenance started for 30 trainees in the Pilot Section of 20km located in the section between Yangon and Bago. At present, accumulated number of trainees amounts to 300, and the various situations relating to

S.K.

technology transfer have been changed. Further, in order to implement the training efficiently, trainings are sometimes repeated in the same place, and also on Dagon line.

In this regard, we would like to consult with MR about various matters including the suitable change of the length of the Pilot Section.

We are planning to give trainings of track maintenance on two railway steel bridges. The joints of rail are very bad. The current MR rail welding technology should be improved for producing long welded rail.

We would like to consider how to give training on rail welding while we are giving training of rail replacement. We are also considering to provide advice on improvement of rail fastening devices. Further we would like to plan to add the training for improvement of level crossing and rail grinding to the current trainings. Up to this March, the above trainings will be suitably considered. Also we would like to plan to give trainings including training for improvement of weak roadbed, with due consideration on selecting the training locations not only in the Pilot Section but also on the Circular line, Dagon line, Thilawa line etc.

7 Closing Speech by Chairman

In this JCC, the progress of the Project has been reported, and various useful proposals and discussions have been presented aiming at the effective implementation of the Project. I appreciate all the JCC members for their earnest discussions.

MR would continue the cooperation with the effective implementation of the Project as much as possible. MR would like to express the appreciation for the effort of JICA and JICA Expert Team to improve the safety and service level of MR.

December 24th, 2014 Nay Pyi Taw

U Thurein Win
Managing Director
Myanma Railways

Dr. S.Kuroda
Leader of JICA Expert Team

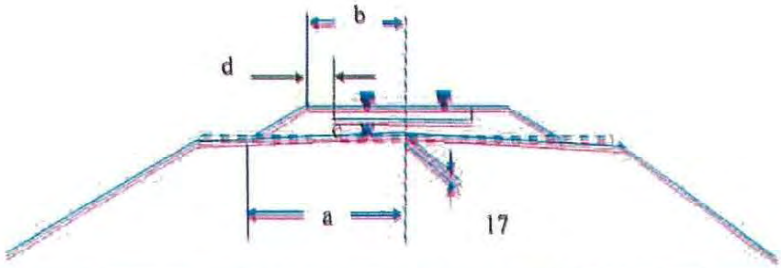
Appendix 8-1 Additional Questions by MR and Answers by JICA Expert relating to the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, Long-term Railway Facilities Improvement Plan

Q1
What is the specification of ballast thickness and volume related to the train speed?

The specification of JR East about ballast thickness and volume related to the train speed is given as follows.

Standard Track Cross Sections and Ballast Shapes (meter gauge) are given below for single track line and double track line. Ballast volume can be calculated based on the standard ballast shape.

(1) Single track line

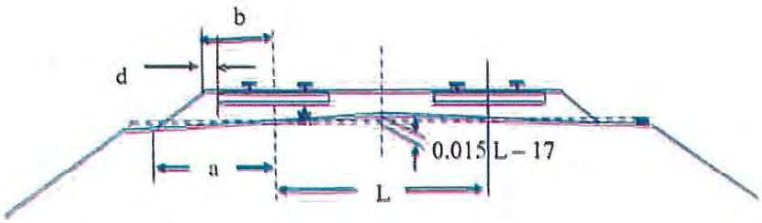


(unit: mm)

Design Train Maximum Speed	Kind of Sleeper	Distance between the center of the track and toe of the ballast slope (a)	Distance between the center of the track and ballast shoulder (b)	Thickness of ballast (c)	Width of shoulder ballast	Remark
>110km/h	PC	≧2240	1400	≧250	400	Width means horizontal distance
	Wood	≧2240	1450	≧250	400	
110≧ >90km/h	PC	≧2240	1400	≧250	400	
	Wood	≧2240	1450	≧250	400	
90 ≧ >70km/h	Wood	≧2080	1400	≧200	350	
	PC	≧2080	1350	≧200	350	
≦70km/h	Wood	≧2080	1400	≧200	350	
≦70km/h for particularly simple line	Wood	≧1970	1400	≧150	350	

(note) 1. In the curve section, shape should be enlarged according to cant amount.
2. For the important sidings, ballast shape corresponding to maximum train speed less than 70km/h should be applied.
For the ordinary sidings, shape for the particularly simple line with the maximum speed less than 70km/h should be applied.
3. Sleeper length 2100mm (wood)
2000mm (PC)

(2) Double track line (meter gauge)



(unit: mm)

Design Train Maximum Speed	Kind of Sleeper	Distance between the center of the track and toe of the ballast slope (a)	Distance between the center of the track and ballast shoulder (b)	Thickness of ballast (c)	Width of shoulder ballast	Remark
>110km/h	PC	≧2310	1400	≧250	400	Width means horizontal distance
	Wood	≧2310	1450	≧250	400	
110≧ >90km/h	PC	≧2310	1400	≧250	400	
	Wood	≧2310	1450	≧250	400	
90 ≧ >70km/h	Wood	≧2140	1400	≧200	350	
	PC	≧2140	1350	≧200	350	
≦70km/h	Wood	≧2140	1400	≧200	350	
≦70km/h for particularly simple line	Wood	≧2040	1400	≧150	350	

(note)
1. In the curve section, shape should be enlarged according to cant amount.
2. For the important sidings, ballast shape corresponding to maximum train speed less than 70km/h should be applied.
   For the ordinary sidings, shape for the particularly simple line with the maximum speed less than 70km/h should be applied.
3. Sleeper length 2100mm (wood)
   2000mm (PC)
4. L ≧ rolling stock gauge + 600mm
   In JR, generally L = 3800mm (can be reduced to 3600mm in inevitable case)

Q2
What is the bearing capacity of road bed consideration for track?

CBR (California Bearing Ratio) based on AASHO (American Association of State Highway Officials) is generally used in the world as a regulation of road bed.

In Japanese Railway, K-value is used as a regulation of road bed instead of CBR.

This is because CBR test is so large scaled that the possible numbers of times of execution of the test per day are limited and big reaction is needed on site. (But Japanese road engineers is often use CBR)

So we write down about K-value as bearing capacity of road bed.

(1)Construction of road bed

①The weather condition of the area must be considered and the semiarid season must be chosen.

②Materials must be mixed enough not to be partial and be used with uniformity.

③Thickness of placing and spreading is set at about 15cm per one layer.

④Compacting must be continued till getting required density. Compacting of road bed must be executed under the range of proper water content which can be obtained by soil test.

⑤Road bed at the part to be connected with structure and the shoulder of a road bed must be constructed with required degree of compaction for each layer of placed and spread material.

⑥Placed and spread materials must be compacted quickly so that the proper water content does not change by raining. As a rule, compacting of placed and spread materials and preparation of gradient of drainage must be completed within a day.

⑦Surface of road bed needs 3% gradient of drainage.

⑧Drainage must be constructed within one layer. After compacting equally, the compacted surface must be finished flatly.

(2)Compacting of road bed

①Supervision Value

・K value which can get from K30 value of plate loading test or K30 value of FWD (Falling Weight Deflectometer) must be over 110MN/m3.

・Degree of compaction must be over 95%.

(3)Report of construction about road bed must include the followings.

①Various test result of road bed material, Quality certification

②Compaction test result of surface of road bed

③Inspection report of finished condition

④Elution test result of hexavalent chromium

Appendix 8-1-3

⑤Photo of inspection circumstance

⑥Photo of Compaction Test

(ref)

What is FWD ?

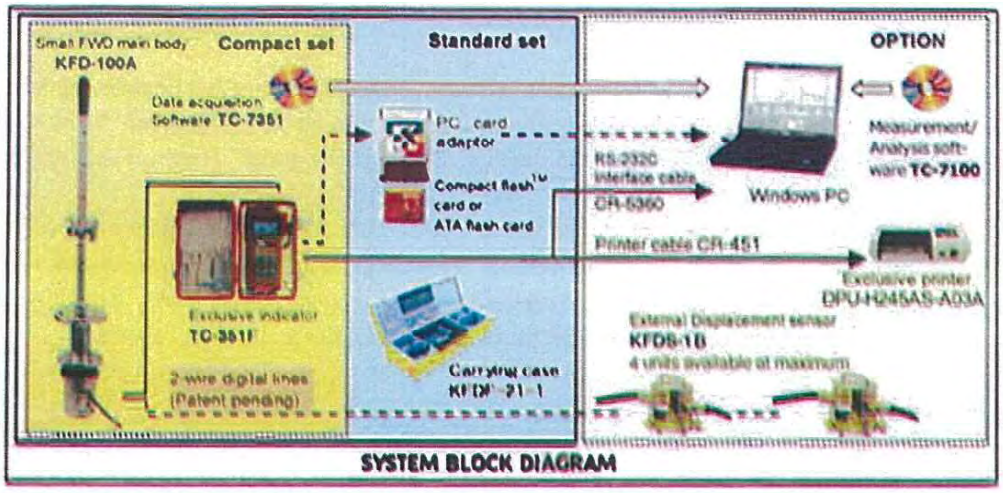
TML Small Falling Weight Deflectometer System FWD-Light

TML small FWD · Falling Weight Deflectometer · FWD-Light® is used for field users because of excellent portability and of enabling simple and quick measurement of coefficient of subgrade reaction and modulus of subgrade elasticity.

OUTLINE OF SYSTEM

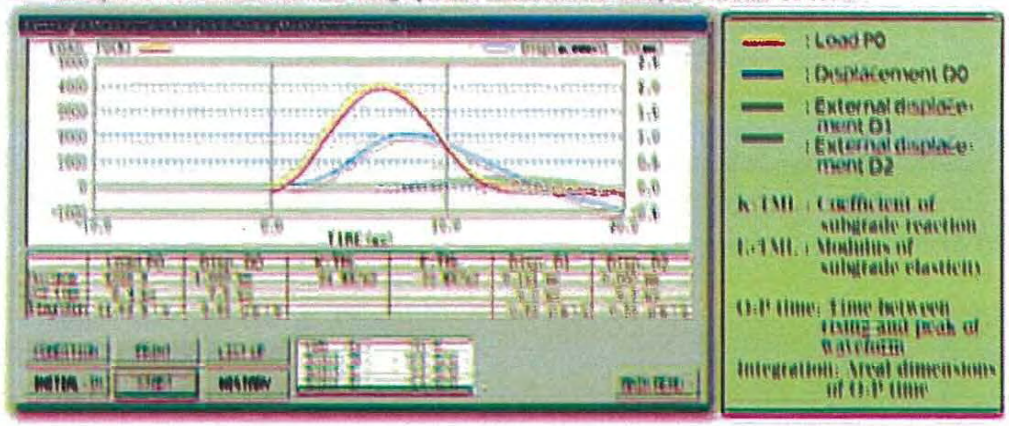
FWD (Falling Weight Deflectometer) is used for estimating construction of pavement or rigidity of subgrade. Also, plate loading test is used for estimating characteristics of subgrade. However, these methods require much time and works for their preparation, data acquisition and analysis. TML small FWD System "FWD-Light" features excellent portability and enables simple and quick measurement of coefficient of subgrade reaction which is called K value and modulus of subgrade elasticity which is called E value. FWD-Light consists of main body KFD-100A and indicator TC-951F. The main body includes load cell and acceleration transducer whose measuring ranges are 20kN of load and 2.5mm of displacement at maximum. Values of maximum load and displacement, and analysis results of K value and E value are indicated on the indicator. Each analysis result can be stored in memory card and printed by exclusive printer. Data stored in memory card can be transferred to a personal computer by directly connecting the card or via the indicator. Measurement and processing software TC-7100 is available as an optional item for indicating waveforms of load, acceleration, velocity and displacement, O-P time and time product using personal computer.

System Diagrams



SYSTEM BLOCK DIAGRAM

■ Example of waveform indication using optional Measurement/Analysis Software TC-7100



OUTLINE OF OPERATION

In this system, weight of main body of Small FWD is made to fall freely, and shock load and displacement by the falling are measured by load cell and acceleration transducer. Displacement is obtained by integrating the acceleration twice. Measurement of external displacement of 4 points at maximum is available by combining external displacement sensor KFDS-1B. TML's original process (patent pending) is employed for integraing acceleration data to obtain displacement with high accuracy and good stability. Outputs of load cell and acceleration transducer are digitized by internal A/D converter of Small FWD main body and transmitted to indicator utilizing TML's original 2-wire network technique (patent pending). The indicator indicates results of analyses and also saves them into memory card. Measurement/Analysis software (TC-7100) is required for measurement system with personal computer. In this system, data indicated on the indicator are transferred to the computer through the indicator without modification. Personal computer displays waveforms of load and displacement and also processes each analysis.

Q3
What are the processes of repairing in damaged steel girders?

I already answer the summary of that in my last lecture "Maintenance Work for Civil Engineering Structure –Steel Bridge-"on 17th December, 2014. On the last lecture, I was asked an additional question "How should railway engineer consider the train speed restriction due to situation of rusted deck girder." Hereby, I answer that as below.

The way to consider the speed restriction due to rusted Deck Girder (DG), one example in Japanese railway, is named "Stress Ratio method (SR)". Using the method, comparing the present proof stress and limit stress for maintaining the required performance of girder basically, it can evaluate proof stress, durability and running stability reasonably. The calculation example of SR for rusted Deck Girder is shown as follows.

【Calculation Example】

(1) General Information of girder and result of individual inspection (refer to Fig.3.1)

A) Deterioration of bearing : None
B) Shaped hole by corrosion on end of girder : None
C) Shaped hole by corrosion on web member : None
D) Shaped hole by corrosion on upper flange and main member : 5mm average thickness
E) Shaped hole by corrosion on lower flange : 10mm average thickness

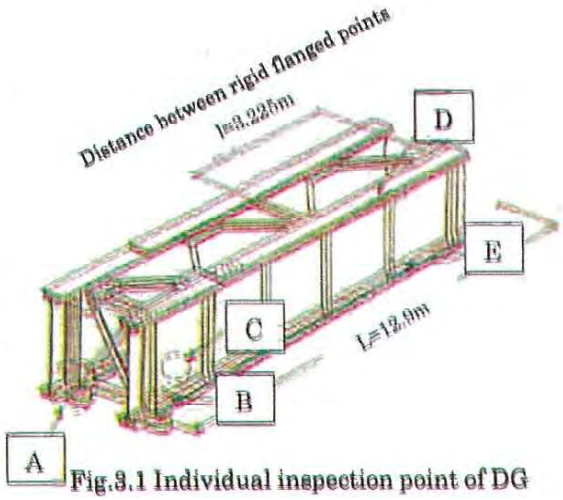


Fig.3.1 Individual inspection point of DG

(2) Live load conditions

- Type of heaviest rolling stock loaded on the bridge : EF64
- Train speed : 110km/h
- Capacity (track grade) : over 20 million tonnage

(3) Study member and items

- Members to be judged soundness : main girder, floor or cross beam, stringer
- Detail survey point : end of cover plate, remarkable shaped hole by corrosion, the place with shaped hole by corrosion on floor or cross beam and stringer, and joint of them
- Assuming condition for this case: none shaped hole by corrosion on end of cover plate, remarkable shaped hole by corrosion around the center of effective span that their thickness are 5mm on upper flange and 10mm on lower flange, no shaped hole by corrosion on the end of girder.

Due to the above results, it should be studied for SR only on the center of span of girder.

(4) Calculation procedure of SR

Refer to Fig3.2, SR is calculated based on it.

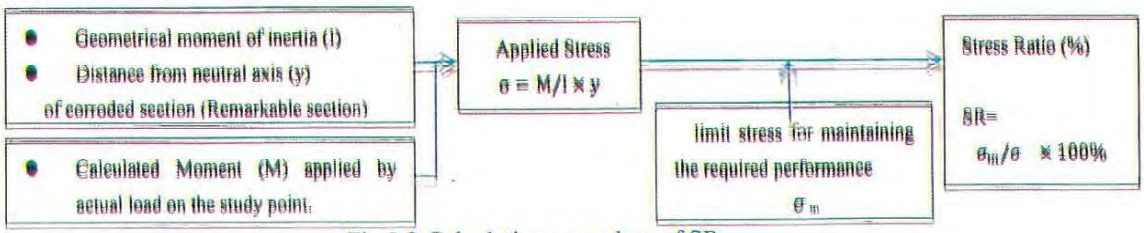
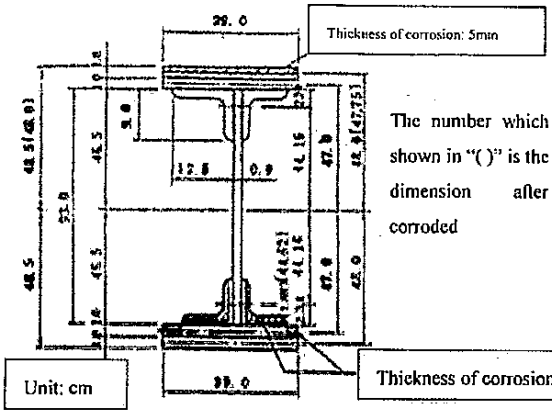


Fig.3.2 Calculation procedure of SR

(5) Calculation of Geometrical moment of inertia and distance from neutral axis of remarkable corroded section.

Geometrical moment of inertia and distance from neutral axis of remarkable corroded section should be calculated based on Fig.3.3



Constructional member	A (cm²)	Y (cm)	A · Y (cm³)	A · Y² (cm⁴)
1 ~ PL 290× 5	14.5	47.75	692	33051
1 ~ PL 290×10	29.0	47.0	1363	64061
2 ~ L 125×90×13	52.5	44.16	2318	102383
1 ~ PL 930× 9	83.7	—	—	60327
2 ~ L 125×90× 3	12.1	−44.62	540	24090
1 ~ PL 290× 10	25.9	−47.0	1217	57213
1 ~ PL 290× 10	29.0	−48.0	1392	66816
TOTAL	246.7			407949

Fig.3.3 Corroded Section

Gap of neutral axis: $\delta = 1224/246.7 = 4.96$ $\quad -A\,\delta^2 = -6069$

Therefore, Geometrical moment of inertia is: $I_n = 401880 \fallingdotseq 401900 cm^4$

Distance from neutral axis is: $y_{upper} = 93/2 + 1.5 - 4.96 = 43.04 cm$

: $y_{lower} = 93/2 + 2.0 - 4.96 = 53.46 cm$

*corroded thickness is converted per original section

(6) Calculation of bending moment

① Bending moment applied by dead load, per 1 rail: M_d

Self-weight 8.4t/ 12.9m/ 2rail ≒ 0.326 t/m

Track-weight 0.225 t/m

Foot-path 0.15 t/m

Since, dead load is W = 0.701t/m

Therefore,

$$M_d = {}^1/_8 W \times l^2 = {}^1/_8 \times 0.701 \times 12.9^2 \fallingdotseq 14.6(t \cdot m)$$

② Bending moment applied by live load, Ks-18: M_l

Bending moment applied by KS-18, refer to table-3.1.

$$M_{18} = 95.21 + (101.8 - 95.21) \times 4/5 = 100.48 \text{t} \cdot \text{m}$$

The equivalent value to live load KS series for the train set which EF68 pulls on the span length 12.9m: 11.7 t

*

Therefore,

$$M_l = M_{18} \times {}^{11.7}/_{18} = 100.48 \times {}^{11.7}/_{18} \fallingdotseq 65.3(t \cdot m)$$

③ Bending moment applied by impact load, allowable passage train speed : 110km/h : M_i

$$\text{Impact coefficient: i} = \frac{K_a \cdot V}{500 \cdot L^{0.2}} + \frac{10}{65 + L}$$

Appendix 8-1-7

Here, K_a=1.0(for shinkansen), 2.0(for conventional train)

$$i = \frac{2 \cdot 110}{500 \cdot (12.9)^{0.2}} + \frac{10}{65 + 12.9} = 0.392$$

Therefore,

$M_i = M_l \cdot i = 65.3 \cdot 0.392 \fallingdotseq 25.6$

Conclusionary, the total of bending moment is:

$M = Md + Ml + Mi = 14.6 + 65.3 + 25.6 = 105.5(t \cdot m)$

(7) Calculation of applied stress

Compressive stress: $\sigma_c = \frac{M}{I} y_u = \frac{105.5 \times 10^5}{401900} \times 43.03 = 1130 kg/cm^2$

Tensile stress: $\sigma_t = \frac{M}{I} y_l = \frac{105.5 \times 10^5}{401900} \times 53.46 = 1403 kg/cm^2$

Considering the two rivet sections to be subtracted from σ_t

$\sigma_t = \sigma_t \times \frac{A_{fe}}{A_{fe} - A_r} = 1403 \times \frac{67.0}{(67.0 - 2 \times 2.5 \times 2.3)} = 1693 kg/cm^2$

Here, Afe: Girder section which were considered corroded flange

Ar: Rivet section to be subtracted from girder section

(8) Calculation of limit stress for maintaining the required performance

Tonnage: over 20 million tonnage

Effective span: $10 \leqq L < 20$

Material type: SS41 *Bridges, constructed before 1950 in Japan, is made of SS41 mainly. And this bridge was constructed before 1950

① Tensile part

Refer to table 3.2, $\sigma_{mt} = 1500 kg/cm^2$

② Compressive part

Refer to table 3.3,

$l / b = Distance\ between\ rigid\ flanged\ points / Upper\ flange\ width = 3225/290 = 11.1$

Therefore, $\sigma_{mc} = 1380 - 0.7(11.1)^2 = 1294 kg/cm^2$

(9) Calculation of SR

Tensile $SR = \sigma_{mt}/\sigma_t \times 100 = (1500/1693) \times 100\% = 89\%$

Compressive $SR = \sigma_{mc}/\sigma_c \times 100 = (1294/1130) \times 100\% = 115\%$

Therefore, this bridge's stress ratio is 89%

(10) Deflection

- Calculation for deflection

In the case of section with "cover plate":

$$\delta = \frac{5.5 M L^2}{48 EI} = \frac{5.5 \times 90.9 \times 10.5 \times 1290^2}{48 \times 2.1 \times 10^6 \times 401900} \fallingdotseq 2.1\ (cm)$$

- Converted deflection by actual measurement

Bending moment applied by design live load, KS-18: M_{18}= 100.5 (1+0.392) ≒140.0t·m

Bending moment applied by EF64:$M_s = M_{18} \times {}^{11.7}/_{18} = 140.0 \times {}^{11.7}/_{18} \fallingdotseq 90.9(t \cdot m)$

Deflection by actual measurement: $\delta_s = 15\ mm$

Appendix 8-1-8

Therefore

$$Converted\ deflection = M_{18}/M_s \times \delta_s = {}^{140.0}/_{90.9} \times 15 = 2.3(cm)$$

From the above, assuming in the case of KS-H type rolling stock passage, it can be thought that 2.1cm deflection would occur according to calculations, but regarding to the actual measurement of it, in the case of KS-H type rolling stock passage, 2.3 cm deflection would occur. Therefore, it can be thought that the stiffness of this bridge had already degraded.

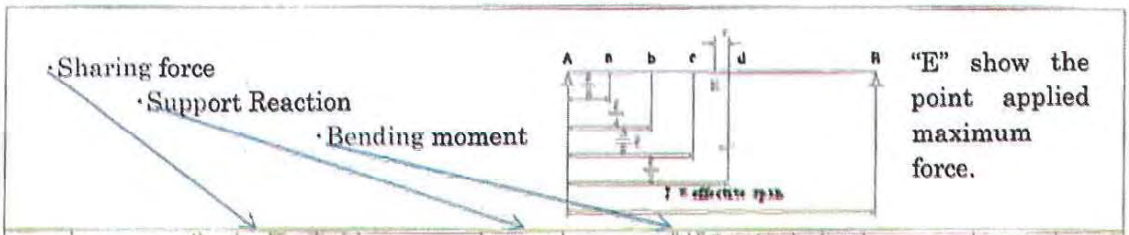
(11) Judgment of SR

SR≤100% : AA,

100≤SR≤120%:A1 or A2

For Myanma Railways, the study of train speed improvement should be done as above. If the SR≤120, review input data V, the train speed, and should try to calculate again until the SR would be over 120%. The train speed which SR would be over 120% is the suitable restriction speed for the bridge. And if SR never be over 120%, it should be considered the strength work for the bridge.

Table3.1. List of Sharing force, Support Reaction, Bending moment applied by live load KS-18 on 1 rail



l (m)	剪力 (t)					反力 (t)	曲げモーメント (t·m)					e (m)	l (m)
	S_A	S_a	S_b	S_c	S_d		M_a	M_b	M_c	M_d	M_e		
1.0	11.00	9.625	8.250	6.875	5.500	11.00	1.203	2.003	2.528	2.750	2.750	0	1.0
1.5	11.00	9.625	8.250	6.875	5.500	11.00	1.805	3.004	3.867	4.125	4.125	0	1.5
2.0	11.25	9.625	8.250	6.875	5.500	13.50	2.406	4.125	5.156	5.500	5.500	0	2.0
2.5	13.20	10.45	8.250	6.875	5.500	16.20	3.266	5.166	6.445	6.875	6.875	0	2.5
3.0	14.67	11.92	9.167	6.875	5.500	18.00	4.469	6.875	7.734	8.250	8.250	0	3.0
3.5	15.71	12.96	10.21	7.464	5.500	20.57	5.672	8.038	9.797	10.18	10.18	0	3.5
4.0	16.55	13.75	11.00	8.250	6.875	22.61	6.875	11.00	12.38	13.50	13.50	0	4.0
4.5	18.00	14.83	11.61	8.861	6.111	24.60	8.297	13.06	14.98	16.68	16.68	0	4.5
5.0	19.60	16.03	12.15	9.350	6.600	26.19	9.763	15.19	18.56	20.25	20.25	0	5.0
5.5	21.37	16.72	12.80	9.760	7.000	27.68	11.63	17.72	22.78	23.63	23.63	0	5.5
6.0	22.50	18.00	13.50	10.13	7.383	29.86	13.50	20.25	27.00	27.84	27.84	0.375	6.0
6.5	23.54	19.04	14.54	10.64	7.516	31.32	15.47	23.63	31.22	31.50	31.50	0.375	6.5
7.0	24.49	19.93	15.43	11.09	7.857	32.83	17.44	27.00	35.44	35.16	35.16	0.375	7.0
7.5	25.36	20.70	16.30	11.61	8.007	34.14	19.41	30.63	39.66	40.50	41.18	0.375	7.5
8.0	26.49	21.43	16.88	12.15	8.550	35.81	21.40	34.43	45.22	45.63	46.85	0.375	8.0
8.5	27.39	22.36	17.47	12.63	8.413	37.50	23.66	38.22	48.02	50.34	50.36	0.117	8.5
9.0	28.40	23.00	18.00	13.03	8.906	39.00	25.80	42.08	52.69	55.30	55.41	0.117	9.0
9.5	29.43	24.08	18.58	13.43	9.084	40.75	27.90	46.01	57.44	60.41	60.47	0.117	9.5
10.0	30.30	24.90	19.17	13.79	9.500	42.57	30.10	50.40	62.18	66.45	66.53	0.117	10.0
10.5	31.20	25.20	19.70	14.17	9.663	43.19	32.08	54.90	67.01	70.65	70.66	0.291	10.5
11.0	32.04	26.06	20.16	14.53	9.886	44.70	34.40	59.40	72.46	76.13	76.46	0.291	11.0
11.5	32.86	26.86	20.84	14.91	9.946	47.33	36.90	63.90	77.91	80.09	82.50	0.291	11.5
12.0	33.60	27.60	21.60	15.11	9.600	48.96	39.60	68.40	84.04	88.65	88.66	0.117	12.0
12.5	34.40	28.40	22.32	16.40	10.15	50.60	42.30	73.35	90.10	95.21	95.24	0.117	12.5
13.0	35.03	29.14	23.14	16.84	10.35	52.16	45.00	78.30	96.34	101.8	101.8	0.117	13.0
13.5	35.83	29.83	23.83	16.19	10.55	53.83	47.80	83.25	102.6	108.4	108.4	0.117	13.5
14.0	36.78	30.36	24.36	16.48	10.74	55.26	50.85	88.20	108.8	114.9	114.9	0.117	14.0
14.5	36.63	31.03	25.03	16.90	10.93	56.99	53.85	93.15	115.0	121.5	121.5	0.351	14.5
15.0	37.47	31.71	25.71	17.37	11.10	58.47	56.80	98.10	121.3	128.0	128.0	0.351	15.0
15.5	38.30	32.34	26.34	17.80	11.33	60.16	59.79	103.5	127.5	134.8	134.8	0.351	15.5
16.0	39.13	33.08	27.00	18.23	11.46	61.80	62.78	108.9	133.8	141.5	141.5	0.351	16.0
16.5	39.96	33.71	27.71	18.67	11.63	63.47	65.78	114.3	140.0	148.2	148.2	0.351	16.5
17.0	40.71	34.46	28.46	19.08	11.70	64.96	68.85	119.7	146.3	154.9	154.9	0.351	17.0
17.5	41.56	35.06	29.06	19.56	12.06	66.68	71.85	125.1	152.5	161.6	161.6	0.351	17.5
18.0	42.38	35.88	29.88	19.98	12.08	68.26	74.85	130.5	158.8	168.3	168.3	0.351	18.0
18.5	43.10	36.60	30.60	20.40	12.20	69.80	77.85	135.9	165.0	175.0	175.0	0.351	18.5
19.0	43.93	37.43	31.43	20.93	12.43	71.36	80.85	141.3	171.3	181.7	181.7	0.351	19.0
19.5	44.76	38.26	32.26	21.76	13.26	72.93	83.85	146.7	177.5	188.4	188.4	0.351	19.5
20.0	45.60	39.10	33.10	22.60	14.10	74.50	86.85	152.1	183.8	195.1	195.1	0.351	20.0
20.5	46.43	39.93	33.93	23.43	14.93	76.07	89.85	157.5	190.0	201.8	201.8	0.351	20.5
21.0	47.26	40.76	34.76	24.26	15.76	77.64	92.85	162.9	196.3	208.5	208.5	0.351	21.0
21.5	48.10	41.60	35.60	25.10	16.60	79.21	95.85	168.3	202.5	215.2	215.2	0.351	21.5
22.0	48.93	42.43	36.43	25.93	17.43	80.78	98.85	173.7	208.8	221.9	221.9	0.351	22.0
22.5	49.76	43.26	37.26	26.76	18.26	82.35	101.8	179.1	215.0	228.6	228.6	0.351	22.5
23.0	50.60	44.10	38.10	27.60	19.10	83.92	104.8	184.5	221.3	235.3	235.3	0.351	23.0
23.5	51.43	44.93	38.93	28.43	19.93	85.49	107.8	189.9	227.5	242.0	242.0	0.351	23.5
24.0	52.26	45.76	39.76	29.26	20.76	87.06	110.8	195.3	233.8	248.7	248.7	0.351	24.0
24.5	53.10	46.60	40.60	30.10	21.60	88.63	113.8	200.7	240.0	255.4	255.4	0.351	24.5
25.0	53.93	47.43	41.43	30.93	22.43	90.20	116.8	206.1	246.3	262.1	262.1	0.351	25.0
25.5	54.76	48.26	42.26	31.76	23.26	91.77	119.8	211.5	252.5	268.8	268.8	0.351	25.5
26.0	55.60	49.10	43.10	32.60	24.10	93.34	122.8	216.9	258.8	275.5	275.5	0.351	26.0
26.5	56.43	49.93	43.93	33.43	24.93	94.91	125.8	222.3	265.0	282.2	282.2	0.351	26.5
27.0	57.26	50.76	44.76	34.26	25.76	96.48	128.8	227.7	271.3	288.9	288.9	0.351	27.0
27.5	58.10	51.60	45.60	35.10	26.60	98.05	131.8	233.1	277.5	295.6	295.6	0.351	27.5
28.0	58.93	52.43	46.43	35.93	27.43	99.62	134.8	238.5	283.8	302.3	302.3	0.351	28.0
28.5	59.76	53.26	47.26	36.76	28.26	101.2	137.8	243.9	290.0	309.0	309.0	0.351	28.5
29.0	60.60	54.10	48.10	37.60	29.10	102.8	140.8	249.3	296.3	315.7	315.7	0.351	29.0
29.5	61.43	54.93	48.93	38.43	29.93	104.3	143.8	254.7	302.5	322.4	322.4	0.351	29.5
30.0	62.26	55.76	49.76	39.26	30.76	105.9	146.8	260.1	308.8	329.1	329.1	0.351	30.0

Table3.2. Limit tensile stress for maintaining the required performance SS41 (in Japan)

Tonnage	Effective span length(m)	Constructed from 1929 to1950	
		Ordinary passage	Temporary passage
20 million ton or above	<10	1500	1760
	10≦L<20	1500	1760
	≧20	1700	1760
From 10 million ton or above to less than 20 million ton	<10	1760	1760
	10≦L<20	1760	1760
	≧20	1760	1760
Less than 10 million ton	<10	1760	1760
	10≦L<20	1760	1760
	≧20	1760	1760

Table3.3. Limit compressive stress for maintaining the required performance SS41 (in Japan)

Rivet type		SV34	
Compressive stress applied on all section	Axial stress	● When: $0< l/r \leqq 110$ $1380-0.065(l/r)^2$ ● When :$l/r > 110$ $7200000(r/l)^2$	①
	Bending	● When: $l/b \leqq 30$ $1380-0.7(l/b)^2$ ● When buckle plate existing on the edge of compressive side or the section shape of web is double, using following formula. $1380-0.4(l/b)^2$	②

*Regarding to ①, l (cm): frame length of member, r(cm) : radius of gyration of all section. But, in the consideration of buckling occurred on the plane of structure of web member which jointed with rivet, l should be 0.9 time as long as actual frame length of member

*Regarding to ②, l (cm): Distance between rigid flanged points, b(cm): Width of frange

*Regarding to girder made of wrought iron or Bessemer steel, it can be applied this table as a rivet girder, but the maximum value must be 1050kg/cm^2

Q4
What are the processes of repairing brick piers?

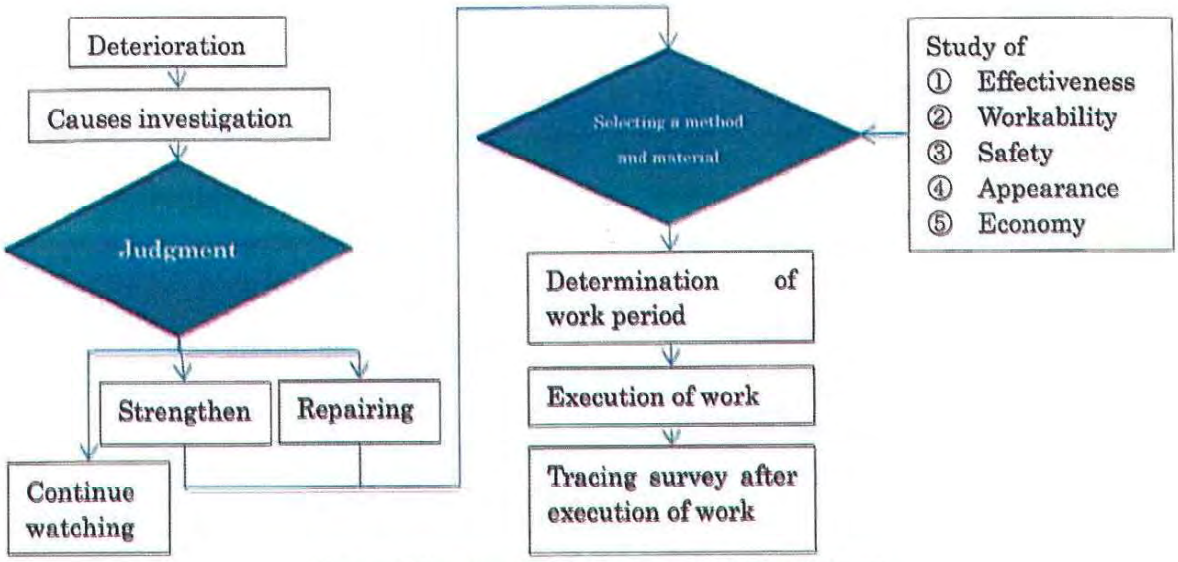
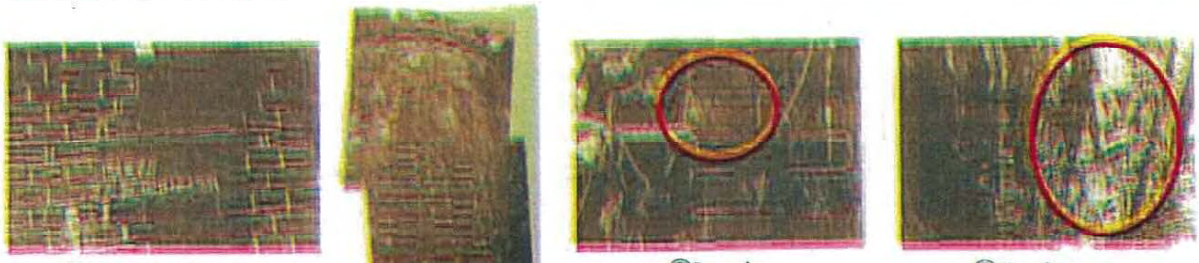


Fig4.1. Major processes of repairing brick piers in Japan

(1) Deteriorations of brick piers
① Horizontal masonry joints breakage
② Vertical masonry joints breakage and vertical crack
③ Swelling, Loosing
④ Chipping, Peering out



①Horizontal masonry joints breakage

②Vertical crack

③Loosing

④Peering out

Fig4.2. Major deteriorations of brick pier

(2) Causes of deterioration
① Aging material degradation
② Wooden foundation rotting
③ Degradation by repetition of live load (fatigue)
④ Train load (live load) increasing, load characteristics changing
⑤ Plants growth

(3) Selecting of work method
① Effectiveness
It should be studied whether repairing work or strength work is effective, proof stress and

durability of pier by the deterioration degree.

② Workability

It should be studied working condition and environment, consultation with road or river administrative office, effect for train operation and other structure and so on, by required performance, surrounding environment, condition for execution of work.

③ Safety

Before execution of work, it should be studied possibility of existence of underground facilities, falling objects to an urban area.

④ Appearance

It should be studied the coordination with surrounding environment, relevance with existing structure.

⑤ Economy

It should be studied the method that carry out the most effectiveness with minimum cost.

(4) Work period

Work period should be selected, except the emergency case, after the sufficient study for kind of deterioration, importance of structure, working method, material for work, environmental conditions, and then executing in the suitable period.

(5) Tracing survey after execution of work

Tracing survey should be done to check the working effectiveness for a time.

(6) Repairing work

① Zonal steel plate wrapping method

This method is to protect missing bricks, stones and bed stones by wrapping zonal steel plate, their width is 10-20cm and their thickness is 5-10mm, horizontally(shown in Fig4.3.). It is major that installing steel plate to pier with gap 10-20mm by bolting, and then injecting non compacting mortar.

And, in the time of fixing bolt into pier, mortar anchor should be used standardly. Steel plate and installing bolt head should be painted for anti-rust.

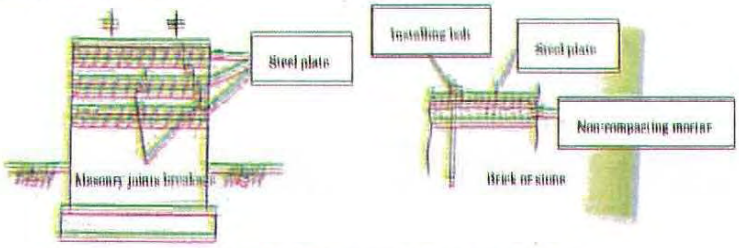


Fig4.3. Zonal steel plate wrapping method

② Replacing by concreating

This method is breaking down the part of pier which had been deteriorated remarkably, such as cracks on brick and stone, then concreating thereon (shown in Fig4.4.). In this method, it is general to measure against the sliding occurred between exist pier and new concreate, such as inserting steel bar for resist horizontal force.

Design standard strength of concreating(σ_{ck}) should be approximately 240kg/cm^2, and supplying water into original face before concreting for prevent missing water from concrete.

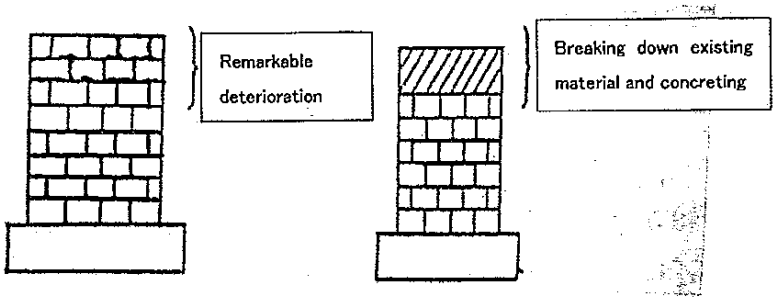


Fig4.4. Replacing by concreating

③ Partial repairing

In the case that horizontal masonry joint breakage occurred only in a limited area of pier and others are in good soundness, it should be better partial repairing (shown in Fig4.5.). When the progress of joint breakage and slipping stone had stopped, spraying concrete would be one of repairing method.

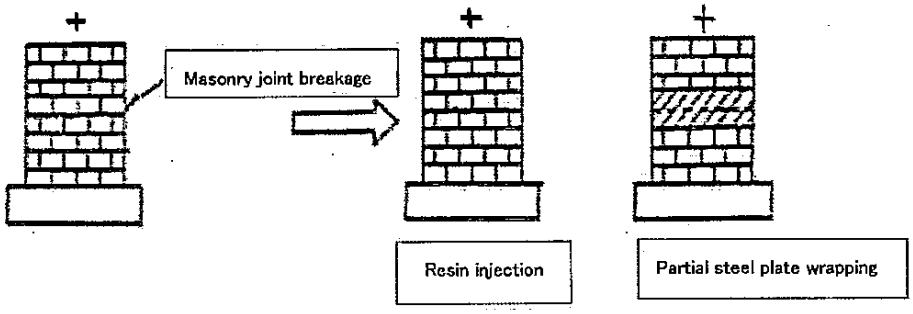


Fig4.5. Partial repairing

(7) Strengthen work

① Concrete wrapping

This work is to wrap the pier by concreting after casting steel bar along the pier fixing sufficiently bottom part of steel bar into the footing of pier.(shown in Fig4.6.) In this work, fixing strength main steel bar sufficiently and uniting pier and new concrete completely, it can be calculated proof force like other reinforce concrete parts with regarding pier as concrete. Therefore, although dead load increases and section becomes bigger by strengthen concrete, this work would be best method for strengthen work in the case that there are no regulation for blocking rate on river and supporting force.

Design standard strength of strengthen concreate(σ_{ck}) should be approximately 240kg/cm^2, and, in the time of fixing steel bar into pier, mortar anchor should be used standardly. Before concreting, it should be mixed superplasticizer into concrete for keeping good workability of concreting and compacting, and expanding agent for preventing crack occurred by drying shrinkage.

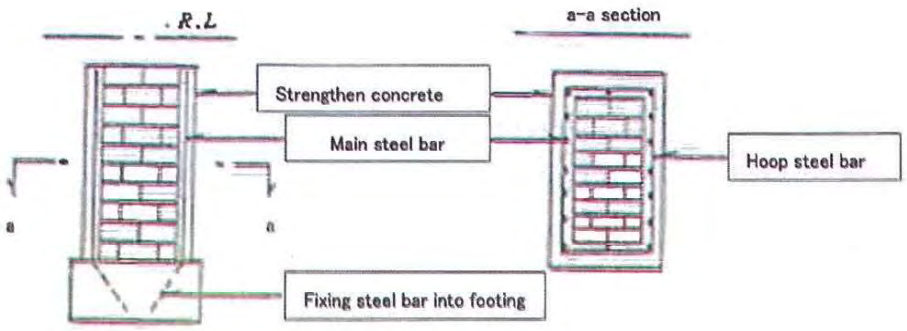


Fig4.6. Concrete wrapping

② Steel plate wrapping

This work is to wrap pier by steel plate installing with dowel bar, and to strengthen the pier by fixing steel plate sufficiently on footing with anchor steel bar(shown in fig4.7.). This work is generally used in the case that there is a problem about blocking rate on river and supporting force.

It should be kept gap, approximately 10-20mm, between steel plate and pier, and no compacting mortar should be injected into the gap. And, it is necessary to anti-rust measurement on part of mounting steel plate and anchor steel bar.

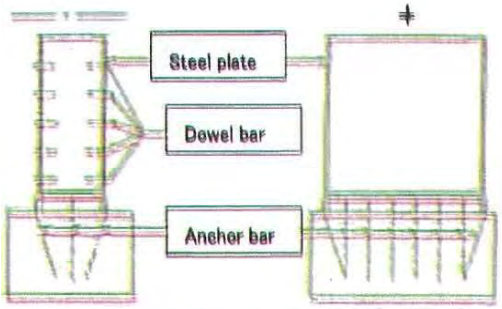


Fig4.7. Steel plate wrapping

Q5
What are the processes of bridge water way control?

Train control, "operation cancellation", "speed control", "alert" are regulated by water level or amount of rain fall considering the effects to structure by scouring pier, riverbed settlement, flowing object impact and height of dike and shore protection. Regulation value is shown as table.5.1

Table5.1. Regulation value against water level raising.

Study items	Speed control	operation cancellation	object of bridge
Stability	The water level which margin of safety ratio is 1.5 in stability analysis	The water level which margin of safety ratio is 1.2 in stability analysis	Bridges threaten by the disaster concern with these study items
Following object	-	The water level which the height is "h(m)" below from the bottom edge of girder.	
Height of dike	-	The water level which the height is "h(m)" below form the top of dike .	

* "h" means the margin height between water surface and bottom edge of girder, and the margin height is determined individually by river condition and surrounding environment and so on. And "h" is regulated by Japanese law," Cabinet Order concerning Structural Standards for River Management Facilities, etc"

Q6
What is the process of rebuilding level crossing?

Roadbed under the level crossing are loaded not only by train load but also by car load. Once construction finished, it is difficult to reconstruct. Construction step with which level crossing is set up again is shown as follows.

①Various conference with road administrators (Period of installation, Safety Countermeasure, etc.)
②Arrangement in the Railway company (Signal and telecommunication, power supply, station, operation, etc.)
③Install temporary level crossing for detouring and make no use of current level crossing
④Remove asphalt pavement or concrete
⑤Remove track (Sleeper and rail)
⑥Reconstruction of roadbed (The same way as that for the new roadbed)
⑦Construction of track
⑧Construction of new pavement
⑨Completion of new level crossing
⑩Remove temporary level crossing

There are many types of level crossing.
Detailed contents are shown in the following pages.

Pavement of level crossing road

The factors that determine the type of pavement when constructing or improving a level crossing road include the volume and type of traffic on the crossing road, the number of train operations on the railway, the bearing capacity of the roadbed, and the weather conditions. When designing the pavement of a level crossing road, as in the case of paving ordinary roads, the characteristics inherent to road pavement should also be taken into account.

The pavement for level crossing roads is classified into the following types based on the materials used:

① Planking or old sleepers (Usually temporary use)
② Concrete block
③ Asphalt
④ Concrete
⑤ Continuous concrete block track
⑥ Other

In addition, the following points should be kept in mind when constructing any type of pavement:

① Considering the drainage from the trackbed ballast, replace the ballast in the level crossing road section and in the areas in front and back of that section, and thoroughly compact the ballast in advance.
② Replace the sleepers as required.
③ Avoid providing rail joints in the level crossing road section. If this cannot be avoided, weld the rails wherever possible.
④ Use tie plates that are common to the main track rails and crossing guards.
⑤ Install crossing guard spacers on the guards at intervals of two sleepers, in the middle of two adjacent sleepers.
⑥ For wide level crossing roads, paint white lines or provide sidewalks to separate the carriageway from the sidewalk. An outline of the construction work, characteristics, etc. for each type of crossing pavement surface is described below.

(1) Plank pavement

Plank pavement offers a convenient way of repairing a railway due to the lightweight pavement materials and simple construction work. However, considerable damage is caused by heavy road traffic, and smoothness is inferior compared to other types of pavement.

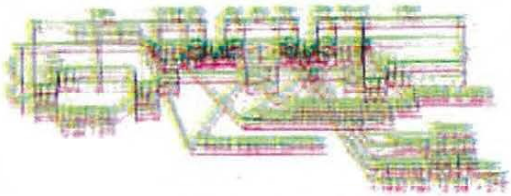
Plank pavement

Example of plank paved crossing

(2) Block pavement

This type of pavement uses factory-made reinforced concrete blocks, with steel frames fitted as required to prevent destruction. These blocks are typically supported by sleepers, but there is also a structure where steel angles are attached to sleepers along the cushioning materials in the direction of the rails, tie pads or adhesive materials are placed on the steel angles, and the blocks are supported by the steel angles. The areas at the ends of the sleepers are trenched, filled with cobblestones, and thoroughly compacted, or cast with edge concrete, as required, to install the blocks. In addition, Japanese cypress or Hiba splints are inserted in areas where the blocks touch the main track rails and guard.

Block pavement



Example of reinforced concrete block paved crossing

Appendix 8-1-19

(3) Asphalt pavement

Asphalt pavement is suitable for non-clayey, hard subgrade having high drying properties in sunny places. Any defect in the subgrade tends to appear directly on the pavement surface. Therefore, asphalt-based pavement is not suitable for structures such as level crossing roads where the subgrade settles due to passing trains, or where a sand-and-crushed-stone base on the subgrade needs to be removed for railway track maintenance. For this reason, asphalt pavement is not commonly used except on level crossing roads where road traffic is relatively heavy and the number of train operations is small. The construction work for asphalt pavement consists of filling the ballast gaps with crusher run, performing rolling compaction, then spraying and spreading asphalt emulsion, and thoroughly performing rolling compaction.

Asphalt paved crossing

(4) Concrete pavement

Concrete pavement, which is constructed by casting concrete in place on the trackbed and the pavement section of a level crossing road, has advantages in terms of the bearing capacity for the train load and road traffic, as well as wear resistance.

However, it has some shortcomings, including difficulty in fastening the rails to provide the same level of elasticity as ordinary tracks, difficulty in maintaining the boundary with the ordinary trackbed, and a prolonged construction period that leads to lengthy restriction of road traffic.

In planning and constructing concrete pavement, the following points should be kept in mind, in addition to the general precautions for pavement work described above:

① Considering the relatively long lifespan of pavement, the bearing capacity of the roadbed needs to be retained for a long period of time (i.e., longer than the pavement life).

② Use crushed stone on the trackbed or carry out roadbed improvements in the

connecting area between the crossing pavement and ordinary trackbed sections so that the amount of track maintenance is reduced.

③ In concrete works, fully compact the concrete with a vibrator and do not stop casting the concrete at the middle of joints.

④ Use asphalt joint materials on the expansion joints.

Concrete paved crossing

(5) Continuous concrete block track

A continuous concrete block track consists of wide reinforced concrete sleepers tightly laid and post-tensioned to construct a strong track panel of PC beams. Since the continuous concrete block track is integral to the sleepers even in paved areas due to its structure, a sufficient effective height of tensile reinforcement is provided, and its strength and weight increase against the negative bending moment caused by vehicle loading, which minimizes the pressure on the roadbed when the ends of sleepers are loaded and eliminates most of the local settlement of the road surface, which is the main cause of the destruction of crossing pavement. Thus, the continuous concrete block track offers great strength that is not comparable to the conventional plank or block pavement. In addition, the rails are directly fastened to the complete concrete trackbed, providing elastic fastening that can sufficiently bear wheel pressure and lateral pressure, and is also durable to vibrations and creeping of rails.

Continuous concrete block track

Example of Continuous concrete block track

(6) Other pavements

Rubber crossings and rubber-covered crossings are gaining acceptance as new types of crossings. Since these crossings are widely adopted in the U.S. and other countries and their effectiveness has been reported, they are expected to be increasingly used.

The main characteristics of rubber crossings include:

① Panel modules allow easy installation and removal.

② Removed panels can be reused or diverted to other purposes.

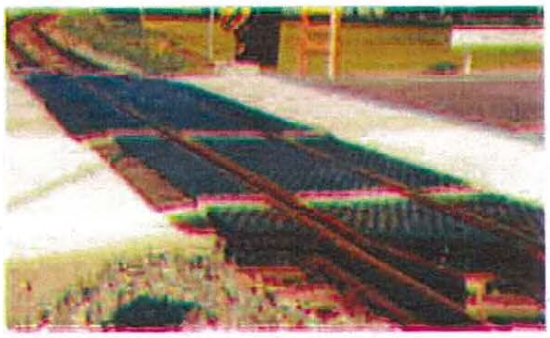
③ Good wear resistance and water resistance.

④ Less noise caused by passing vehicles.

⑤ Elastic. Free from damage, warping and corrosion.

⑥ Good workability allows use in turnouts and curved sections.

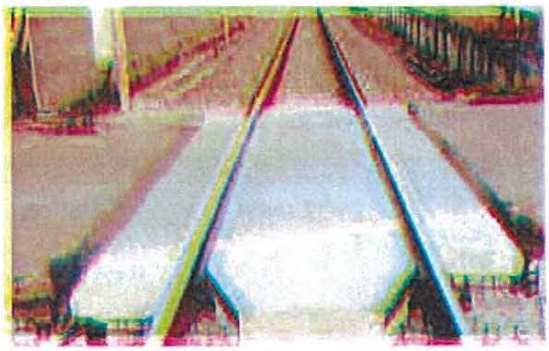
⑦ Uneven surface has slip prevention effect.



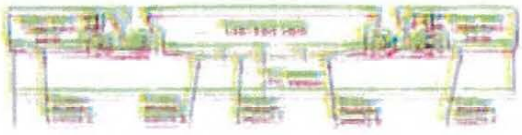
Rubber Crossing

Example of Rubber Crossing

Other types of new crossing pavement include the RTRI (Railway Technical Research Institute) type developed for light traffic crossings with a width of about 5 meters or less. This type provides flangeways, eliminating guard rails, and allows the use of PC sleepers. In addition, the pavement can be quickly removed and restored using a crane for maintenance of the track in the crossing pavement (Fig. 40.5).



Detachable crossing



Example of detachable crossing

Q7

Tamping work with Japanese Hand Tie Tampers, I would like to know·

(a) Process of works?

(b) How many Japanese Hand Tie Tampers to be used for 1km?

(c) Quantity of fuel to be used for 1km?

(d) Total working days for 1km

(e) How many labours required for 1km?

The detailed quantity is different depending on construction conditions.

In case of Japan, these answers from (a) to (e) will be as follows.

(a) Process of works?

Tamping step has already been taught by the first textbook and detailed step are written in P229·331.

①Jack up Rail

②Tamping using by Tie Tamper

③Arrange ballasts

Key point

①Usually we use Tie Tamper 4sets as one unit. One or Two parties tamp ballasts at the same time.

②Tie Tamper compacts ballasts by vibration. It is necessary to keep vibration and not to add power into ballasts..

③The range of tamping by Tie Tamper is shown below.(Fig. 6.1)

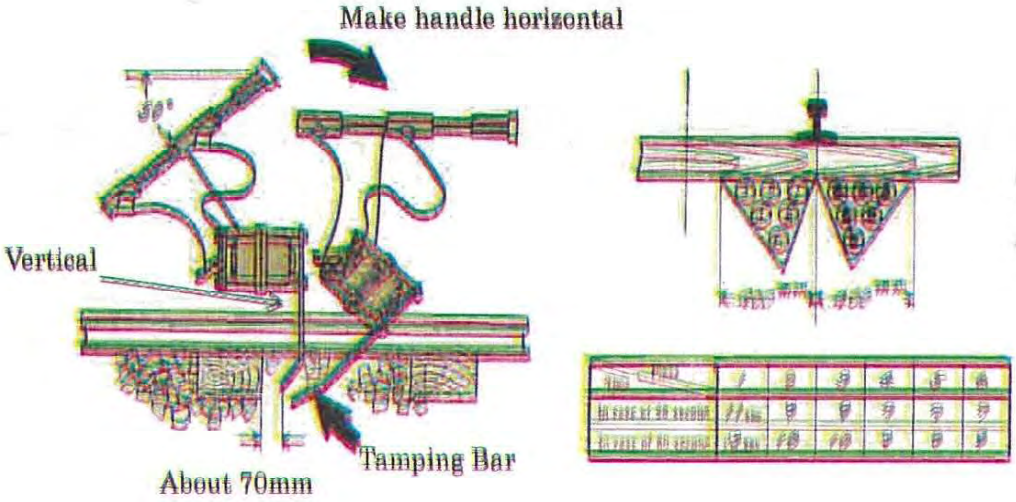


Fig 6.1 The range of tamping by Tie Tamper

④The relation between jack up volume and tamping time based on difference of ballast should be referred to the next graph (Table 6.1)

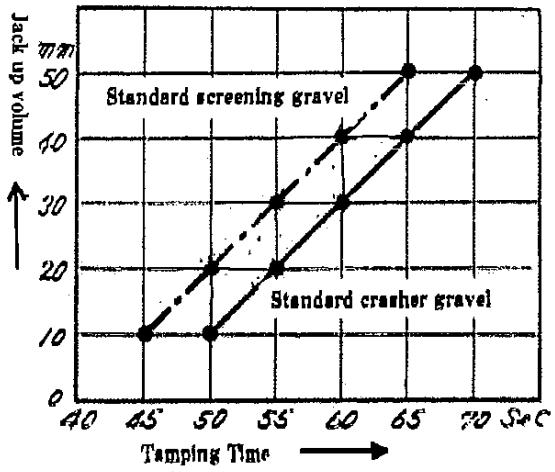


Table 6.1 The relation between jack up volume and tamping time

⑤Tie tamper must be kept so that the tamping bar should be vertical at 70mm distance from the side of sleeper. (Fig.6.1) The tie tamper is inserted into ballasts by its weight and vibration.

⑥After tip of tamping bar is inserted and passes around the under surface of sleeper, we make handle horizontal and tamp ballast under the sleeper When we use tie tampers, noise are so big, so we must establish safety rule and arrange watchman. We must not lose the moment of refuging from train.

⑦Tamping time depends on kinds of ballast and jack up volume per once. Standard time is 50-60 seconds per one place. It is proper time to tamp 50 seconds for less than 20mm of jack up volume and tamp 60 seconds for over 20mm of jack up volume. (Table. 6.1)

⑧In case where many ballasts of big size exist, we tamp them longer. (10-15secnds additionally)

There are many research about tamping time. Fig 6.1 is considered as effective example.

(b) How many Japanese Hand Tie Tampers to be used for 1km?

Depend on the track situation.

Usually, we use 4 tie tampers (1unit) and it takes 5 hours to tamp 100m.

So it takes 10 days to tamp 1km except holidays.

(c) Quantity of fuel to be used for 1km?

We calculate under the condition of (b) and following condition.

- Fuel efficiency ratio: 367g/kw/h (using 4 tie tampers)
- Generating power : 2.9kw (Generator)
- Price of gasoline: 815Kyat/ℓ

367g/kw/h × 2.9kw = 1.06ℓ/h

1.06ℓ/h × 5hours = 5.3ℓ

5.3ℓ × 815Kyat/ℓ = 4320Kyat (per day)

(d) Total working days for 1km

Mentioned at (b)

(e) How many labours required for 1km?

In case of using 4 tie tampers, 8 persons are needed.

(4 persons use tie tamper, 2 persons are support, 1 person is in charge of power supply and code arrangement, 1 person is watchman)

If you want to make tamping time shorter, 8 tie tampers are needed.

This case will need more than 12 persons.

Q8

Responsibilities and rights to decide by maintenance engineers for track maintenance work

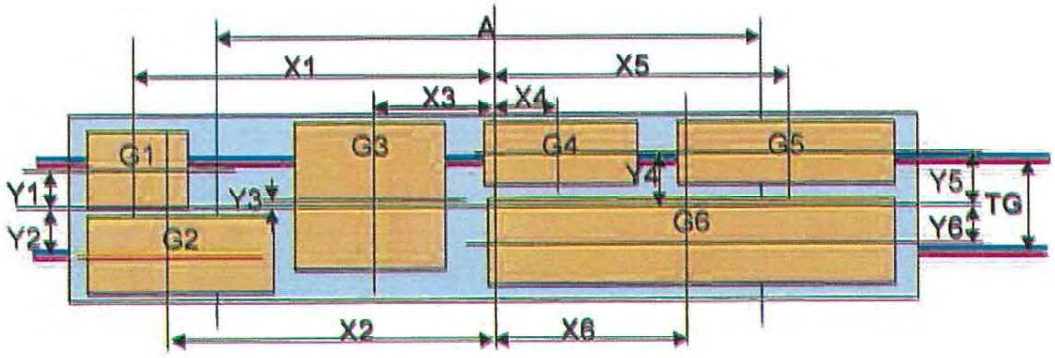
The current situations of JR East with respect to this matter are as follows.

Organization	Responsibilities / Matters in charge
Headquarters (H.Q.)	1) Establishment of technical standards/ regulation 2) Establishment of basic plan 3) Preparation of plans such as for accident prevention, for introducing new technology, etc. 4) Allocation of budget to branch office
Branch Office	1) Establishment of work plan based on basic plan of H.Q. 2) Supervison of work executed in the area in charge of Branch office 3) Establishment of plan of track inspection by High Speed Track Inspection Car and outsourcing the inspection work to the contractor 4) Request of budget to H.Q.
Track Technical Center (1) Planning and Safety group (2) Planning group	1) Establishment of track maintenance plan (yearly, monthly, weekly, daily) based on data of High Speed Track Inspection Car and other various inspection data 2) Outsourcing of track maintenance work to contractors based on contract and general management of contract 3) Control of some specific equipments such as crane, inspection equipments (supersonic rail defect inspection device, train vibration measurement device), track bicycle with engines, etc. 4) Coordination of the work with other different technical fields.
(3) Track maintenance group	1) Execution of various inspections 2) Supervison of work by contractors 3) Execution of acceptance inspections
Contractor A	• Execution of track maintenance based on contract, measurement and collection of data of the specified locations
Contractor B	• Execution of track inspection by High Speed Track Inspection Car.

Q9
In the event of train derailment due to the uneven load, how to consider the loading condition? We would like to know the calculation method.

When there is unbalance between front and rear bogie it will not directly cause derailment but when there is unbalance between left and right wheel, wheel load becomes small and it might cause the derailment.
Calculation method for loading balance is as follows.

① Measure the distance from body center to center of the loading objects.
When location of the object is right from body center positive value is applied for Xn and when location of the object is left from body center negative value is applied for Xn.
When location of the object is upper than the body center positive value is applied for Yn and when location of the object is lower than the body center negative value is applied for Yn.



② Multiply weight of object by each measurement to calculate the moment.

Object	Weight	Longitudinal Dimension	Lateral Dimension	Longitudinal Moment	Lateral Moment
1	W1	X1	Y1	W1 × X1	W1 × Y1
2	W2	X2	Y2	W2 × X2	W2 × Y2
3	W3	X3	Y3	W3 × X3	W3 × Y3
4	W4	X4	Y4	W4 × X4	W4 × Y4
5	W5	X5	Y5	W5 × X5	W5 × Y5
6	W6	X6	Y6	W6 × X6	W6 × Y6

③ Summate the moment for longitudinal and lateral.

Longitudinal: $\Sigma(Wn \times Xn)$

Lateral: $\Sigma(Wn \times Yn)$

④ Divide the longitudinal summation by half of bogie center.
And divide the lateral summation by half of track gauge.

Example

①

Object1 W1 = 100kg X1 = - 4.6m Y1 = 0.4m
Object2 W2 = 250kg X2 = -4.1m Y2 = -0.5m
Object3 W3 = 400kg X3 = -2m Y3 = 0.1m
Object4 W4 = 200kg X4 = 1m Y4 = 0.6m
Object5 W5 = 300kg X5 = 4m Y5 = 0.6m
Object6 W6 = 400kg X6 = 3m Y6 = -0.4m
Distance between bogie center: 7.77m

②

Object	Weight	Longitudinal Dimension	Lateral Dimension	Longitudinal Moment	Lateral Moment
1	100	-4.6	0.4	-460	40
2	250	-4.1	-0.5	-1025	-125
3	400	-2	0.1	-800	40
4	200	1	0.6	200	120
5	300	4	0.6	1200	180
6	400	3	-0.4	1200	-160

③

Longitudinal moment:
-460 -1025 -800 +200 +1200 +1200 = 315(kgm)
Lateral moment:
40 -125 +40 +120 +180 -160 = 95(kgm)

④ Loading balance

Longitudinal: 315/(7.77/2) = 81.08kg
Lateral: 95/(1/2) = 190kg

Load on right bogie is 81.08 kg heavier than load on left bogie .
Load on upper wheels is 190kg heavier than load on lower wheels.

Q10
In the event of train derailment, only one or two bogies of middle coach among one train length. Which are the most possible factors for this derailment?

Most possible cause is applying brake only on locomotive. When brake is applied on locomotive and not applied on other coach compressive coupler force is applied on the coach. Car body center is not parallel to track center because of slack between track and coupler is oblique to car body. Lateral direction component of coupler force will increase the lateral pressure of wheel and it might cause the derailment.

Q11
The factors should be care on bogies of coaches.

When there is unbalance of spring (especially in primary suspension) there will be unbalance in wheel load. Wheel load shall be measured when coach is constructed or after over hall and if there is unbalance it must be improved by shimming. If unbalance is too big and cannot be improved by shimming it is considered that spring is deteriorated and spring shall be replaced.

Q12
The factors should be care for preventing of derailment on curves.

(1) From the view point of rolling Stock
In the curved track lateral pressure will increase in following cases.
Outer rail:
Compressive coupler force when braking or pushing
Centrifugal force when train speed is high
Attack angle of wheel and rail
Rotating resistance of bogie
Inner rail:
Tensile coupler force when locomotive is accelerating
Tilting by cant when train speed is low
Attack angle of wheel and rail
Rotating resistance of bogie
Also wheel load will decrease in following cases.
Outer rail
Tilting by cant when train speed is low
Uneven rail height at transient curve where cant is gradually changed
Inner rail:
Centrifugal force when train speed is high
Uneven rail height at transient curve where cant is gradually changed

Track shall be properly maintained based on maintenance standard.
Train speed shall be properly controlled.

(2) From the view point of track engineering
① Maximum allowable speed should be observed
In case of JR (G=1067mm)
Balanced Cant =Cm + Cd =$8.4\frac{V^2}{R}$ → $V=\sqrt{\frac{(Cm+Cd)R}{8.4}}$
where Cm = Real cant (mm), Cd= cant deficiency (mm), V=train speed (km/h), R= radius of curve (m).
In case of JR, Cm max=105mm, Cd max =50mm (general vehicles)
then, $Vmax=\sqrt{\frac{(105+50)R}{8.4}}=4.3\sqrt{R}$
In case of R=400m, Vmax=86km/h
The maximum speed for respective curve should be observed.
In case of MR, track gauge =1000mm, so the formula giving the maximum speed should be different from that for JR.

② Slack should be given to the curved track as specified by the Technical Standards of MR

③ Track irregularities should be within the allowance values specified by the Technical Standards.
In case the track irregularities of horizontal and vertical alignment, cross levels, gauges are

very large, lateral force to the rail given by the wheel flange will become large, leading to climbing derailment.

④ Length of transition curves should be provided according to the Technical Standards.
In case of JR, L ≧400Cm,
where L =transition curve length (m), Cm=real cant (m)
This length is required for preventing derailment due to 3-point support of wheel flange by rail on the transition curves.
Also track irregularities should be kept within allowable limits specified by Technical Standards.

⑤ In the section where the sharp curve and steep down gradient are superposed, derailment is apt to occur. Accordingly in such sections the guard rail should be installed as explained in slide No. 27., 28 of the PPT used for presenting the "Recommendation on Technical Standards of MR" with respect to Manual of Engineering Dept (MED), Chapter IV, Permanent Way I (Material and Theory).

Q
For Signaling and Telecommunication Department, they have requested that to propose and discuss in coming workshop, the adaptable organization aligning with new system and instruments apply in Yangon Mandalay Rail-line development project.

First of all, it should be mentioned that a required maintenance system can be determined based on the contents of the rehabilitation/modernization of Y-M Line.

Ordinary laborers and skilled laborers grade 4 and 5 deployed at respective stations should be trained so as to have more professional electrical knowledge to cope with modernization of signalling/telecom. facilities from mechanical/wire type to electric type. In case the ordinary laborers and skilled laborers grade 4 and 5 are trained to become such electrical staff as to be able to understand how to deal with the modernized facilities and to implement adequate maintenance work, the present maintenance organization of MR is applicable to maintenance of the modernized facilities.

Among the trained ordinary laborers and skilled laborers grade 4 and 5, some capable members should be selected, and should be further trained to become junior engineer 3 who should play a role of managing ordinary laborers and skilled laborers grade 4 and 5. They should be organized to form [Maintenance Center], a maintenance organization which implements necessary inspections and maintenance works, and keeps the signalling/telecom. facilities installed at every station in uniformed good conditions.

Then a Division managed by Divisional Engineer, Assistant Engineer, and Junior Engineers 1 or 2 should be established for supervising /managing the Maintenance Centers under the jurisdiction of the Division. Division will function for distributing necessary budget and staff among Maintenance Centers, and for supervising Maintenance Centers so as for them to implement necessary maintenance work adequately.

The above-mentioned organization recommended for MR signalling/telecom. maintenance is based on the maintenance organization practiced by the current Japanese Railways Companies.

Electrified signalling/telecom. facilities will require less maintenance work than the mechanical/wired facilities. However, among the electrified facilities, track circuit, electric switch machine, and locking device of turnout making use of electric circuit will need daily and close inspection and maintenance. Especially with respect to these facilities, Maintenance Center as a whole should grasp the conditions of all the facilities in its charge, and they should be maintained by all the members of Maintenance Center.

Facilities installed at each station should be maintained not only by the staff deployed at that station, but also should be maintained by other staff of the Maintenance Center, namely should be maintained from the various points of view, resulting in ensuring uniform level of maintenance. Staff should be given intensified training for the maintenance of these facilities, and should try to maintain them as a part of the system, in close cooperation with the track maintenance staff.

Among the signalling/telecom. facilities/equipments to be increased newly, warning devices at the level crossings need daily inspection and maintenance. They are sometimes damaged by the pedestrians. Without appropriate inspection and maintenance of these warning devices at the level crossings, some large accidents may occur, resulting in exerting unfavourable impact on MR.

Ordinary laborers especially for maintaining warring devices installed at level crossing should be newly recruited, although the required number of them should depend on the number of modernized level crossing. These recruited ordinary laborers should be placed under the command of Maintenance Center. In recruiting these new ordinary laborers for maintenance of warning devices at level crossing, it is suggested that you should choose able ones among the laborers engaged in the modernization work of Y-M Line.

It is expected that OCC equipment will be increased hereafter. In this regard, in order to manage OCC, the post of [Signal Dispatcher] should be established, who manages the central device of OCC and gives various instructions to Maintenance Center with respect to maintenance of signalling/telecom. facilities installed at each station.

The fundamental role of the Signal Dispatcher should be the management of OCC, and in the future he should also play a role of coordinator for Maintenance Centers within his Division; and after the installment of the centralized monitoring equipment of

signalling/telecom. facilities, he should monitor the situations of the signalling/telecom. facilities by using the centralized monitoring equipment, in order to detect the malfunction of the facilities and to give necessary maintenance instructions.

(We attach here the current maintenance organization chart of signalling/telecom. facilities for each Division of MR, and also the recommended maintenance organization of signalling/telecom. facilities corresponding to the modernization of Y-M Line, prepared with due consideration on the experiences of JR Group.)

Lastly we would like to suggest that MR should continue the study on the appropriate maintenance organization for the rehabilitated/modernized signalling/telecom. facilities of Y-M Line, which will take the concrete shape gradually hereafter.

Current maintenance organization of Signalling&Telecommunicartions facilities

S/No.	Station name	Divisional engineer	Assistant engineer	Junior engineer 1/2	Junior engineer 3	Supervisor	Skill labor grade 4	Skill labor grade 5	Ordinary labor
1	Yangon			1		1	1	4	4
2	Pazundaung						1	4	4
3	Mahlwagon	1					1	4	4
4	Thingangyun							1	
5	Toegyaungkalay						1	4	4
6	Ywathagyi							1	1
7	Laydaungkan							1	1
8	Darbain								1
9	Kawche								
10	Tongyi								1
11	Kyauktan								1
12	Tawa								1
13	Payathonzu								1
14	Bago			1	1		1	4	4
15	Shwele								1
16	Payagyi				1			1	
17	Pyinbongyi							1	
18	Kadok								1
19	Panugdawthi								1
20	Bimshaylayae							1	
21	Daik-u		1					1	
22	Pyuntaza				1		1	2	3
23	Nyaunglebin			1				2	
24	Tawwi	1						1	
25	Peinzalok								1
26	Thategon							1	
27	Kyauktaga				1			1	
28	Penwegon								1
29	Tawgywe-in								1
30	Kanyutkwin				1			1	
31	Nyaungbintha								1
32	Pyu							1	
33	Zeyawadi							1	
34	Nyaungchidauk								
35	Kywebwe								
36	Banbwegon							1	
37	Oktwin				1			1	
38	Thaungdaingon							1	
39	Taungoo	1		1	1		1	5	

Appendix 8-1-36

Reccomended maintenance organization of Signalling&Telecommunicartions facilities <1>

S/No.	Station name	Divisional engineer	Assistant engineer	Junior engineer 1/2	Junior engineer 3	Supervisor	Skill labor grade 4	Skill labor grade 5	Ordinary labor	Ordinary labor (For Level crossings)
1	Yangon → OCC Signal dispacher			1		1	1	4	4	
2	Pazundaung → Yangon						1	4	4	?
3	Mahlwagon	1					1	4	4	?
4	Thingangyun							1		?
5	Toegyaungkalay						1	4	4	
6	Ywathagyi							1	1	?
7	Laydaungkan							1	1	?
8	Darbain								1	?
9	Kawche									?
10	Toegyi								1	?
11	Kyauktan								1	?
12	Tawa								1	?
13	Payathonzu								1	?
14	Bago			1	1		1	4	4	
15	Shwele								1	?
16	Payagyi				1			1		?
17	Pyinbongyi							1		?
18	Kadok								1	?
19	Panugdawthi								1	?
20	Eimshaylayse							1		?
21	Duik-ti		1					1		?
22	Pyuntaza				1		1	2	3	
23	Nyaunglebin			1				2		?
24	Tawwi	1						1		?
25	Peinzalok								1	?
26	Thaiegon							1		?
27	Kyauktaga				1			1		?
28	Penwegon								1	?
29	Tawgywe-in								1	?
30	Kanyutkwin				1			1		?
31	Nyaungbintha								1	?
32	Pyu							1		?
33	Zeyawadi							1		?
34	Nyaungchidauk									?
35	Kywebwe									?
36	Banhwegon							1		?
37	Oktwin				1			1		?
38	Thaungdaingon							1		?
39	Taungoo	1		1	1		1	6		

Division 7 OCC Signal Dispacher

Division 7 Maintenance

Division 7 S&T Indirect Management

Division 7 Maintenance Center (2)

Division 6 Maintenance Center (1)

Division 6 S&T Indirect Management

Division 6 Maintenance Center (2)

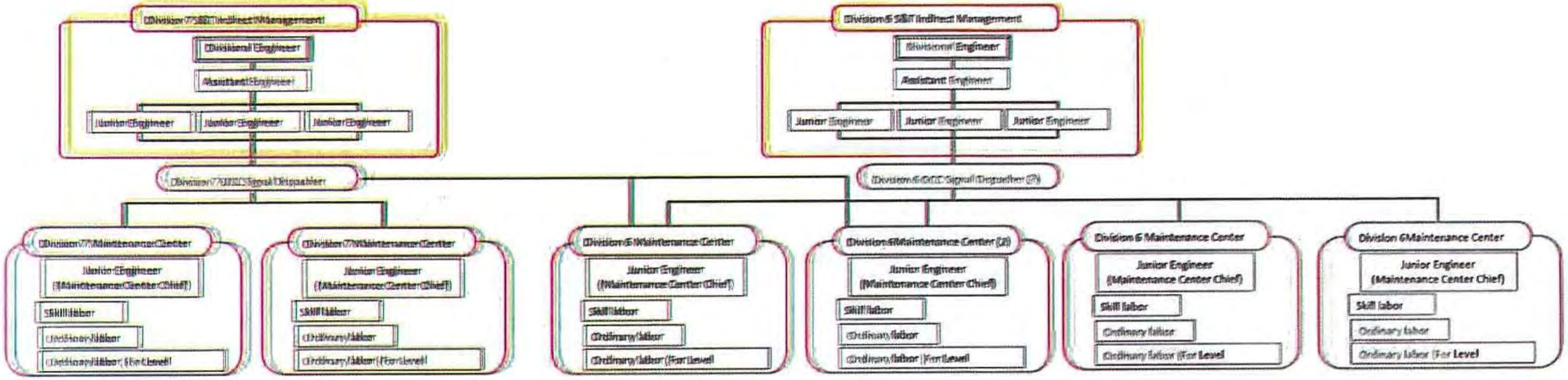
Division 6 Maintenance Center (3)

Division 6 Maintenance Center (4)

Division 5 Maintenance Center (1)

Appendix 8-1-37

Recommended maintenance organization of Signalling&Telecommunications facilities <2>



Appendix 8-1-38

Appendix8-2 Summary of Discussions Made during the summarizing Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, Long-term railway Facilities Improvement Plan

1. 1st day, 15th December, 2014

Q1-1. (Dr. Kuroda's presentation, Page 38)
4 JRs in Honshu are in the black but some JRs outside Honshu are in the red (deficit operation). Is the utilization rate of the latter low? Even if some JRs in the red cannot make up the deficit by interest of management stabilization fund, why don't you close these lines? I'd like to know the reason that they are not abolished.

A1-1. (Dr. Kuroda)
Just because of being in the red, we can't abolish the railways. As the railways have the characteristics and role different from the road transport, the railways are required for economic development of the country. Railways contribute to Japanese economic development even if they are in the red.

Q1-2. (Mr. Takami's presentation, Structure 6&7)
About financial situation, was JNR in the red for 16 years?

A1-2. (Mr. Takami)
Yes, JNR was in the red for 16 years, from 1963 to the privatization as shown in Mr. Kuroda's presentation page 43.

Q1-3. (Dr. Kuroda's presentation, Page 26)
Is the cant given to rail? Do train cars have the cant?

A1-3. (Dr. Kuroda)
Yes, there is the cant given to the rail. Train car has spring, the body is slanted due to the centrifugal force on curve line.

Q1-4. (Dr. Kuroda's presentation)
In Japan, the total route kilometer of meter gage is longer than that of Shinkansen by 10 times. How fast is the meter gage?

A1-4. (Dr. Kuroda)
On the meter gage, the maximum train speed is 120km/h~130km/h generally, or 160km/h in a specific section. JR uses 2 kinds of the gage, 1067 mm and 1435 mm.

Q1-5. (Mr. Kuroda's presentation)
In Japan, as for the personnel 4 or 5 men are deployed per 1 km, while in Myanmar it's about 3 men. How many personnel are required per 1 km in the present situation of MR?

A1-5. (Dr. Kuroda)
I can't answer quickly about the exact number of the required personnel. By introducing the new technology, you can reduce the number of required personnel. JR outsources the major part of track maintenance work (construction) to private companies and this system is effective for reducing the required personnel.

2. 2nd day, 16th December, 2014

Q2-1. (Mr. Ishikawa's presentation)
In Myanmar, railway track has the longitudinal and vertical gap between rails, and then the resistance would increase more. Should we calculate with consideration of these gaps?

A2-1. (Mr. Ishikawa)
In Japan we don't consider of these gaps. If any, those are negligible small compare to other resistance.

Q2-2. (Mr. Ishikawa's presentation of "Tractive effort (Locomotive) and Tractive effort curve (EMU)")
If the trains' speed increases, its traffic effort value will become "0"? And what is the value of speed its traffic will be close to "0"?

A2-2. (Mr. Ishikawa)
Actually speed doesn't increase so much because the running resistance is being applied during running. Therefore tractive effort never becomes "0". For example, even the case that train is running on down slope and become very high speed, tractive effort never becomes "0".

Q2-3. (Mr. Ishikawa's presentation of "Calculation of brake distance")
How do you calculate the idle running time as 2 second?

A2-3. (Mr. Ishikawa)
Actually, the running time is set based on experiment date. It can be calculated from diameter of pipe, length of pipe etc. but it is very complicated.

Q2-4. (Mr. Ishikawa's presentation of "Calculation of brake distance")
In Japan, all of the trains including Shinkansen, subway and other trains can stop on the determined position of plat home "exactly". The precision depends on the result of accurate calculation, the high-performance machine or the driver's experience?

A2-4. (Mr. Ishikawa)
It depends on the driver's skill (practice and experience). Because the brake shouldn't be kept a constant force for speed decreasing, it's necessary for drivers to raise or to lower the brake force until train stops exact location.

Q2-5. (Mr. Ishikawa's presentation of "Calculation of brake distance")
In Myanmar train, passengers would be shaken very much when the brake is working, but it doesn't happen in Japan. Why is it?

A2-5. (Mr. Ishikawa)
In Japan, train has load compensation system for braking so that deceleration is same according to brake command either train is full loaded or empty.

Q2-6. (Mr. Ishikawa's presentation)
In the calculation of gradient resistance, weight is multiplied by gradient. Isn't it necessary to consider of the gravitational acceleration "g" ?

A2-6. (Mr. Ishikawa)
The unit of gradient resistance is kgf in this case. When representing the force as N, it should be multiplied by "g".

Q2-7. (Mr. Ishikawa's presentation)
When curve and gradient exist at same location, curve resistance and grade resistance will be applied. In this case how to calculate the train resistance? Can we calculate the train resistance by adding the two simply or do any synergism effects by the combination of the two?

A2-7. (Mr. Ishikawa)
In case of like that, you just calculate adding curve resistance and gradient resistance.

Q2-8. (Mr. Ishikawa's presentation)
In Myanmar railway some trains are running without applying brake on coaches. Should such condition (train require more brake distance) be informed from mechanical section to signaling section?

A2-8. (Mr. Ishikawa)
First of all, the trains with insufficient brake should not be allowed to operate. The situation that brake is applied only locomotive and not applied on coaches of wagons shall be improved as soon as possible.
In Japan when any one axle is non-brake train is not allowed to operate in normal speed. So Japanese situation is different from Myanmar. Japan has the rule that all trains must stop within 600 m from top speed. The signal system is designed and constructed under such condition.
The train with insufficient brake should restrict the maximum speed in order to stop within a certain distance.

Q2-9. (Mr. Ishikawa's presentation, Gradient Resistance)
①Taking account of the grade and the gravitation, how much weight of freight can be transported by trains?
②As following situation, how to calculate?
Grade: 40/1000、Hp: 2000,Locomotive weight(t): 72

A2-9. (Mr. Ishikawa)
①Using the grade and the weight of freight car (wagon)
②200Hp in 2000Hp is used as auxiliary power. (2000－200＝1800Hp)
20% will be lost as generator loss, motor loss, etc.
1800Hp×0.8＝1440Hp (Power of locomotive)
Hp is converted to kW
1440Hp×0.75＝1080kw (108000w) = 108000Nm/s
72 t ×40kgf=2880kgf
28224N (gradient resistance of locomotive)
→Ex. In 10km/h, it can carry freight by about 900t.

(The below photo showing the calculation.)

Appendix 8-2-4

3. 3rd day, 17th December, 2014

Q3-1. (Mr. Takami's presentation, P5)
For example, in the situation that Deck garter is 18 m, how fast do we set the maximum speed?

A3-1. (Mr. Takami)
When the bridge condition is sound, it isn't necessary to set speed limit regardless of the kind and length of bridges. If any erosions, there is a possibility that proof stress decreases. Therefor speed limit often is set after inspect in detail.

Q3-2. (Mr. Takami's presentation, P5)
The reason to ask the earlier question is that there are many 18 m bridges in Yangon to Mandalay and the trains of 100 km/h pass through the bridges. We need to know that for passing the trains, we should repair the bridges or not.

A3-2. (Mr. Takami)
First of all, it's necessary to do assessment and judge the safety from detail inspection.

Q3-3. (Mr. Takami's presentation)
In south area of Myanmar, we re-paint the bridges near sea in tar once two years, is it OK? We use weaved hemp soaked in tar and pinch it to bearing to protect cracks.

A3-3. (Mr. Takami)
It's necessary to watch carefully and take action because the number of trains increases in the future and the maintenance way probably change. According to related thesis, it is said that re-painting once for 6-7 year is appreciate.

Q3-4. (Mr. Takami's presentation, about SK type)
In Myanmar, there are cases that we construct Square type beam diagonally not Skew type beam. Are there structural problems?

A3-4. (Mr. Takami)
It's necessary to pay attention for it like Skew type. Checking is important because once a crack occurs, it becomes wrong soon. Especially, it's important to inspect around bearings.

Q3-5. (Mr. Matsuo' presentation, about payment)
We want to know about payment, especially mid-term payment.

A3-5. (Mr. Matsuo)
Basically we don't pay in advance, exceptionally in the case where the period of construction is long, we conduct mid-term payment.
In contract, mid-term payment is allowed to be conducted once in half-year. However the proceeding is complicated, normally we conduct work progress control and mid-term payment once a year, one month before of March (closing account). In that time, the contractor reports the present work progress to JR East. Then, JR pays the finished portion to the contractor. Actually 10% of the total contract money is withheld, JR keeps it and pay it at completion of the construction. And in the contract, for 10 years after finish of construction, the contractor should be responsible for troubles of construction.

Q3-6. (Mr. Matsuo' presentation of 2nd day)
At the acceptance inspection, what dose taking photos mean? In Myanmar we finish only sign on papers.

A3-6. (Mr. Matsuo)
It means the confirmation for quality. Inspectors check the quality of construction in the photos. It's important to record the process of construction. After getting all records, JR pays money to the contractor.

Q3-7. (Mr. Matsuo' presentation, about the acceptance inspection)
How do you do the acceptance inspection of reinforcement bar?

A3-7. (Mr. Matsuo)
Mill sheet is issued by manufacturer. Normally we accept the Mill sheet and receive reinforcement bars. But when these need structural calculation, sometimes we conduct detailed inspection.

Q3-8. (Mr. Mitani's presentation)
We have been discussing ATP with the D/D team for the Yangon-Mandalay trunk line alone. As we have understood very well that introduction/utilization of ATP system involves a number of different divisions, however, we want to include those related to rolling stock additionally in the discussion from now on.

A3-8. (Mr.Mitani)
The D/D team members for the Yangon-Mandalay trunk line (those in charge of rolling stock, in particular) have difficulty in estimating the cost to install on-board control units on the existing rolling stock. You are advised, therefore, to have a meeting with those in charge of rolling stock.

Q3-9. (Mr. Mitani's presentation)
The wayside coils are fixed on PC sleepers in the ATP installation plan. Are these PC sleepers of special design/manufacture? Can't those existing in Myanmar be used in place?

A3-9. (Mr.Mitani)
The wayside coils are fixed by using dedicated PC sleepers with pre-drilled bolt holes, as this design ensures easier track maintenance. Bolt holes can't be drilled, however, on the PC sleepers manufactured in Myanmar. In installing a wayside coil between sleepers, we use a special fitting metal in Japan. To follow suit in Myanmar using existing PC sleepers, design a special fixing metal by referring to the precedent case in Japan. As this coil fixing system makes it difficult to provide track maintenance services, however, you are advised to consult the Civil Department in advance on its introduction.

Q3-10. (Mr. Mitani's presentation)
Regarding the ATP introduction plan for the Yangon-Myanmar trunk line, we understand that ATP is activated when the home signal indicates a red aspect. However, home signals indicate yellow and blue aspects as well. Does ATP check train speed in indicating such aspects?

A3-10. (Mr.Mitani)
When a home signal indicates a yellow or blue aspect, it doesn't check train speed or sound an alarm, as the block section thereunder is guaranteed. The ATP action of the home signal changes according to its aspect. The aspect of the related distant signal also changes accordingly. Therefore, there are no problems consequently.

Q3-11.(Mr. Mitani's presentation)
In case a wayside coil has been destroyed or stolen, does the system function on the safety side? Are there any alarming devices to notify relevant station masters or other responsible personnel of the abnormalities of the system?

A3-11. (Mr.Mitani)
ATP is designed based on the concept of fail-safe in the same way as signaling equipment. In case an ATP cable has been stolen/cut or a wayside coil has failed, speed check is implemented as the aspect of home signal is red, thereby guaranteeing that the system doesn't function on the dangerous side. As maybe apprehended, however, the system doesn't function normally nor implement speed check, in case whole a wayside coil has been stolen.
As the ATS-S system of Japan is nothing else but mere a backup system for signal equipment, it doesn't have a failure monitoring function. Despite that, however, a failure can be detected in case one has occurred, as it results in some abnormality or others on the rolling stock side. In case a failure monitoring function is required in introducing the system into Myanmar, you are advised to discuss it with Japanese designers minutely and incorporate the results into the specifications.

Q3-12.(Mr. Mitani's presentation)
We have understood the protective function required for home signals. Violation of starter signal by departing trains at stations is equally dangerous, however. Isn't it necessary, therefore, to install ATP for starter signals in the same way as for home signals? If necessary, please record to that effect in the minutes in order to urge its introduction.

A3-12 (Mr.Mitani)
It is wonderful for you to have noticed it. As accidents often occur in Japan due to starter signal violation, we are installing ATP for starter signals as well. Please discuss whether ATP is necessary in Myanmar among different divisions based on the results of this workshop. We will record the discussion at this workshop in JICA's report and reflect it in the study.

Q3-13.(Mr. Mitani's presentation)
Shall ATP be installed as well for starter signals at the Yangon Central station?

A3-13 (Mr.Mitani)
We aren't affirmative in the grant aid project. However, the Yangon Central station should be installed with ATP for starter signals in its yard, as it handles a number of trains. Please consult with the experts in different teams, therefore, on the most appropriate improvement projects for that purpose.

Q3-14. (Mr. Mitani's presentation)
Are there any points the Civil Department shall observe regarding the maintenance of ATP after installation?

A3-13

To transmit the signal conditions, metal cables for ATP wayside signal coils are laid close to or to cross rails. In track maintenance work, the cables are often erroneously cut in Japan. To prevent such mishaps, attention shall duly be paid in cable laying work, therefore.
Furthermore, the S&T Department shall (1) by all means notify the Civil Department of the execution of rail-crossing or close-to-rail cable laying work, (2) make it thoroughly known among track maintenance workers and (3) make every effort to prevent accidents. The Civil Department is advised to prepare a ledger to control ground portions around the rails based on the information. When new facilities and systems are introduced increasingly in such a manner, linking between different divisions shall be strengthened accordingly. Each division is required to have discussions within its organizations on the above issues including the results of this workshop.

4. 4th day, 18th December, 2014

Q4-1. (Mr. Ishikawa's presentation)
In Japan, the brakes of a train work at the same time. However in Myanmar, the effect of brake is different between left and right wheels. Will this unbalance cause the derailment?
And because Myanmar has not enough spare parts, we cannot repair the brake system totally at the same time. So old parts and new parts are mixed in same car and it may cause the unbalance of brake effect.
Our situation is different with the one of Japanese, how do we solve?

A4-1. (Mr. Ishikawa)

In a passenger coach all brake shoes are linked and all brake shoe will work at the same time. If one brake shoe is defective all the brake shoes will not work. Therefore it will not happen that brake is applied only one side and the other side is not applied.
I cannot answer it without checking the trains actually.

Q4-2. (Mr. Ishikawa's presentation)
When the gaps between brake shoe and wheel is different between right wheel and left wheel, will it causes the accidents when running on the curve?

A4-2. (Mr. Ishikawa)
In the coach brake shoes are linked and will be applied all the brake shoe evenly. It's impossible that only one side of the brake shoe works. Even if one side of brake shoe is blocked by something and only the other side of brake shoe works brake force will be applied for both wheels because wheels are connected by axle.

Q4-3. (Mr. Ishikawa's presentation)
A locomotive has 3 bogies and the brake of 2 bogies 3 don't work. In such situation is the derailment happen at the location where gradient and curve because the brake effect is unsufficient? We had experience that when brake is applied only for locomotive wagon in the middle had derailed.

A4-3. (Mr. Ishikawa)
Such case (applying brake only locomotive) is not good but it isn't the only reason, probably other reasons are considered.

(Mr. Kuroda)
In Japan we use the derailment prevention guard to protect derailment at the location where the descending grade is superposed on the sharp curve, because derailment is apt to occur at such locations.

Q4-4. (Mr. Ishikawa's presentation P11)
Which type is this brake shoe?

A4-4. (Mr. Ishikawa)
It's type of cast iron.

Q4-5. (Mr. Ishikawa's presentation)
In Myanmar, It is told that a two-axle car shall not be coupled between bogie cars because this formation causes derailment easier. Why is this?

A4-5. (Mr. Ishikawa)
Generally probability of derailment is higher in two-axle car than bogie car. But there is no technical reason that possibility of derailment becomes much higher when two-axle car is coupled between bogie cars.

Q4-6. (regarding the observation of train in station)
How did you think about observing the train?

A4-4. (Mr. Ishikawa)

As far as I observed, brake system is not working in the all the passenger cars'. Brake is not partially applied in a car. Also I observed that many oil dampers installed in bolster are not working. Some are attached with big gaps and some of the attachment are broken. It necessary to improve oil damper because oil damper is essential parts for riding comfort.

Q4-7. (regarding the observation of train in station)
What percentage of accident happening do you think by observing the train?

A4-7. (Mr. Ishikawa)

It is impossible to answer what percentage, but the situation that brake is applied only for locomotive is very dangerous and easy to cause derailment.

Q4-8. (Mr. Ishikawa's presentation, Centrifugal force)
In the slide centrifugal force is calculated as 2500N for one wheel. How much the critical value?

A. (Mr. Ishikawa)

In this case wheel load is 3.75t and 2500N is equivalent to 0.25t. Derailment factor Q/P is about 0.067. We can say that it is still very safe level just considering the centrifugal force but many factors shall be considered in the same time.

Q4-9. (Cant)
Please teach how to calculate setting value of cant?

A4-9. (Mr. Ishikawa)

Cant or super elevation is applied for safety and ride comfort. Ideal case is direction of resultant force of gravity and centrifugal force is perpendicular to vehicle floor. But train is not running in same speed. Value of cant will be limited so that when trains is stand still vehicle will not turn over to inside even there is wind from outside and passenger will not feel uneasy.

(Mr. Kuroda)

JR sets the values of the max cant and the maximum cant deficiency. About this topics, please confirm the previous text book.

Q4-10. (Mr. Ishikawa's presentation)
When there is gradient the trains are easy to slip or derail, how should we drive it? For example, the situation that brake is available only locomotive and 10 passenger cars are coupled and speed is 40km/h, is that dangerous?

A4-10. (Mr. Ishikawa)
In any case brake shall be applied for all cars. But if not it depend on the effect of brakes, and applying strong brake is dangerous.

Q4-11. (Mr. Ishikawa's presentation)
When there is gap between couplers and emergency brake is applied, there will be impact on couplers. Will it causes derailment?

A4-11. (Mr. Ishikawa)
When there is gap at couplers there will be speed difference between two cars when brake is applied. The kinetic energy will be emitted and changed to coupler force when couplers hit each other until speed of two cars become same. Duration is very short but value is big therefor there is possibility to cause derailment.

Q4-12. (Brake)
Is it dangerous to brake powerfully by judging that the point needs sharp downward slope actually at the point of gentle downward slope? Therefor is it dangerous to judge the force of brake by drivers' sense because of leading slip accident? What's the solution?

A4-12. (Mr. Morihara)
The countermeasure is to educate the driver how to set the operation of brake according to grade and car's performance. If it's impossible, the speed should be decreased for stopping soon at the position long distance from the slope.

Q4-13. (Brake)
In Myanmar, the junior of two drivers plays the role to pull emergency brake. How is Japanese rule?

A4-13. (Mr. Morihara)
In Japan, only one driver operates a train.

Q4-14. (Brake)
How situations the drivers can use the emergency brake in?

A4-14. (Mr. Morihara)
In Japan, when drivers noticed the dangerous situation by themselves, they can use it. Normally the operation manual of brake is prepared by each office. A driver need practices of driving before he can drive by himself. The way to brake depend on the geographic situations, therefor it's impossible to decide the regular distance at starting brake.

Q4-15. (Delay)
Sometimes long distance trains are delayed. In Japan, when trains are delayed, where do drivers contact with?

A4-15. (Mr. Morihara)
We contact the operation control center. In Japan, because radiotelephones is equipped with trains, drivers can contact that center directly.

Q4-16. (The experience of driver skill)
Our MR needs the improvement of driving skill to increase speed, So please give us the advice from Japanese skill.

A4-16. (Mr. Morihara)
In Japan, the know-how in driving is transmitted from senior colleague to junior. It's important to transmit the know-how. For example, on which point do you need to pay more attention? And it's necessary to be careful about driving crossing the level crossing because that has much crossing of cars or pedestrians just before the passage of the train and so on. We share such risks. These risks should be protected by receiving guidance, regular meeting and information exchange among the drivers.

Q4-17. (Japanese experience)
Have you ever experienced the derailment accident like Fukuchiyama-line?

A4-17. (Mr. Morihara)
We have never experienced.

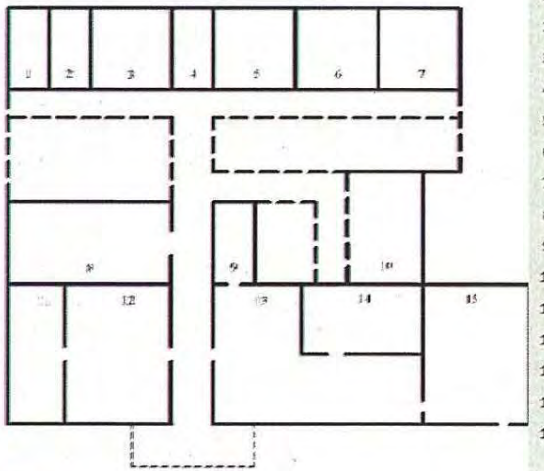
Q4-18. (Speed limit)
In Japan, how the speed limit is set?

A4-18. (Mr. Morihara)
We set it based on the condition of grade and curve.

BACKGROUND INFO

- 1976 – Started on discussion with GTZ of Germany
- 1979 – Signing the agreement
- 1980 – Started the construction of the building
- 1980 – Installation of machineries
- 1981 – Opening of R.T.T.C on October, 24th
- 1987 – GTZ (GIZ) Hand -overed to Myanma Railways

Layout Plan of R.T.T.C



1. Principal
2. Administration office
3. Staff Room
4. Aids Room
5. Class Room, Electric
6. Class Room, Hydraulic & Pneumatic
7. Class Room, Basic Metal
8. Electric Workshop
9. Tool Hatch
10. Lavatory
11. Welding Shop
12. Basic Metal Workshop
13. Machine Shop
14. Store
15. Workshop, Special Courses

Vission of Ywataung Railways Technical Training Centre (RTTC)

Future adoption of Modernized Railways Technology for Myanma Railways by RTTC 's training.

Mission of Ywataung Railways Technical Training Centre (RTTC)

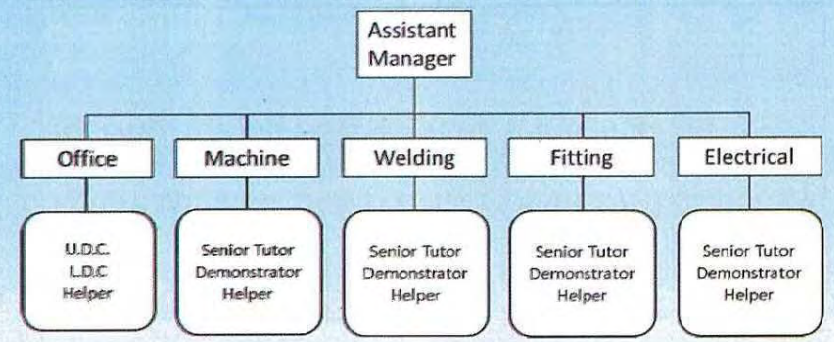
1. To produce the skilled workers for Myanma Railways.

2. To increase the productivity and Quality Control Techniques in the workshops and depots.

Aims and Objectives of R.T.T.C

- To upgrade the technical skills of the fitters who are employing in Myanma Railways, especially those working on Diesel Locomotives.
- To train the new recruits required by the workshops and sheds.
- To upgrade the technical skills of the supervisory staffs.
- To train new teaching staffs who will replace those lost due to natural attrition.

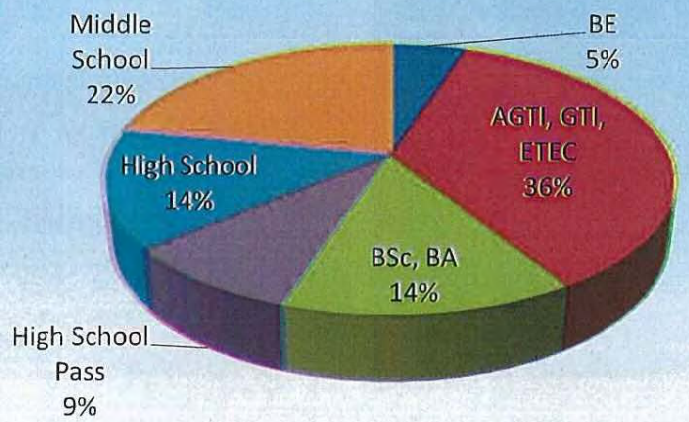
Organization Chart



Number of Staff

Srl. No.	Type of Employees	Sanctioned	Present	Remark
1	Assistant manager	2	1	
2	Senior Tutor	4	2	
3	Demonstrator	6	4	
4	Helper	-	2	
5	U.D.C	2	1	
6	L.D.C	2	1	
7	Grade (1)	-	1	
8	Grade (2)	1	2	
9	Labour	15	8	
	Total	32	22	

Education levels of RTTC's Existing



Major Training Courses

Srl	Description	Basic Course		Advanced Course	
		Trainee	Period	Trainee	Period
1	Welding Course	12	16 Weeks	8	8 Weeks
2	Machine Course	12	16 Weeks	8	8 Weeks
3	Fitting Course	15	16 Weeks	8	8 Weeks
4	Electrical Course	12	16 Weeks	8	8 Weeks
	Total	**51**		**32**	

Additional Courses

Srl	Description	Trainee	Period
1	Basic Diesel Locomotive Repair Course	12	4 weeks
2	Advanced Diesel locomotive Repair Course	12	2 weeks
3	Basic Electric Repair Course	12	4 weeks
4	Advanced Electric Repair Course	12	2 weeks
5	Basic Electronic Course	30	3 weeks
6	Refresher Course on Technical Skills	10	4 weeks

Existing Annual Training Plan = (160) Persons/year
Total (5256) Persons were trained in RTTC now from 1981.

Electric Courses

Basic	Advanced
Basic Electricity Mathematics Drawing House Installation Motor control Metal Working	Motor Winding Pneumatic and Electro Magnetic Locomotive Wiring

Welding Courses

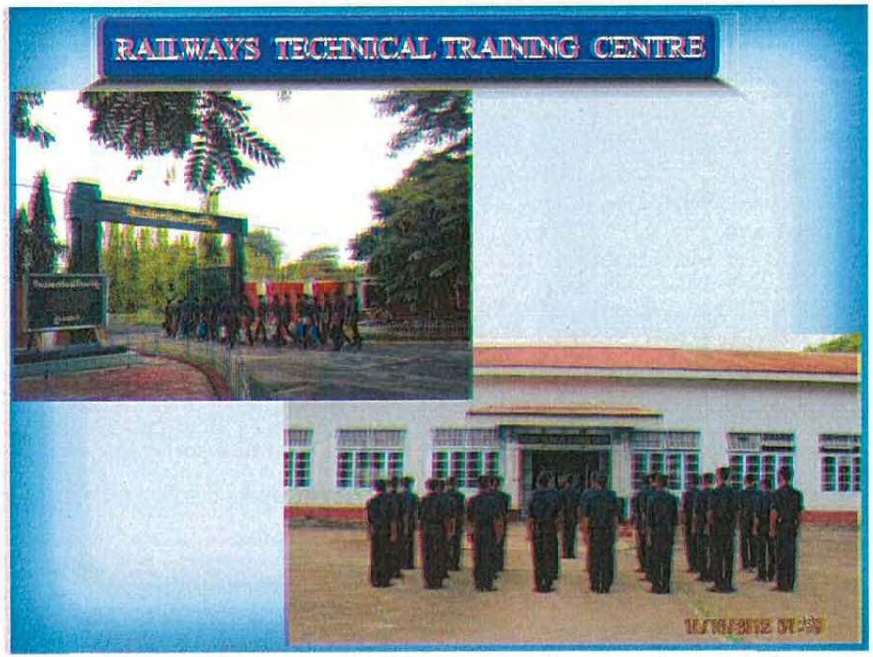
Basic	Advanced
Gas Welding ARC welding	Fine Thin and Body Welding Frames Welding Metal Active Gas Welding (MAG) Metal Inert Gas Welding (MIG)

Machine Courses

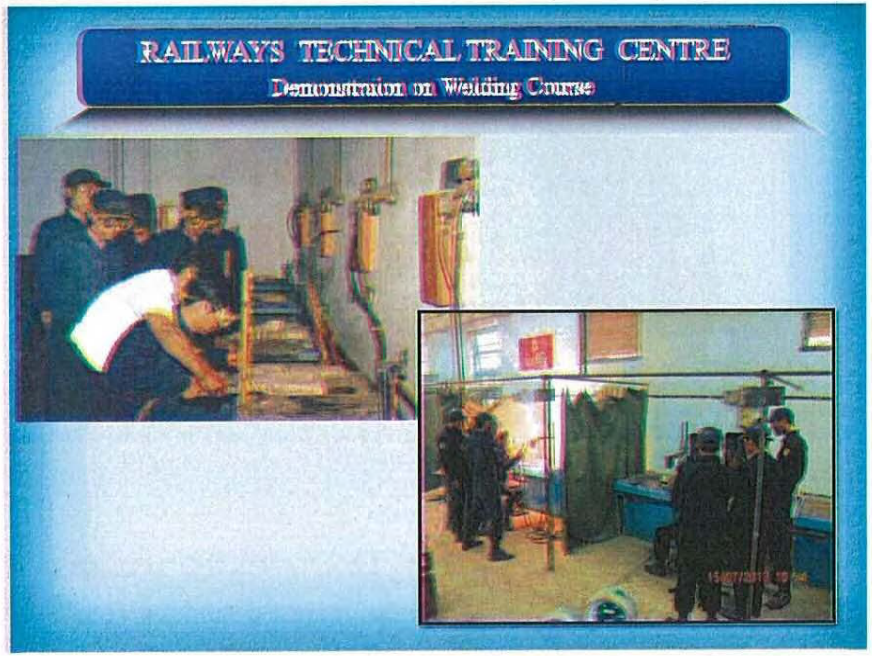
Basic	Advanced
Work shop/ Fitter Metal Drawing Mathematics	Tool Grinding Pneumatic & Hydraulic

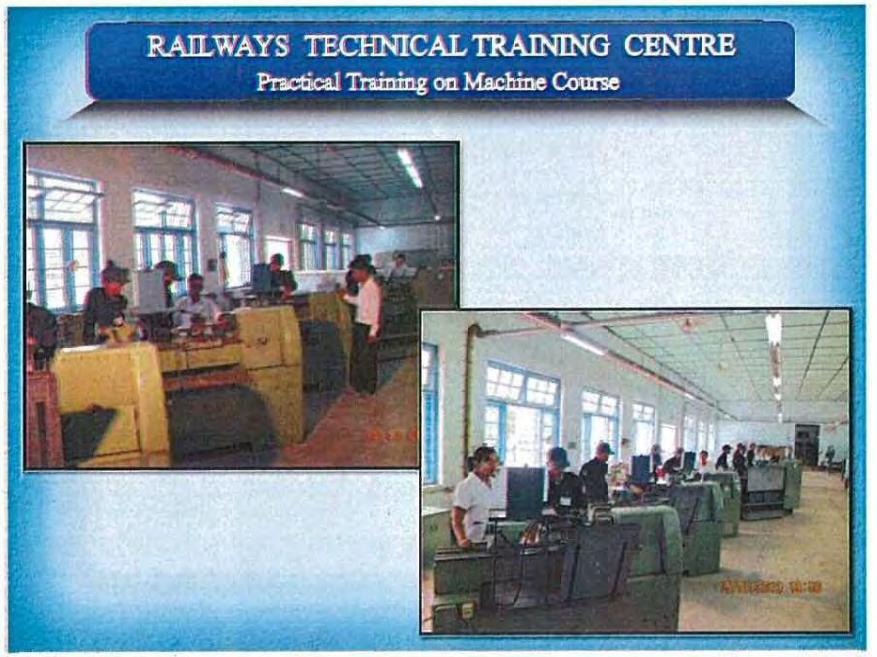
Fitting Courses

Basic	Advanced
Drawing Metallurgy Mathematics Metal Working	Diesel Engine Repair course Auxiliary and Brake Repair Course Diesel Engine Fuel Pump and Governor course Gear Course (Transmission) Bogie Course

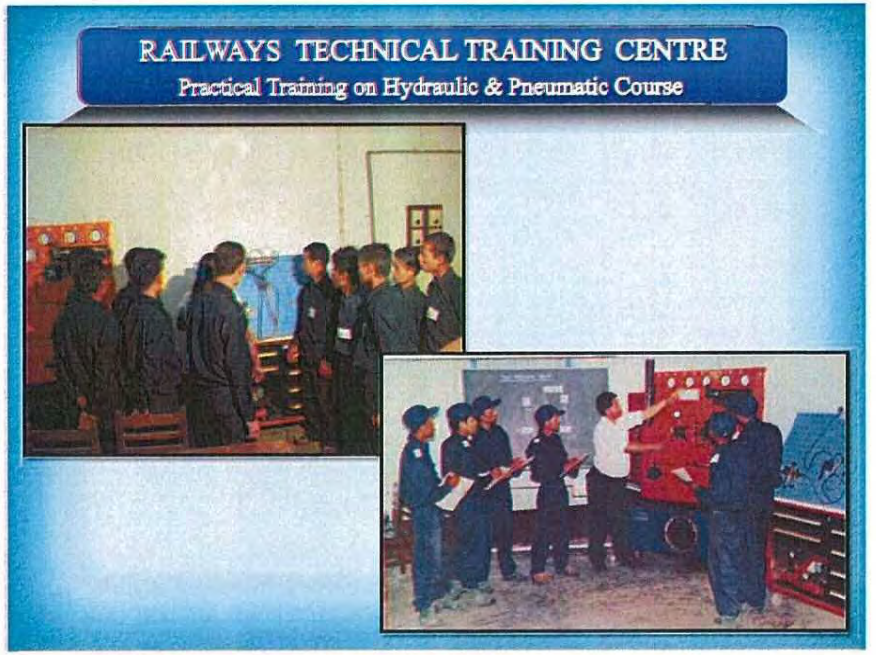


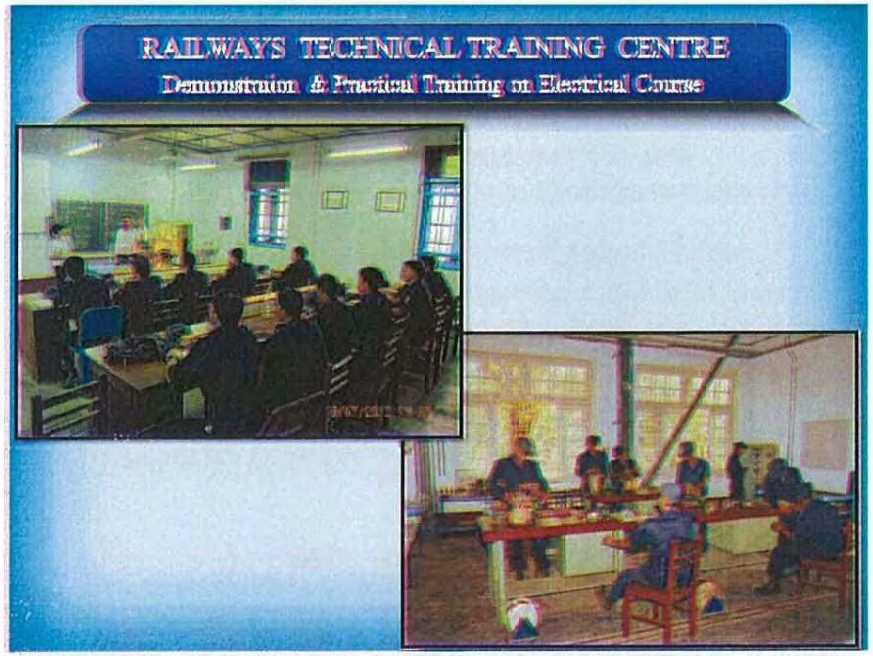
Appendix 8-3-7

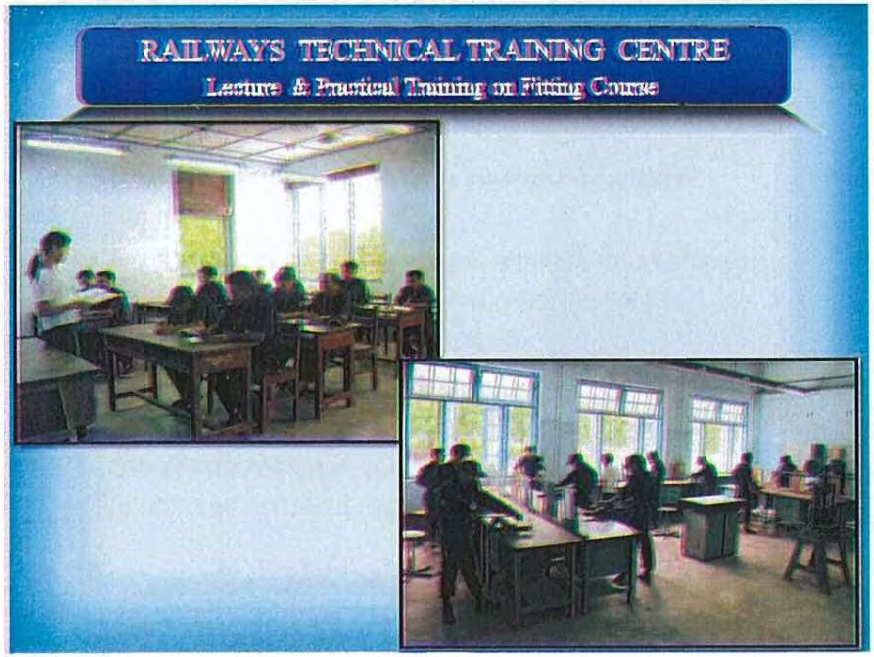




Appendix 8-3-8







RTTC

U Min Aung, General Manager, Ywataung Workshop and Visiting member of JICA Expert Team

Certification

Dormitory

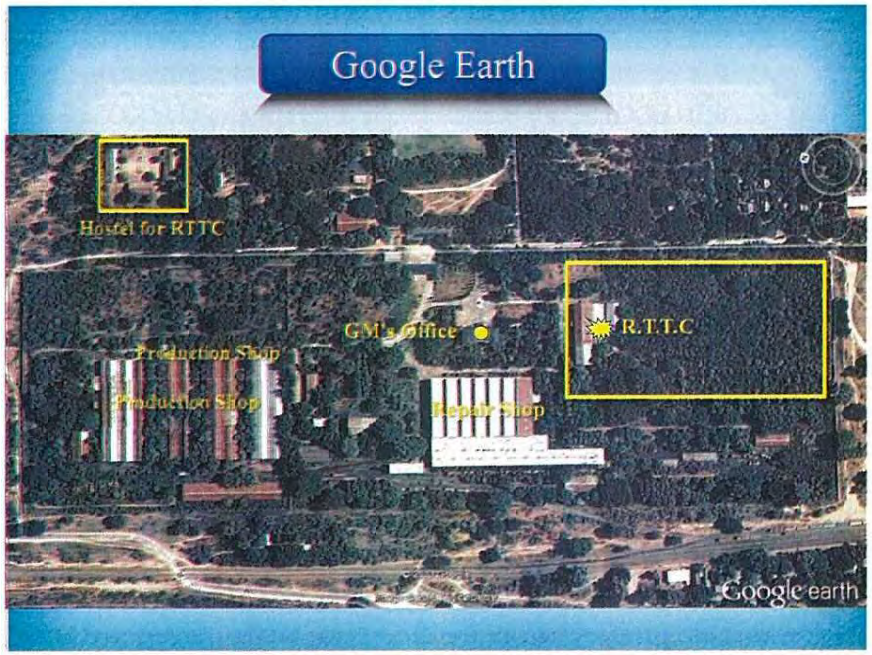
It is recommended to divide the one large room into small units for several number of trainees.

Upgrading Plan

- To upgrade existing facilities especially for Additional Courses. (e.g. Engine, Hydraulic Transmission, Brake System, Electrical Control System,...)
- To introduce CAD, CAM and CNC Training Course.
- To extend Basics Electronic Course.
- To upgrade skill for Diesel Locomotives Repair.
- To refurbish and extend existing Building for additional trainings .
- To facilitate Machineries, Equipments and Testing Instruments .
- To refresh and update Teaching Curriculum
- To improve capacity building of trainers.

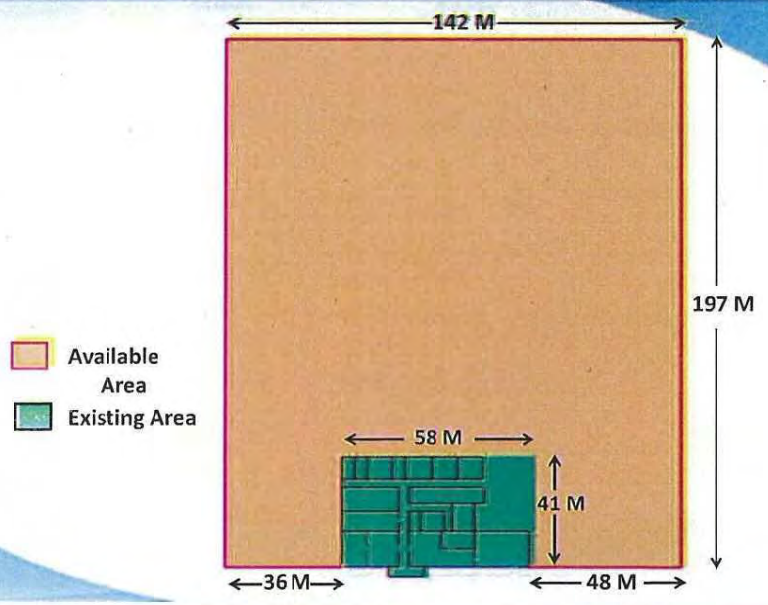
Upgrading Plan

- Estimated Budget - US$ (3) million
- Foreign Aid - Grant
- Area of Project - Diesel Locomotive Workshop, Ywataung, Sagaing Region
- Period of Project - From 2015-2016 Fiscal Year to 2016-2017 Fiscal Year



Available Space Can be Extendable Area

Available Space Can be Expanded Area



Advantages

- Capacity Building of Human Resources .
- Acquiring appropriate Training Format
- Improved Training Methods .
- Higher quality of skilled workers .
- Improved quality of supervising staff .
- Higher level of technical knowledge .
- Foundation for producing highly skilled workers and supervisors needed for new construction of Locomotives in future .

(I) General

Questionnaire on RTTC	Answers by Ywataung
1. Assitance by GTZ. **What were assisted by GTZ ?** Buildings, machineries, Lodging for teachers and trainees , preparation of Curriculum, Training of teachers.	The ***Total Assistance*** to the given is ***7 Million DM*** (Deutsche Mark), which was divided as follows:- (1) ***4 Million DM*** for services of the ***Experts*** to be extended 180 Man-months , including the services of ***Stores Experts***. (2) ***Material Assiatance*** including the ***Machines for Teaching Aids*** and the ***Machines for improvement in the Main Workshop*** to the value of ***3 Million DM***. *Building* - Constructed by Myanma Railways. ***Machineries*** - **Material Assistance by GTZ (GIZ).** *Lodging for Teachers* - MR's Lodging . *Lodging for Trainees* - MR 's Lodging. ***Preparation of Curriculum*** - GTZ (GIZ) was started for the regular training courses. For the Additional courses, MR prepared. ***Training of teachers*** - GTZ (GIZ) arranged some teachers were trained in Germany and some were trained in Sinde, Myanmar.

(I) General

Questionnaire on RTTC	Answers by Ywataung
2. **Regarding the floor plan of RTTC , Where are the lodgings for teachers and trainees ?**	We did not mention lodging of teachers and trainees in the floor plan, because it was mentioned Training Center only. ***For teachers*** Arranged by Myanma Railways, not GIZ by using existing quarters. ***For trainees*** MR constructed Hostel for trainees (60 persons) , not GIZ. This Hostel is existed in outside of workshop and 0.5 Kilometer far from RTTC building.

(I) General

Questionnaire on RTTC	Answers by Ywataung
3 After handover of RTTC from GTZ (GIZ) to MR on Oct.4,1987 , what kind of follow up assistance was made by GTZ (GIZ) ?	After hand-overing period, some ***vocational trainings*** were aided. ***In 1992***, five numbers of MR's staffs (Non-officers and Engineering Graduates) were selected and sent to Germany for the vocational training and training period was 15 Months. Those trainees are as per below. 1. U Thet Lwin (Now General Manager, Insein workshop) 2. U Aung Myint (Now Deputy General Manager, Headoffice) 3. U San Myint (Now Assistant General Manager, Insein workshop) 4. U Myint Zaw (Now Divisional Mechanical Engineer, Myitnge) 5. U Maung Maung Zaw Oo (Resigned) ***In 2013***, persons from KfW Development Bank and GIZ visited to RTTC. ***In December, 2014***, Director of KfW Development visited to RTTC and he will arrange a Junior Project Manager to visit RTTC in the March,2015.

(I) General

Questionnaire on RTTC	Answers by Ywataung
4. What kind of training are provided for maintenance / design / manufacturing of passenger coaches, freight wagons ?	It is not directly concerned with RTTC. Personnel of Headoffice will answer for this question in complete. For Myanma Railways , this training is really necessary.
5. How to select the trainees ?	Trainees are selected by head-office based on the age, education level and health .

(I) General

Questionnaire on RTTC	Answers by Ywataung
6. Is any license or qualification given to the trainee after completing the training ?	Certificate was given to the trainees when trainings were completed by ceremonies.
7. Are there any tasks in the field that require such license/ qualification described above to implement the tasks ?	In the field, some tasks required those certificates. For example a staff who implement welding works must have concerned certificates.
8. Are there any benefits for the trainees after completing the training such as promotion or raise in salary ?	No benefits , such as promotion or raise in salary for the trainees after completing the training immediately. But RTTC's certificates will be considered in the promotion examination.

(I) General

Questionnaire on RTTC	Answers by Ywataung
9. What is the typical career path of the staffs for each field such as station staff, track work staff, workshop staff, driving staff, etc. and how are the role of RTTC for their stepping up ?	In Myanma Railways, existing typical career path is mentioned as below. For the station staff, Operation Department recruit separately. For the track work staff, Civil Department recruit separately. For the Rolling Stock workshop and Depot staffs, Mechanical and Electrical Department recruit separately. For the locomotive driving staff, Mechanical and Electrical Department selected from the depots staffs based on the age, education level and health. After selection, selected persons will be sent to CITC for the concerned training courses . For the some driving courses, trainees must be sent to RTTC for the Basic Electronic Training Short Term Course. Previously ,Some driving staffs were recruited from outside who have Government Technical Certificates by examination. The role of RTTC is not directly concerned for their stepping-up. RTTC is undertaking to upgrade of staffs who work in Mechanical and Electrical Department .

(I) General

Questionnaire on RTTC	Answers by Ywataung
10. Who make the materials of training such as text books , mock-ups ?	Mechanical and Electrical Department provide the materials of training such as text books, mock-ups, Job pieces and etc.
11. When new technology is introduced, will any training be planned in RTTC for operating and maintaining of the new technology ?	In Myanma Railways , before introducing new technology , concerned staffs will be selected and sent the training course in outside that is foreign or local area. After this training courses, they became trainers for the other staffs by on job training mostly. Previously, we did it like this. The one of the objectives of Upgrading RTTC is training to be planned for the introducing new technology.

(II) Organization

Questionnaire on RTTC	Answers by Ywataung
1. Where is the Manager ?	No Manager for RTTC in organization Chart. At present, a Divisional Mechanical Engineer who have Bachelor of Engineering is undertaking this RTTC. It is U Khin Maung Htun.
2. To what department of MR's Headquaters does RTTC belong ?	Mechanical and Electrical Department is undertaking RTTC.
3. Teachers are transferred periodically ?	Not periodically transferred. Some teachers were transferred to other areas for the next promotion and some were transferred to RTTC from other departmental areas. For example , the teachers mentioned in answer of your question General - No.3 were transferred to RTTC after their foreign training, then they were transferred from RTTC to other areas for promotion.

(II) Organization

Questionnaire on RTTC	Answers by Ywataung
4. Some of the teachers come from Headquarters, Divisions, Workshop or Universities ?	Some of the teachers come from Divisions and Workshops and who have Government Technical Certificates and Engineering Graduates.
5. What is the difference of role between two assistant managers ?	The two assistant managers in the organization means two categories that Mechanical and Electrical.
6. What are UDC and LDC ?	UDC means Upper Divisional Clerk and LDC means Lower Divisional Clerk.
7. What are grade (1) and grade (2) ?	Grade (2) means the one step higher than labour, lowest level of staffs. Grade (1) means the one step higher than Grade (2).

(II) Organization

Questionnaire on RTTC	Answers by Ywataung
8. What are BE, GTI, EGTI, ETEC ?	BE = Bachelor of Engineering GTI = Technical Certificate of Government Technical Institute EGTI = Technical Certificate of Government Technical Institute Evening Class. (Only allowed to attend for government staffs who passed 10th.Standard by entrance examination) Government Staffs who passed ETEC and qualified for EGTI. ETEC = Engineering Technology Evening Classes (Only allowed to attend for government staffs who passed 8th. Standard by Entrance Examination)
9. What is the difference between High School Pass and High School ?	High School Passed = Who passed High School (10th. Standard) High School = Who did not pass High School (10th. Standard) and only passed 9th. Standard

(III) Training Schedule for the years 2013-2014

Questionnaire on RTTC	Answers by Ywataung
Are there any training course of [Basic Electronic Course] and [Refresher Course on Technical Skills] in 2013-2014 ?	In 2013-2014 no refresher Course on Technical Skills and Basic Electronic Course were opened three time due to the recruit of driving staff..

(IV) Upgrading of RTTC

Questionnaire on RTTC	Answers by Ywataung
1. What is CNC ?	CNC means Computerized Numerical Control.
2. Facilitation of Machineries and Equipments means improvement of them ?	It means to upgrade existing facilities by adding state-of-the-art machineries and equipments.
3. What is the attitude of GTZ for upgrading of RTTC ?	Before German-Myanmar Cooperation meeting in November 2014 , RTTC was not considered to upgrade by GTZ (GIZ). GM (Ywataung) submitted to upgrade RTTC in this meeting. After this meeting, Director of KfW Development Bank visited RTTC in the second week of December 2014 and he will report to Federal Ministry for Economic Cooperation and Development of Germany. Besides, he arranged to survey RTTC by Junior Project Manager of GIZ in March 2015. According to the Ministry's decision, they will decide that RTTC will be upgraded or not. It is existing situation of GIZ's attitude.

Machinery List at Railways Technical Training Center,Ywataung

Srl No	Name	Machine No	Brand & Country of Origion	In Service Starting	Original Cost	Remark
1	Drill Machine	102902	Germany	26.5.1981	3817/ 14 DM	Fitting Course
2	Slotting Machine	25494 , 80061	Stick , Germany	26.5.1981	74037/ 48	- " -
3	Drill Machine	102896	Germany	26.5.1981		- " -
4	Bending Roller Press	8913035	Fastic, Germany	5.3.1981	24955 / 24	- " -
5	Hydraulic Press	25494 , 80061	Assembled in RTTC	7.5.1986		- " -
6	Forming Machine	8043207	Fastic , Germany	26.5.1981	33975/ 39	- " -
7	Drill Machine	5280	Almenrall , Germany	7.5.1986	29305	- " -
8	Overhead Crane	114065	Heinrich de Fries GmbH,Germany	7.5.1986	63530 DM	- " -
9	AEGC Screw Press	13666/1	13666/1	26.5.1981	1825/00	- " -
10	Plate Shear	SH 01 4237 01	Stick mann & Hiller	26.5.1981	36563/36	- " -
11	Welding Rectifier Rexalist 354- 251 2Wo	4830122	Messier griesher Germany	26.5.1981	5620 DM	Welding Course
12	Welding Rectifier Rexalist 354- 251 2Wo	4830124	Messier griesher Germany	26.5.1981	5620 DM	- " -
13	Welding Transformer Ehrom 310	4840078	Messer Griesheim - Germany	26.5.1981	3020 DM	- " -
14	Welding Transformer Ehrom 310	4840071	Messer Griesheim - Germany	26.5.1981	3020 DM	- " -
15	TIG Welding Machine	430045	Messer Griesheim - Germany	26.10.1981	8195 DM	- " -
16	Welding Machine WARDMIG 350-2	4020139	Messer Griesheim - Germany	26.10.1981	7730 DM	- " -
17	Cutting torch Secator	5930154	Messer Griesheim - Germany	26.10.1981	2240 DM	- " -
18	Drill Machine	102903	Germany	1981		Electric Course
19	Drill Machine	102879	Germany			- " -
20	Grinding Machine	660013	Germany	1981		- " -
21	Lathe Machine	1726377	Germany	1981		- " -
22	Sawing Machine	1710	Germany	1981		- " -
23	Annealing Machine	1596	Germany	1980		- " -

Srl No	Name	Machine No	Brand & Country of Origion	In Service Starting	Original Cost	Remark
24	Cooler Lathe Machine	9559	WEILER, West Germany	26.5.1981	15941.20 Kyats	Machine Course
25	Pedestal Grinder	690026	REMA - West Germany	26.5.1981		- " -
26	Tool Grinder	040774	REMA - West Germany	26.5.1981		- " -
27	Lathe Machine	9557	WEILER -West Germany	26.5.1981	15941/20	- " -
28	Shaper	61279	Klopp West Germany	23.7.1983		- " -
29	Pedestal Grinder	060014	REMA - West Germany	26.5.1981		- " -
30	SHAPER ATLAS			26.5.1981	52167/24	- " -
31	Lathe Machine	9558	WEILER -West Germany	26.5.1981	15941.20 Kyats	- " -
32	Lathe Machine	3009.48	FRITZ KERN Gmt H & CO. KG W. Germany		131447.60Kyats	- " -
33	Drilling	102901	West Germany	26.5.1981		- " -
34	SAWING	5246	BEHRINGER - West Germany	17.1.1986	22625 /87	- " -
35	Drilling	102897	West Germany			- " -
36	Drilling	102900	West Germany	26.5.1981		- " -
37	KUNZMANN MILLING Machine	14694	KUNZMANN - West Germany	26.5.1981	145170.48 Kyats	- " -
38	KUNZMANN MILLING Machine	14693	KUNZMANN - West Germany	26.5.1981	145170 .48Kyats	- " -
39	Surface Grinder	12810	HAUNI-WERK - KORPER &	26.5.1981	74761.46Kyats	- " -
40	Cylindrical Grinder	60346	OVERBECK -West Germany	23.7.1983		- " -
41	Lathe Machine	9552	WEILER - West Germany	26.5.1981	108979. 68Kyats	- " -
42	Tool and Cutter Grinder	1304 -545	SCHREYER - West Germany	26.5.1981	44673.64 Kyats	- " -
43	Tool Grinder	040773	REMA - West Germany	26.5.1981		- " -
44	Precision Grinder	660015	REMA - West Germany	26.5.1981		- " -

Background History of CITC

- Central Institute of Transport and Communication (CITC) had been officially established as a training school under former Ministry of Transport and Communication at Sin Ma Lite Dockyard in Yangon since 1972.
- On 15th July of 1978 , it was shifted to current place of Meiktila Township, and operated by the name of Central Institute of Transport and Communication (CITC).
- Automobile Trainings, Railway Trainings and Telecommunication Trainings have been conducting there.
- On 29th January of 1992, CITC has been placed under the Ministry of Rail Transportation as the former Ministry of Transport and Communication was restructured into three Ministries as Ministry of Transport , Ministry of Communication and Information Technology and Ministry of Rail Transportation.

Cont;

- Since 29th January of 1992, Automobile Trainings and Railway Trainings have been conducting as the communication training were excluded in its training programmes.
- All training courses of Technical Training Division were not conducted any longer because the training courses of Basic Arc Welding, Basic Electrical, Course and Basic Fitter Course had been shifted to Rail Transportations Training Centre(RTTC) of Ywa Htaung Diesel Locomotive Factory.
- Simillary, Automotive Mechanics Courses had not been carried on in 2006 and Driving Courses in 2010-2011 because of no longer sending of trainees from Road Transport Corporation(RTC).
- At present, CITC continues to open just for Rail Training Courses.

Vision

- To tain and cultivate service personnel to be effctiveness and efficeciness in moral, discipline and high operational capacity for land transportation service sector of the state.

Objectives

- To train the service personnel to be skilled in their trades in accord with the proceduers of working manual and to keep abreast of advanced technologies.
- To train the service personnel to be skilled in management and to use of their abilities by using effectively and efficiently the combination of capacities in hand.
- To train the service personnel to understand the present national political cause and to gain smooth public relation.

Policy

- To train the service personnel understanding ongoing democratization government system and policies, rules and regulations, and advanced technologies, and to be able to manage skillfully in actual implementations.

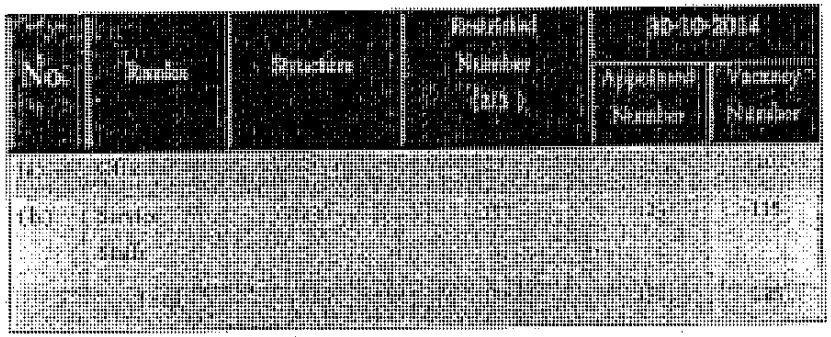
Procedures

- Conducting the training courses for instructors, staffs and trainees in order to develop their techniques and work-field skills, and to keep right perception on morale and discipline.
- Arranging excursions to work related factories, mills and training courses for the sake of exposure not only to be skill in their work-fields but also apart from theory.

Cont;

- Conducting the training courses, under the guidance of Ministry, which are actually needed for the service personnel who are serving in the various departments of the Ministry of Rail Transportation.
- Implementing the Skill Training Courses for the service personnel such as Induction Training Courses,Skill Upgrading Training Courses, Retraining and Apprentice Training Courses accordingly.
- Arranging scholarship programme for service personnel in order to develop job-related skills and understand well on advanced technologies, and cooperating with international training institutes.

Structure/ Restriced/ Appointed (30-10-2014)



56.6%

2014-2015 Opening of Training Courses (until 15th Oct; 2014)

Sin.	Training Departments	Opened		Opening		To Open	
		Course	Number	Course	Number	Course	Number
(a)	Training Department(Literature)	3	62	2	28	1	20
(b)	Training Department(Material)			1	12		
(c)	Automobile Training Department	5	14				
(d)	Rail Training Department	9	177	4	82	7	160
(e)	Mechanic Training Department			1	19		
	Total	13	253	8	141	8	180

Excluded Training Course within Proposed Courses (2014-2015)

Sin.	Training Departments	Opened		Opening		To Open		Remarks
		Course	Number	Course	Number	Course	Number	
1	**Rail Training Department**							
	(a) Junior Assistant Supervisor Course Ticket Collector and Station Clerks (TC/SC)	1	14	-	-	-	-	-For the needs of Myanma Railways
	(b) Locomotive Driver (Shunting) Course	-	-	1	25	-	-	-Substitution for Assistant Locomotive driver (Apprenticeship) Course
	Total	1	14	1	25	-	-	

The Courses to be opened in 2014-2015

Sr.	Department	Number	Duration		Remark
			From	To	
1	**Training Department (Litcature)**				
	- Basic Clark (Computer) (35/2014)	20	1.12.2014	13.2.2015	
	Rail Training Department				
2	a) Traction Motor Maintenance (9/2014)	10	20.10.2014	24.10.2014	
	b) Train-Guard (Special) (10/2014)	15	10.11.2014	12.12.2014	
	c) Apprentice Mechanical & Electrical Engineering (Special) (8/2014)	15	1.12.2014	20.3.2015	
	d) Junior Engineer (3) (Railroad) (Refresher) Course(14/2014)	15	22.12.2014	26.3.2015	
	e) Locomotive Driving Assistant-2 (21/2014)	25	29.12.2014	20.3.2015	
	f) Station Master (Roresher) Course (35/2014)	20	19.1.2015	13.3.2015	
	g) Assistant Station Master (Apprentice) Course (33/2014)	60	5.1.2015	7.8.2015	-To open in 2014-2015 Training Year.

The Courses Conducted by the Training Departments

1. Training Department (Literature)

Sr.	Name of Course	Duration	Acceptance Capacity	Instructor's responsibility		Remarks
				Internal	External	
1	General Management & Leadership (Officer)	3-weeks	25	45%	55%	
2	Management (Supervisor) Course	6-weeks	20	40%	60%	

1. Training Department (Materials)

Sr.	Name of Course	Duration	Acceptance Capacity	Instructor's responsibility		Remarks
				Internal	External	
1	Store Keeping Course	10-weeks	15	70%	30%	

3.Automobile Training Department

Sr.	Name of Course	Duration	Acceptance Capacity	Instructor's responsibility		Remarks
1	Automobile Supervisor Course	15-weeks	15	80%	20%	
2	Driving (Grade-3)	8-weeks	15	90%	10%	
3	Driving (Grade-4)	11-weeks	20	100%	-	
4	Basic Driving	12-weeks	30	100%	-	
5	Automobile Mechanic (Grade-2)	8-weeks	20	100%	-	
6	Basic Automobile Mechanic	14-weeks	20	100%	-	
7	Basic Automobile Electric	8-weeks	10	100%	-	

4. Mechinical Training Department

Sr.	Name of Course	Duration	Acceptance Capacity	Instructor's responsibility		Remarks
1	Basic Welding	15-weeks	20	100%	-	
2	Basic Electric Arc Welding	15-weeks	20	100%	-	
3	Basic Fitter Course	15-weeks	20	100%	-	
4	Basic Computer Drawing (Auto CAD 2D/3D)	16-weeks	12	100%	-	
5	Basic Computer Course	10-weeks	12	100%	-	

5. Rail Training Department

(a) Transportation Training Unit

1	Assistant Station Master (Apprentice)	26-weeks	50	90%	10%	
2	Station Master (Refresher)	6-weeks	22	100%	-	
3	Ticket Collector &Station Clark (TC/SC)	17-weeks	50	95%	5%	
4	Station Clark ; Ticket Inspector & Ticket Collector (Refresher)	5-weeks	30	90%	10%	
5	Number Marker (Basic)	6-weeks	50	100%	-	
6	Train Guard (Basic)	5-weeks	15	100%	-	
7	Train Guard (Refresher))	5-weeks	15	100%		
8	Train Guard (Special)	5-weeks	15	100%	-	
9	Junior Engineer(Grade 4)	5-weeks	10	65%	35%	

(b) Mechanical & Electronic Engineering Training Unit

1	Apprentice Mechanic & Electrical Engineering (Special)	16-weeks	15	25%	75%	
2	Locomotive Driver Course	20-weeks	25	55%	45%	
3	Assistant Locomotive Driver (Apprenticeship) Course	20-weeks	25	55%	45%	
4	Locomotive Driver (Shunting) Course	12-weeks	25	45%	55%	
5	Assistant Locomotive Driver Grade-II Course	12-weeks	25	50%	50%	
6	Locomotive Driver (Apprenticeship) Course	39-weeks	20	70%	30%	
7	Locomotive Driver (Refresher) Course	8-weeks	20	40%	60%	
8	Disel Locomotive Repair Course	10-weeks	10	50%	50%	

(d)Civil Engineering Training Unit

1	Rail Track (Refresher) Employee In-Charge	5-weeks	14	100%	-	
2	Junior Engineer -III , Rail Track (Refresher)	13-weeks	12	75%	25%	
3	Junior Engineer -IV, Rail Track (Apprentice)	33-weeks	20	Still tasking		

- Total Courses, can be conducted. ⇒ (42) kinds
- Instructors' responsibility for all Courses ⇒ (71.67)%
- External Instructors' responsibility ⇒ (28.33)%

Plan of Training at CITC for 2014-2015

The CITC has train 500 to 700 staffs of Ministry of Rail Transportation every year planning of training course for 2014- 2015 are-

Sr	Training course	Frequency	Term (week)	Person
	Training Literature Department			
1	General Management and Leadership Course	1	4	19
2	Management (Supervisor) Course	2	6	44
3	Computer Course;-			
	(a) AutoCAD Course	1	15	8
	(b) Office Application & DTP Course	2	11	38
	Total	**5**	**-**	**77**
	Automobile Training Department			
1	Basic Driving and Repair Course	1	11	14
2	Basic Driving and Repair Course (Transport and Planning Department)	1	8	25
	Total	**2**	**-**	**39**
	Training Aids and Store Department			
1	Store Keeping Course	1	10	12
	Total	**1**	**-**	**12**
	Railway Training Department			
1	Junior Engineers Rail Road(Apprenticeship) Grade IV Course	1	34	22
2	Junior Engineers Rail Road Grade III (Refresher) Course	1	14	15
3	Railroad Tracks Employee Course	1	5	11
4	Diesel Locomotive Repair Course	1	10	15
5	Diesel Electric Locomotive Repair Course	1	10	15
6	Coach Inspectors Technicians Grade IV Course	1	16	15
7	Assistant Station Master Course	1	18	14
8	Assistant Supervisors (Guards) Basic Course	1	8	29
9	Assistant Supervisors (Guards) (Refresher) Course	1	5	15
10	Second Supervisor (Number Taker) Course	1	6	28
11	Station Masters (Refresher) Course	1	8	20
12	Second Station Masters (Apprenticeship)Course	1	30	60
13	Train Guard Special (Refresher) Course	1	5	15
14	Station Clerk and Ticket Collectors (Refresher) Course	1	5	20

Sr	Training course	Frequency	Term (week)	Person
15	Train Guard Special Course	1	5	15
16	Electrical and Mechanical Engineers (Apprenticeship) Course	1	16	15
17	Guard Inspector Course	1	6	15
18	Locomotive Drivers Course	1	20	25
19	Assistant Locomotive Drivers (Grade II) Course	1	12	25
20	Locomotive Drivers (Shunting) Course	2	12	39
21	Traction Motor Maintenance	1	1	10
	Total	**22**	**-**	**438**
	Technical Training Department			
1	Basic Electric Course	1	15	19
	Total	**1**	**-**	**19**
	Grand Total	**30**	**-**	**585**

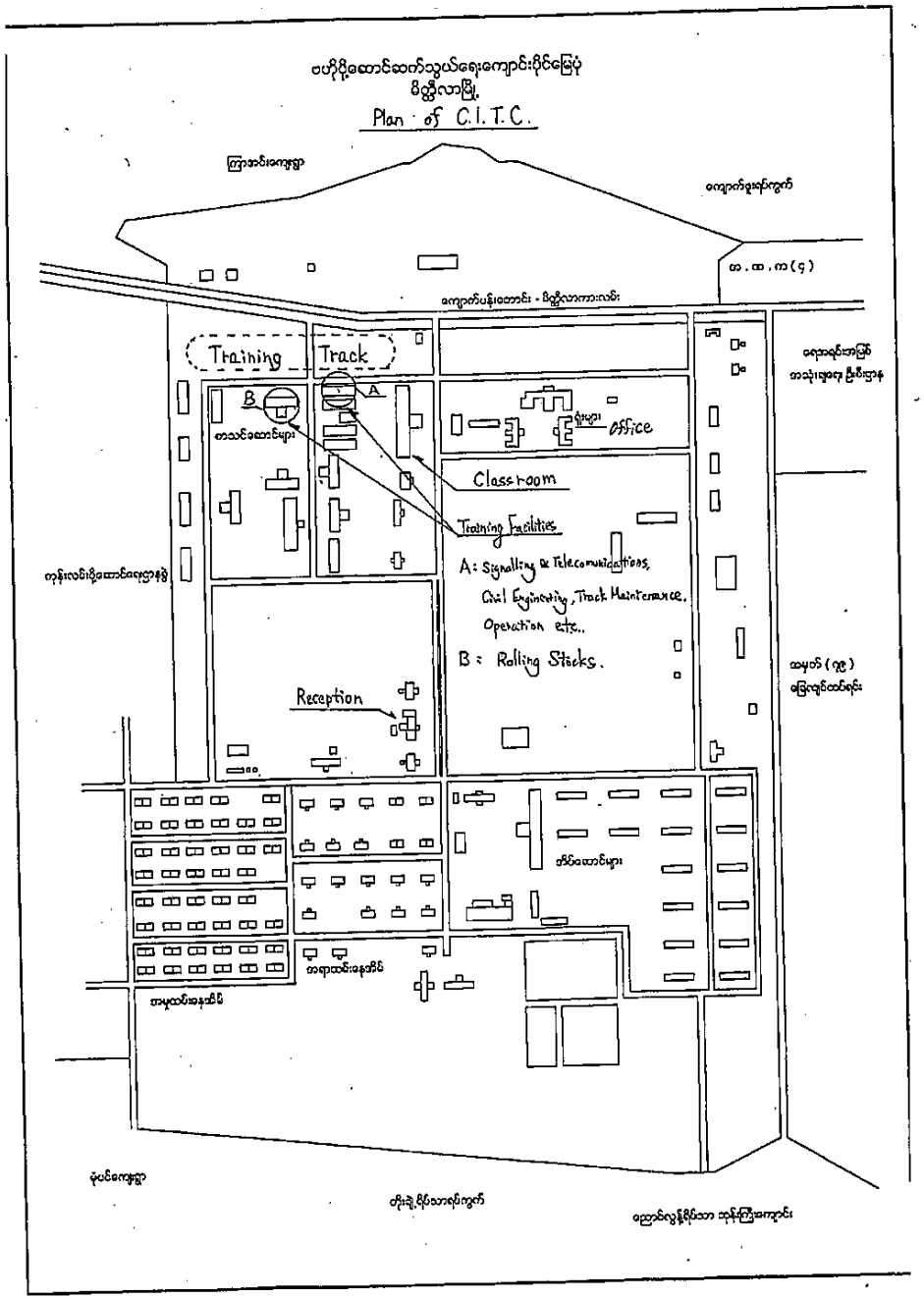
Other miscellaneous information of CITC

(1) General

1) Teachers are generally replaced every two years. However teachers of computer continue to stay without being replaced periodically.
2) Teachers are dispatched from the headquarters or divisions of MR
3) Test of trainees: paper test: should be more than 50 marks for passing the test
   practical training test: judging whether he is successful or not by observation.
4) Trainees entering the CITC are selected by the managers of MOR
5) Meals are provided free of charge. Budget, 500 kyats per day.
   Example: Breakfast: Chinese dish of fried rice
   Lunch: Soup, vegetables, rice
   Dinner: Meat, vegetables, rice
6) After completion of a training course, a completion certificate is granted to a trainee. Certificates are necessary for promotion and without completion certificate, the next advanced training course cannot be allowed.
7) Any trainings for new comers to MOR are not provided.
8) Materials for training including text books, and mock-up are prepared by CITC and authorized by the headquarters of MOR

(2) Practical training

1) Training of welding
   There is a welding training room where trainees of Basic Course and Advance Course are trained about welding techniques: gas welding, are welding. With respect to welding training, 30 % of training by lecture and 70% by practical training.
2) There is a machine laboratory where trainees of Basic Course and Advance Course are trained about machining. With respect to machining training, 40 % of training by lecture and 60% by practical training for Basic Course, and 50 % by lecture and 50 % by practical training for Advance Couse.
3) Training Equipment
   a) Tablet blocking equipments installed at CITC are broken, so trainees must go to the nearby stations for practical training..
   b) Various track materials are displayed in the training room
   c) Training of repair of locomotives is executed at RTTC, and training of operation of locomotives is executed at CITC.
   d) With respect to assistance by foreign countries for training equipments, China and India are extending their cooperation.
   e) Practical training track
      Training of various track maintenance works are provided here, including assemble of turnouts, replacement of rails and sleepers, track inspection. However, training of rail welding and large sized track maintenance machines are not implemented here.



CITC

Dr. Aung Myo Kyaw, Deputy Director of CITC and Visiting Members of JICA Expert Team

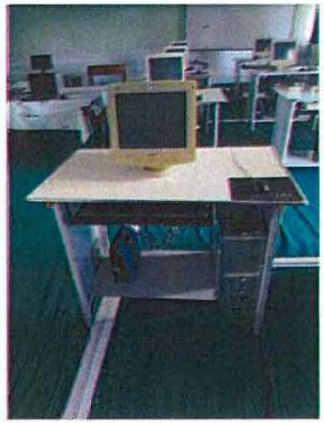
Certification

Lecture room

Lecture room (rather dark)

Desk for trainee (small)

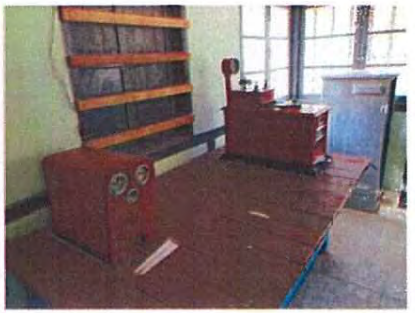
Lecture room



Computer Room

lecture

Training Equipment①



Signaling

Training Equipment②

Railway model

Explanatory Diagram
"type of bridge girders

Training Equipment③

Track maintenance materials, equipment and tools

Training Equipment④

For train operation

For rolling stock
maintenance

Practical training track

Bridge on practical training track

"Baily pin" structure bridge, is installed on the track.
But this structure is a minor type on operating line of MR.

PROJECT ON IMPROVEMENT OF SERVICE AND SAFETY OF RAILWAY IN MYANMAR

1

Two Subprojects Composing the Project

The Project consists of two sub projects:

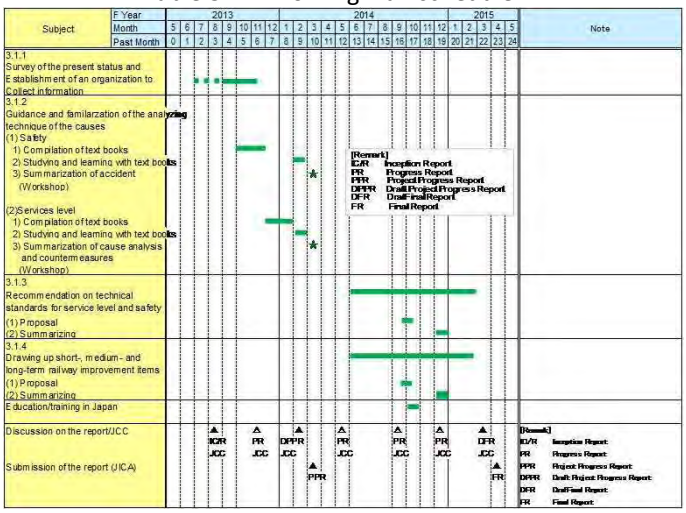
(A) Based on analysis of causes of accident and low service level, recommendation on technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level

(B) Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project

2

Progress of the Subproject A

Table 5.1.1 Working Plan schedule



Major Activities of Subproject A and Major Outputs (1)

Major Activities		Major Outputs
Items	Contents	
5.1.2 (1) Establishment of Organization to collect information	Organization of Counterpart Team	Table 4.1 Progress Report, March 2015
(2) Present status of Safety and Service level of MR	Analysis of MR statistics and preparation of "Present Situations of Safety and service Level of MR"	Appendix 8-1, Progress Report March 2014

Major Activities of Subproject A and Major Outputs (2)

Major Activities		Major Outputs
Items	Contents	
5.1.3 Guidance and familiarization of the analyzing technique of the causes of accident and low service level	Execution of Training program of cause analysis of accidents/low service level and establishment of countermeasures (Feb. 10 – 28, 2014)	Details of Training Program are described in Progress Report, May 2014
	(1) Class room lecture of text book JICA experts explained the past accidents and their countermeasures, and the measures for improvement of the service level in Japan . Discussions between JICA lecturers and MR participants. Major advices to MR by JICA experts.	・Text Book distributed among MR experts JICA experts' advices, Progress Report, May 2014

Major Activities of Subproject A and Major Outputs (3)

Major Activities		Major Outputs
Items	Contents	
	(2) Workshops **1) The purpose of the workshop** To make MR experts be familiarized with analysis of causes of accidents and low service levels and establishment of countermeasures. MR experts by themselves tried to analyze the causes of actual MR's accidents and low service levels and to establish the appropriate countermeasures. **2) Discussion between MR experts and JICA experts on presentation by MR experts.** JICA experts made comments,and also presented advices to MR experts regarding major issues identified through discussion.	Summary and details of comments and advices by JICA experts are given in Appendix 2-1 of Progress Report, May 2014.

Major Activities of Subproject A and Major Outputs (4)

Major Activities		Major Outputs
Items	Contents	
	3) Comments of training program by MR participants. In order to find out the major response of MR experts to the Training Program (the lectures by JICA experts and Workshop), the questions were asked to each MR participant.	The answers to each question by MR participants are shown in Table 2.4 of the Progress Report, May 2014
	(4)Training for measurement of train vibration In order to make MR experts to be familiarized with how to apply the vibration measurement of train to control of track maintenance and improvement of vehicle performance, JICA experts instructed measurement and analysis of actual Train Vibrations on Feb. 27, and 28th.	The details of the training of measurement of train vibration are presented in [Vibration Measurement Report] included as a part of the Progress Report, May 2014.

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Major Activities of Subproject A and Major Outputs (5)

Major Activities		Major Outputs
Items	Contents	
	(5) Investigation of Customer's Satisfaction Level of MR passenger transport In order to investigation customer's satisfaction level of MR passenger transport, interview survey was conducted on March 4 to 7 2014, between Yangon Station and Nay Pyi Taw Station on Yangon-Mandalay Trunk Line 3 kinds of train and class, "Express Upper", "Express Ordinary" and "Local", were targeted and at least 120 passengers were sampled for each train kind/class. For interviewing, a questionnaire consisting of 20 questions was prepared.	The details of the interview survey and the result of the analysis of the answers to the questionnaire are summarized in th Progress Report, May 2014.

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Major Activities of Subproject A and Major Outputs (6)

Major Activities		Major Outputs
Items	Contents	
5.1.4 Recommendation on technical standards relating to administrative and maintenance aspect to improve the service level and safety	**(1) Collection of Major Technical Standards of MR** JICA Experts collected the relevant major technical standards relating to safety and service level in the respective engineering fields.	
	(2) Review of Technical Standards and proposal of recommendation JICA Expert Team made reviews on the collected technical standards and proposed recommendations on these technical standards	Appendix 1 [Report of Proposal of Recommendation on Technical Standards of MR and Short-, Medium-, and Long term Railway Facilities Plan](Herein after referred to as "Report of Proposals") attached to Progress Report September 2014.
	(3) Discussion of Report of Proposal by Working Group Report of Proposal was submitted to the workshop and discussed by the members of Working Group for Service and Safety Improvement.	Appendix-2 [Summary of discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium- and Long-term Railway Facilities Improvement Plan] to Progress Report Dec. 2014 Appendix 8-1, Additional Q & A of Workshop, Progress Report March 2015

Major Activities of Subproject A and Major Outputs (7)

Major Activities		Major Outputs
Items	Contents	
	(4) Revision of the Report of Proposal The Report of Proposal was revised as required according to the discussion mentioned in (3) above.	Appendix-1 [Revised Report of Proposal of Recommendation on Technical Standard of MR and Short-, Medium-, and Long-Term Railway Facilities Improvement Plan}, Progress Report, Dec. 2014
	(5) Summarizing Workshop Revised Report of Proposal was submitted to Summarizing Workshop and discussed by Working Group Revision of the Report of Proposals was very limited, so JICA Experts made several presentations relating to improvement of service and safety of MR in addition to explanation of Revised Report of Proposals. The agenda is as shown in the following Table Agenda 1. Explanation of Revision of the Report of Proposals 2. Railway Development in Japan 3. Running Performance of Rolling Stock 4. Supervision of Construction Work 5. Maintenance Work for Civil Engineering Railway Structure 6. Supplementary Lecture on ATS etc.	Appendix 8-2 Summary of Discussions Made during the Summarizing Workshop for Recommendation on Technical Standards and for Drawing Up Shot-, Medium-, Long-term Railway Facilities Improvement Plan, Progress Report March, 2015

Major Activities of Subproject A and Major Outputs (8)

Major Activities		Major Outputs
Items	Contents	
5.1.5 Drawing up of Short-, Medium-, and Long-term railway facilities improvement plan	**(1) Setting up the principles** In drawing up Short-, Medium- and Long-term railway facilities improvement plan (hereinafter referred to as RFIP) from the view point of upgrading safety and service of MR, the following principles are set up 1) Focusing on the rehabilitation and modernization of the existing lines. 2) Excluding new line construction and improvement of international transport 3) Focusing on facilities relating to upgrading safety and service, but excluding the facilities relating to economic development, railway business expansion, or revenue increase 4) Due consideration on Myanmar Development Cooperation Forum 2013 5) Due consideration on "Survey Program for National Transport Development Plan in the Republic of the Union of the Myanmar" by JICA (June 2014) 6) Further the following preconditions or policies have been assumed. i) Yangon-Mandalay line and Yangon Transit System defined as "Most Important Lines" ii) Mandalay- Mitkyna line, Yangon-Pyay line, Yangon-Pathein line and Yangon-Dawei line defied as "the Next Important Lines" iii) All other lines defined as "Other lines" iv) As indicated in the Inception Report, Shot term corresponds to 2015-2018 Medium term corresponds to 2018-2025 Long term corresponds to 2025- 2045	

Major Activities of Subproject A and Major Outputs (9)

Major Activities		Major Outputs
Items	Contents	
	(2) Drawing up Short-, Medium-, Long-term railway facilities improvement plan Submission to the Workshop, and Discussion by Working Group for Service and safety improvement	Appendix 1 [Report of Proposal] attached to Progress Report September 2014. Appendix 2 [Summary of discussion in the Workshop for Recommendation on Technical Standards and for Drawing up Short-, Medium-, and Long-term Railway Facilities Improvement Plan] attached to Progress Report Dec.2014.
	(3) Revision of the Report of Proposal The Report of Proposal was revised as required according to the discussion mentioned in (2) above.	Appendix 1 [Revised Report of Proposal of Recommendation on Technical Standard of MR and Short-, Medium-, and Long-Term Railway Facilities Improvement Plan] the Progress Report, Dec.2014
	(4) **Summarizing Workshop** Revised Report of Proposal was submitted to summarizing Workshop and discussed by Working Group	Appendix 8-2 Summary of Discussions Made during the Summarizing Workshop for Recommendation on Technical Standards and for Drawing Up Shot-, Medium-, Long-term Railway Facilities Improvement Plan, Progress Report March, 2015

Major Activities of Subproject A and Major Outputs (10)

Major Activities		Major Outputs
Items	Contents	
5.1.6 Education / training in Japan	11 MR experts visited Japan from Oct. 19 to Nov. 1, 2014 to attend [Institutional Management Improvement Course]	Appendix 3 [Workshop Report of the Institutional Management Improvement Course in Japan] attached to Progress Report, Dec. 2014

5.1.9 Recommendation Addressed to Achievement of Overall Goal

The following are the items, the pursuit of the implementation of which will contribute to further upgrading the safety and service level of MR.

(1) Repetition of the training program and workshop similar to those provided by the Project, to further promote the relevant technology transfer

(2) Updating and revising the current Technical Standards so as to match the technical development and modernization of MR.

(3) Modernization of Training Institutes, RTTC and CITC, with respect to training facilities/ equipments, curriculum etc.

(4) Establishment of a research unit by which fundamental theoretical analysis of track structure, and rolling stock such as calculation of stress, deformation, vibration, and fundamental measurements of technical data such as vibration, stress, deformation, relevant forces,, temperature are implemented.

(5) Establishing the priority of each railway line from the socio-economic point of views, with due consideration on the recommendation of “Survey Program for National Transport Development Plan in the Republic of the Union Myanmar” prepared by JICA (June 2014), and implementing the modernization of each line step by step based on the established priorities.

Major Issues of RTTC and CITC To BE Improved (1)

1. Upgrading of RTTC

Major issues to be improved are described below. (It should be noted that RTTC is the training institute for upgrading the technical skills of the staff working for diesel locomotives)

(1) RTTC was established with the cooperation of GTZ of Germany, and mainly machineries for training, preparation of curriculum, training of teachers were offered by GTZ. The RTTC started the training activities in 1981. Installation of machineries for training was executed about 30 years ago, so they should be modernized. Now GTZ is under consideration for upgrading the RTTC, but not yet decided. It is recommended that RTTC should be upgraded with due consideration on modernization of MR.

(2) Further the following can be mentioned for consideration.

(a) Facility

Dormitory of RTTC consists of one large room and very old. It is recommended to divide the one large room into small units for several number of trainees so that their privacy can be secured and they can study individually at the night time.

(b) Equipments/ Machineries

When a new system is introduced, a mockup for the new system shall also be provided to make trainees to be familiarized with the system.

Mockup shall also have a function to simulate the failure of locomotives intentionally and trainees should find out how the failures have happened and learn the procedure to repair them.

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Major Issues of RTTC and CITC To BE Improved (2)

2. Upgrading of CITC

(1**) Future upgrading plan of CITC.**

The CITC has the future upgrading plan as shown below.

1) **Reviewing and Upgrading the Training Curriculums**

- More attractive and practical lectures, classrooms and practice facilities to motivate the trainees are necessary.
- Recruited excellent new experts and engineers will be trained in near future to cope with the development of market oriented economy of Myanmar.
- To furnish the teaching and training equipments for the more effective training.
- To cultivate the technical know-how of instructors.
- To implement the effective training courses by upgrading the existing personnel strength.
- To cooperate with the donor partners.
- To promote the domestic and foreign scholarship program so that the instructors could receive advance technology and teaching techniques.

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Major Issues of RTTC and CITC To BE Improved (3)

2) Requirements of the CITC for Training Equipments

Sr No	Description	Unit	Qty	Remark
1	Desktop Computer Class Room 40 Sets, Furniture Fully Equipped Accessories	1-Lot	40- Nos	
2	Locomotive Driving Simulator(Full Cab)	1-Set	1-Nos	
3	Multimedia Class Room PC 30 Sets+ Furniture + Fully equipped Audio,Video Accessories	1-Lot	30-Nos	
4	Training for Automotive Vehicles (Saloon,Wagon,Van)	7-Nos	7-Nos	
5	Digital Ultrasonic Flaw Dector	1-Nos	1-Nos	
6	On Board Diagnosis Machines Fully Equipped and Accessories	1-Set	1-Nos	

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Major Issues of RTTC and CITC To BE Improved (4)

(2) **Some recommendations by JICA Experts**

(a) Track

To cope with the modernization of Yangon – Mandalay line and Yangon Circular line, MR requires to introduce the new technologies such as long-welded rail, application of large scale track maintenance machines, track maintenance corresponding to the train speed up to 100km/h.

Lectures relating to these new technologies, and training equipments for training for these new technologies should be provided.in the laboratories and on the practical training track.

(b) Rolling stock

When a new system is introduced, a mockup for the new system shall also be provided to make trainees to be familiarized with the system.

Mockup shall also have a function to simulate the failure of locomotives so that trainees could find out how the failures have happened and learn the procedure to repair them.

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Major Issues of RTTC and CITC To BE Improved (5)

(c) Signalling & Telecom.

- It's necessary to establish a curriculum for dealing with every equipment including Interlocking.
- Electronic Interlocking and Relay Interlocking will be introduced to MR from now on. It is necessary to understand their operation mechanism by training. Understanding their operation mechanism will contribute to their life prolongation.
- The electric switch machine and the track circuit should be installed in CITC as signal practical training equipments because their maintenance becomes very important for MR after its modernization.
- All signal training equipments in CITC are of old types. However, these old types are still used on local railway lines. Then CITC should repair these old type training equipments so that they can be used as training equipments.

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Major Issues of RTTC and CITC To BE Improved (6)

(b)Train Operation

i) The area of the desk is small

In the training center of Japan, the trainee places a textbook, a reference book and a notebook on a desk and while referring to each of them, he listens to the lectures.

ii) The inside of the classroom is dark.

- The visual information that a person can recognize decreases in the dark.
- In Japan, necessary illumination corresponding to kinds of work is specified by a law.

iii) Most of the apparatuses for training how to handle them on-site relating to train operation such as signal panels and so on are used only for display.

In Japan, many railway companies install apparatuses handled on-site in the training center and utilize them for handling skill education.

iv) The passing standards of the knowledge test is more than 50%.

- Japanese railway company makes passing standard a little more severe for ensuring train operation safety.
- When a trainee becomes unacceptable in the reexamination, he is made to leave from the training center in consideration of his unfitness.

v) With respect to the operation skill test of the trainees, there is not the clear passing standard

Japanese railway company establishes the passing standard of the skill test clearly for evaluating a trainee. By doing so a fair skill evaluation is made possible and what parts of a training course a trainee cannot yet understand can be made clear and in addition, the uniform evaluation is possible even if an evaluator is changed.

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Major Issues of RTTC and CITC To BE Improved (7)

(e) Civil Engineering Structure

i) Course

- Training courses should be established not only for maintenance of bridge but also for maintenance of tunnels, earth structure and other civil engineering structures.
- For the bridge maintenance course, trainees should learn several types of bridges, such as concrete bridge, PC bridge and steel bridge.

ii) Equipment

- A bridge, “Baily pin” structure, is installed on the practical training line. But this structure is a minor type on operating line of MR. It should be replaced with other ones that are major type of bridges in MR, such as Deck girder.
- It is advised to install necessary equipments for practical training of maintenance of bridge including concrete, steel, PC.

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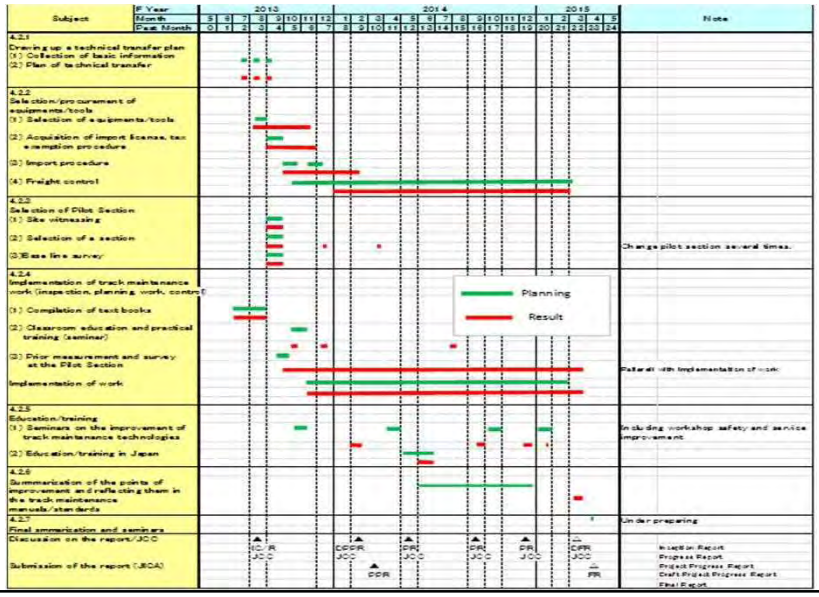
Progress of the Subproject B

5.2.1 Drawing up a plan for technology transfer



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5.2.2 Procurement of the required equipments/tools

74 kinds of equipments/ tools are being prepared by Japan side and delivered to MR gradually.

5.2.3 Selection of Pilot Section

At the beginning, technology transfer of track maintenance started for 30 trainees in the Pilot Section. At present, accumulated number of trainees amounts to 300, and the various situations relating to technology transfer had been changed. Further, in order to implement the training efficiently, trainings were sometimes repeated in the same place, and also on Dagon line. In this regard, we consulted with MR about various matters including the suitable change of the length of the Pilot Section.

Divisions of trainee and members till now

	Date From	Date To	Division	Number	Remark
1	25.10.2013	12.5.2014	(7)Yangon (6)Bago	24 6	
2	12.5.2014	12.6.2014	(7) Yangon (5)Taunggu (7)Yangon (8)Mawlamying (9)Hinthada	10 6 5 4 5	To perform the chainging of trainees
3	12.6.2014	12.7.2014	(7) Yangon (2)Ywataung (3)Mandalay (10)Pakauku	10 8 8 7	To perform the chainging of trainees
4	12.7.2014	12.8.2014	(7) Yangon (1)Myitgyinar (4)Kalaw (11)Bagan	10 6 7 7	To perform the chainging of trainees
5	12.8.2014	12.9.2014	(7) Yangon (5) Taunggu (8) Mawlamying (9) Hinthada	10 6 6 8	To perform the chainging Of trainees
6	12.9.2014	13.10.2014	(7) Yangon (2) Ywataung (3) Mandalay (6) Bago	10 6 6 8	To perform the chainging Of trainees
7	13.10.2014	12.11.2014	(7) Yangon (9)Hinthada (8)Mawlamying (5)Taunggu	10 7 7 6	To perform the chainging Of trainees
8	12.11.2014	11.12.2014	(5)Taunggu (2)Ywataung (3)Mandalay (10)Pakauku	10 8 9 7	To perform the chainging Of trainees
9	9.1.2015	6.2.2015	(7) Yangon (4)Kalaw (9) Hinthada (11)Bagan	10 7 7 7	To perform the chainging Of trainees
10	9.2.2015	4.3.2015	(7) Yangon (1)Myitgyinar (6)Insein (10)Pakauku	10 6 7 7	To perform the chainging Of trainees
11	9.3.2015	Untill now	(7) Yangon (4)Kalaw (5)Taungu (11)Bagan	10 6 7 7	To perform the chainging Of trainees
Total				348	

5.2.4 Implementation of track maintenance

Ballast compacting work (Hand Tie Tamper)

Ballast compacting work (Rammer)

Conveying Ballasts

Measuring Track

Screening Ballasts

Taking down 50N Rail

Rail Joint Work

Remending Alignment

Maintenance of turnout①

Maintenance of turnout②

Track Maintenance on the Bridge

Correction of track gauge

Strengthen rail joint

Improvement Formation

Replace sleeper

Surveying

5.2. 5 Education/Training

① In Myanmar （lecture, on site)

② In Japan (We invited to Japan 2 Group last year.)

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5.2.6 Summarization of the points of improvement and reflecting them in the track maintenance manuals/standards

We summarize the points of reflection through the whole of maintenance work and compile the maintenance manuals to meet the present status of the track maintenance in Myanmar in consideration of the local organizations, working conditions and climates.

5.2.7 Final summarization and seminars

In closing the above technical transfer course on track maintenance work, we will open seminars for the trainees participated in the program and track maintenance members for other sections selected through consultation with MR.

Thank you for your attention !

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