

The Project on Improvement of Service and Safety of Railway in Myanmar



9th JCC (Draft Final Report)
January 29th, 2016, at Nay Pyi Taw

JICA Expert Team



Japan International Cooperation Agency

1

Table of Contents

1. Project Summary
2. Basic Plan of Project Implementation
3. Project Implementation Organization
4. Final Reporting of the Project
 - 4.1 Recommendation of technical standards relating to administrative and maintenance aspect and drawing up railway facilities improvement plan to improve service and safety level
 - 4.2 Technology transfer of track maintenance technology to improve the level of service and safety through implementation of the Pilot Project
 - 4.3 Bridge maintenance training
 - 4.4 Others
5. Major issues to be tackled with, good schemes for better implementation, lessons obtained through implementation



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2

1. Project Summary

2. Basic Plan of Project Implementation

2.1 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 Myanmar Railways is improved (Overall goal)
2	Administration and maintenance ability is improved for the enhancement of service and safety of Myanmar 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



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3

Summary of PDM (Project Design Matrix) Modifications

From the original PDM, two reviews for revision were conducted to most effectively and efficiently capture Project performance as summarized below:

Narrative Summary	Objectively Verifiable Indicators		
	PDM _{ver1} R/D (March 2013)	PDM _{ver2} Inception Report (August 2013)	PDM _e Terminal Evaluation (January 2016)
Overall Goal			
Service and safety level of Myanmar Railways is improved	① Number of annual accidents on Yangon-Mandalay line decreased 20% from 2011-2012's 118 cases	① Number of annual accidents on Yangon-Mandalay line decreases compared with the present and past records	[no change]
	② Average sanction speed on Yangon-Mandalay line increased 10% from 2011-2012 average (number of 2011-2012 average sanction speed to be set later)	② Number of speed restricted locations on Yangon-Mandalay line decreases compared with their present number	[dropped]
		③ Journey speed on Yangon-Mandalay line increases compared with the present journey speed	[no change]
		④ Punctuality of express passenger trains on Yangon-Mandalay line is improved compared with the present situation	[no change]
	③ Satisfaction level of clients is enhanced	⑤ Satisfaction level of clients is enhanced	[dropped]
		⑥ Number of passenger	[dropped]

4

2.2 Implementation plan

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, equipment), 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 equipment and materials.

To conduct track maintenance (inspection, planning, work) jointly with MR staff, making use of the equipment 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

5

2.3 Project Section

The site is located between Yangon and Bago in the Yangon 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. But, the various situations relating to technology transfer have been changed. MR hoped to make many trainees to receive workshop of track maintenance rather than the length of Pilot Section. In order to implement the training efficiently, trainings were sometimes repeated in the same place, and also on Dagon or Thilawa line near Toegyaunggale Sta, and Yangon Sta.

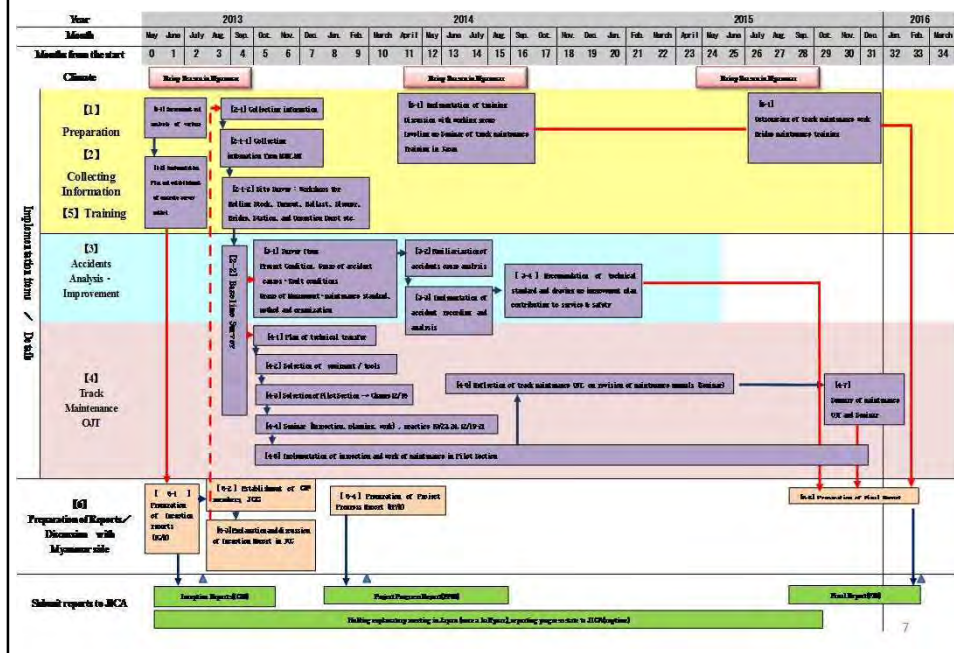
Accumulated number of trainees amounts to 574



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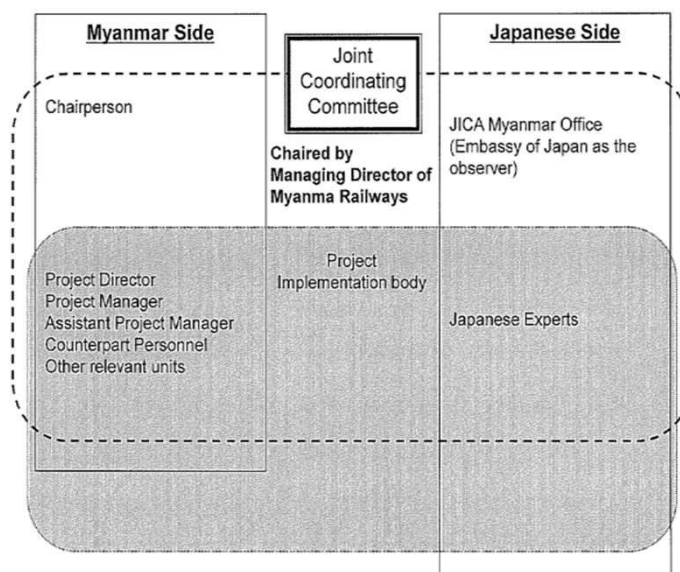
6

2.4 Flow Chart of project implementation



3. Project implementation Organization

3.1 Structure of project implementation Organization



3.2 Implementation body on the Myanmar side

3.3 Implementation body on the Japan side

Field	Myanma Railways	Japanese Side (JICA Expert Team)
Project Director	U Aung Win (U Saw Valentine) / General Manager (Technical & Admin. Support)	Nobuyuki MATUO (Sadaaki KURODA) /Leader
Project Manager	U Tin Soe/ General Manager(Civil) U Saw Valentine/ Advisor	Mitsuru TAKAMI (Nobuyuki MATUO) /Deputy Leader
Railway Policy/ OM Improvement	U Kyaw Kyaw Myo /AGM (Passenger)	Hiroshi KOMATSU
Track Maintenance	U Than Htay/ DGM (Civil) U Tin Myint (U Maung Maung Than)/ AGM (Civil) U Min Aung /AE (Civil)	Osamu HAGA (Kazuhiro MURAO, Masato WAKATSUKI, Hideo FUJIWARA) (Kiyoshi MIYAMOTO) Keiichi KOBAYASHI (Hisayoshi MITSUI) Makoto TOYA (Shigenori TANAKA) Hisashi KOMATSU (Takashi ITO) Masahiro OSANAI
Signaling & Telecommunications	U Khin Maung Thein/ DGM (S&T) (U Myint Lwin, AE (S&T), U Han Nyunt, AGM (S&T))	Ryuhei MITANI (Kichi TAKEMURA)
Rolling Stock	U Win Oo/ GM (Rolling Stock) (U San Myint/ Train operation, U Thet Lwin/ DGM(Rolling Stock))	Makoto ISHIKAWA
Train Operation	U Htay Myint Aung/ DGM (operation) (U Zaw Pe Sein/ Divisional Traffic Manager)	Shunji MORIHARA (Hideharu IGARASHI)
Structure	U Tin Win/ DGM (Civil)	Mitsuru TAKAMI (Kiyoshi MIYAMOTO)
Procurement of Equipment & Materials	U Khin Maung Than (U Win Htein) / DGM(Supply)	Tomohiro AIZUKI (Yuichi TANIGUCHI, Tsuyoshi NAKAMURA)
Outsourcing of track maintenance work	U Maung Maung Than/ DGM (Civil)	Nobuyuki MATUO
Bridge maintenance training	U Maung Maung Than/ DGM (Civil)	Mitsuru TAKAMI
Policy Advisor	Mitsuo HIGASHI	

3.4 Establishment of Joint Coordinating Committee (JCC)

and Its Functions

- ① To discuss the yearly project implementation plan described under the scheme determined based on R/D, and approve it
- ② To evaluate the outputs and total progresses of the yearly project implementation plan
- ③ To approve the necessary items regarding to project output smoothly
- ④ To discuss / study the several major problems appeared in the project implementation

In this project total 9 times JCCs were held in Nay Pyi Taw as following dates.

Kick off meeting 28th June, 2013

1st JCC 28th August, 2013

2nd JCC 27th February, 2014

3rd JCC 29th May, 2014

4th JCC 29th September, 2014

5th JCC 19th December, 2014

6th JCC 13th March, 2015

7th JCC 17th July, 2015

8th JCC 28th October, 2015

9th JCC 29th January, 2016

(5) Training for measurement of train vibration

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



Measurement of train vibration

Investigation of Customer's Satisfaction Level

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

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

4.1.6 Education/ training in Japan



Operation Center in Akita

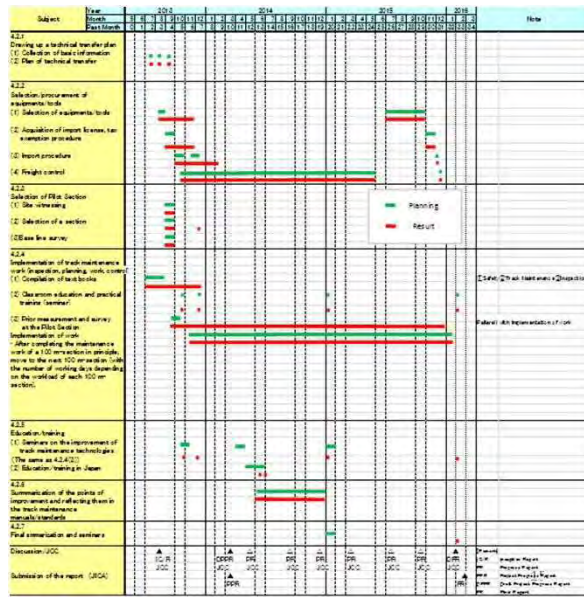


Railway Museum in Saitama

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

4.2.1

Drawing up a plan for technology transfer



4.2.2 Procurement of the required equipment / tools

JICA Expert Team supplied 74 kinds of equipment 1st time and 9 kinds of equipment 2nd time.

It is suggested that MR shall distribute at least one set to each division, as agreed in the 8th JCC.

Additional equipment in 2nd time

No.	Item	Unit	Manufacturer
1	Analog standard gauge G=1000	8	KANEKO CO.,LTD.
2	Instrument detection for track	8	KIDOUGIKEN
3	Tie tamper	8	SHIBAURA ELRTEC CORPORATION
4	Generator	8	SHIBAURA ELRTEC CORPORATION
5	Equipment for ballast tamping	8	HITACHI KENKI KAMINO CO., LTD.
6	Basket made by bamboo or plastic	40	SEKISUI KAGAKU KOGYO CO., LTD.
7	Light track trolley 1ton G=1000	8	YOSHIKE KAKEN KIKI CO., LTD.
8	Rail lifting machine	10	TOKO SANGYO CO.,LTD
9	Jack for rail	48	NICH CO., LTD.

4.2.3 Selection of Pilot Section

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

- (1) Compilation of text book
- (2) Classroom education and practices (seminars)



3 kinds of textbook in Myanmar language



Training of classroom using by text of Myanmar language

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

- 1) **Ballast compacting work (use of hand tie-tampers)**
- 2) Ballast sieving
- 3) Rail renewal work
- 4) Rail joint work (rework on rail clearance (rail joint clearance), correction of rail joint depression)
- 5) Track realignment work
- 6) Turnout maintenance work
- 7) Inspection and maintenance of bridge sections
- 8) Correction of track gauge
- 9) Improvement of formation
- 10) Supervision and evaluation of track condition (Test for running confirmation)



Explanation of Hand Tie Tamper



Tamping Work



Mending alignment



Exchange Sleepers

19



Track Maintenance on the Bridge



Changing to 50N Rail



After changing 50N Rail



Speed increasing Test

20

4.2.5 Education/training

(1) In Myanmar

We have educated **574 trainees** belonging to all divisions in MR.

(2) In Japan

We hold workshop about track maintenance in Japan twice. First workshop was from June 9th to 20th in 2014. Second workshop was from June 23rd to July 4th. We requested cooperation from JR East and Japan Railway Track Consultants. Contents of this workshop were lectures and practical track maintenance.



Lecture from Dr. Osanai in Tokyo



Exchange rail work in Tokyo

21

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

(1) Reflection of track maintenance

We list general reflections in planning, implementing and after finishing throughout track maintenance for two and a half years with MR.

① Planning of track maintenance

- At first, arrival of equipment from Japan was delayed. Therefore there was a restriction because we could not help using equipment which existed in Myanmar.
- **After changing workshop, work place was around Toggyaunglae station to make trainees study special section of turnout, bridge and curve, etc.**
- It was difficult to make work plan of the day because train schedule was incorrect.
- It was difficult to make plan based on natural condition which was raining suddenly and sudden rising in the temperature, etc.
- In some places, it was difficult to change work plan by being delayed arrival of provisions of equipment such as ballast and sleeper.
- The condition of roadbed was worse than we had imagined.
- It was difficult to make work plan which consider climate all the year round.

22

②Implementation of track maintenance

- It took much time to move to the site and carry equipment at many places except station premises because there were few approach road.
- In station premises, there were many suspends of work temporarily by shunting of locomotive.
- Train schedule was incorrect. So there were many situations which we had to stop train.
- We think that it is necessary to maintain tools which is using on site in addition to equipment from Japan.
- We had difficulty taking shelter in rest and raining suddenly between stations because there were no roof.

③After finishing track maintenance

- We could taught how to use equipment to trainees in Yangon. But we couldn't teach it all to trainees from other region because there were many kinds of equipment.
- Now trainees from other region are implementing track maintenance by themselves. We could follow up only Bago area in other region.
- Maintenance of equipment using frequently (For example level, rail jack and tie tamper, etc.) are needed to keep maintaining after hand over.

23

(2) Summarization of the points of improvement and implementation

We drew up track maintenance manuals in accordance with organization of MR taking into consideration of work organization on site, work situation and natural condition such as climate.

We drew up manuals which MR staff can use easily such as step of work and how to use equipment. **We translated to Myanmar language in order to read easily for MR staff.**

Manuals consist of work, safety and inspection. We distributed additional reference which were written not only contents of work but also backbone of theory or formula to inspectors

4.2.7 Final summarization and seminars

We held seminar gathering concerns engaged in track maintenance on the occasion of ending track maintenance from 2nd to 5th in February 2016. We tried to eliminate unknown thing and Q and A session were conducted actively. This was the last step that MR staffs maintain by themselves. We hope MR staffs expand to all parts of the country.

24

4.3 Bridge maintenance training

4.3.1 Survey of existing bridge maintenance of MR.

- (1) Outline of MR Bridges
- (2) MR bridge maintenance implementation body
- (3) Mahalwagon Bridge Depot
- (4) Internal rules
- (5) Major problem of MR bridge maintenance



Inside view of bridge depot



Rivetting Work

25

4.3.2 Bridge maintenance training plan

Considering the survey results, this training aims for improving MR bridge maintenance technology of superstructure **mainly through seminar and training on site.**

- (1) Training outline
- (2) Text book
- (3) Implementation body
- (4) Equipment and tools

4.3.3-6 Implementation report (Phase1-4)

We have implemented bridge maintenance divided into 4 steps.

Our curriculums of bridge maintenance were site visit (Big bridges such as Gokteik Viaduct, Inwa and Sittaung, and small bridges, etc.), lecture and general inspection, etc.

26



Training on site at Gokteik Viaduct



Training on site at No.9 Bridge



Visual Inspection



Seminar for bridge maintenance

27

4.3.7 Review the bridge maintenance training

Through the training, MR trainees were always watching carefully for JICA Expert action, be earnest to learn more bridge maintenance technology, act same as JICA Expert Team action. JICA Expert Team and BMC (Bridge Maintenance Consultant) appreciate MR trainee attitude. After complete of Phase4 training, **MR trainee's comments** were collected. Major comment are shown as followings.

- ① A trainee could learn new technology and remind forgot technology.
- ② Before training, a trainee considered bridge needs no maintenance, and when it will be deteriorated, it should be replaced new one.
- ③ After training a trainee comes into think that inspection and repairing are best way for maintain bridge.
- ④ A trainee could learn necessary technology in detail through repeated study the theory and implementation.
- ⑤ **A trainee could learn the progress of bridge deterioration and how to maintain them.**
- ⑥ **A trainee could learn the major inspection item, inspection method, and calculation.**

28

4.4 Others

4.4.1 Cooperation and assistance by the government of the countries other than Japan in the field of railways

The assistance 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 from China, India Yugoslavia and Republic of Korea (As of Dec. 2014)

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

4.4.2.1 Visit of RTTC and CITC by JICA Expert Team

4.4.2.2 RTTC

It is recommended that **RTTC should be upgraded with due consideration on modernization of MR.** Facility and equipment/ machineries are the next thing to be renew.

29

4.4.2.3 CITC

Some recommendations by JICA experts for modernizing CITC

Future plan of the CITC

- To conduct **more training courses** annually.
- To **review and upgrade the training curriculums** using currently in the courses.
- To collect the skilled instructors and training aids to be more effective for the training courses.
- To **cultivate the technical know-how instructors.**
- To promote trainer of the training program
- To implement the effective training courses by upgrading the existing personnel strength
- 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

- 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 .
- 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.
- Recruitment of excellent new expert and engineers will be trained in near future due to the development of Myanmar market oriented economy.
- To aspire the teaching and training aids to be more effective for the training courses.
- To cultivate the technical know-how instructors.
- To implement the effective training courses by upgrading the existing personnel strength.**
- To cooperate with donor partner** just like JICA.

30

4.4.3 Outsourcing of track maintenance work

We made a report and power point about track maintenance.

Outline is as below.

- (1) Background
- (2) Hearing investigation from Myanma Railways
- (3) Precondition toward outsourcing of track maintenance
- (4) Example of Japan
- (5) Outsourcing of track maintenance for Myanma Railways
- (6) Conclusion

At present, example of Japan may be only reference. In the future, when MR changes to privatization or most important target is to improve profit, we think example of Japanese outsourcing of track maintenance will be helpful.

31

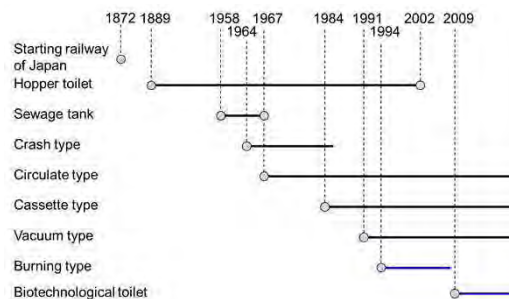
4.4.4 Sanitary system on Rolling Stock

There were many requests from MR about sanitary system on rolling stock. In this workshop, **We introduced Japanese sanitary system** and transition on rolling stock in the morning. We explained each type of sanitary system in detail and had a question and answer session in the afternoon.

Many contents were discussed about equipment or cost in the Q and A session. There were many opinions that which type was suitable for MR.



Lecture of sanitary system



Change of Toilet System of Railway in Japan

32

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

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

- (1) To implement the project more effectively, the Counterpart Team and Working Group for Service and Safety Improvement were strengthened by including both the MR experts stationed at Yangon, and those stationed at Nay Pyi Taw.
- (2) With respect to guidance and familiarization of the technique to analysis the present status and causes of accidents and poor services, the Training program and the Workshop were programmed and implemented. (Repetition, analysis and education)
- (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 Team.**
- (4) **With regard to drawing up short-, medium-, and long-term railway facilities improvement plan, it is described.**

33

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

Our first priority is safety in our technical cooperation. We distributed protect tools such as helmet to all trainees. We strongly taught safety throughout track maintenance work. We hope to keep in mind of safety.

It is necessary for MR to maintain railway and input equipment continuously. This time, we provided with additional equipment to distribute main tools to all divisions. We think that MR must change the organization and supply new equipment by themselves.

MR staff, especially inspectors, must certainly **teach to next generation** at the site to inherit technique within MR. Head office and person in charge of Civil at each division must help and follow-up them.

34

5.3 Bridge maintenance training

In order to make MR deeply understanding, training curriculum was carried out in the repeated cycle **lecture(pre-study) – training (implementation) – lecture (review)** for each technology. It was defined that training of Phase1 and 2 are aimed for train basic technology, Phase3 and 4 are done for advanced technology.

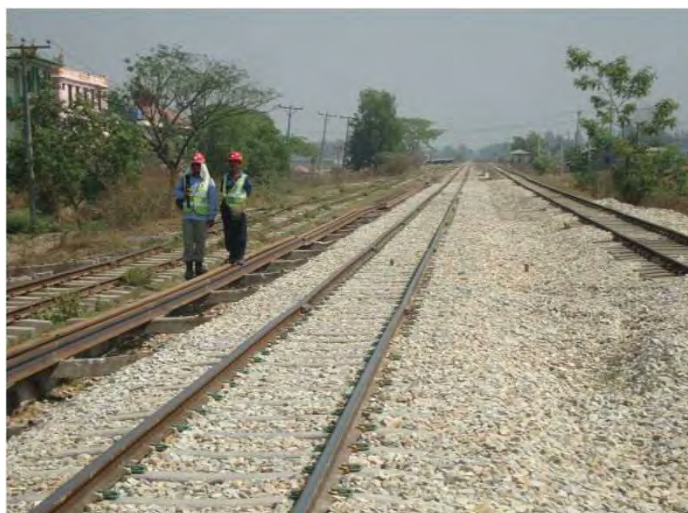
In order to train bridge repairing technology which needs much budget, and to teach the technology that MR trainee learned to other engineer, **MR made the report that described the technology that they learned in this training** with Myanmar language and reported to Deputy Minister of MORT and other relevant authorities.

Japanese bridge maintenance technology was very suitable for MR bridge maintenance since following reasons.

Present MR situation, No document are remained, deteriorated bridge, poor maintenance, is much similar to Japanese situation around from after WW II to before modernization.

35

Thank you for your attention !



36

ミャンマー国 鉄道安全性・サービス向上プロジェクト 国内報告会



2016年2月19日（金） JICA【本部】

JICA Expert Team

日本コンサルタンツ(株)
(株)オリエンタルコンサルタンツグローバル
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報告の内容

1. プロジェクトの概要と目的
2. プロジェクト実施の基本方針
3. プロジェクト実施体制
4. プロジェクトの終了報告
 - 4.1 安全性・サービス向上に資する鉄道の改善と
運営・維持に係る技術基準の提言
 - 4.2 パイロットプロジェクトの実施を通じた
保線技術の向上の技術移転
 - 4.3 橋梁メンテナンス
 - 4.4 その他
5. 今後に向けての提言
6. JICA Expert Teamとしての振り返り



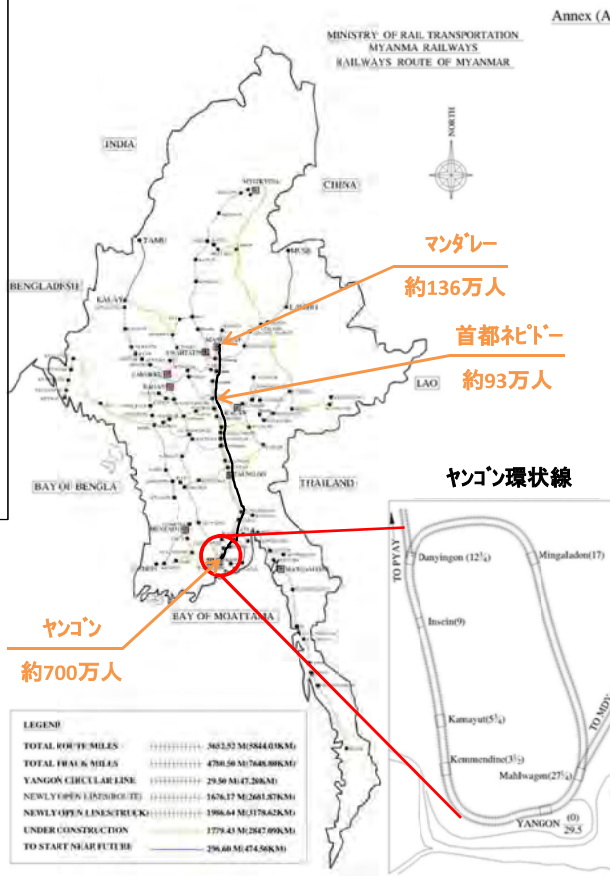
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2

ミャンマーの鉄道について

ミャンマー国鉄(以下「MR」)の概要

路線延長: 約6,100km, **複線化率:** 約11%
路線数: 38路線(うち、電化路線1線)
1日の列車本数: 447本(うち貨物24本)
車両数 機関車412両、気動車256両、
 客車1,369両、貨車3,384両
職員数 20,479人 **利用者数** 約13万人/日
 (2,000人/日以上の利用者がある路線は、わずか9線区)
年間の収入: 62,198百万チャット(約59億円)
支出: 123,126百万チャット(約118億円)
主要路線:
 ヤンゴン～マンダレー線(約620km)
 ヤンゴン環状線(約48km)



ミャンマーの鉄道の状況について

現状: 設備の老朽化・メンテナンスレベルの低下と技術力の喪失により、鉄道機能は著しく低下

課題: 近代化に向けて、業務・組織全般にわたる抜本的な改革が必須

軌道や土木構造物の状況



軟弱地盤に埋もれた軌道



大きな地盤変位が発生していても使用している分岐器



洗掘された橋脚



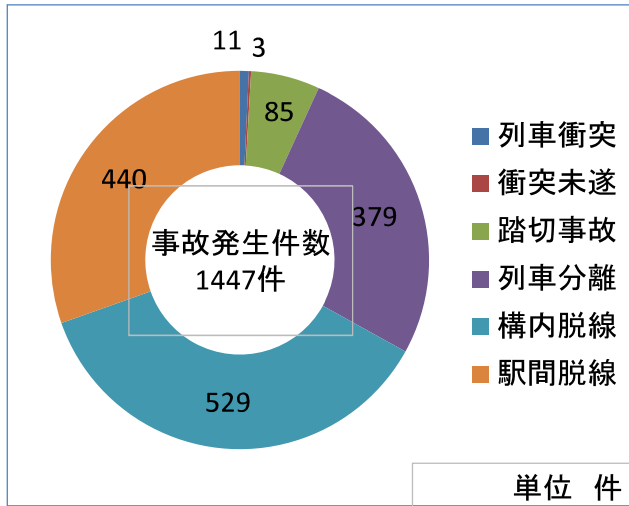
橋梁上の脱線痕

安全にかかわる状況について

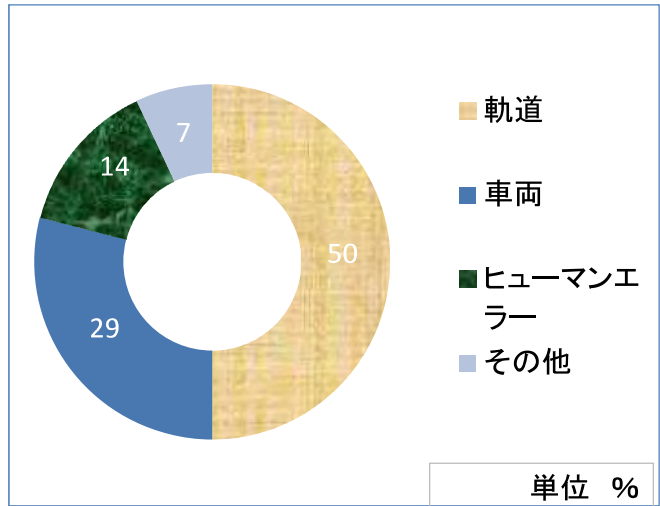
ヤンゴン～マンダレー線における事故発生件数の推移と事故原因の割合

○過去10年間(2002～2012)の集計

事故発生件数

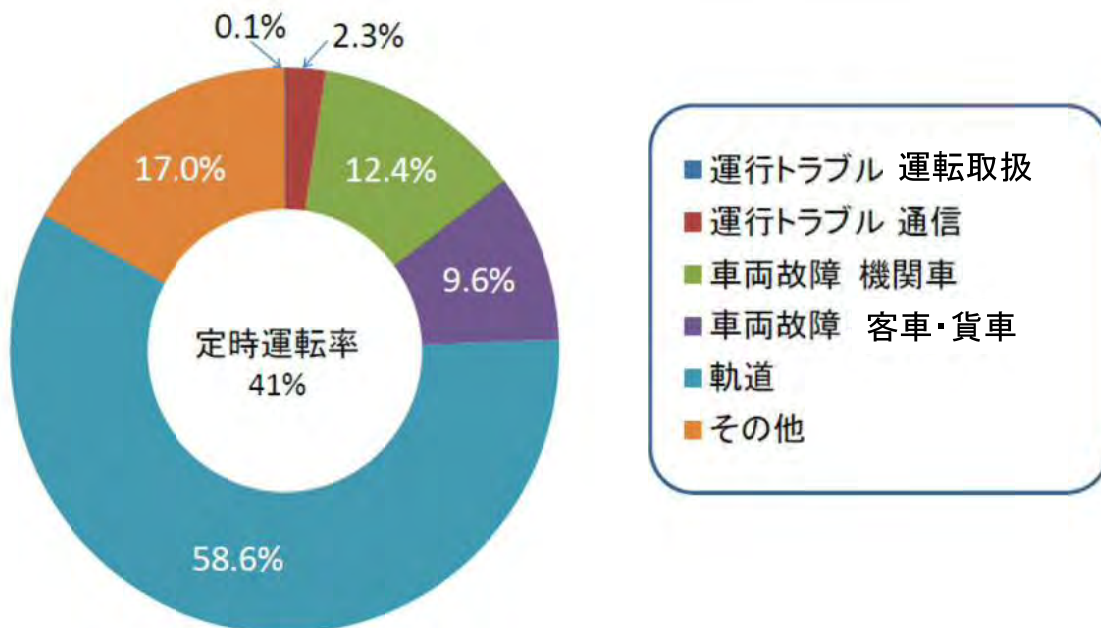


事故原因の割合



※概ね3日に1度の割合で事故発生
※列車脱線が全体の7割程度

過去3年間の定時運転率と遅れの原因



1. プロジェクトの概要

MRの安全性及びサービス向上に資する鉄道運営・維持管理能力の強化をはかる。(2013.5～2016.3)

① 安全性・サービス向上に資する鉄道の改善と運営・維持に係る技術基準の提言 → 事故分析に基づき、鉄道改善項目を明らかにする

現地(ミャンマー)

- ・ 事故及び低サービスレベル分析に基づいた安全・サービス向上に資する改善への提言
- ・ MRとの現場調査により、各分野の現状、事故原因、不具合状況等を把握を実施
- ・ 日本の事故事例と改善方策、サービス向上方策の紹介

国内(日本)

- ・ 本邦招聘研修(鉄道組織運営改善コース)

②パイロットプロジェクトの実施を通じた保線技術の向上の技術移転 → 保線作業の研修等を通じて保線の基礎技術を取得する。

現地(ミャンマー)

- ・ MR路線の特定の20kmをパイロット区間とし軌道整備のOJTを通じた技術移転

国内(日本)

- ・ 本邦招聘研修(軌道整備コース)

2. プロジェクト実施の基本方針

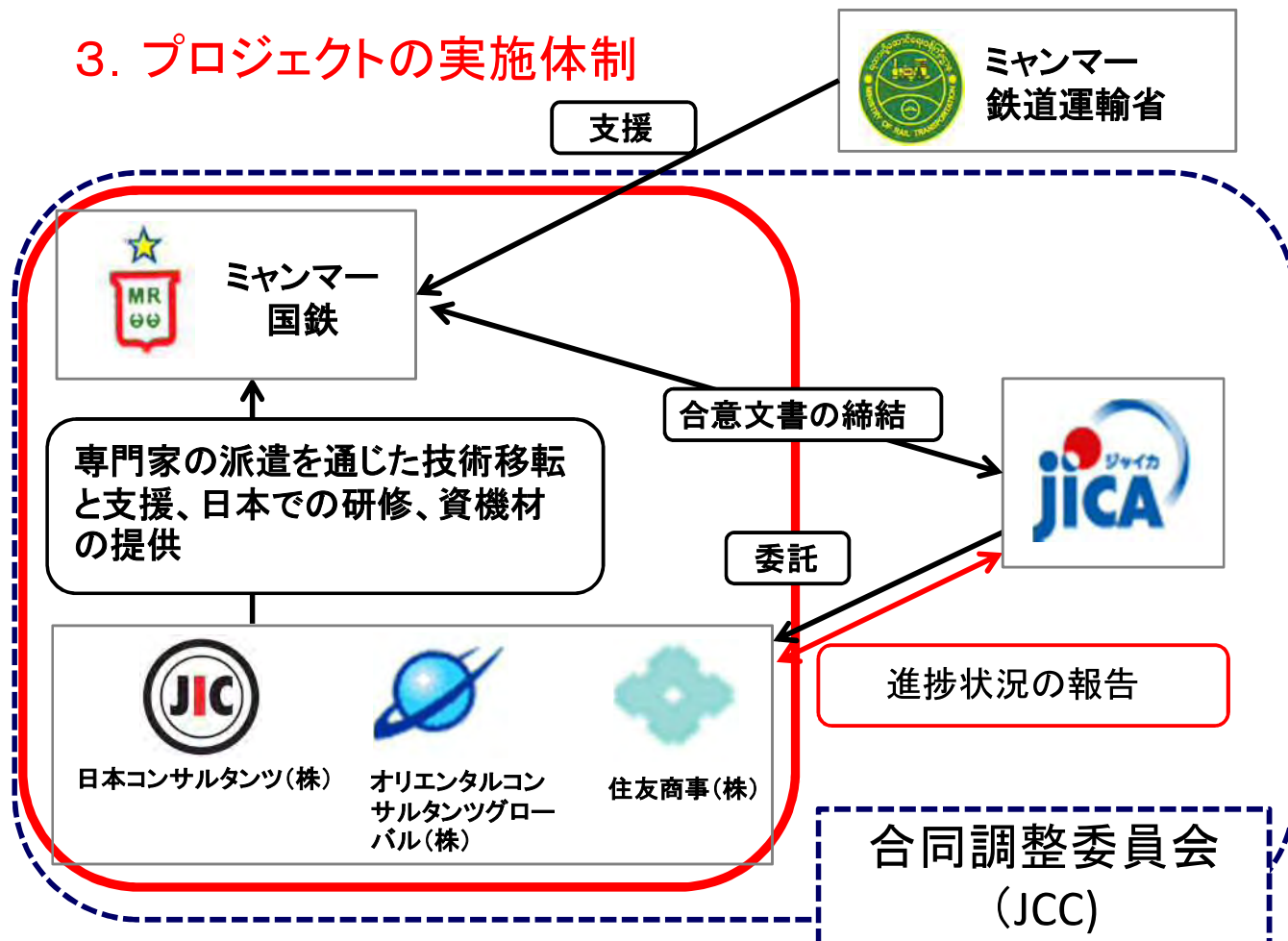
上位目標とプロジェクト目標について

上位目標とプロジェクト目標	
1	MRの安全性及びサービスが向上する。 (上位目標)
2	鉄道の安全性及びサービス向上に資する運営・維持管理能力の強化を図る。(プロジェクト目標)



期待される成果	
成果1	事故分析等に基づきMRの安全性及びサービス向上のための運営・維持管理に係る鉄道改善項目の課題が整理される。
成果2	パイロットプロジェクトの実施を通じて安全性及びサービス向上のための保線措置(事故、その他これに類する異常時)の対応を通じ、技術力が向上する。

3. プロジェクトの実施体制



ミャンマー側と日本側のカウンターパート

Field	Myanmar Railways	Japanese Side (JICA Expert Team)
Project Director	U Aung Win (U Saw Valentine) / General Manager (Technical & Admin. Support)	Nobuyuki MATSUO (Sadaaki KURODA) /Leader
Project Manager	U Tin Soe/ General Manager(Civil) U Saw Valentine/ Advisor	Mitsuru TAKAMI (Nobuyuki MATSUO) /Deputy Leader
Railway Policy/ OM Improvement	U Kyaw Kyaw Myo /AGM (Passenger)	Hiroshi KOMATSU
Track Maintenance	U Than Htay/ DGM (Civil) U Tin Myint (U Maung Maung Than)/ AGM (Civil) U Min Aung /AE (Civil)	Osamu HAGA (Kazuhiko MURAO, Masato WAKATSUKI, Hideo FUJIWARA) (Kiyoshi MIYAMOTO) Keiichi KOBAYASHI (Hisayoshi MITSUI) Makoto TOYA (Shigenori TANAKA) Hisashi KOMATSU (Takashi ITO) Masahiro OSANAI
Signaling & Telecommunications	U Khin Maung Thein/ DGM (S&T) (U Myint Lwin, AE (S&T), U Han Nyunt, AGM (S&T))	Ryuhei MITANI (Kiichi TAKEMURA)
Rolling Stock	U Win Oo/ GM (Rolling Stock) (U San Myint/ Train operation, U Thet Lwin/ DGM(Rolling Stock))	Makoto ISHIKAWA
Train Operation	U Htay Myint Aung/ DGM (operation) (U Zaw Pe Sein/ Divisional Traffic Manager)	Shunji MORIHARA (Hideharu IGARASHI)
Structure	U Tin Win/ DGM (Civil)	Mitsuru TAKAMI (Kiyoshi MIYAMOTO)
Procurement of Equipment & Materials	U Khin Maung Than (U Win Htein) / DGM(Supply)	Tomohiro AIZUKI (Yuichi TANIGUCHI, Tsuyoshi NAKAMURA)
Outsourcing of track maintenance work	U Maung Maung Than/ DGM (Civil)	Nobuyuki MATSUO
Bridge maintenance training	U Maung Maung Than/ DGM (Civil)	Mitsuru TAKAMI
Policy Advisor		Mitsuo HIGASHI

作業スケジュール

経過月数	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
年度	2013												2014												2015													
業務項目	月	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3		
【1】準備作業																																						
[1-1]各種関連資料の整理・分析																																						
[1-2]業務の実施方針及び具体的な調査方法の確立																																						
【2】現地での情報収集作業																																						
[2-1]情報収集及び準備作業																																						
[2-2]ベースライン調査																																						
【3】事故分析・改善																																						
[3-1]調査項目																																						
[3-2]事故原因検証・分析手法習熟																																						
[3-3]事故記録作成、事故分析の実施																																						
[3-4]安全性・サービス向上に資する技術基準の導入に関する調査・鉄道改善項目検討																																						
[3-5]技術移転計画の策定(短期・中期・長期)																																						
【4】保線OJT																																						
[4-1]技術移転計画の策定																																						
[4-2]資機材の選定																																						
[4-3]パイロット区間の選定																																						
[4-4]保線(検査、計画、作業)のセミナー																																						
[4-5]保線の練習、検査・作業の実施																																						
[4-6]保線実施の反省、取扱要領の作成																																						
[4-7]保線OJTのまとめとセミナー																																						
[追加]橋梁メンテナンス、保線外注化他																																						
【5】研修関係																																						
[5-1]研修等の実施																																						
[6]レポートの作成/貴機構及び相手国との協議																																						
[6-0]キックオフミーティング																																						
[6-1]インセプションレポートの作成、貴機構への説明及び協議																																						
[6-2]ミャンマー国実施機関へのインセプションレポートに基づく説明及び協議																																						
[6-3]C/Pメンバーの配置、JCCの設置																																						
[6-4]プロジェクト進捗報告書の作成、提出																																						
[6-5]プロジェクト終了時報告書の作成、提出																																						

合同調整委員会の設立

(JCC : Joint Coordinating Committee)

- ①R/Dの定めた枠組の下に形成されたProjectの年間作業計画を審議し、承認する。
- ②プロジェクトの**年間作業計画の成果と全体的な進捗状況**を評価する。
- ③プロジェクトの**成果に関する必要な承認**を円滑に行う。
- ④プロジェクトの**実施中に生ずる主要な諸問題**について検討し審議する。

本プロジェクトでは、次のとおり全9回のJCCを開催した。

キックオフミーティング：2013年6月28日

- | | |
|-------------------------|----------------------|
| 第1回 JCC: 2013年8月28日 | 第2回 JCC: 2014年2月27日 |
| 第3回 JCC: 2014年5月29日 | 第4回 JCC: 2014年9月29日 |
| 第5回 JCC: 2014年12月19日 | 第6回 JCC: 2015年3月13日 |
| 第7回 JCC: 2015年7月17日 | 第8回 JCC: 2015年10月28日 |
| 第9回 JCC: 2016年1月29日(最終) | |



4. プロジェクトの終了報告

4.1 安全性・サービス向上に資する鉄道の改善と運営・維持に係る技術基準の提言

4.1.1 教科書に基づいた教室での講義

事故及び低サービスレベルの原因の分析手法についての指導と習熟
(日本における過去の事故事例・災害事例と対策についての説明)



JR中央本線 大月駅構内 衝突脱線事故例



JR花輪線 橋脚洗掘・倒壊事例



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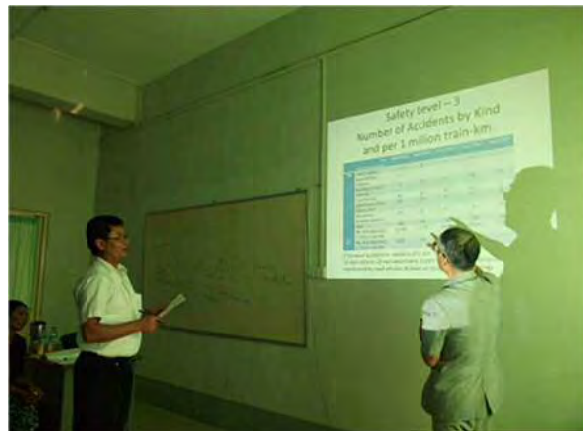
13

4.1.2 ワークショップ

MRの専門家に事故及びサービスレベル原因分析と対策樹立の手法を習熟させる。その方法として、MR専門家にMRの実際の事故、低サービスレベルの事例を選ばせ、彼ら自身に原因分析、対策立案を実施させた。



ワークショップの状況
(MR研修生によるプレゼンテーション)



MRのプレゼンテーションに基づいた
JICA専門家の講評



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14

4.1.3 MR旅客輸送に対する旅客満足度の調査

列車内で満足度調査のため、20項目の質問事項につき、インタビューを120名に対して実施した。



急行列車でのインタビュー調査



普通列車でのインタビュー調査

質問事例

- ①列車の乗り心地はどうか
- ②バスでなく、なぜ列車を選んだのか
- ③列車の座席やトイレはきれいか
- ④MR職員の接遇はどうか 他



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4.1.4 安全とサービスレベル向上に資する運営・維持管理にかかわる技術基準に対する提言

以下に示す各分野別の技術基準(車両、軌道、構造物、信号通信、運転)をレビューし、提言を行った。

A--Rolling stock	
1	Diesel Electric Locomotives and Diesel Hydraulic Locomotives Maintenance Instruction Schedule (Mechanical)
2	Diesel Electric Locomotives and Diesel Hydraulic Locomotives Maintenance Instruction Schedule (Electrical)
3	Examination 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 Specifications for Meter Gauge 2000 Horse Power Diesel Electric Locomotives
7	Technical Specifications for In-Service Diesel Electric 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 Passenger Coaches
13	General Technical Specifications for Meter Gauge Bogie Passenger Coach Type BDTEZ
14	Technical Specifications for Meter Gauge Bogie Ballasted Hopper Wagons
15	Particular Technical Specification for Meter Gauge Four-Axle Bogie Well Wagon for Container
16	Technical Specification for Meter Gauge Bogie Day Upper Class Passenger Coach
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 XXI Technical Appendices
5	Manual of the Engineering Department Chapter IX Miscellaneous
C--Structures, Building, Station 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	
TRAIN SIGNALLING INSTRUCTIONS for the Double and Single Lines by Electric Block Instruments and by Telegraph or Telephone	
1	Telephone
2	Manual of the Engineering Department--Chapter VIII--Signal and Tele-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	Chapter III working of Trains General
4	Chapter IV Accidents
5	Chapter XIII The Following Trains System

4.1.5 短、中、長期鉄道設備改善計画の策定

MRの安全とサービスレベル向上の観点から策定された短、中、長期鉄道設備改善計画を策定（軌道、車両、信通、運転、構造物の各分野ごと）
 （短期：2015年～2018年、中期：2018年～2015年、長期：2025年～2045年）

（構造物の例）

Table 2.5.1 Short-, Medium-, and Long- term railway improvement items(Bridge)

Railway improvement items	2015	Short term	2018	Medium term	2025	2035	Long Term	2045
1. Bridge								
(1) Maintenance work improvement								
•Collection of drawings, compilation of maintenance work recording book								
•Computerized Bridge data, profile, inspection and rehabilitation records.								
•Investigation for river bed and compilation of Bridge Book								
•Foot plate installation between two rails								
•Foot way and scaffolding for inspection installation.								
•Construction of side path to approach a bridge								
(2)Rehabilitation of aged bridges								
•Repainting, Replace of member bearing, Reconstruction								
(3)Natural Disaster Prevention Work								
•Installation of water level gauge								
•Installation of automatic measuring water gauge and its signal								
•countermeasure against wind by train control or wind break fence installation								
•Installation of protection work for river bed								
•Installation of bridge protection work on underpass part								
•Installation of fall fence on cross over part								
(4)Others								
•Mahwagon Bridge work shop modernization								
•Investigation and countermeasure work for abating extreme noise and vibration								

Legend

- ① Maximum priority division (Y-MYCL)
- ② Priority division (M-Myrkina, Y-Pyay, Y-Pathein, Y-Dawei)
- ③ Except ① and ② division
- ④ All division

4.1.6 日本での研修（鉄道組織運営改善コース）

MR関係者（各部門の中堅幹部11名）を本邦に招聘し、鉄道関連施設の見学を通じて鉄道組織運営改善に関する知識育成をはかる。
 （11名×2週間）



軌道検測車添乗（京葉線）



指令見学(JR東日本秋田支社)



4.1.7 プロジェクト実施運営上の課題

- (1) プロジェクトを一層効果的に実施するために、カウンターパートチームとWorking Group for Service and Safety Improvementは、YangonとNay Pyi Tawのそれぞれに駐在するMRの専門家(カウンターパート)両方を含める事によって強化された。
- (2) 事故と低サービスレベルの現状と原因の分析手法をMR専門家に習熟させるためのトレーニングプログラムとワークショップを繰り返す。
- (3) サービスレベルと安全の向上に資する運営・維持運営に関わるMRの技術基準の近代化を進める。
- (4) CITC (Central Institute of Transport and Communication) 及びRTTC (Railways Technical Training Center) といったMRが使用している教育施設・設備の近代化
- (5) 短、中、長期鉄道設備改善計画については、予算の制約の考慮、各線区に社会・経済的及び政治的観点から、優先度を付けるべきである。社会・経済的観点からの優先度を付ける場合、JICAが2014年6月に作成した【Survey Program for National Transport Development Plan in the Republic of the Union of the Myanmar】を十分に考慮すべきである。

19

4.2 パイロットプロジェクトの実施を通じた保線技術の向上の技術移転

4.2.1 保線作業の技術移転（検査、計画、作業）

(1) テキストの編集

(2) セミナーの開催



軌道の作業、検査、安全の3種類の
ミャンマー語のテキスト



テキストを用いたセミナー開催の状況

20

(3) 検査、計画、作業の実施

この研修では、レール交換のような作業を除いて、主に昼間の列車間合いで作業を行った。検査、1)~10)の保線作業を行ってきた。主な作業を以下に示す。

- 1) 道床つき固め(ハンドタイタンパー使用)作業
- 2) 道床ふるい分け作業
- 3) レール交換作業
- 4) 継目に関する作業(レール遊間(レール継ぎ目の隙間)直し作業、継ぎ目落ち整正作業)
- 5) 通り直し作業
- 6) 分岐器の保守作業
- 7) 橋梁区間の検査、作業
- 8) 軌間直し
- 9) 施工基面整備
- 10) 軌道状態の管理及び評価(走行確認試験の実施)



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21



ハンドタイタンパーの使い方説明



突き固め作業



通り直し作業



マクラギ交換

22



橋梁上の作業



50Nレールへの交換



50Nレール交換後の軌道



走行確認試験

23

4.2.2 資機材供与について

JICA Expert Team として、1回目に74種類の資機材、2回目に9種類の資機材を供与した。2回目に供与した資機材は、保線作業の中でも頻繁に使用する資機材で、MRの全管区に行き渡るように配慮して決定したものである。

2回目に供与した追加資機材(9種類)

No.	Item	Unit	Manufacturer
1	Analog standard gauge G=1000	8	KANEKO CO.,LTD.
2	Instrument detection for track	8	KIDOUGIKEN
3	Tie tamper	8	SHIBAURA ELRTEC CORPORATION
4	Generator	8	SHIBAURA ELRTEC CORPORATION
5	Equipment for ballast tamping	8	HITACHI KENKI KAMINO CO., LTD.
6	Basket made by bamboo or plastic	40	SEKISUI KAGAKU KOGYO CO., LTD.
7	Light track trolley 1ton G=1000	8	YOSHIIKE KAKEN KIKI CO., LTD.
8	Rail lifting machine	10	TOKO SANGYO CO.,LTD
9	Jack for rail	48	NICH CO., LTD.

24

4.2.3 研修について

(1) ミャンマーにおける研修

MRの全国の**574名**に対して研修を行った。（当初は、ヤンゴン地区を中心とした研修生30名で開始したが、研修途中からMRの要請により、全国の研修生に受講させたいということから、1ヶ月交代で多くの職員に研修を受けさせる方法に変更



研修生への保護具（ヘルメット、安全靴、安全チョッキ等）の配布



トーチャンカレー駅構内の研修生の寮
（今回の研修のためにMRが建築）

25

4.2.3 研修について

(2) 日本における研修

日本で保線関係の講習会を2回行った。JR東日本、日本線路技術（株）他、多くの企業の協力をいただいた。研修の内容は、座学講習と保線作業、見学等である。（11名×2週間×2回）



東京における保線講習の状況



レール交換の実習
（JR東日本東京支社訓練センター）

26

4.2.4 保線作業技術移転の振り返り（主なもの）

- ・バラストやマクラギといった資機材の到着の遅れがあるケースがあったため、計画していた作業を急遽変更することがあった。
- ・駅構内や踏切近辺を除いて、作業場所へのアプローチ道路がほとんどないため、多くの場所において資機材の運搬や作業現場への移動など、多くの時間を要した。
- ・間合い作業で行ってきたが、列車ダイヤが正確でないことが多く、列車を止めざる得ない状況がたくさんあった。
- ・駅間作業では、屋根がないため突然の雨や休憩時に避難する場所探しに苦労した。
- ・機材をMRへ引き渡した後、タイタンパーやレールジャッキといった頻繁に使用する機材をMR自身で維持管理していくことは、重要だと考える。



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27

4.3 橋梁のメンテナンス

4.3.1 MRの橋梁の現状調査

- (1) MRの橋梁の概要
- (2) 維持管理体制
- (3) マルワゴン橋梁工場
- (4) 維持管理体系
- (5) 橋梁維持管理の課題



工場内の状況



リベット打ち作業

28

4.3.2 橋梁の維持管理の訓練

現況の調査を受けて、現地の訓練、セミナー等を通じて、維持管理技術の向上を図ることを目的とした。

- (1) 橋梁維持管理訓練の方針
- (2) テキストの作成
- (3) 実施体制
- (4) 使用道具など

4.3.3 橋梁維持管理訓練の実施（Phase1-4）

4段階のステップに分けて、訓練を実施した。

MRから依頼のあった大規模橋梁（ゴッティー、インワ、シッタン）および小規模橋梁の調査と検査、橋梁保守の講義などを行った。



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29



ゴッティー橋梁の変位測定の様況



9番橋梁の検査の着眼点訓練



下部工の目視検査



橋梁保守の講義の様況

30

4.3.4 訓練の感想

- ① 橋梁維持管理について、忘れていた技術を思い出し、新しい技術が学べた。
- ② 橋梁は建設後、何もしなくてもよいと思っていた。見た目で悪くなっている橋は架け替えればよいと思っていた。
- ③ 検査して直していくことが重要であることに気がついた。
- ④ 必要な知識を理論と実施で、繰り返し教わることで理解が深まった。
- ⑤ 橋がどの様に壊れるから、どのようにメンテナンスするかを学べた。
- ⑥ 検査する着眼点や検査方法、及び計算式が学べた。



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31

4.4 その他

4.4.1 保線作業の外注化

保線の外注化講習は、2015年の4月6日のR/Dで新しく加わった内容である。

概要は以下の通りである。

- (1) 背景
- (2) MRからの聞き取り調査
- (3) 保線作業外注化に向けての前提条件
- (4) 日本の事例
- (5) MR向けの保線作業の外注化

現時点では、日本の例は参考程度として考えるのが良い。将来、MRが民営化したり重要な目標が利益を得るようになったとき、日本の保線の外注化の事例が参考になるのではないか。

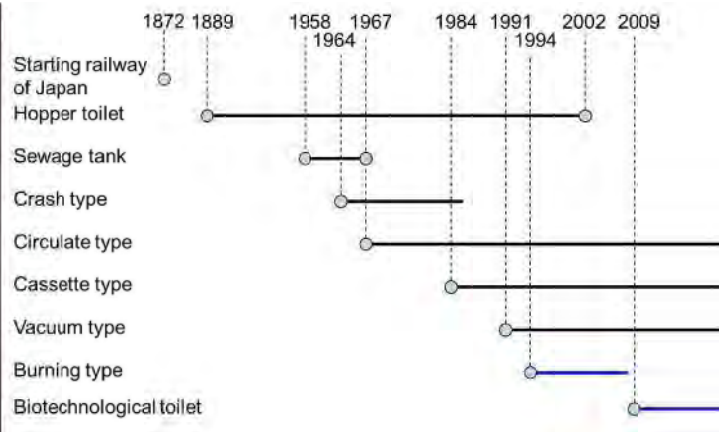


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32

4.4.2 車両のトイレシステム

MRから車両のトイレについての講義の要望が多くあった。この研修では、日本の車両のトイレの移り変わりや日本の事例を紹介した。午後には詳細な説明と質疑応答があり、活発に行われた。



講義の状況

日本の鉄道におけるトイレの移り変わり



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33

5. 今後に向けての提言

5.1 安全性・サービス向上に資する鉄道の改善と運営・維持に係る技術基準の提言

- (1) 目標とする技術移転を促進するために、このプロジェクトで実施したものと同様なトレーニングプログラムとワークショップを繰り返す事。
- (2) MRの技術発展と近代化に歩調を合わせて、現行技術基準を見直し、改正する。また、教育設備、教育器具、カリキュラム等の近代化を通じて、教育機関の向上を図る。
- (3) 応力、変位、振動の計算等、軌道、車両の基礎的理論解析並びに振動、応力、変位、力、温度等基礎的技術データの測定を実行できる研究組織の設立する。
- (4) JICAにより2014年6月作成された【Survey Program for National Transport Development Plan in the Republic of the Union of the Myanmar】の提言に十分考慮を払って社会・経済的観点から各線区の優先度を確立し、この優先度に従い順次各線区の近代化を進める。



Japan International Cooperation Agency

34

5.2 パイロットプロジェクトの実施を通じた保線技術の向上の技術移転

- (1) 全管区の作業員が、ヤンゴン周辺で研修を行って、地元に戻っているため、地元に戻った作業員が、追加資機材を確実に使用して、保線作業を行えば、線路の状態は改善されていく。
- (2) 研修を受けなかった職員や新しい職員に、研修を受けた職員が指導することが大切である。次世代への技術の継承という点で、MR内で、研修センターや現場での指導を通じて、技術を伝えることが大切である。
- (3) MRでは、保線の一部外注化が進められている。外注化が進んだとしても、MR内に、保線技術に詳しい人材を確保していくことが大切である。いわゆるインハウスエンジニアを抱えておくことであり、彼らが技術の核を担うことで、安全やサービスのレベルが保たれる。

35

5.3 橋梁メンテナンス

- (1) 修繕が必要な量を把握するために、MRは全ての橋梁の状態把握と優先順位付けを行う。
- (2) 橋梁維持管理に必要な予算を確保する。
- (3) 橋梁維持管理に必要な道具と設備の近代化を図る。
- (4) 60ft以下の橋梁の維持管理の強化
- (5) 防災工事の推進
- (6) Supervisor, Skill Worker, General Worker クラスの技術力向上

36

6. JICA Expert Teamとしての振り返り

苦労した点

- ・安全に対する考え方の違い
- ・現地通訳、技術スタッフへの指導
- ・資機材の不足(バラスト、締結装置等の軌道材料など)
- ・過酷な気象・現場条件
 - ・最高気温40℃以上
 - ・紫外線指数12
 - ・雨季におけるスコール
 - ・アプローチ道路がない など

良かった点

- ・鉄道事業における安全性やサービスを再認識
- ・MR職員、JICAインターン等の人材育成の場

今後の取り組み(案)

- ・地元に戻った研修生のフォロー(574名)
- ・追加資機材の調達
- ・核となる人材の育成(教育機関の近代化、研究ユニットの検討を含む)
→ 関係機関と調整しながら、継続していきたい

ミャンマーの鉄道について(最近の話題)



ヤンゴン中央駅



チャンシッター踏切(自動警報装置、遮断機)



気仙沼線を走っていた中古のディーゼルカー



路面電車の開通(広島電鉄から)

38

ご清聴ありがとうございました。



鉄道運営改善研修



保線技術移転研修

About outsourcing of track maintenance

Final Report

December 2015

JICA Expert Team

Contents

- 1 . Background
- 2 . Hearing investigation from Myanma Railways
- 3 . Precondition toward outsourcing of track maintenance
- 4 . Example of Japan
- 5 . Outsourcing of track maintenance
for Myanma Railways
- 6 . Conclusion

(Attachment)

Appendix - 1 Amendment Record of discussion
between Myanma Railways and JICA

1 . Background

The government of Myanmar requested the government of Japan to implement a project of technical cooperation or “The project on improvement of services and services of railway in Myanmar.”

Based on this request, JICA expert team conducted this project from May in 2013 to May in 2015. In April, 2015, there were additional requests which were training for track maintenance, outsourcing of track maintenance and outline of bridge maintenance from Myanma Railways (hereinafter MR) A term of construction work was hereby put off till March in 2016.

This report was edited by result of meeting and example in Japan about outsourcing of track maintenance. Technical supports are usually made a progress on site. On the other hand, outsourcing of track maintenance is summarized at the point of view from head office because this is conducted by head office.

2. Hearing investigation from MR

We surveyed hearing investigation from MR and examined how to proceed outsourcing of track maintenance. We show the result of hearing investigation.

We sort each item in comparison with case of Japan.

2. 1 About the purpose of outsourcing in case of Myanmar

The purpose of outsourcing is that engineers are less and track maintenance work should be conducted appropriately by mechanization.

In Japan, the main purpose of outsourcing is that track maintenance should be conducted effective work using ability of private company.

We understood the different purpose of outsourcing of track maintenance in Myanmar and Japan.

2. 2 About the transformation of work by outsourcing

Track maintenance workers have another job and don't devote themselves to track maintenance work. They will be able to devote themselves to one work by outsourcing of track maintenance.

MR can't proceed schedule of one –year plan. MR is thinking that other works will be done by outsourcing of track maintenance. This shows that not only track maintenance works aren't done well but also other works aren't done well.

In Japan, outsourcing of track maintenance work has effects of leveling works through the year and efficiency by outsourcing of simple work.

2. 3 About the role of contractor and MR in case of outsourcing

MR will order and exercise quality control. MR tried to outsource track maintenance to local company several years ago, but it didn't go well. There were no companies because workers were less and they had to import machines of track maintenance from foreign country. Machines of track maintenance are special type and they can't be converted from machine of general construction.

MR is planning that we conduct track maintenance work in cooperation with China between Mandalay and Myitkyina from 2015 to 2016. MR is searching many ways and hope to outsource many track maintenance works finally.

In case of Japan, almost of track maintenance works are outsourced and Japan Railway mainly specialize in supervision task.

2. 4 About the work of outsourcing

MR would like to leave the track maintenance work to private companies. But this is case by case. For example, in Bago area, sleepers have already changed to PC and track maintenance works are mainly welding of rail and inputting ballasts. And there are two cases of leaving track maintenance to only 1 company and of leaving it to 2 companies

In Japan at first, changing sleepers, inputting ballasts and other simple work had been outsourced. After that, range of outsourcing were extended. Now whole of track maintenance work are outsourced.

2. 5 About the current situation of outsourcing

MR is conducting outsource of track maintenance between Bago and Waw now. Finally, MR is planning outsource of track maintenance between Bago and Mawlamyine in 4 years. In this section, there are 2 companies. One company is Joint Venture of China and Myanmar and this company is conducting welding of rail. One more company is from Myanmar and conductiong change of sleepers cleaning of ballasts. MR hoped to outsource to only one company, but company can't deal with the work. MR usually don't supervision on site and only exercise quality control.

2. 6 Are there review of mechanization and organization accompanied by outsourcing?

Budget in Myanmar is very small. It is difficult to do outsource at the same time other things. At first, outsourcing is needed. After that, it may begin discussion about review of organization.

In case of Japan, introducing big track maintenance machine and review of organization were conducted parallel to outsourcing. As a result, staff could be reduced substantially.

2. 7 About safety countermeasure to contractor by outsourcing

In current situation, there are no books and rules about safety. MR only do to tell orally while working. Working itself is only told to learn by watching others and grab the timing. Senior should teach their experience to younger generation.

On the other hand, there is a culture that can't keep a rule in Myanmar. In hardware side, there are little budget. So MR can't buy helmets and safety shoes.

In case of Japan, contents about safety are included in the contract and specification. Therefore, contractor itself teach safety activity to workers.

2. 8 About a future of track maintenance

Track maintenance will be mechanized as outsourcing. Contractor will have to keep track maintenance machine. MR would like to be Japanese style finally, but it will be difficult for the time being.

In Japan, track maintenance was tried for elimination after outsourcing. Besides, we think that track maintenance will be increased in sophistication and elimination from now on.

3 Precondition toward outsourcing of track maintenance

There are 2 forms of work at the maintenance work and constructing.

One form is direct control, namely railway staff are mainly conducted. Another form is conducted by private company based on construction specification and contract.

Supervision of Direct control is in the chain of command of JR(MR) because JR(MR) staff engaged in the work. Contract work is based on contract, so supervisor and contractor are connected by rights and duties.

We describe the difference of direct control and contract work as below.

3. 1 Direct control work

In case of direct control work, work is conducted by JR(MR) staff who know the work and railway well. They also know relation rules and internal situation. Supervisor should be mainly careful of special point.

3. 2 Contract work (Outsourcing)

In case of contract work, the person who don't know train operation and railway situation well sometimes engage in the work. So supervisor of order side (JR (MR)) must arrange site manager who knows specification and railway neighboring construction well. Site manager must be made known to all workers. It is necessary for site manager to plan for establishment of accident prevention system.

(Attention)

(1)Before beginning construction, contractor must submit countermeasure of accident prevention to JR(MR).

Ex.

- Equipment of prevention about construction site
- Construction method of places requiring caution
- Placement of security guard, etc.

(2)Before beginning construction, JR(MR) makes contractor create memorandum for ensuring safety and exchanges copies. In case of changing plan, JR(MR) must make new one and exchange copies, too.

(3)In case of using heavy machinery for construction and Rail Gang Car, JR(MR) makes contractor submit memorandum about using them. If construction period becomes long and there are many kinds of construction, JR(MR) makes contractor submit memorandum every kinds of construction.

(4) In case of concerning train operation and safety for passengers, JR(MR) must make contractor submit paper of construction meeting by the day before. JR(MR) must hold a meeting and gives directions to contractor.

(5) In case of construction concerning train operation, JR(MR) must make contractor confirm train driving situation of the day. If there needs on-site witness, construction work must begin after supervisor arrives at site. In case of necessity of a watchman, contractor must arrange watchman certainly.

(6) Contractor must install safety equipment and check them regularly.

(7) Contractor must make workers wear protective equipment

About using trolley

(1) In case of absence of supervisor (Responsible person of trolley), don't use trolley.

(2) Before using trolley, make an inspection of trolley which belongs to contractor.

(3) During safekeeping, trolley must be locked and supervisor must keep a key.

(4) Using out of designated date and section are prohibited.

About railway track closing and using maintenance car

(1) Contractor must plan considering train interval and quantity of work.

(2) Contractor must inspect material, equipment and lighting, etc. and prepare backup.

(3) Contractor must widely make workers know working method, role sharing, estimated time and precaution.

(4) In case of absence of supervisor (Responsible person of maintenance car), don't use maintenance car.

(5) Contractor must make driver be well aware of track alignment and gradient, etc. in advance.

(6) When maintenance car pauses under using, make arrangement not to happen rolling motion.

(7) Don't load over standard load

4 Example of Japan

4. 1 Introduction

Track is different from other civil structure and track is not designed as permanent structures. Accordingly, track always occur subsidence, transformation and worn out, etc. by train load. These maintenance works were conducted by man power mainly around the time train were introduced. In Japan, track maintenance machines were introduced about 40 years ago. Now most of track maintenance work are conducted by machine.

During this term, not only mechanization of track maintenance but also review of organization and outsourcing has been conducted as modernization of track maintenance. Here, we show how to proceed outsourcing in Japan

4. 2 Transition

We show the transition of organization system and work system, etc. of track maintenance in Japan as below.

4. 2. 1 Before modernization of track maintenance (Before 1964)

(1) Organization, Work form

- Track gang in charge of 5-10km unit executed inspection and work.
- Mainly distributed work at small range and repair at any time

(2) Role of contractor

- 7 railway industrial companies were established as national policy during 1941-1943 all over Japan.
- Main work were disaster restoration, construction of new line and improvement.
- Contractor were undertaking the work exceeded ability of JNR during 1949-1974
(Ex. Supplementation of ballast, Changing to PC sleepers, etc.)

4. 2. 2 Modernization of track maintenance (1964~70')

(1) Organization, System

- Change from Track gang system to sub-district system to correspond to rapid progress of track maintenance technique.
- Sub-districts were established under Track Maintenance Section.
- Track Maintenance Section had 3-5 Sub-districts (Track Length is 40-60km)
- Sub-district had 3-4 Inspection Gangs and 1 Track Gang.
- Role of Track Maintenance Section were supervision of Sub-districts and order

outsourcing work.

- Role of Sub-districts were direct control work, inspection and supervision.
- Track Gang divided into Working Gang and Inspection Gang
- Working Gang: periodic maintenance
- Inspection Gang : periodic inspection and collecting data by mechanization

(2) Work Form

- Change from repair at any time to periodic maintenance
- Transition to big unit concentration work premised mechanization

4. 2. 3 Outsourcing of track maintenance at yard (1973~)

- Outsourcing of yard were implemented. Targets were semi-main line and side track of yard, rolling stock depot and freight terminal.
- Maintenance work of contractor began in earnest by implementing outsourcing of yard
- Main line and special turnouts were direct control work.
- Fluctuated works like improvement construction inside station were effective at outsourcing.

4. 2. 4 New Track Maintenance system (1978~80)

(1) Organization, system

- Full introduction of mechanization (especially MTT)
- Supplementary work of exchanging rail, exchanging sleepers, ballast cleaning and roadbed work were outsourced. Contract system began in earnest.
- Working Gang divided to Machine Working group and Working group

(2) Work Form

- The works which were needlessness of high technology, over direct ability and difficult work by direct control work were outsourced.
- Role of Machine Working group were driving or overhaul of track maintenance machine, etc.
- Role of Working group were tamping where MTT couldn't work easily.

(3) Revise of supervision of Track Construction

- Supervision guide was enacted by expanding outsourcing.

4. 2. 5 Improvement of track maintenance (1982~85)

(1) Organization, system

- Reform to technical group which can manage high technique

- Expansion of outsourcing range
- Working group was abolished.
- Machine Working group changed to Track Maintenance Machine group with altering job contents
- Inspection Gang changed to Track Maintenance supervision group with improving job contents

(2) Work Form

Track Maintenance supervision group

: Track patrol, survey, inspection, technical work concerning safety and construction, supervision of construction or presence, etc.

Track Maintenance Machine group

: Driving track maintenance machine, overhaul and repair of track maintenance machine or equipment, supervision of repair construction, supervision of supplementary work with MTT

(3) Outsourcing of work

Direct control work and outsourcing work were divided by subdivision of line level and working contents (Ref Appendix 1)

(4) Role of contractor

Many kinds of maintenance work could be constructed by contractor except driving Track Maintenance Car (Ex. MTT)

4. 2. 6 Improvement of work concerning track maintenance

and civil engineering (1985~)

(1987 : From JNR to JR (Private Company))

JNR(JR) reviewed working contents and tried to improve efficiency. Lower line at local area changed to efficiency system reflecting local condition.

(1) System

Track Maintenance supervision group

- : Track maintenance was conducted deliberately.
- : Restructure of track maintenance depot

Track Maintenance Machine group

: Review of MTT and party of Track Maintenance Machine group

(2) Organization

Review of business territory of Track Maintenance Section

Merger of sub-district and Track residence

(3) Work Form

All works except using maintenance car and supervision of track closing are target of outsourcing. The construction amount of the contractor expanded drastically

4. 2. 7 Small track maintenance section system (1988~2000)

(1) Organization, system

Sub-districts were abolished and transition to small track maintenance section
Efficient business operation was performed by simplification of organization.

(2) Work form

- Introduction of track maintenance supervision system
- Automation of inspection
- Promotion of operational mechanization
- Person in charge of track closing and maintenance car were expanded to former member of JR

4. 2. 8 System of 21century (2001~)

(1) System and Organization

JR : Technical group of track maintenance supervision

Partner company(Contractor) : Technical group concerning construction

Transition to new system which specialize in major

→ Organization of JR changed to system of track maintenance technical center.

(2) Work form

- Outsourcing of machine and MTT
- Inspection work were transferred to contractor
- Person in charge of track closing and maintenance car were expanded to employee of contractor.
- Network building including partner companies

4. 2. 9 Transition of maintenance work

The above is the transition of organization, system and work system, etc. of track maintenance in Japan. We show arrangement of these in Table.1

4. 3 How to outsourcing in Japan

When we maintain track, we need to maintain effectively using other ability

In case of using other ability, we must conduct outsource based on basic way of thinking as we secure high technique in railway company. We show basic way of thinking which examined in case of outsourcing some parts of track maintenance in Table. 2.

Around this, we divided “The work of direct control” and “Contract work”.

We show Utilization of outsourcing in track maintenance work in Table. 3, 4.

We ranked trunk line, local A, local B, and side track. We discussed which is better, direct control or contract work, against each maintenance work.

Although above, we can construct by direct control in case of unexpected accident and small scale repair work, etc.

5 Outsourcing of track maintenance for Myanma Railways

5. 1 About ranking of each line

We described example of Japan. If MR arranges the same way about outsourcing in Japan, MR needs to rank all lines. Evaluation items are importance of the line, passenger-kilometer, ton-kilometer and characteristic situation, etc. But we don't have detailed data about these. So we show the way of thinking.

We show the list of section, passenger-kilometer, ton-kilometer and importance in Table. 5. If we have detailed data, we write down in this Table and big line about passenger-kilometer and ton-kilometer will be trunk line. And rank is smaller as number is less. But if number is less and the line is important in Myanmar, we can judge as a trunk line.

Throughout this meeting, No.1~4, 7, 14, 16, 18~20, 32, 33, 37 were judged as trunk line as index of importance in Table 5.

Table 5 List of section in MR

Sr	Section		Passenger (Passengermile)	Freight (Tonmiles)	Importance	Rank	Remarks
	Station	Division					
1	Yangon - Mandalay	7-3					Double Track
2	Myohaung - Myitkyina	3-1					
3	Bago - Mawlamyine	6-8					
4	Kemmendine - Pyay - Bagan	7-6-11					
5	Nabar - Katha	2					
6	Kaungmudaw - Budalin	2					
7	Paleike - myin gyan - Bagan	3-11-11					
8	Myohaung - Lashio	3					
9	Thayeze - Madaya	3					
10	Thazi - Myingyan	4-3					
11	Thazi - Yatsauk	4					
12	Aungban - Loikaw	4					
13	Taunggyi - Sitekaung - Moene	4					
14	Pyinmana - Chauk - Bagan	5-11					
15	Abya - Nyaungkhashe	6					
16	Letpadan - Tharrawa	6					
17	Nyaunglebin - Madauk	6					
18	Mawlamyine - Ye - Dawei - Seikkan	8					
19	Magway - Taunggyingyi	11					
20	Pathein - Henzada - Kyangin	9					
21	Chaug-U - Pakokku - Kyaw - Kalay	2-10-10-10					
22	Sathwa - Dayingabo - Shwedaga	11-11-6					
23	Einchelese - Sattukone	6					
24	Bakye - Thayet - Minhla	9					
25	Sittwe sections						
26	Pakokku - Sinphyukyun	10					
27	Alone - Bawdthaung	2					
28	Pyawbwe - Ywataw	5					
29	Magway - Kanpyar	11					
30	Katha - Moetagyi	2					
31	Pyay - Paukkaung	6					
32	Henzada - Zalon - Nyaungdon - Hlaingthayar	9-6-7					
33	Pathein - Einme	9					
34	Dawei - Thayetchaung	8					
35	Kyaingtone - Wunkaung	4					
36	Thaton - Myinegalay	8					
37	Yangon - Circular & Suburban line	7					Circular and To Hlawga are Double Track
38	Pazungdaung - Htaw Li Kue	7					Tram

5. 2 Example of outsourcing in the way of Japan

We show the plan which work should be outsourced based on ranking in Table.6, 7.

Table 6 Outsourcing work (Part1)

				Main Line			Side track	Remarks
				Trunk Line	Local A	Local B		
	Track Repairing	Hand work	Correction of gauge					
			Spot surfacing					
			Correction of alignment					
			Adjustment of joint gaps					
			Continuous tamping					
			Others					
	MTT Work	Operation					Using Track maintenance car	
		Pre and after work					Using Track maintenance car	
	Material Repairing	Rail fastening system	PC					
			Others					
		Ballast supplementation	Responsible person					
			Others					
	Material Replacement	Replacement of track						
		Replacement of track panel						
		Replacement of rail	Acutual work					
			Pre and after work					
		Replacement of tie plate						
		Replacement of sleeper	Replacement machine					
Others								
Replacement ballast								
Others								
Turnout	Track Repairing	Correction of gauge and alignment						
		Continuous tamping						
		Others						
	Material Repairing							
	Replacement of material	All replacements	Assembly					
			Replacement					
		Part replacement						
		Replacement of sleeper						
		Replacement of ballast						
	Others							
Other Works	Roadbed work	Replacement of roadbed						
		Weeding	Mechanization					
			Others					
		Improvement of formation level						
		Improvement of drain						
Others								

Table 7 Outsourcing work (Part1)

				Main Line			Side track	Remarks
				Trunk Line	Local A	Local B		
Other Works	Convey Work	Clearing Snow	Machine	X	X	X	X	No relation in Myanmar
			Others	X	X	X	X	No relation in Myanmar
		Frost shim work		X	X	X	X	No relation in Myanmar
		General	Rail carrying					
			Sleeper carrying					
			Others					
	Using motor car							
	Various Work	Level crossing work						
		Roadway sign Work	Repainting					
			Others					
		Material Work						
		Instrument Work	Lank A					
			Lank B					
			Others					
		Security Work	On-site attending					
			Others					
		Others						
	Inspection Others	Around Check						
Inspection								
Survey								
Guard Others	Guard							
	Others	Emergency repair (Ex. Accident)						
		Survey of operation accident						
		Supervision of slow speed others						
Supervision and on-site attending								
Various construction								

	Working directly
	Working directly or Outsourcing
	Outsourcing
X	Not implemented

We are thinking that trunk line and local line in case of using maintenance car are basically direct control. Various works depend on the work. We arranged basic track maintenance work in local line.

6 Conclusion

MR has already begun a part of outsourcing. But this outsourcing is different from Japanese transition. In case of MR, one of purpose of outsourcing is fair work because staff have some jobs. At this style, cost will increase and profits will get worse as the company.

In case of Japan, railway companies have tackled with trimming down the organization and leveling work throughout a year at the same time outsourcing. So we must consider cost reduction.

At present, example of Japan may be only reference. In the future, when MR changes to privatization or most important target is to improve profit, we think example of Japanese outsourcing of track maintenance will be helpful.