APPENDIX 6

訓練用説明資料
(運営・組織体制、運転・運行・安全設備、軌道、路盤・橋りょう、車両)

Seminar for Railway Organization and Operation

March 2014

Lecture by Shinya NAKAMURA/Takashi KIKUIRI,

Team Leader/Deputy Team Leader, JICA Study Team

Railway Organization and Operation

Study for Safety Operation and Management of Railway in the Republic of Ghana

March 2014

JICA Study Team

Contents

1. Privatization of Railway

What is Privatization ?

- Privatization is the process of transferring ownership of a business, enterprise, agency, public service or public property from the public sector (a government) to the private sector, either to a business that operates for a profit or to a nonprofit organization.
- It may also mean government outsourcing of services or functions to private firms, e.g. revenue collection, law enforcement, and prison management.

Objectives of Privatization

- Greater efficiency
- Improvement of services provided
- Promotion of competition
- Reveal the true and full cost of the service provided
- Reduction of burden (or government subsidy)
- Raise extra revenues for the government
- Separation of debt

Advantages/Disadvantages of Privatization

- Advantages
  - Clarification of decision-making and improved management flexibility
  - Diversification
  - Improved service and decrease in fares due to competition from private enterprises
  - Reduction of government subsidy and gain of tax revenue from Railway
- Disadvantages
  - Possibility of minimization of service and quality due to cutting costs
  - Difficult to acquire funding if financial health worsens.

Privatized Railways around the world

- Africa

  Côte d'Ivoire/Burkina Faso (1995), Togo (1996)
  Cameroon, Malawi (1999), Mozambique (2002,2004)
  Madagascar, Zambia (2003) etc.
- Europe

  Sweden (1988), Italy (1992), U.K., German, (1994)
  Netherlands (1994-2000) etc
- Asia

  Japan (1987), Indonesia (1999)

Scheme of Privatization

- Division of Management

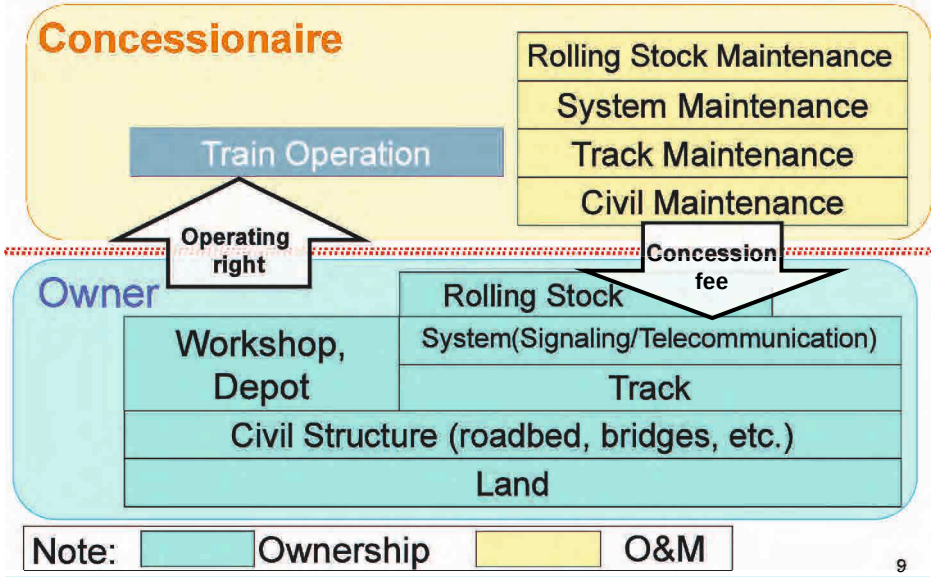
  A method in which infrastructure management and services/operation are divided, and independently accounted for. The European Union pursued such a division of management at national railways; most of the European national railways (or the equivalent) adopted division of management.
  There are cases where the upper and lower parts of organization are divided only for accounting purposes, or where multiple upper structures exist after introducing open access.
- Regional Division

  A method by which the national organization is divided regionally, and the management of a regional company is downsized. Example: JR Group, Japan

Concession Method

- In a concession arrangement, existing railway facilities and the right of management are assigned to a private company (concessionaire) for a consideration (concession fee) over a long term.
- It is expected that the private company holding the right of management will profit from managing the railway business while making capital investments as necessary. Oftentimes, it is obliged to pay a certain percentage of the profit or revenue to the national government.
- This system is adopted in many African countries.

Concession Method



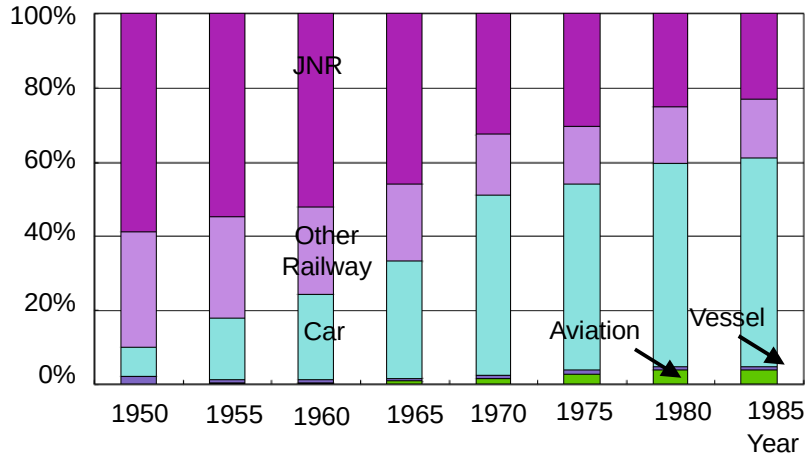
Case Study
Japan National Railway Reform

Background of Japan National Railway (JNR) reform

- Decreased railway transportation share and volume (both passengers and cargos)
  - Ongoing motorization rapidly expanded share of auto transportation.
  - Severe competition with airlines in long-distance transportation.
- Deteriorated Management of JNR
  - Annual deficits exceeded 1 trillion yen annually in 1980s.
  - Huge subsidy from government (600 billion yen in 1985)

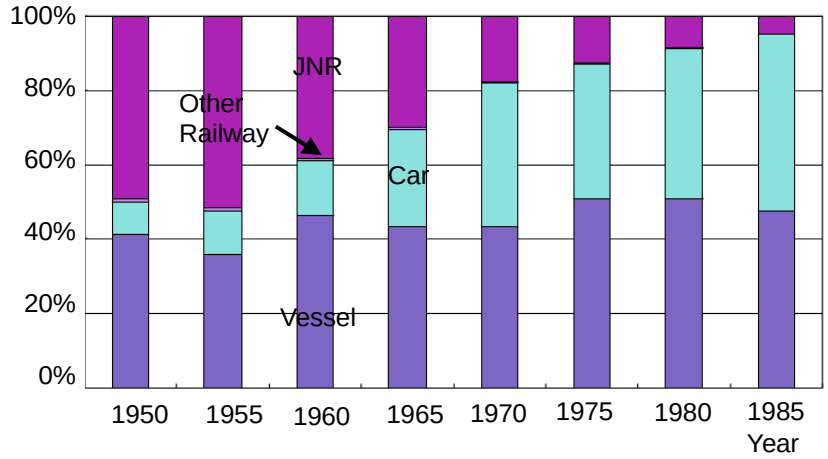
Transportation Share (Passenger)

Share of passenger-km



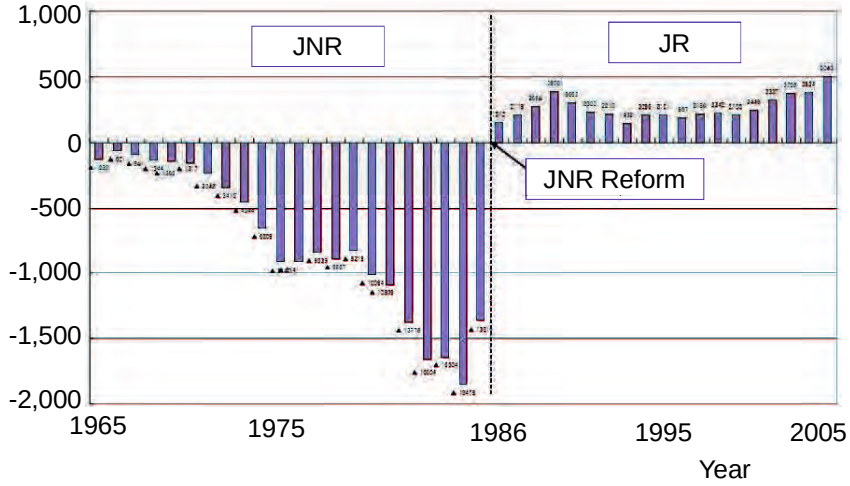
Transportation Share (Freight)

Share of t-km



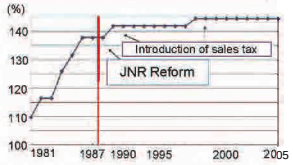
Current Balance of JNR/JR

(million JPY)



Basic Concept of JNR Reform

Huge debt and subsidy



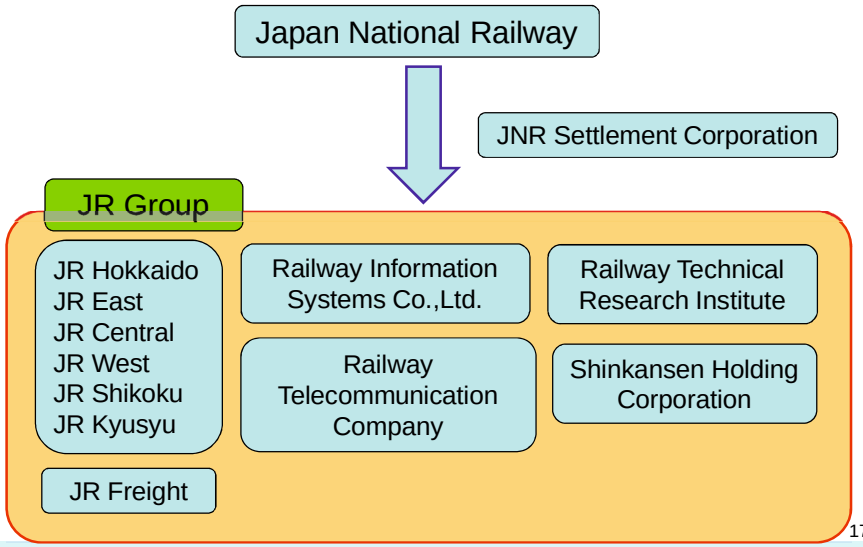
- Repeated fare hike
- Degradation in service
- Frequent occurrence of an accident

JNR Reform (1987)

Basic Concept of JNR Reform

- 6 passenger companies and 1 cargo company
- Transformation into stock corporations
- Deregulation and clarification of responsibilities (expansion of lines of business, approval of fares, etc.)
- Disposal of long-term debts (set up JNR Settlement Corporation)
- Reduced numbers of workers

Organization after Splitting and Privatization



Demarcation of JR

Results of JNR Reform（1）

- Improved service

  Passengers increased due to more frequent service and improved vehicles.

  198 billion passenger-km in1988→246 billion in 2005
- Entered non-railway businesses (selling, dining, travel, hotel, etc.)

  Deregulation promoted non-railway businesses.
- Decreased accidents

  900 accidents in 1988 → 455 accidents in 2005
- Streamlined management

  In 2007, seven JR companies produced a current surplus of 500 billion yen in total, and paid a corporate tax of 240 billion yen.

Results of JNR Reform (2)

- Unprofitable local lines discontinued

  Among unprofitable local lines, 1,846.5 km was discontinued, and 1,310.7 km converted into third sector railways.

- Disposal of long-term debt

  Result was a failure because sale of land was frozen when prices soared, and listing of JR shares was delayed due to sluggish stock markets.

  In addition, obligations increased to level above initial debt.

** A third sector railway is a former JNR line taken over by a company established with investments from municipality and private companies.*

2. Non-Railway Business

Purpose of Non-railway Businesses

- To strengthen profitability

  By focusing on highly profitable non-railway businesses, to diversify business portfolio and strengthen profitability

- To create synergy with railway business (and contribute increase in users)

  Mutual customer transfer cycle emerges between railway and non-railway businesses (synergistic effect)

- Effective use of idle assets

  Utilization of extra railway sites produced by downsized railway business.

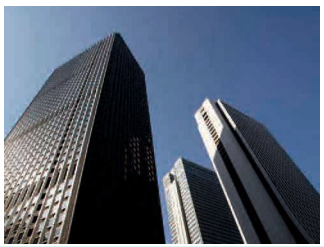
Contents of Non-railway Businesses (1)

- Retailing and dining

  Operation of retail, dining shops in ports and railway sites, mail-order business via Internet

- Real estate

  Leasing and management of office buildings and warehouses, development of residential lands along railway lines



Contents of Non-railway Businesses (2)

- Advertising business

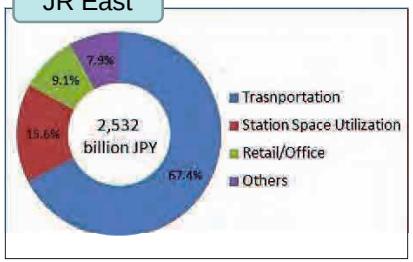
  Use stations and trains where many customers gather as advertisement spaces

- Leisure and service business

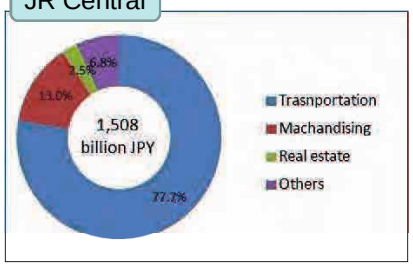
  Operation of hotels and sports, amusement, and exhibition facilities.

Revenue from Non-Railway Business

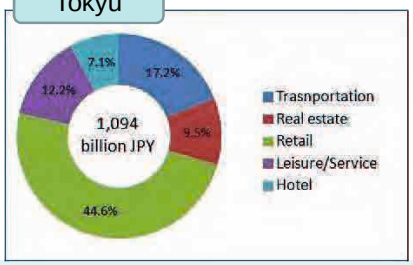
JR East



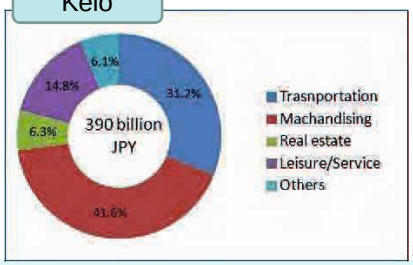
JR Central



Tokyu



Keio



Case Study

Non-Railway Business of JR East

Non-railway Business Operations of JR East (1)

- Background

  JR East had almost no business resources other than railway operation at time of privatization in 1987, but,

  - Need existed to build a stable management foundation in view of the future shrinking of railway businesses.
  - Need existed to secure employment of many employees of JNR.

⇒Expansion of non-railway businesses was an urgent task.

Non-railway Business Operations of JR East (2)

- Period of looking for new opportunities (‘90s)

  Because the splitting and privatization eliminated most restrictions on the scope of business, JR East embarked on various modes of business based on employee proposals supported by the company.

⇒ Due to shortage of know-how, most businesses were closed.

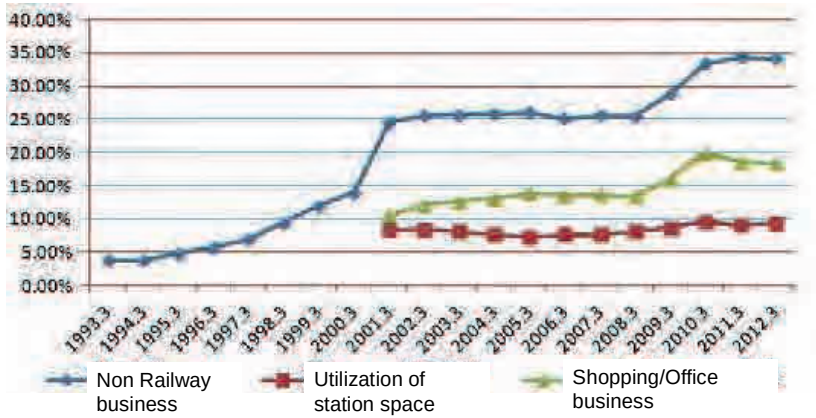
- Period of development (2000 on)

  Refocusing on “stations” as the company’s greatest managerial assets, it pursued non-railway businesses for convenience of users and higher profitability.

⇒ Development of “*Eki-naka”* (in-station) businesses.

Non-railway Business Operations of JR East (3)

Share of Non-Railway Business operating income



Development of Non-railway Businesses by JR East(4)

- “*Eki-naka*” Business

• *Eki-naka* refers to the commercial space developed in stations controlled by railway operators in Japan.

• Commercial facilities have been developed by railway operators in spaces on the main transit lines or corridors for users in stations, because they found that the stations attract customers and provide convenience.

Development of Non-railway Businesses by JR East(5)

- Online Shopping

Development of Non-railway Businesses by JR East(6)

Mineral Water

Food

Miscellaneous goods

Model Train

DVD

Issues in Managing Non-railway Businesses

Issues in Managing Non-railway Businesses

- Selection of kinds and modes of business

  Businesses unrelated to railway service and scattered turn out to be unsuccessful.

- Independence of non-railway business sector

  Plan under which non-railway business division is able to undertake independent investment and ordering needed.

- Developing employees dedicated to non-railway businesses

  Need to train dedicated employees to compete with other businesses.

- Competition with neighboring commercial facilities

  Pressure put on operators of existing commercial facilities nearby

3. Development along the Railway

Development along the Railway (1)

Measures to increase passengers:

- Residential area development
- Amusement park, Museum, Zoo etc.
- Department store at/close to terminal station
- Event

  e.g. sports game, concert, exhibition
- Attracting university, large-scale factory
- Tourism resources development

Development along the Railway (2)

In Japan, urban development along the railway in conjunction with railway construction has been involved actively.

e.g. Hankyu Railway, Tokyu Railway

⇨ TOD (Transit-Oriented Development)

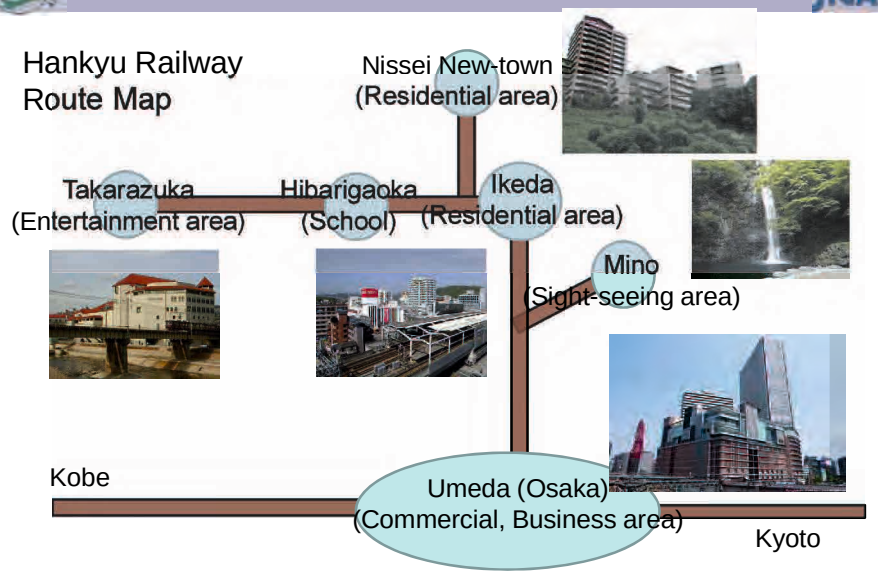
Mixed-use residential and commercial area designed to maximize access to public transport

Development along the Railway (3)

Development History of Hankyu Railway

Year	Railway	Development
1910	Umeda (Osaka) -Takarazuka, Mino	Residential area in Ikeda Zoo in Mino
1911		Amusement park at Takarazuka
1913		Girl chorus at Takarazuka
1920	Umeda (Osaka)-Kobe	
1924		Musical theater at Takarazuka
1925		Market at Umeda terminal station (Osaka)
1926		Hotel at Takarazuka
1929		Department store at Umeda terminal station (Osaka)
1936		Professional Baseball Team

Development along the Railway (4)



Case Study

Development Procedure along Tsukuba Express Railway

Tsukuba Express Railway (1)

Tsukuba Express Railway

Length: 58.3km
(underground: 16.3km)
Max Speed: 130km/h
Opening: 24 Aug. 2005

Tsukuba Express Railway (2)

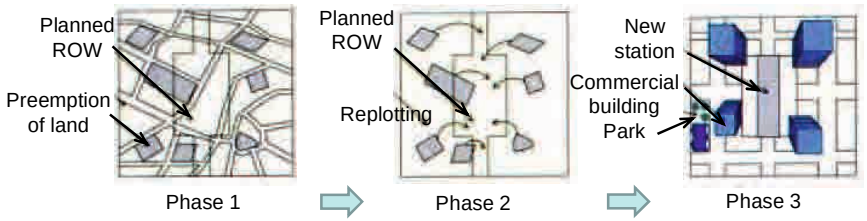
Purpose of Tsukuba Express Railway

- Development of transportation network in the northeast area of Tokyo
- Congestion mitigation of the existing railway
- The residential land supply in the Tokyo metropolitan area
- Development of industry infrastructure and formation of core business city along the railway

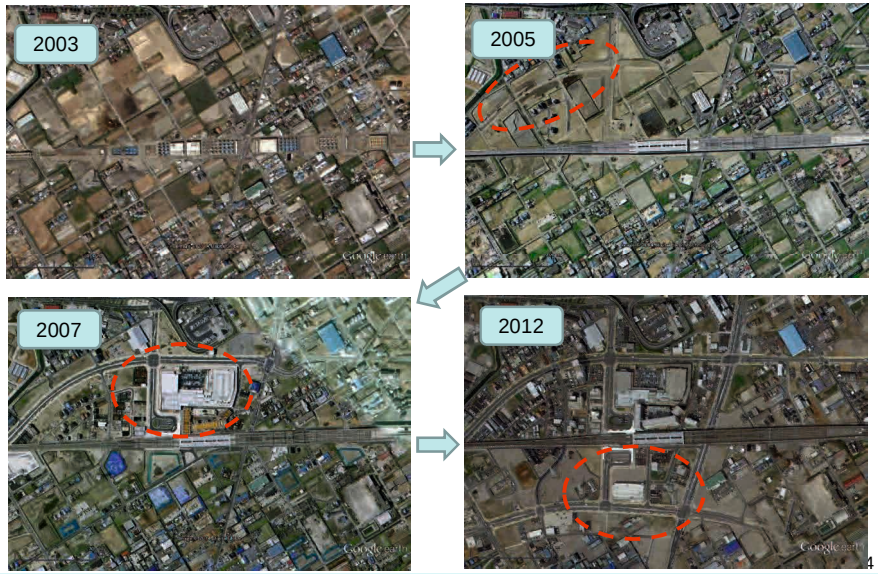
Tsukuba Express Railway (3)

Act on Special Measures concerning Comprehensive Advancement of Housing Development and Railway Construction in Metropolitan Areas (1989)

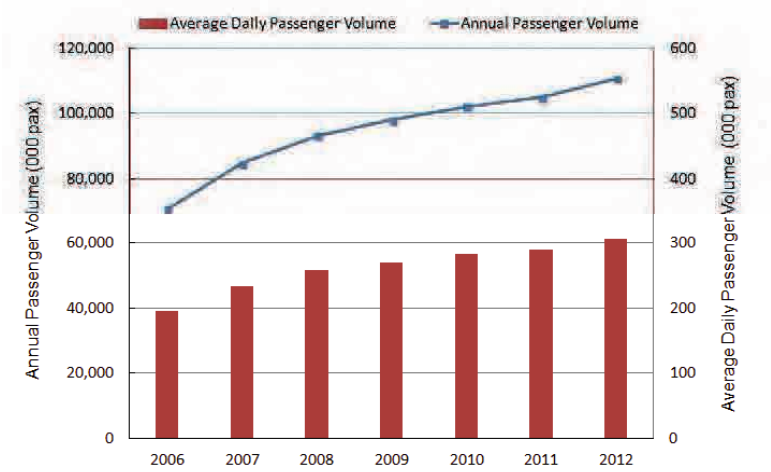
- The integrated development of transportation access and residential areas
- Implementation of integrated land readjustment project in order to facilitate the land acquisition for railway



Tsukuba Express Railway (4)



Tsukuba Express Railway (5)



Possibility of non-railway business in Ghana railway

Possibility of non-railway business in Ghana railway

- Effective utilization of land
  ⇒Parking lot, housing, office/commercial building
- Utilization of Human resources
  ⇒Technical consulting service
  (Project management, design, construction supervision)

Lecture for Safety Operation

From 18th March to 28th March 2014

Lecture by

Hideharu IGARASHI,

Safety Operation Expert, JICA Study Team

Railway Safety in Japan



Japan International Consultants for Transportation Co., Ltd.(JIC)

Company Profile

COMPANY NAME	Japan International Consultants for Transportation Co., Ltd.(JIC)
HEAD OFFICE	9th floor Shin-Kokusai Building 3-4-1 Marunouchi, Chiyoda-ku, Tokyo100-0005,Japan
ESTABLISHMENT	November 1, 2011
CAPITAL	JPY 495,000,000
EQUITY STRUCTURE	East Japan Railway Company 53% West Japan Railway Company 20% Tokyo Metro Co., Ltd. 20% Kyushu Railway Company 1% Japan Freight Railway Company 1% Tokyu Corporation 1% Keihan Electric Railway Co., Ltd. 1% Seibu Railway Co., Ltd 1% Keio Corporation 1% Osaka Municipal Transportation Bureau 1%
MAIN BUSINESS ACTIVITIES	Research related to railway projects, consulting for railways and other transportation systems, dispatching railway specialists overseas, educating/training overseas railway personnel, etc.

About me (1/2)

- Apr. 1985: Entered Japanese National Railways（JNR）
  - Inspector of rolling stoke workshop
- Apr. 1987:Succeed to East Japan Railway Company (JR EAST)
  - Rolling stoke engineer for maintenance & design of new EMU

AC/DC Compatible EMU Type415-1901

About me (2/2)

- Oct.1994: JiCA Expert - Training Center Project of SRT
- Jun.1997: Developed ATOS system
- Feb.2001: registered consulting mechanical engineer
- Apr.2001: Developed & Revised COSMOS system
- Mar. 2004: JiCA Expert -Senior Adviser of SRT Governor
- Apr. 2006: Manager of International Dept. in JR EAST
  - -Attended more than 600 visitor from the foreign countries in annual)
  - -Joined many International Conference, UIC※, UITP※2, etc,
- July 2010: JiCA Expert DGR, Indonesia
- Since June 2012 Japan International Consultants for Transportation

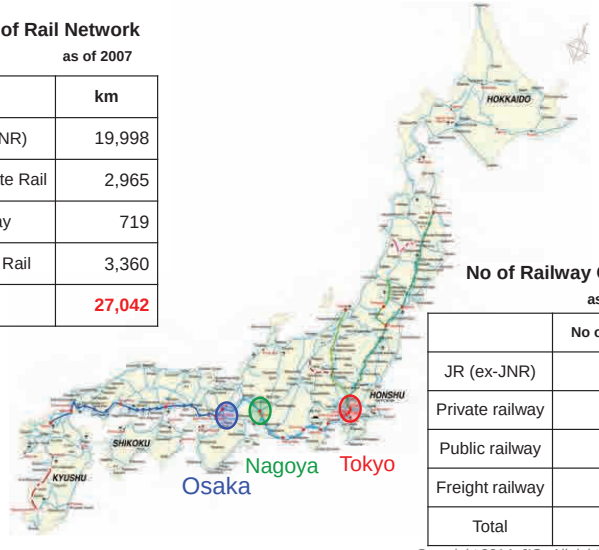
※ UIC: International Union of Railways: Union Internationale des Chemins de Fer
※2UITP：L'Union internationale des transports publics

Outline of the Japanese Railway

Length of Rail Network

as of 2007

	km
JR (ex-JNR)	19,998
Major Private Rail	2,965
Subway	719
Regional Rail	3,360
Total	**27,042**



No of Railway Operators

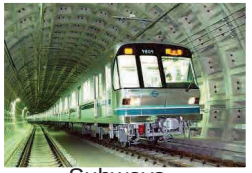
as of July 2010

	No of companies
JR (ex-JNR)	6
Private railway	176
Public railway	11
Freight railway	12
Total	**205**

Various Types of Transportations Mode


Shinkansen (HSR)


Urban Rail


Subways


Local Rail


LRT


AGT (Automated Guideway Transit)


Monorail (1)


Monorail (2)


MAGLEV

Each operators have each situations


JR Group


Major Private Sector


Local Sector

Difficult only one government law

Government improvement for down-sizing

Reduce the government permissions

For sustainable railway operation

government : ground rule

Operator: local rule

Customer oriented

Why?

Transportation is under competitive situation.

Early decision making

Back Ground

- In 1990s' the Railway Business Act was improving for Customers' convenience, the amendment being promoted in terms of independent and business ownership.
- The railway business has changed from the licensing system to the entry allowed system, due to activation under free competition. The supply-demand adjustment is the removal of restrictions.

The railways system certification(1)

- Under the conventional rule, when the railway operators have been constructing the new facilities or building the new rolling stocks, they needed the ministry permission.
- After revised, Operators can do the design verifications and the completed confirmations by themselves.

The railways system certification(2)

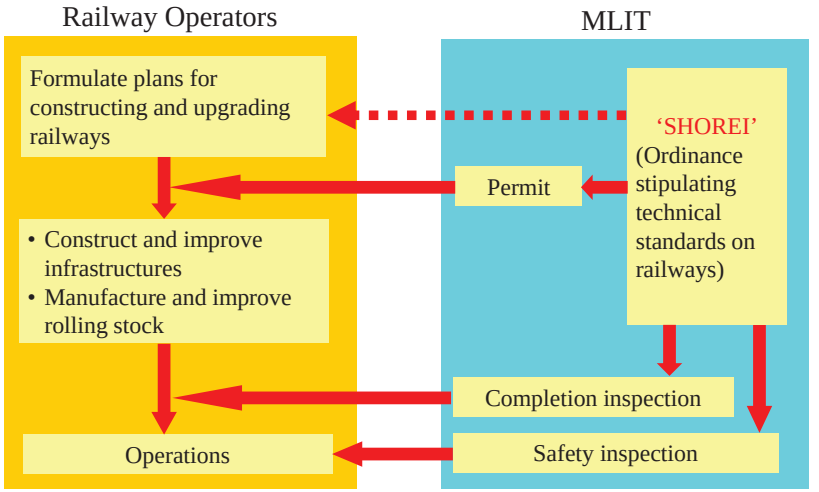
- Upon certification, the MLIT judged
  the organization and responsibilities,
  the procedure of design and completion,
  and the internal auditing system
  in advance.
- If each requirements are ok,
  then the MLIT acknowledges the approve for the operators.

Legal System concerning Railways in Japan

- Railway Business Act
  (Roles and obligations of railway operators)
- Railway Operation Act
  (Upper limit on fares)
- Ministerial ordinance on the technical standards of railway operations
  (Standards for equipment needed for safe operation)
- Announcement on the periodic inspection of facilities and railcars
  (Standards for the maintenance of equipment)

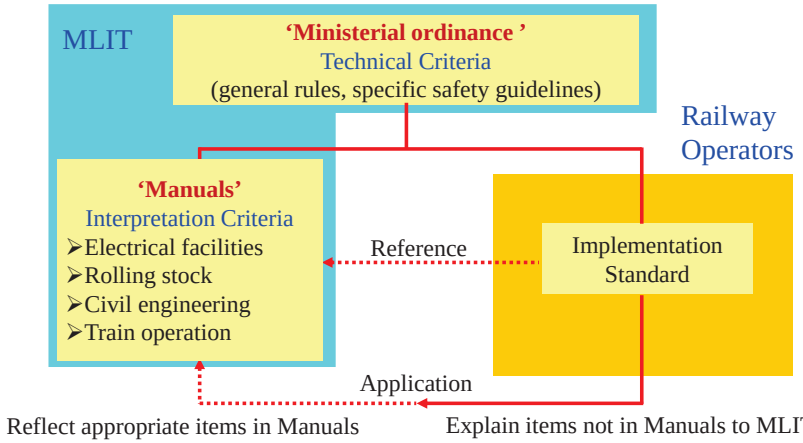
What is “RAMS”?
Evaluation standards for Reliability, Availability, Maintainability and Safety.
which have been established by International Electricity committee(IEC) in September, 2002.

Framework for Ensuring Railway Safety

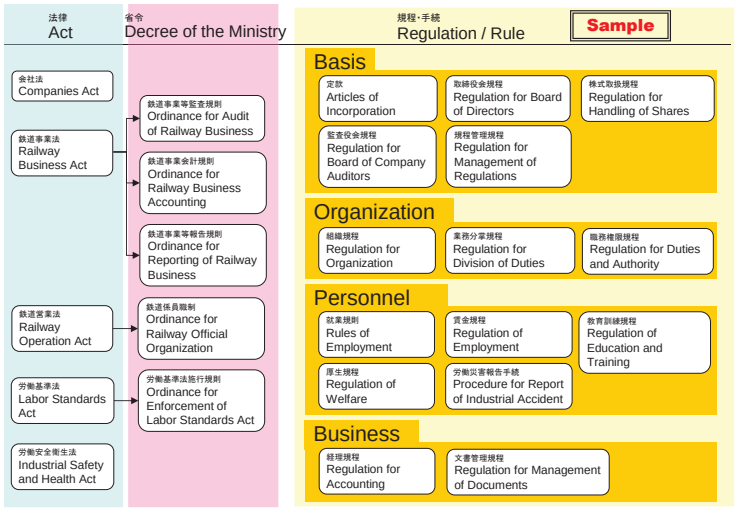


MLIT: Ministry of Land, Infrastructure and Transport

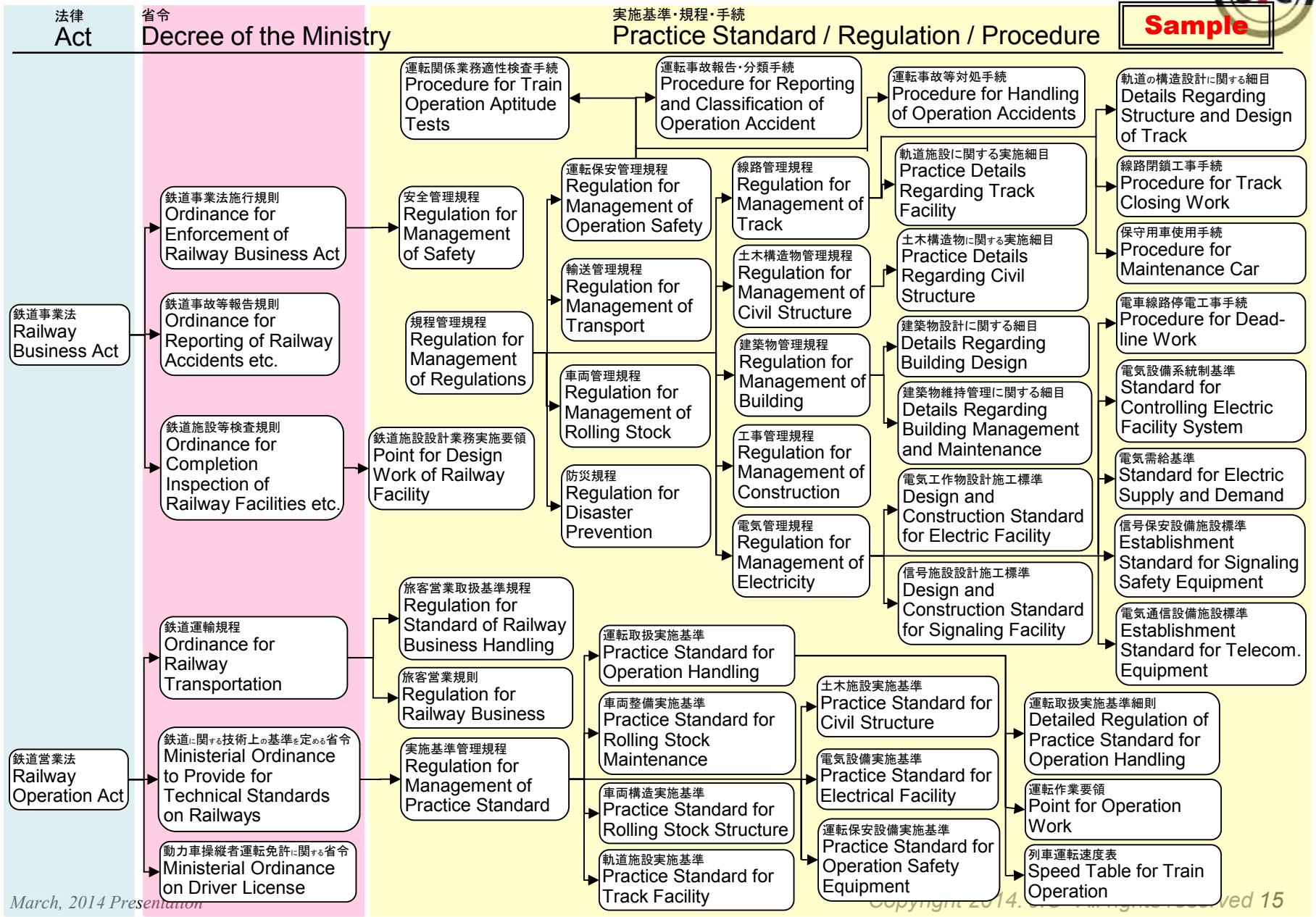
System of Railway Technical Standards



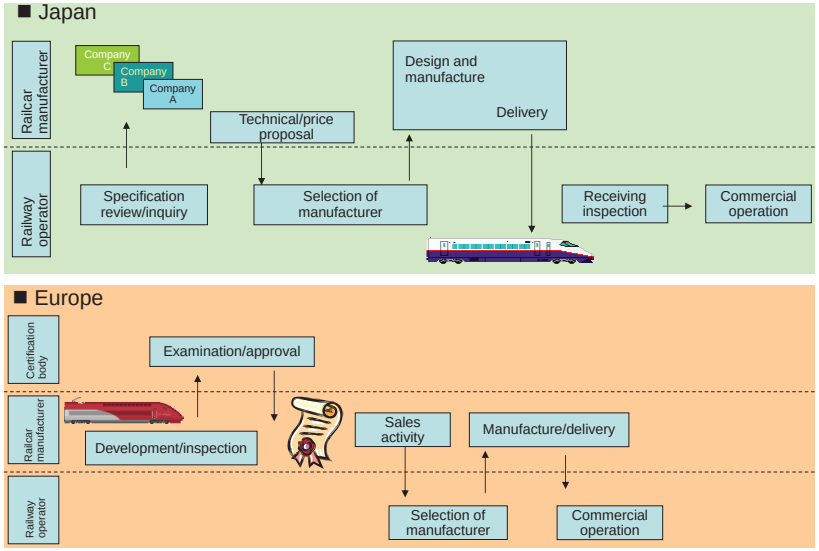
App-1. Regulation for Management of Railway Company



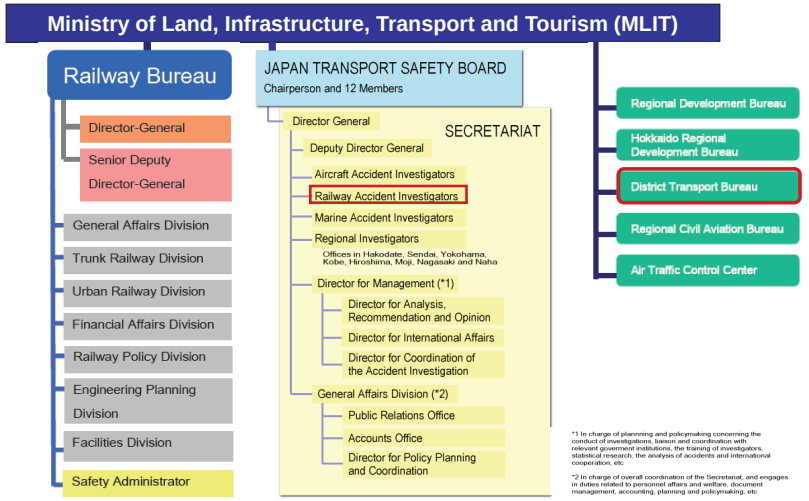
App-2. Regulation for Operation and Maintenance of Railway System



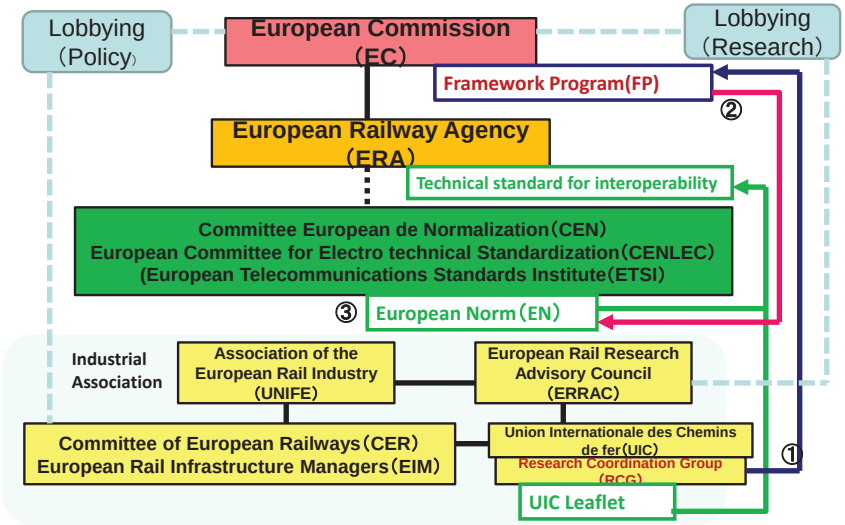
Differences between Europe and Japan in How Railcars are Ordered



Organization of MLIT



Relation of the European railway- organizations



① Inspection of driver's aptitude

Law related to driver's license

- **Possession of the driving license required**
- **In the following cases, the license is canceled or suspended.**
  - **In case of violating the law or regulations related to the driving.**
  - **In case of not satisfying medical or psychological requirements.**

① Inspection of driver's aptitude

The process of getting a license and driving independently

- Inspection of driver's aptitude
- Subject study 3.5 months
- Examination for knowledge
- Study of driving skill 4.5 months
- Examination for driving skill
  Acquisition of license
- Probation
- Examination for driving

① Inspection of driver's aptitude

Law of inspection of driver's aptitude

■ **When becoming a driver:**

- **Medical inspection**
- **Psychological inspection**

■ **Regular inspection:**

- **Medical inspection （Every year）**
- **Psychological inspection (Every 3 years)**

② Driver's License

Training Subjects & hours

Subject	Hours
Basis of Safety	21
Railway car	119
Driving regulations	92
Signal, Track	42
Electricity	40
Driving theory	60
Maintenance	18
Job safety	8
Total	400

Subject	Hours
Fundamental of driving	15
inspection before departure from depot	10
Probation	440
Procedure after incidents	50
Total	515

Practical training with training tracks

② Driver's License

How a driver's license is acquired?

Driver's license

Examination by the MLIT (2 times /year)

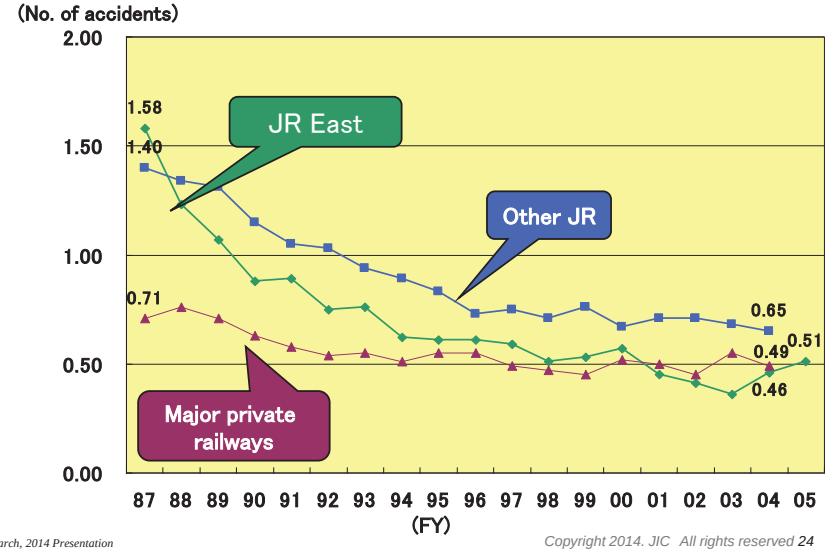
※MILT: Ministry of Land and Infrastructure

Examination by an organization MLIT - specified (JR East)

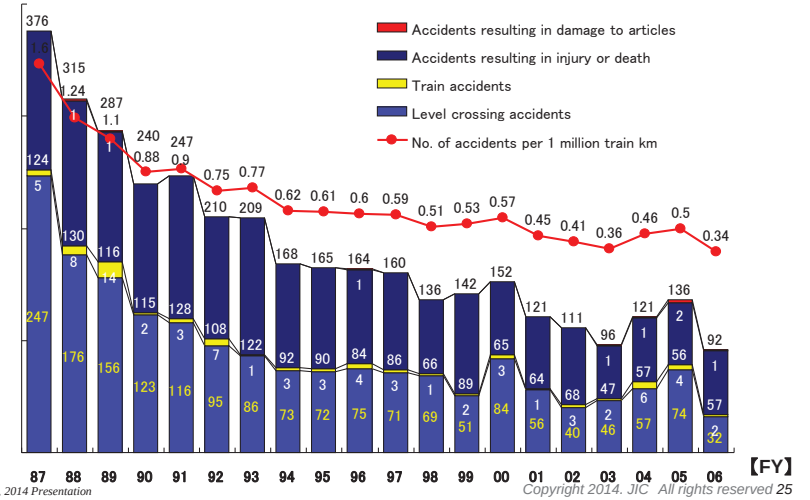
JR East General Education Center

Training with a simulator

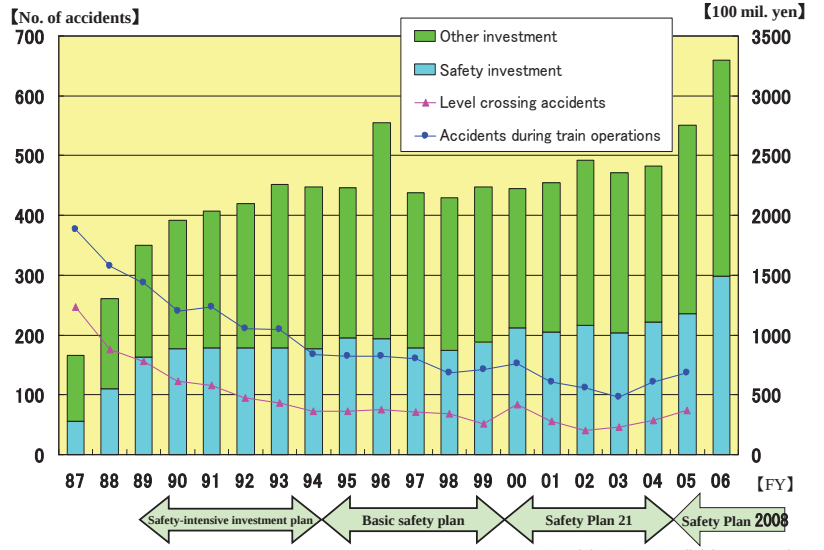
Railway Accident per Million Train-km



Fluctuations in the No. of Accidents During Train Operations



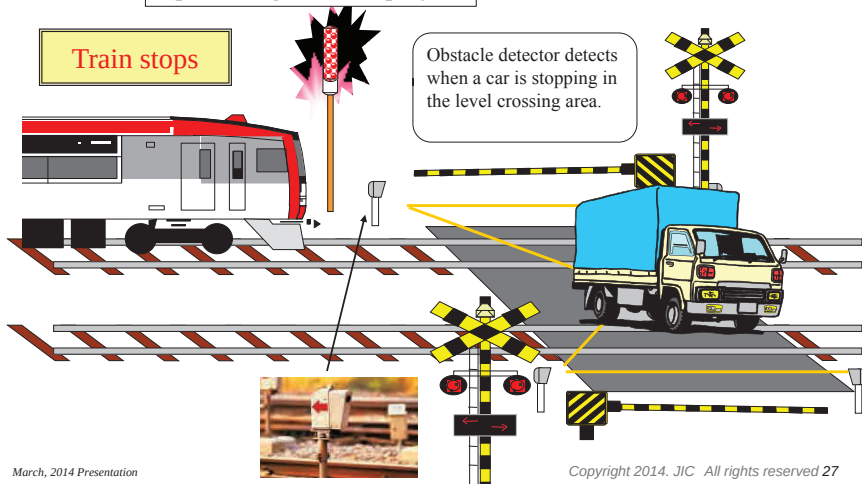
Investments for Railway Safety



For Safety Transportation

Preventing Serious Accidents

Special signal is displayed



Employee Training


Fire Drill

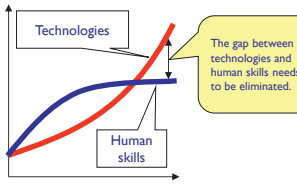

Escape Drill


Emergency Operation Drill


Emergency Drill on Real Rolling stoc

Employee Training

Employee Training



<Learning from accidents>

- **Railway safety begins by learning from accidents.**
- **Remembering past accidents and conscientiously learning from them**
- **Sharing knowledge of failures, and implementing countermeasures (safety-focused corporate culture, with emphasis placed on learning from past failures)**


JR East General Education Center (one center)


ractical training on training track bed


"History of Accidents" exhibition room


JR East General Training Centers (13 centers)


Training with a simulator

Category of Railway accident

- Train Accident
  Collision, Derailment, Fire Accident
- Level crossing Accident
- Road obstacle accident
- Passenger obstacle accident
- Property damage
- others

Inspection Items

1. Commitment for transportation safety
2. utilization of facilities and rolling stocks
3. **Maintenance situations** of facilities and rolling stocks
4. **Safety** Devise
5. Management of construction
6. countermeasure for Accident and Natural disasters
7. **Maintenance activities**
8. **Staff organization**
9. **Vocational Training**
10. **Management Ledger and Design documents**
11. **Progress for direction by Ministry**
12. **Others**

Report Responsibilities

In case of accident, operators have to inform to ministry or regional office by aural. And they have to send report within 2 weeks.

a. Dead passenger or operating staff
b. Dead or injured more than people
c. Human error of Operating staff or Facilities' Faults
d. Disturbed mainline more than 3 hours
e. Others

Analyze of Reports

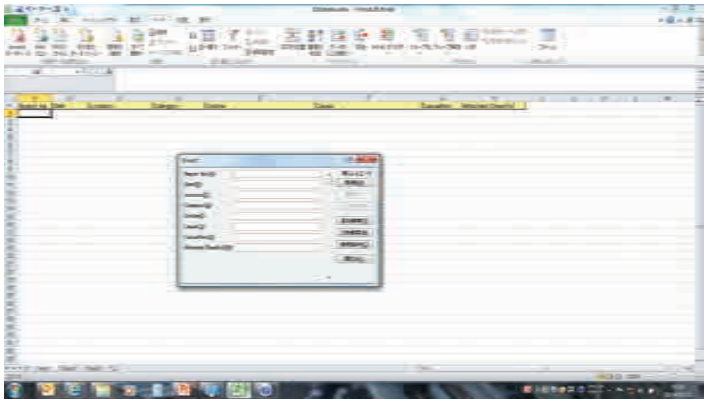
- MLIT analyze the each report and inform to statistic result for operators and others
- number of accident
- regional, JR or others and so on

Example of incident report

Incident Report

		Written Section	
Category		Reactor Event	
Date/time	Wether		
Location	line	Station・Yard (Based Point km m)	
	Level Closing Class	Obstruct Detector	Condition
Train	Type	From	to
	Composition cars Series	Belonging Depot	
Event			
Proses			
	【note】		
Casualties	【Casualties】 people (detail:Passenger ・Crew ・pedestrian)		
	【name】	【age】 y/o	
	【Address】		
	【Symptoms・Hospital・Others】		
Persons Concerned	Belonging Position Age		
	Entered Present Experience Name		
	Belonging Position Age		
	Entered Present Experience Name		
Effect	Passenger Train Canceled Delayed (～ minutes) Total delay minutes		
	Freight Train Canceled Delayed (～ mimutes) Total delay minutes		
	transfer passengers to another means of transport people		
◆If necessary, Attached sheets	written		Tel

Simplified incident database



Thank you for your kind attention

Training for Track Maintenance

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,

Track Expert, JICA Study Team

Railroad Tracks Maintenance Training

Track Expert, JICA STUDY TEAM
Kiyoshi MIYAMOTO

Training Schedule		
1st	AM	Introduction of Railroad Tracks Maintenance Training activities.
	PM	Lecture of maintenance methods and safety train operation.
2nd	AM	Lecture of the Tracks repairing methods and provisional standards for defective fasting devices and rail irregularities.
	PM	Carrying out "pre-training" activities at the site of lateral line in Takoradi station.
3rd	AM	Hand-on training for measurement of defective devices and track irregularities on a 100m long section the main line.
	PM	Preparing maintenance report of track irregularity and defective devices based on the investigation results.
4th	AM	- ditto –
	PM	
5th	AM	Preparing track irregularity charts based on investigation results.
	PM	Installation of the provisional standard of track irregularity for emergency maintenance and preparing listing/directory of track irregularities value and over limit sections. These activities will lead to the preparation of Work Plan for track investigation.
6th	AM	- ditto –
	PM	
7th	AM	Training of rail investigation for the straight sections Repair works for fasting devices in accordance with the Work Plan.
	PM	Measurement of track irregularities after the investigations.
8th	AM	- ditto –
	PM	
9th	AM	Training of rail investigation for the curve sections in accordance with the Work Plan.
	PM	Measurement of track irregularities after the investigations.
10th	AM	- ditto –
	PM	
11th	AM	Observation of track conditions after the investigations.
	PM	Post-program session

Railroad Tracks Maintenance Training
Purpose and outline

Track Expert, JICA STUDY TEAM
Kiyoshi MIYAMOTO

(Purpose of Railroad Tracks Maintenance Training for GRCL Staff)

In recent decades, railroad track maintenance was not performed in Ghana's railways in accordance with the basic track maintenance cycle, and staff training in maintenance operations was rarely conducted . As a result, railway track deterioration increased, causing frequent derailments and other forms of accidents. . This situation has even led to questioning the necessity of such railways.

This training program is designed for selected GRCL staff and aims at improving technical skills with respect to the track maintenance cycle, so that the Ghana Railway can be operated stably and safely.

(Proposal for Training to GRCL Staff)

Generally, track maintenance is carried out in accordance with the following cycle;

1) Inspect
   Inspection of track materials and measurement of track irregularities under the existing conditions:
2) Plan
   Planning of the implementation procedures:
   (a) stating the method and the process under which to replace defective track materials; and
   (b) selecting inspection sites where the track irregularity is high.
3) Do
   Implement the track maintenance in conformity with the "Plan".
4) Check
   Check to see if the "Plan" is being properly implemented and review the selected procedure.
5) Act
   Act to get the greatest benefit from the "Plan" .
   The "Plan" shall be refined and improved in accordance with the results of process in the next cycle.

Based on the above mentioned basic cycle, this training will be carried out as follows:

1) Inspecting the conditions of track materials and the measurement of the track irregularities between Takoradi to Nusta (63km), aiming at grasping the current conditions.
2) Setting out the Work Plan by analyzing the track conditions from the control sheets prepared based on the inspection, and determining defective sleepers, track materials which require immediate replacement and locations where urgent repair works of gauge irregularities would be required.
3) Replacement of defective sleepers and materials as well as investigation of gauge irregularities in accordance with the Work Plan.
4) Measure of gauge irregularities after completion of maintenance cycle (as provided above) in order to

asses the effectiveness of the Work Plan..

5) Based on the result of the activities above, improve the Work Plan with more details and prepare the updated version of the Work Plan for the next steps

(Training Schedule and Contents)

The details of our training are as follows;

		Training	Purpose
1st	AM	Introduction of Railroad Tracks Maintenance Training activities.	To remind of the importance of safe train operations and maintenance.
	PM	Lecture of maintenance methods and safety train operation.	
2nd	AM	Lecture of the Tracks repairing methods and provisional standards for defective fasting devices and rail irregularities.	To initiate the installation of the provisional standards for defective fasting devices. Teaching 1. method for selecting location for track repairs 2. measurement method of track irregularities 3. preparation of track irregularity charts.
	PM	Carrying out "pre-training" activities at the site of lateral line in Takoradi station.	"Pre-training" is implemented for the purpose of leaning the measurement of defective devices and track irregularities.
3rd	AM	Hand-on training for measurement of defective devices and track irregularities on a 100m long section the main line.	Grasping techniques of measurement of defective devices and track irregularities.
	PM	Preparing maintenance report of track irregularity and defective devices based on the investigation results.	
4th	AM	- ditto –	
	PM		
5th	AM	Preparing track irregularity charts based on investigation results. Installation of the provisional standard of track irregularity for emergency maintenance and preparing listing/directory of track irregularities value and over limit sections. These activities will lead to the preparation of Work Plan for track investigation.	To initiate preparation of the Work Plan and establishing the importance in implementation of immediate repairs of the sections which over limit value of track irregularities were measured in order to prevent derailments and other accidents.
	PM		
6th	AM	- ditto –	
	PM		

7th	AM	Training of rail investigation for the straight sections Repair works for fasting devices in accordance with the Work Plan.	The measuring of track irregularity value for the straight sections is including measurement of the thickness of the measuring coma, so its values should be reduced by the total track irregularity values.
	PM	Measurement of track irregularities after the investigations.	
8th	AM PM	- ditto –	
9th	AM	Training of rail investigation for the curve sections in accordance with the Work Plan.	To initiate measuring of track irregularity value for the curve sections (including cant, versine and slack), so those values should be reduced by the total track irregularity values.
	PM	Measurement of track irregularities after the investigations.	
10th	AM PM	- ditto –	
11th	AM	Observation of track conditions after the investigations.	To teach the basic method of track investigation and the repair effect to measure the track irregularities after the investigation.
	PM	Post-program session	

The measurement of defective fasting devices and track irregularities will be conducted in 5 groups, each consisting 3 members. .

Each group will make track irregularity charts to choose priorities of the repair works and locations. The location of the training will be decided according to the result of one selected group, chosen by the lecturer, Mr. Miyamoto.

(Expected Result)

Potential accidents, such as derailment, that occur due to bad track conditions could be prevented by implementation of the Track Maintenance Cycle as per the Work Plan. Such cycle ensures the safe and stable operation of the Manganese transportation between Takoradi to Nusta and could also increase GRCL staff safety awareness.

Further training activities can be provided to other employees and newly recruited GRCL staff by the staff already participated in the Railroad Tracks Maintenance Training, Thus, the track maintenance method could be understood by all GRCL staff in the end and the knowledge obtained throughout the training activities could be utilized in track inspection for the whole of the Western Line, including the branch line to Awaso. In addition, the result of this training can be applied throughout the the Eastern and the Tema Lines, which are currently being operated in the limited sections .

In conclusion, continuing the safe and stable operation of the Western Line will lead to the increase of the transportation volume of Bauxite and Manganese by trains, and thus to the reduction of per-unit transportation cost by trains. Consequently, it could be highly expected that Ghana's international competitiveness with respect to those natural resources could be improved.

(Note : Mr. J K Fang, General Manager of Ghana Bauxite Company informed the JICA Study Team that at present (November, 2012) the unit cost of bauxite ore by the road transportation was 16 US$, whereas that by the railway transportation was about 10 US$.)

Training for Track Maintenance 1/6
"Maintenance Plan"

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

Contents of Training Program

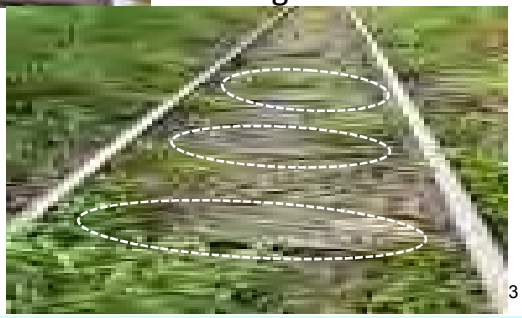
1. Current conditions and Issues
2. Recommendation of training program
3. Setting up the maintenance regulations for defective sleepers, fastenings and track irregularities
3. Measuring method of the track irregularities at the selected sections
4. Example for the report of Inspection results

1. Current conditions and Issues

Grasping the current conditions

- Sleepers Continuously Damaged.

- Broken Sleeper
  (Due to the Derailment)



Grasping the current conditions

- Uplifted Shank Spike

- Fastening device can be pulled up easily by hand

Grasping the current conditions

- Wheel burn (Kojokrom～ Angu)

- Excessive Joint Gap beyond 100mm(Kojokrom - Angu)

Grasping the current conditions

- Missing Fasting Devices

Grasping the current conditions

- Extremely Short Rail in the Joint Gap (Dunkwa - Awaso)

- Ballast under the sleeper is too short and width of formation does not measure to standard (Takoradi～Kojokrom)

2. Countermeasures (Outline of the training)

Countermeasures (Outline of the training)

Current conditions :
- Track Inspection is not enough.
- Provisional criteria for rail irregularity is not clear.

Level of Urgency ★★★ *Urgent*

Recommendations:
- Setting up the *provisional criteria for rail irregularities*. (It is preferable to adopt the standard of Japanese 3rd level line for the time being.)
- Implementing the periodic inspection; *4 times a year* (Standard of Japanese 3rd level line)

Countermeasures (Outline of the training)

Current conditions :
- Due to insufficient budged for the track maintenance, regular maintenance could not carry out.

Level of Urgency ★★★ *Urgent*

Recommendations:
- Emergent maintenance work should be implement for the section between Takoradi to Nsuta which is under the operation.

Countermeasures (Outline of the training)

Current conditions :
- In the whole section, there are many wheel burns on the top of rail .

Level of Urgency ★★★ *Urgent*

Recommendations:
- Wheel burns have to be removed as soon as possible and changing to the new rails.

Countermeasures (Outline of the training)

Current conditions :
The structure of rail joints is not correct at many rail joints
- **Joint gap is too much**
- **Two rails are connected with only one bolt**
- **Rail of insufficient length is inserted into the joint gap**

Level of Urgency

Recommendations:
- **Pull back the rail and insert full length rail or insert the short rail more than 5m length.**
(*According to the Japanese standard)

Countermeasures (Outline of the training)

Current conditions :
- **Ballast under the sleeper is too short.**
- **Insufficient formation is founded at the several locations.**

Level of Urgency

Recommendations:
- **The maintenance work plan should be managed for of these locations, especially between Takoradi to Nusta.**
- **If defective locations are found, suitable countermeasure has to be implemented as soon as possible.**

3. Setting up the maintenance regulations for defective sleepers, fastenings and track irregularities

Setting up the maintenance regulations

Provisional Standard for Judgment of Sleepers (Wooden):

1. Erosion in progress and not properly functioning
2. Broken due to derailment in the past and thus not properly functioning
3. Highly possibly hollow assumed by checking with hammer
4. Too Loose to firmly hold the fasting devices due to too large holes

Provisional Standard for Judgment of Fastenings:

1. Incorrectly positioned or (or missing)
2. Not properly functioning due to uplift from the baseplate and thus
3. Easily removable by hand
4. Movable only by hitting with a hammer

Point of Remember for Rail Irregularities Inspection (Regular maintenance) :

- **If the track irregularity is over the provisional standard for normal revel, maintenance work should be carried out at some time.**
- **The result of maintenance work is reported by ordinary channels.**

Provisional Criteria for Rail Irregularities (Normal/ Urgent) :

	Gauge	Level	Cross level	Alignment	Twist
Normal	+6 to - 4	±9			——
Emergency	+20 to -10	———	±19		±18

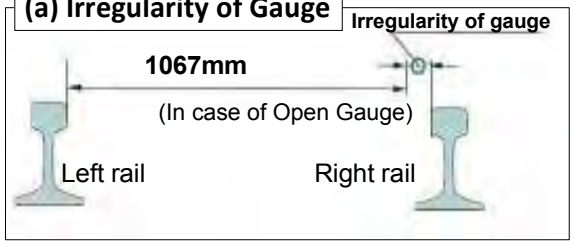
Point of Remember for Rail Irregularities Inspection (Emergency maintenance) :

- **If the track irregularity is over the provisional standard for emergency level, maintenance work should be carried out immediately within 3 weeks.**
- **The result of maintenance work should be reported to the director of track maintenance section and area control branch division.**
- **In case of the maintenance work could not carried out within 3weeks, reducing of train speed has to be considerd.**

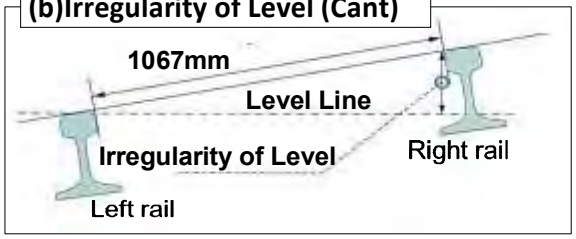
4. Measuring method of the track irregularities at the selected sections

Measuring of track irregularities

(a) Irregularity of Gauge

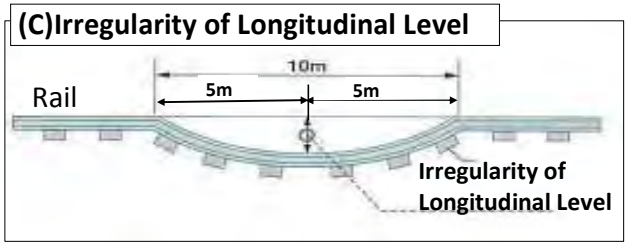


(b)Irregularity of Level (Cant)

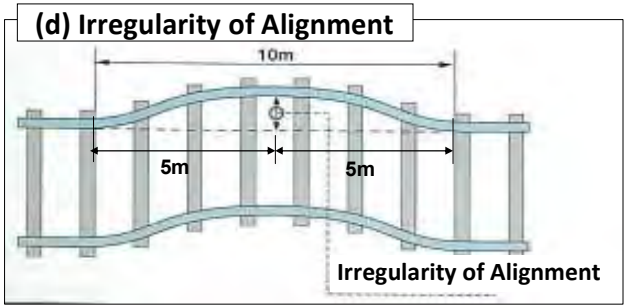


Measuring of track irregularities

(C)Irregularity of Longitudinal Level

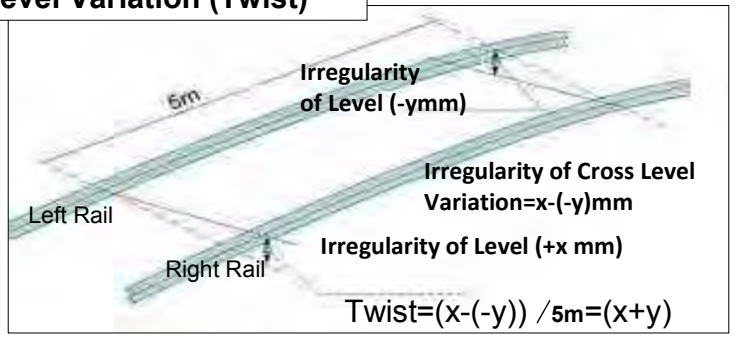


(d) Irregularity of Alignment



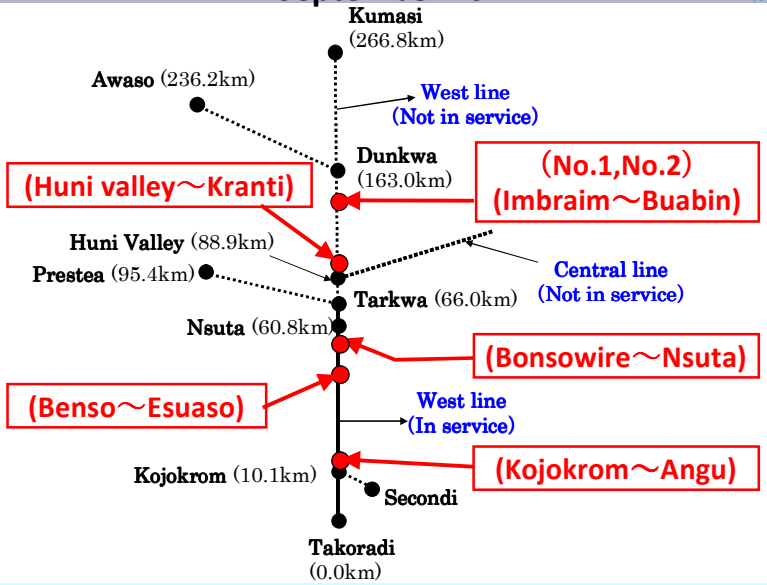
Measuring of track irregularities

(e) Irregularity of Cross Level Variation (Twist)



Measuring of track irregularities

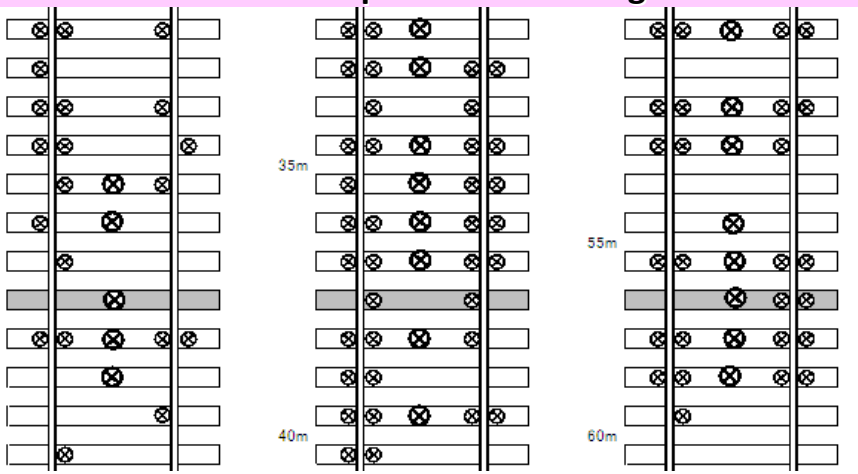
Location of the Site Investigation in September 2012



4. Example for the report of Inspection Results

Reporting the Inspection results

Example for the Investigation report of defect sleepers and fastenings



Reporting the Inspection results

Past Inspection Result of the Raito of defect sleepers

Section		Nos. of whole sleepers inspected (Sleeper)	Nos. of defect sleepers (Sleepers)	Ratio of defect sleepers (%)
Takoradi ~ Nsuta	Kojokrom~Angu	210	13	6
	Benso～Esuaso(No.1)	100	41	41
	Benso～Esuaso(No.2)	83	37	45
	Bonsawire～Nsuta	90	30	33
Northern -part of Nsuta	Huni Valley～Kuranti	140	26	19
	Imbraim～Buabin(No.1)	114	41	36
	Imbraim～Buabin(No.2)	153	19	12

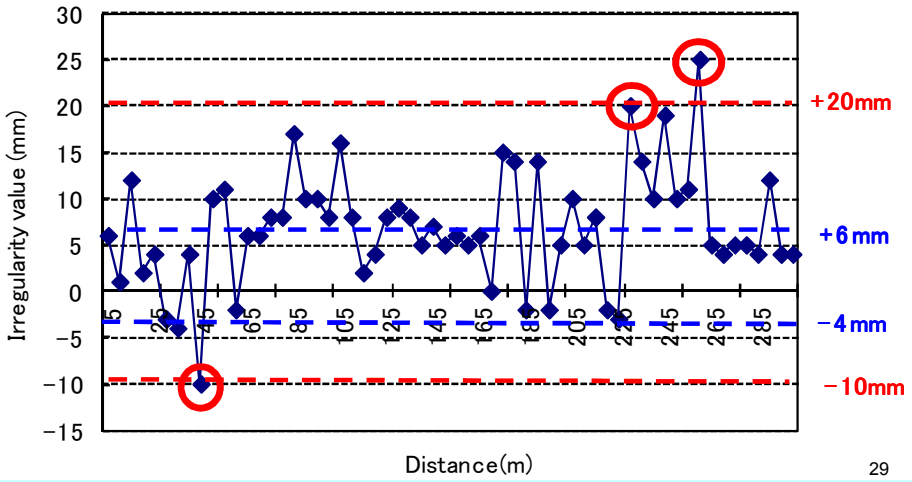
Reporting the Inspection results

Example for result of gauge irregularity (Maximum and Minimum)

Section		Date measured	Maximum and minimum gauge irregularity	
			Over +20mm	Less −10mm
Takoradi ～ Nsuta	Kojokrom～Angu	2012/5/25	—	−22, −21, −12
	Benso~Esuaso(No.1)	2012/11/1	—	−17, −14, −13
	Benso~Esuaso(No.2)	〃	—	−22, −12
	Bonsowire～Nsuta	2012/4/27	25, 20	−10
Northern -part from Nsuta	Huni Valley～Kuranti	2012/9/18	20	−10
	Imbraim~Buabi(No.1)	2012/5/1	24,20	—
	Imbraim~Buabi(No.2)	2012/5/2	22	—

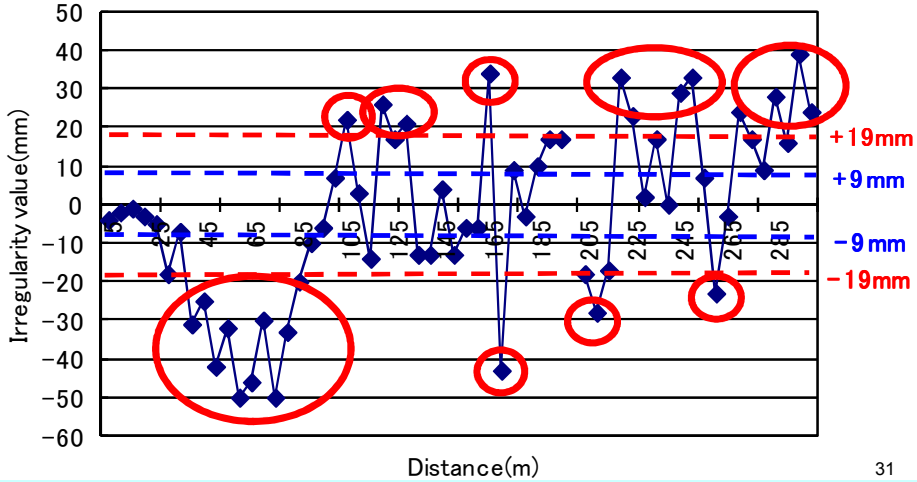
Reporting the Inspection results

Example for result of track irregularity (Gauge) Inspection



Reporting the Inspection results

Example for result of track irregularity (Longitudinal Level)



Reporting the Inspection results

Example for number of locations which are exceeding the provisional standard of track irregularities for Emergency level

	Section	Alignment		Longitudinal level		Twist
		Left rail	Right rail	Left rail	Right rail	
Takoradi ~ Nsuta	Kojokrom~Angu	1	1	0	2	0
	Benso~Esuaso (No.1)	0	0	6	2	0
	Benso~Esuaso (No.2)	0	0	2	5	4
	Bonsowire~Nsuta	3	Over 20	1	Over 20	4
Northern part from Nsuta	Hunivalley~Kurantl	0	0	1	1	0
	Imbraim~Buabi (No.1)	9	8	3	10	8
	Imbraim~Buabi (No.2)	2	6	7	Over 10	6

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Training for Track Maintenance 2/6 "Maintenance Method"

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

0

Track Inspection Method and Recording

1

Track Inspection Method and Recording

Track Inspection Method and Recording

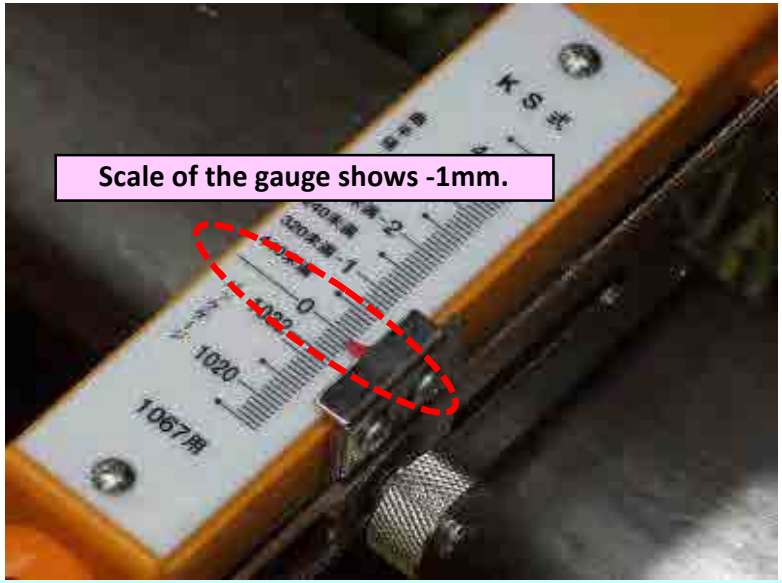
Inspector wrote the track irregularity on the rail surface with white chalk. White line shows measurement point and it should be marked in every 5m.

(L: Longitudinal Level irregularity) = +20mm,
(G: Gauge irregularity)= - 1 mm,

Track Inspection Method and Recording

Inspector is measuring the cross level irregularity with the level gauge.

Track Inspection Method and Recording



Track Inspection Method and Recording

Staff is checking the defect sleepers with the hammer.

6

Track Inspection Method and Recording

GRCL staff pulls the 10m length thread for measuring longitudinal level irregularity.

7

Track Inspection Method and Recording

Chief Civil Engineer who is the executive of GRCL is taking the lead in measuring track irregularities and he recorded the data on the paper.

8

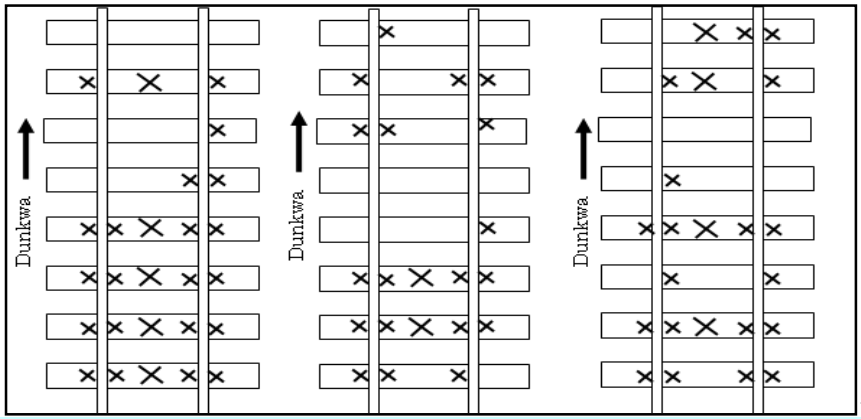
Track Inspection Method and Recording

9

Inspector is measuring the alignment irregularity.
(Quantity of alignment irregularity is measured with the 10m length thread. At the center of its thread located 14mm under from the rail surface, the distance between rail side surface and thread means alignment irregularity. But in case of curve section, the quantity of the versine of the curve is taken off from the data.
(White line shows measurement point and it should be marked in every 5m.)

1. Inspection report of defective sleepers and fastenings

Date measured:____/____/____
Section measured:_____mile
Name measured:



2. Inspection repot of track irregularities

Date measured:____/____/____
Section measured:_____mile
Name measured:

No. (5m Interval)	Quantity of track irregularity(mm)							Remark
	Gauge	Cross Level	Left side rail		Right side rail		Twist	
			L.L.	A.	L.L.	A.		
1								L.L.: Longitudinal Level A : Alignment
2								
3								
4								
...								
...								
...								

3. Work plans for the emergency level of track maintenance

Name measured:

Priority order.	Date	Sections which are over the urgent tolerance		Value of track irregularity (mm)						Remarks
		from	to	Gauge	Left side rail		Right side rail		Twist	
					L.L.	A.	L.L	A		
1										
2										
3										
4										
...										
...										
...										

Track Inspection Method and Recording

4. Report of the gauge irregularities after the emergency maintenance.

Date measured:____/____/
Section measured:_____ mile
Name measured:

Date of urgent maintenance	Priority order	Section of urgent maintenance		Track irregularity after urgent maintenance work had carried out (mm)						Remarks
				Gauge	Left side rail		Right side rail		Twist	
		From	To		L.L.	A.	L.L.	A.		

Reporting Method 1

Point for emergency maintenance 1 :
The maintenance plan should report to chief civil engineer and get his admission.

Reporting Method 1

Firstly, it will be made the control drawings of selected track maintenance sections of emergency level according to the "2. Inspection repot of track irregularities" .
After doing that, it will decide prioritized sections of the maintenance works and making "3. Work plans for the emergency level of track maintenance".

Reporting Method 2

Secondly, it should carry out the emergency maintenance works for selected sections in accordance with "3. Work plans for the emergency level of track maintenance".
After the implementation of emergency maintenance, the track irregularities inspection should be continuously implemented and making "4. Report of the gauge irregularities after the emergency maintenance."

Reporting Method 2

Point for emergency maintenance 2:
The emergency maintenance works should implement within one month and report the measurement results after the maintenance works."4. Report of the gauge irregularities after the emergency maintenance." should be submitted to Chief Engineer.

Training for Track Maintenance 3/6
"Basic Maintenance"

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

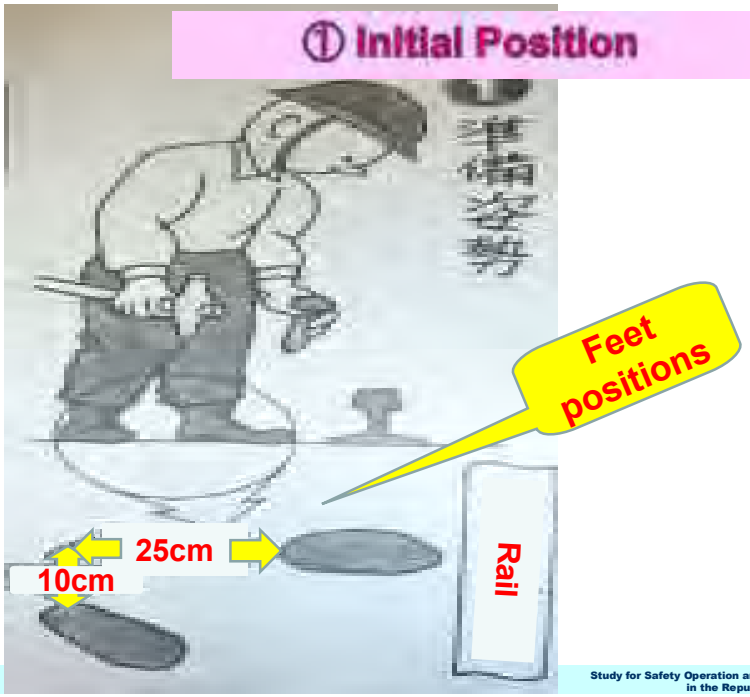
Reporting Method 3

Thirdly, if there are the impossible case of implementation of emergency maintenance within one month, the sufficient train speed should be considered for the sections immediately, and train speed will reduce at the sections for the prevention of train accidents such as derailment.

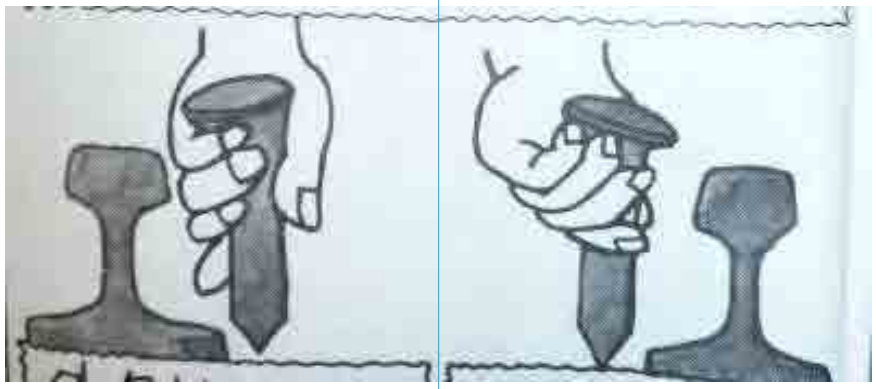
Basic Maintenance

1. Driving method of the dog spike

① Initial Position



Gripping and setting up of the dog spike



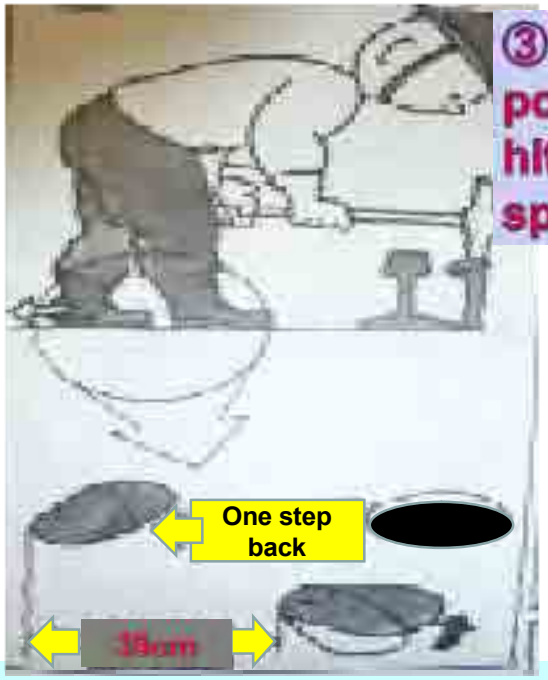
In case of outer gauge

In case of inner gauge

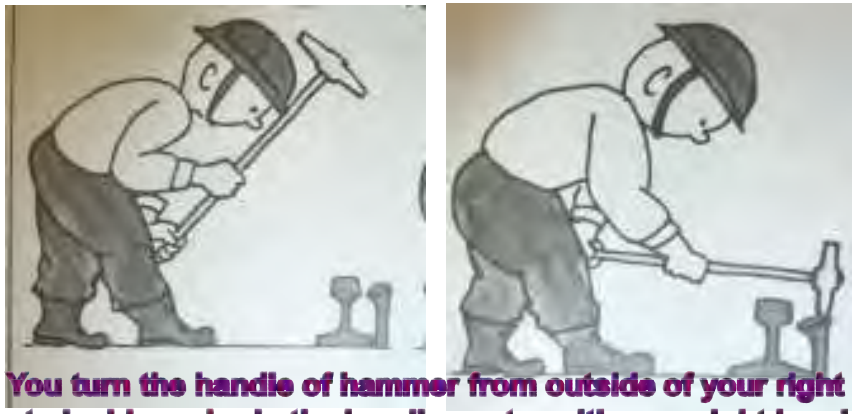
② Setting up the dog spike

You set up the dog spike vertically in order not to be twisted by hitting and hit the dog spike head slightly about two times.

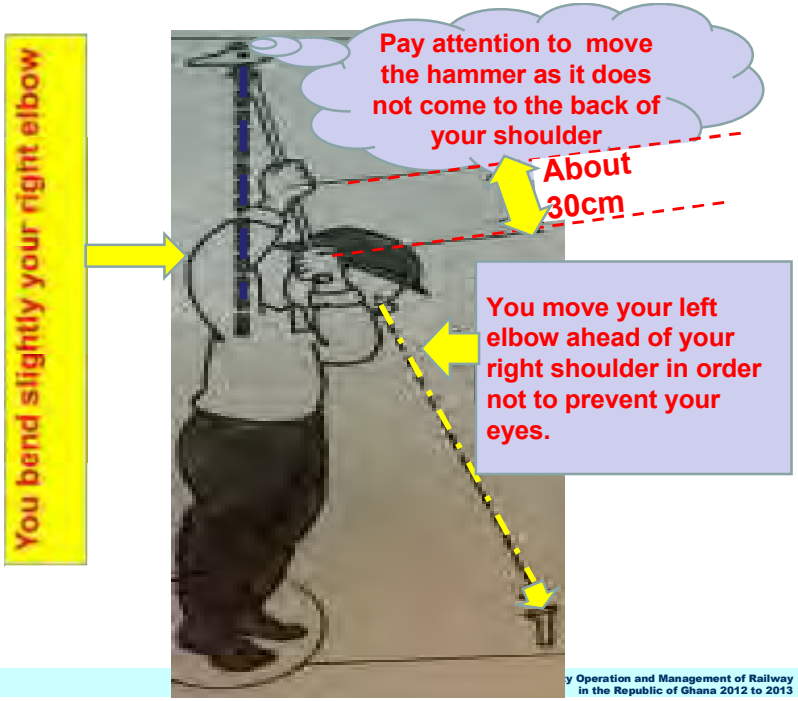
③ Initial position of slight hitting the dog spike



④ Slight hitting of the dog spike

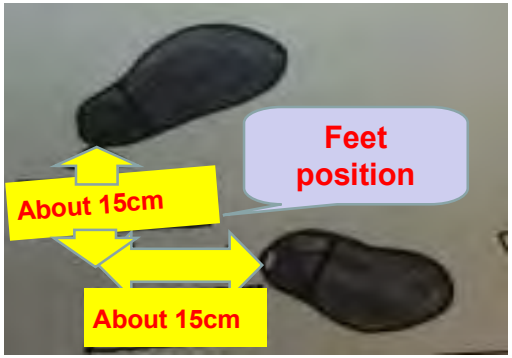


1) You turn the handle of hammer from outside of your right leg to inside and grip the handle center with your right hand and the handle end with your left hand. You put up the hammer low.
2) You hit the dog spike slightly until its tip is inserted into the sleeper.

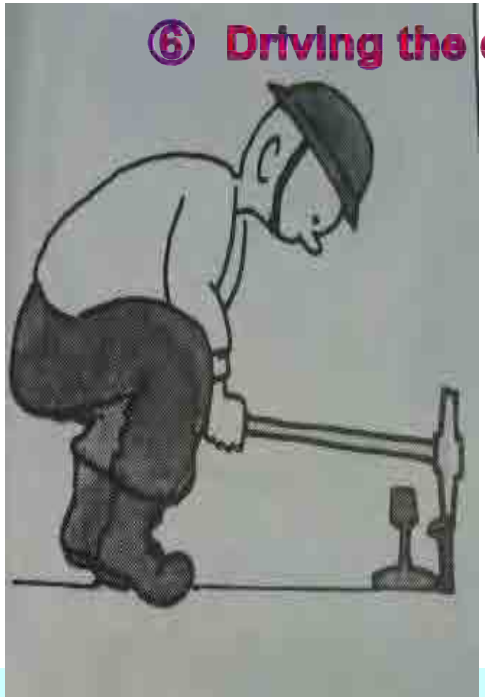


⑤ Real driving of the dog spike

You swing up the hammer until near your body, sliding your right hand along the handle from its end to the spot about 30cm up

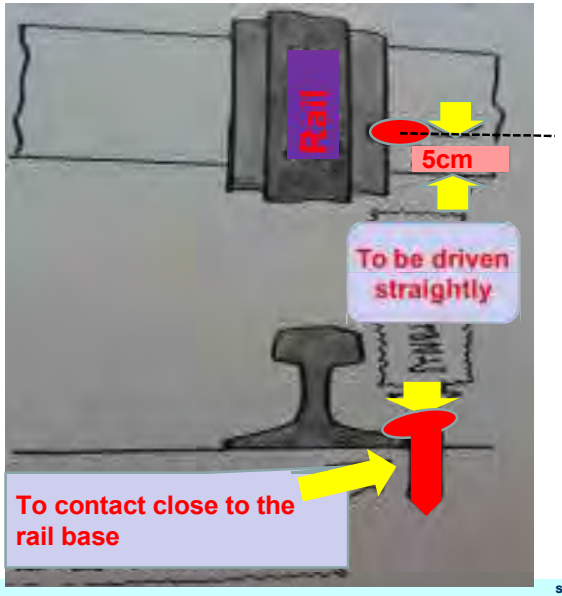


⑥ Driving the dog spike



You lead the hammer with your left hand mainly, and lower the handle end and driving the dog spike, putting a lot of your power into your stomach.

Correct condition of dog spike

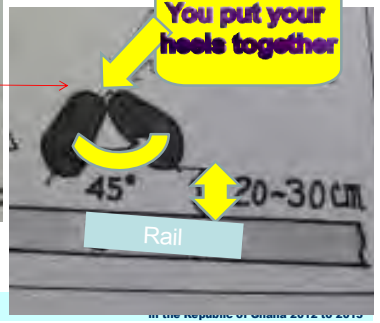


Basic movement

Rail surface checking

① Posture arrangement

Feet position
You put your feet out of the gauge



You put your hands on the rail surface and lean your body out of rail

Introduction

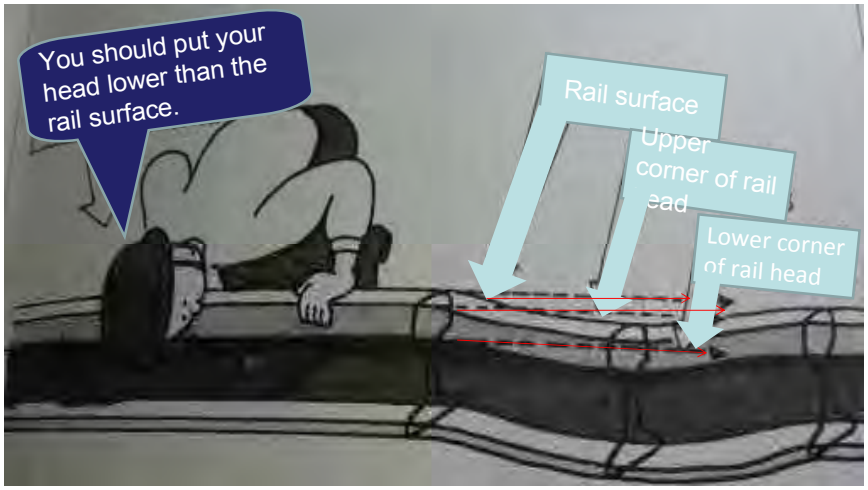
1. You should select the right side rail or left side rail which you can check easily track condition.

2. You should check the rail surface condition from the lower part in case of the gradient section.

3. You should check the rail surface condition in the direction which you can catch the sunlight at your back.

4. You should not have anything in your hand.

5. You should check the rail surface condition at the position



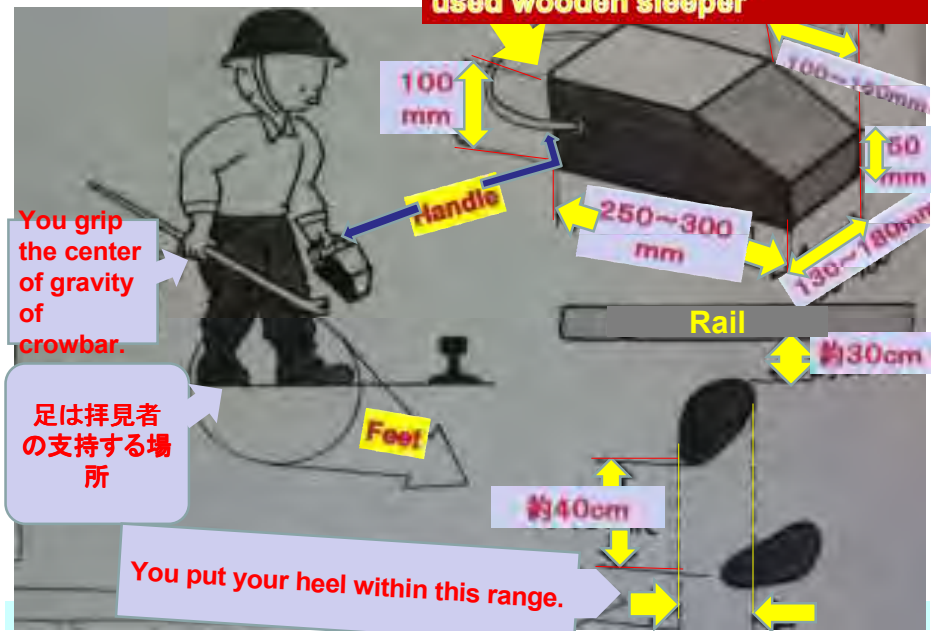
You should see through the rail surface or upper and lower corner or see through alternately, first the rail surface then upper and lower corner.

Basic Maintenance

Raising the rail surface (By the crowbar)

① Initial Position

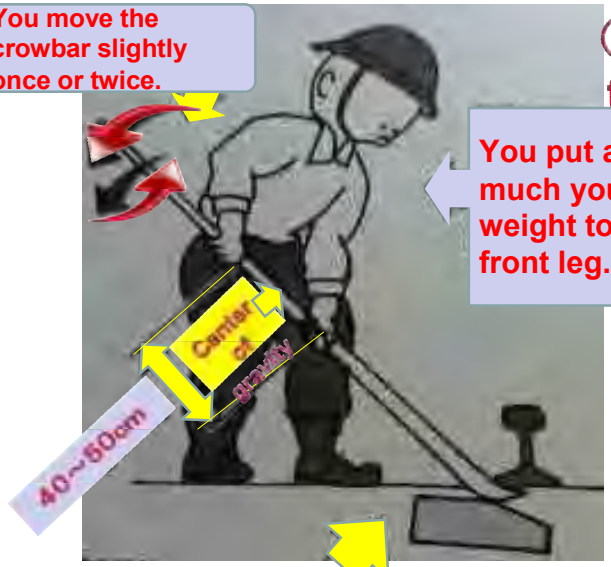
Crowbar stand made of hard and used wooden sleeper



② Installing the crowbar stand

③ Installing the crowbar

You move the crowbar slightly once or twice.

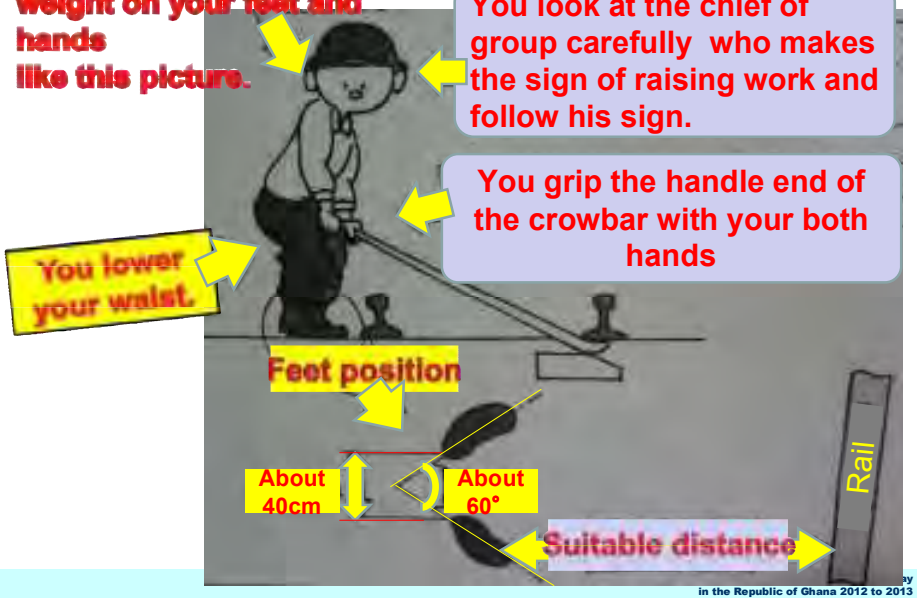


You put a little much your weight to your front leg.

You should install the claw of crowbar deeply between stand and rail and move the crowbar slightly once or twice.

④ Raising the track

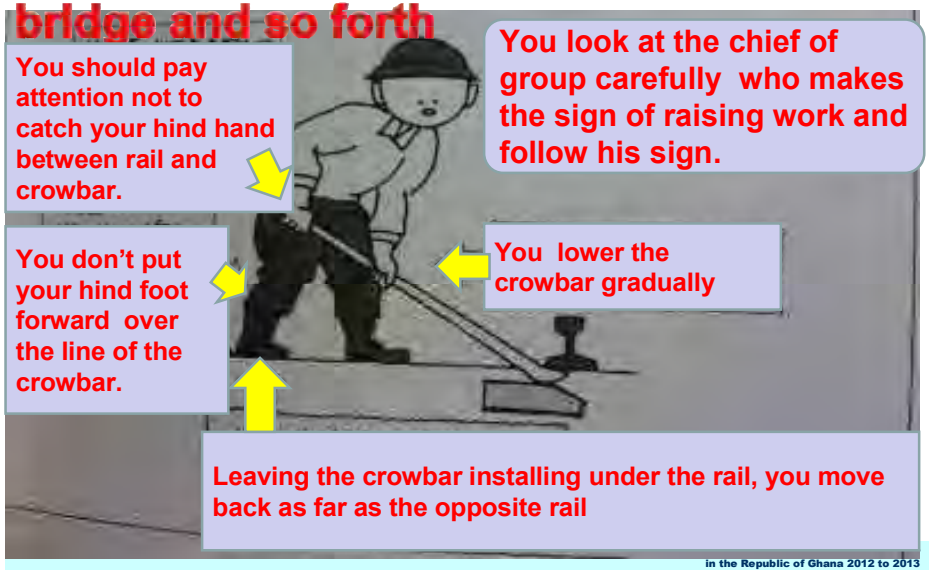
You bend your body forward and put your all weight on your feet and hands like this picture.



You look at the chief of group carefully who makes the sign of raising work and follow his sign.

You grip the handle end of the crowbar with your both hands

In case where you can't make the posture like ④, for example , on the bridge and so forth



You should pay attention not to catch your hind hand between rail and crowbar.

You look at the chief of group carefully who makes the sign of raising work and follow his sign.

You don't put your hind foot forward over the line of the crowbar.

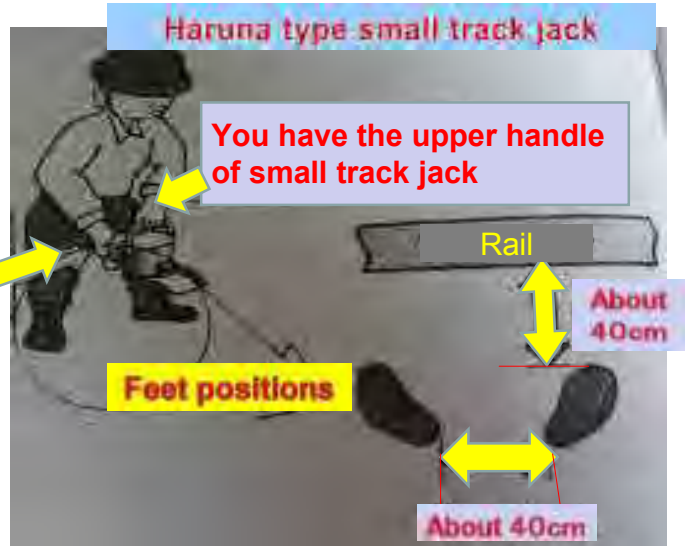
You lower the crowbar gradually

Leaving the crowbar installing under the rail, you move back as far as the opposite rail

Basic maintenance

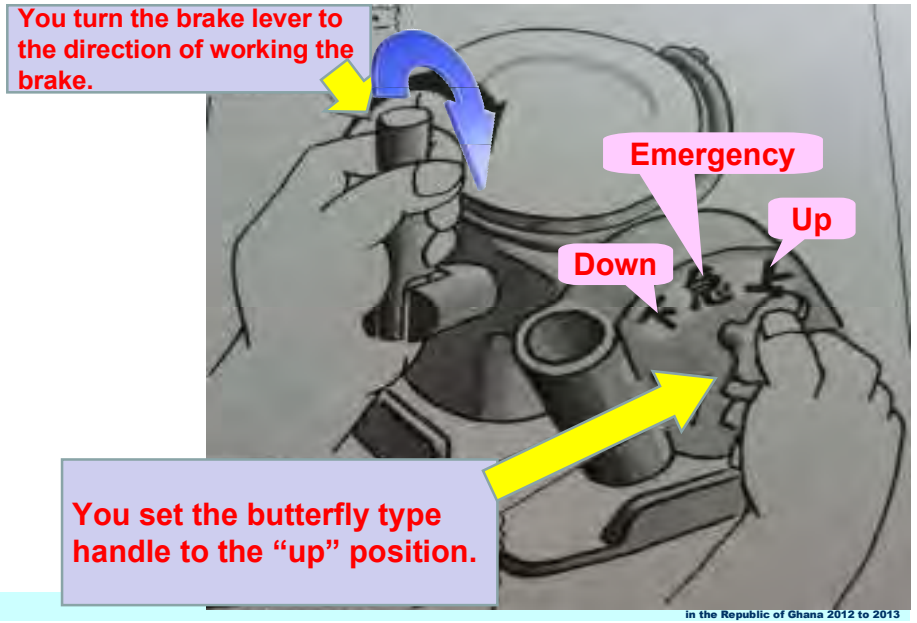
Rail surface raising (By small track jack)

① Initial Position

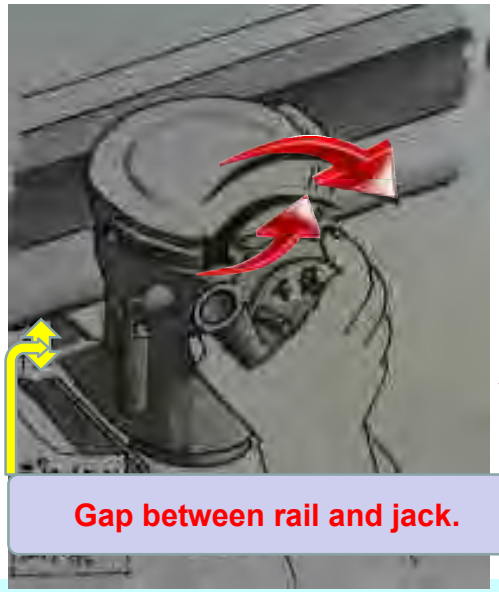


② Installing the small track jack (Outside of the gauge)

③ Preparation for rail raising (1)

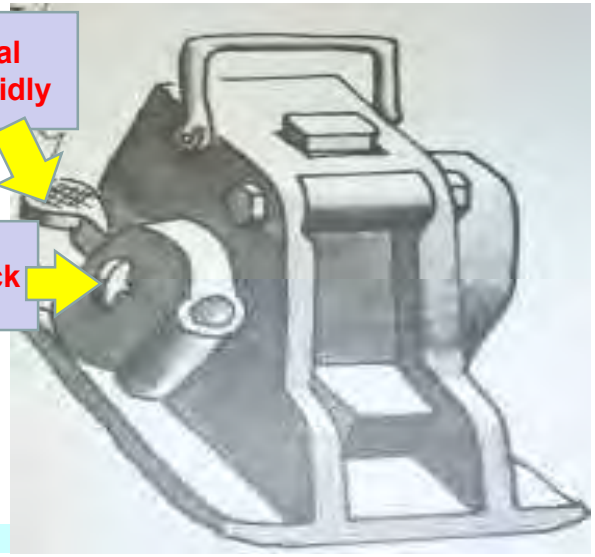


④ Preparation for rail raising (2)



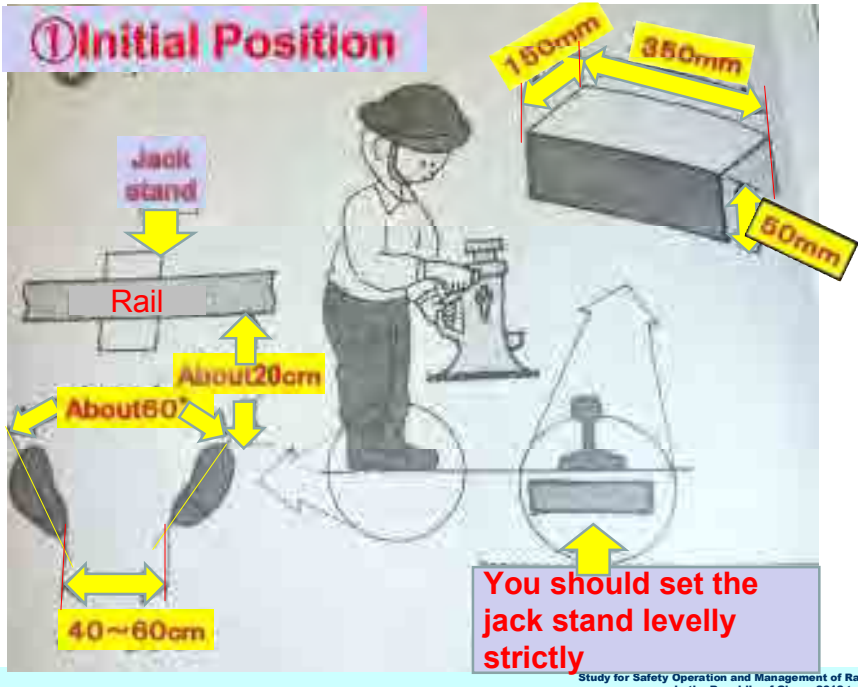
Small jack

(Handling of this jack applies in the same way of Haruna type jack)



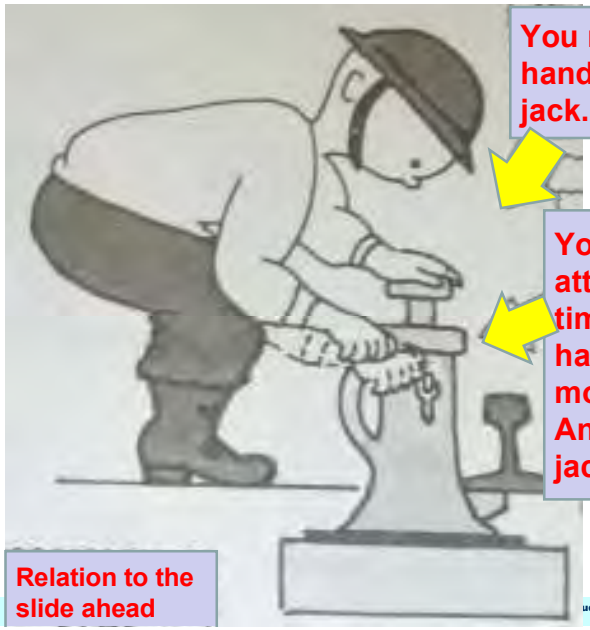
Basic maintenance

Rail surface raising (By track jack)



② Setting the track jack (1)

② Setting the track jack (2)

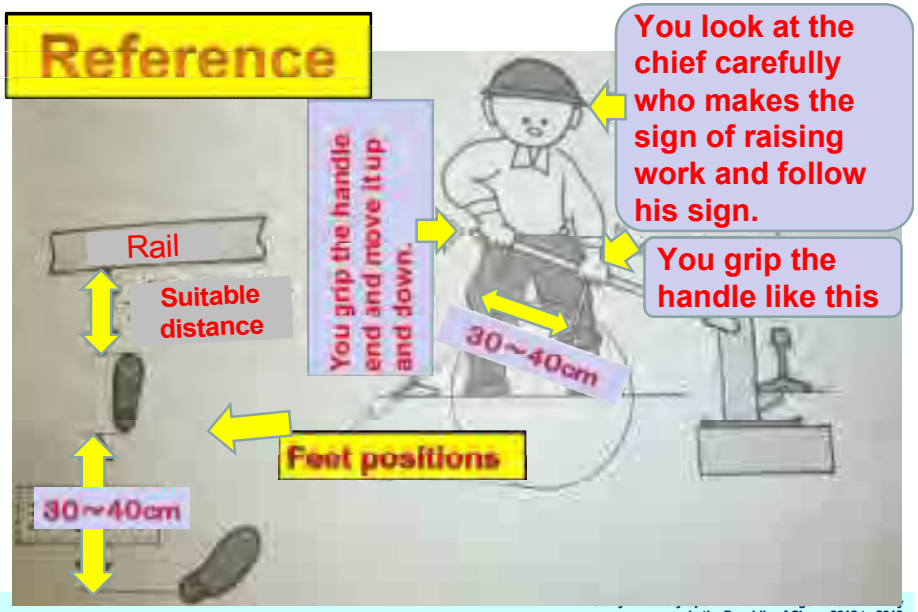


You remove your left hand to grip the top of jack.

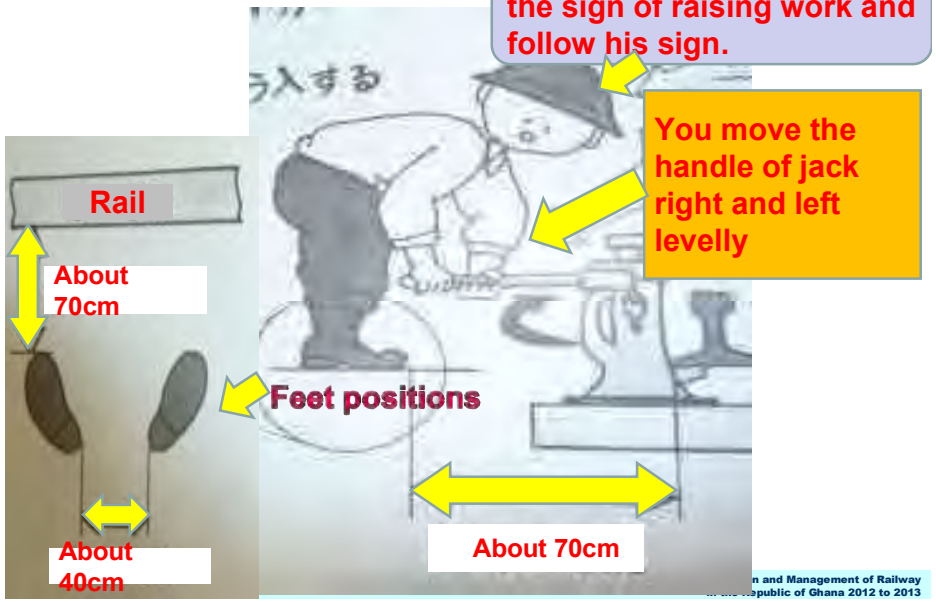
You move the handle attachment several times with your right hand until you can't move it
And you insert the jack handle into it.

Relation to the slide ahead

In case of using another type track jack



③ Raising the track



Basic maintenance

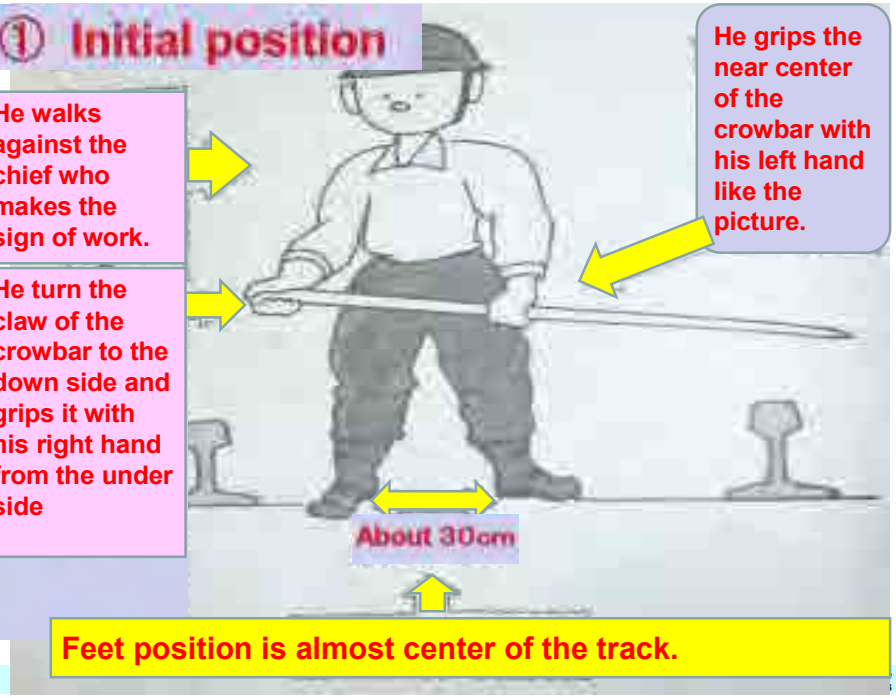
Track alignment work

① Initial position

He walks against the chief who makes the sign of work.

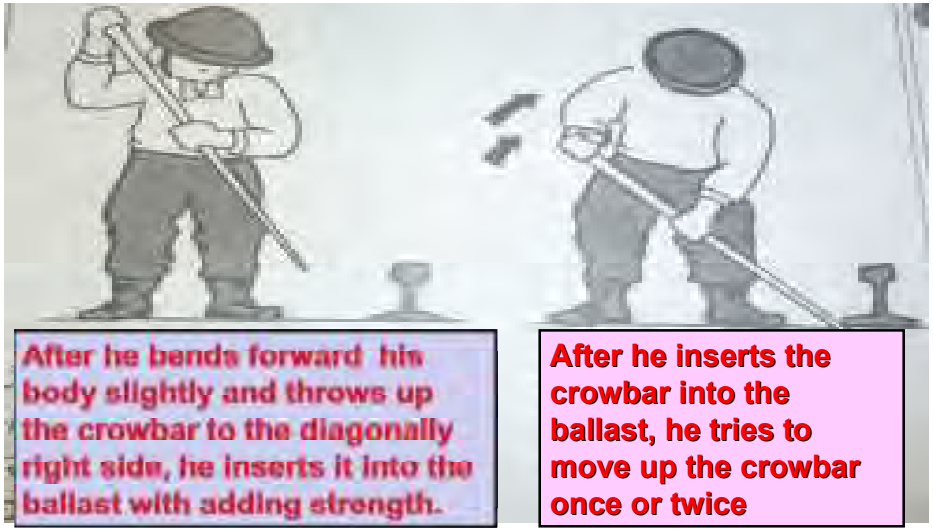
He turn the claw of the crowbar to the down side and grips it with his right hand from the under side

He grips the near center of the crowbar with his left hand like the picture.



Feet position is almost center of the track.

② Inserting the crowbar into the ballast



After he bends forward his body slightly and throws up the crowbar to the diagonally right side, he inserts it into the ballast with adding strength.

After he inserts the crowbar into the ballast, he tries to move up the crowbar once or twice

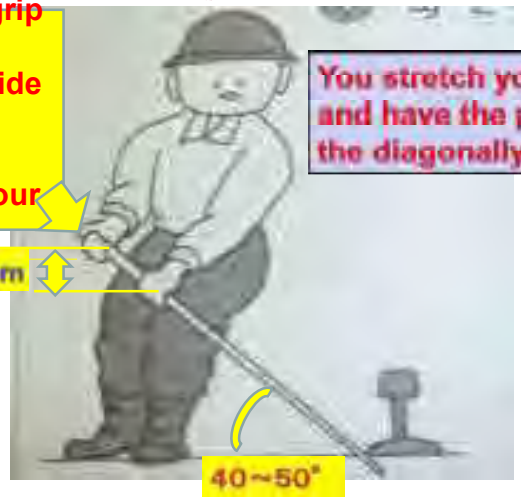
Pay attention not to injure other workers, In case of inserting the crowbar into the ballast

③ In case where it is difficult to insert the crowbar into the ballast

In case where it is difficult to insert the crowbar into the ballast, you should insert it after you pick the ballast with the crowbar at the opposite side of the rail and loosen the ballast.

④ Initial position for track alignment work

You should grip the crowbar from under side of it, like holding the crowbar in your arms



You stretch your body and have the posture to the diagonally right side

You should put your both heels together at near center of the gauge

⑤ Track alignment work

1) He lowers his waist slightly with the sign of chief

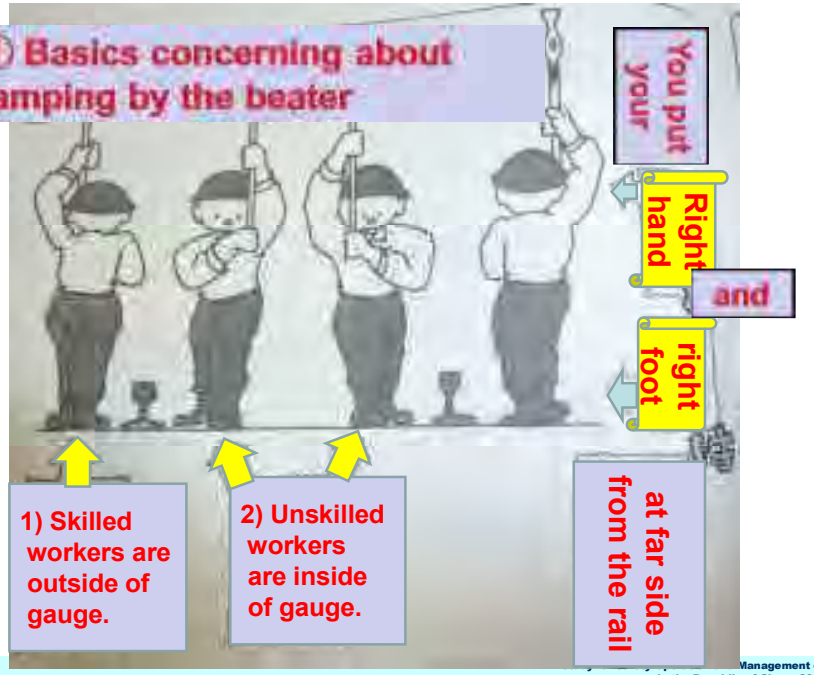
2) He puts his power suddenly, standing firm and bending your body backward and left .

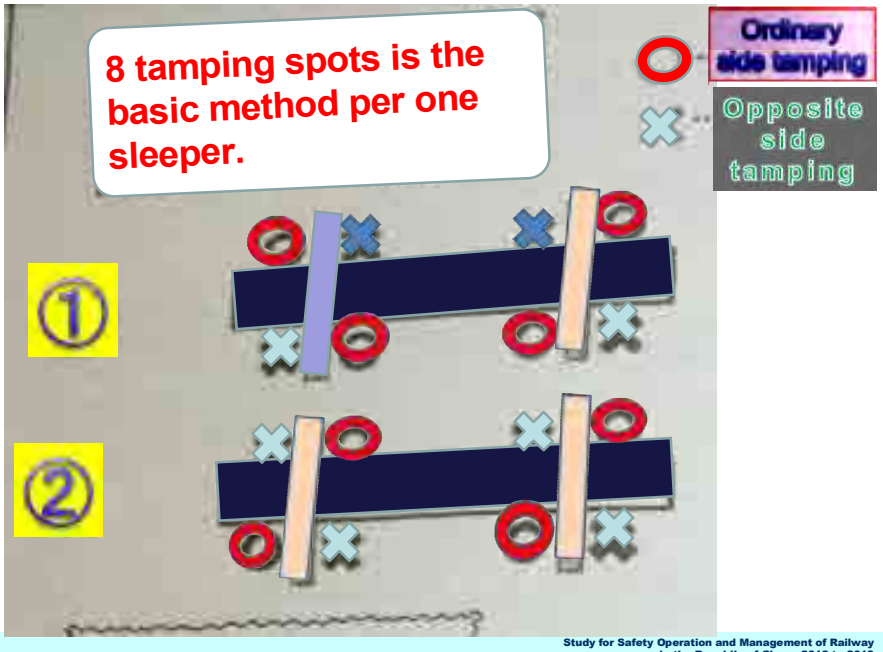
⑥ Simple alignment work

In case of simple alignment work, you can do the alignment work, leaving the posture which you inserted the crowbar into the ballast.

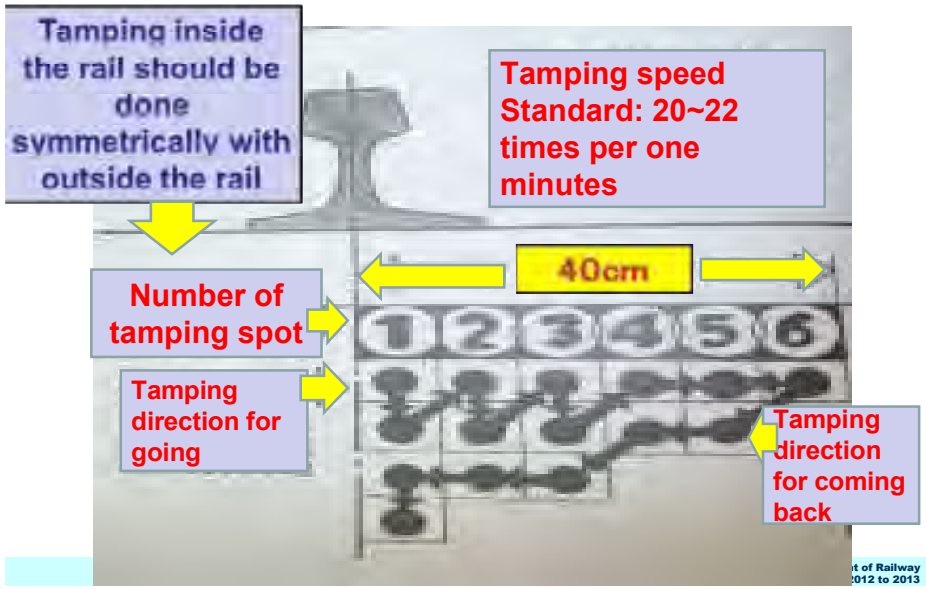
Basic maintenance

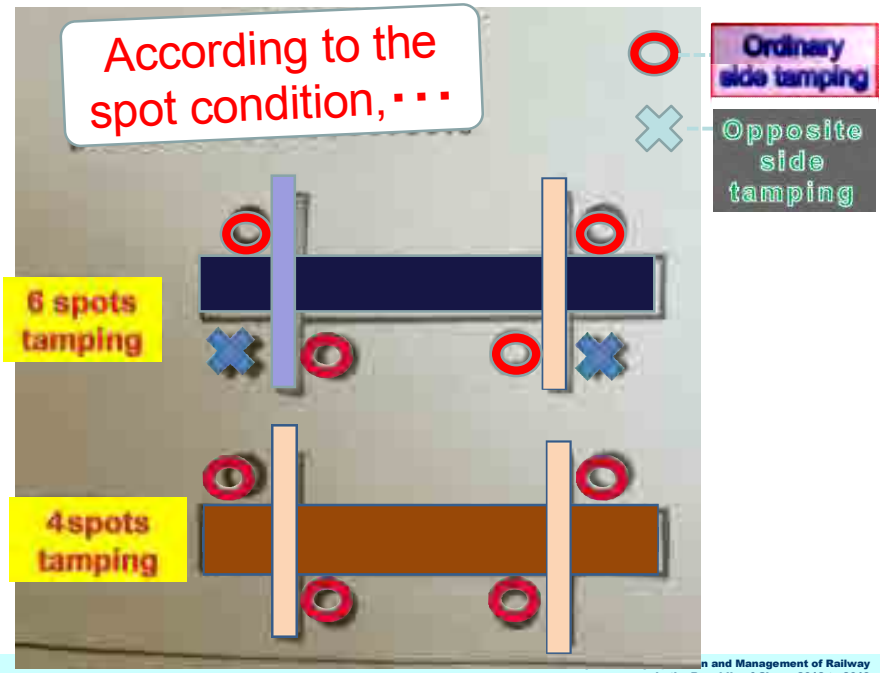
Tamping by the beater

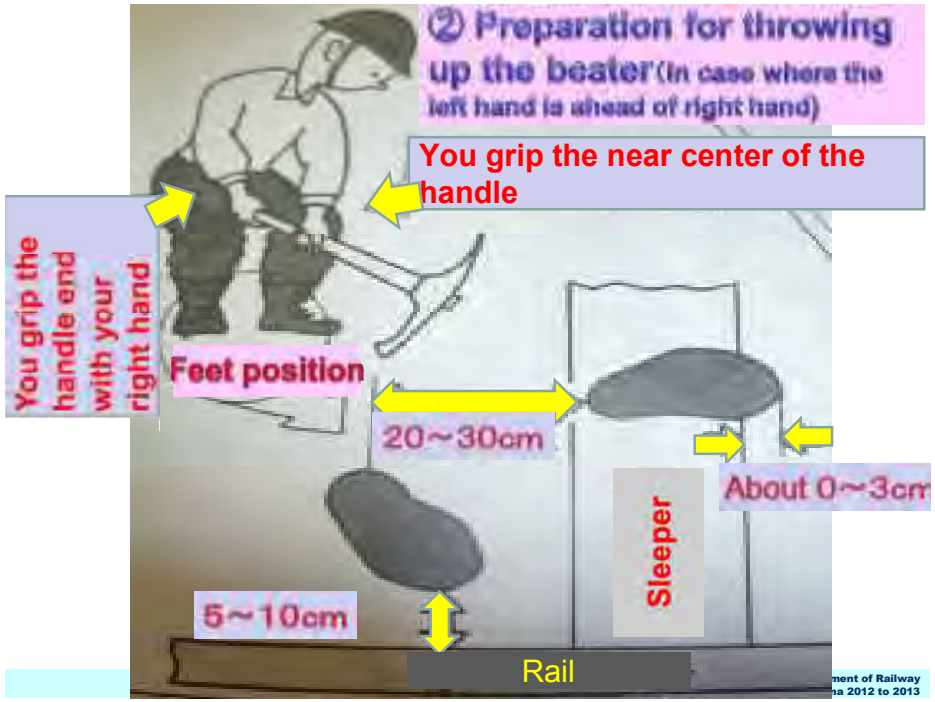


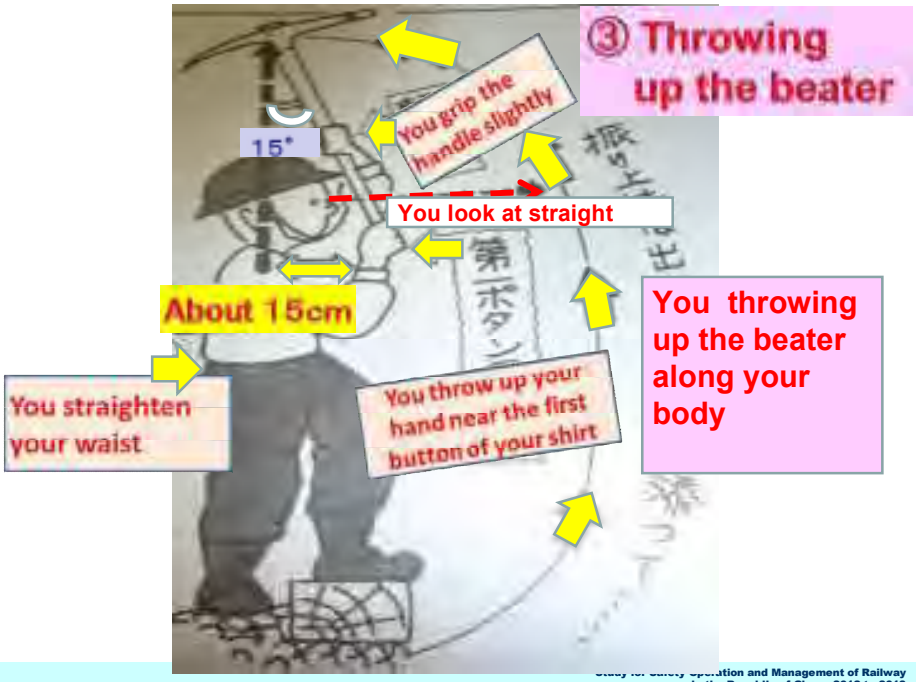


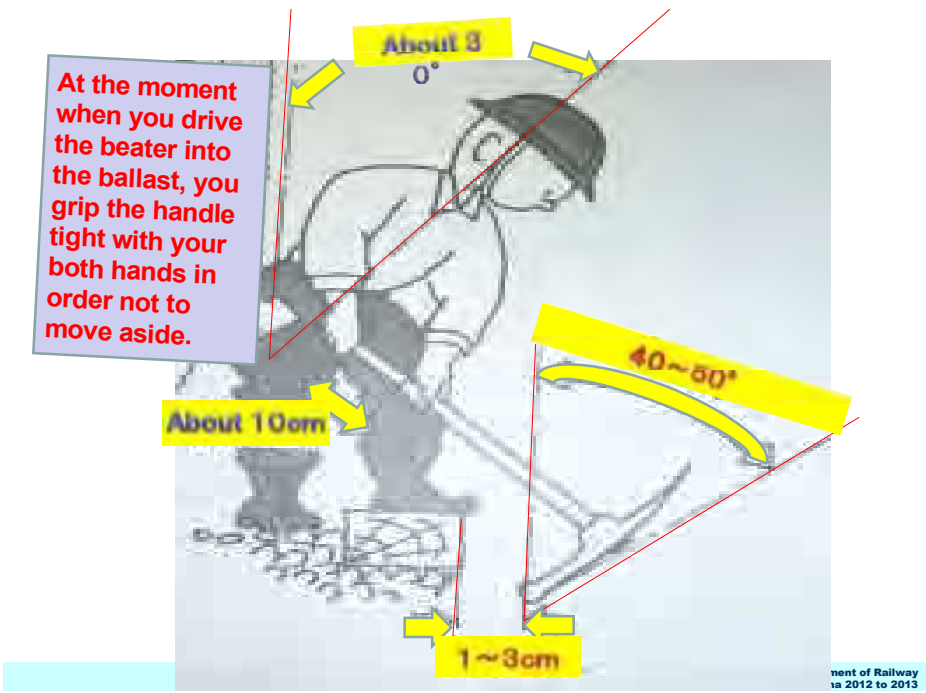
Tamping range and order

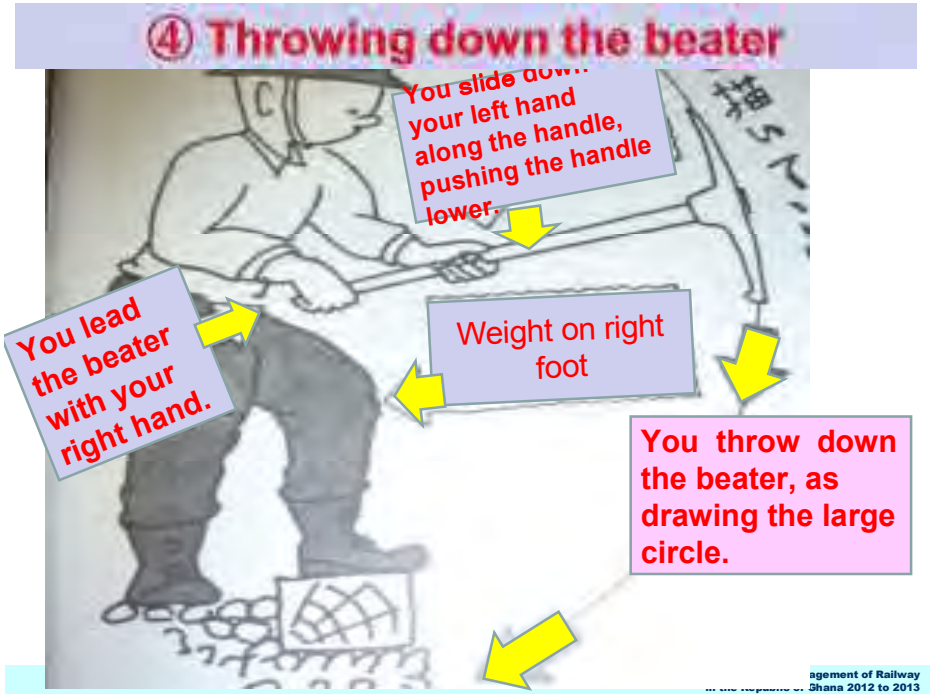








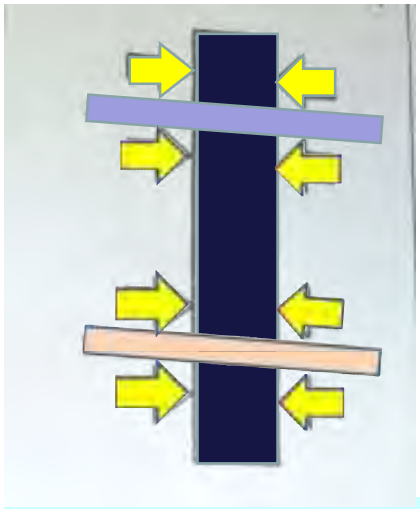




Basic maintenance

Tamping by tie tamper

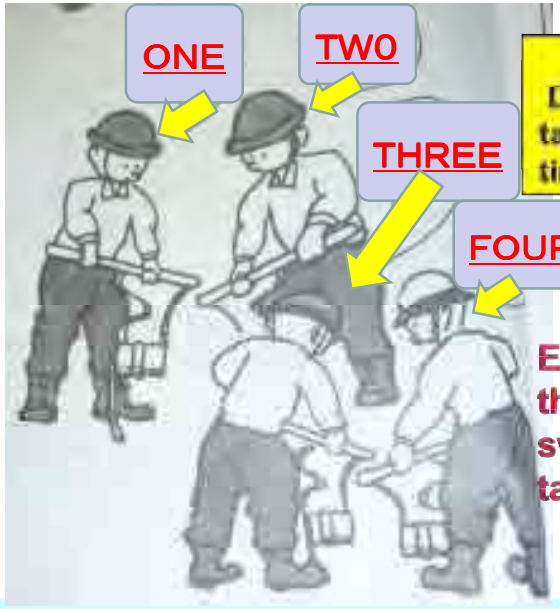
① Tamping spots



Nos. of tamping spot and workers:

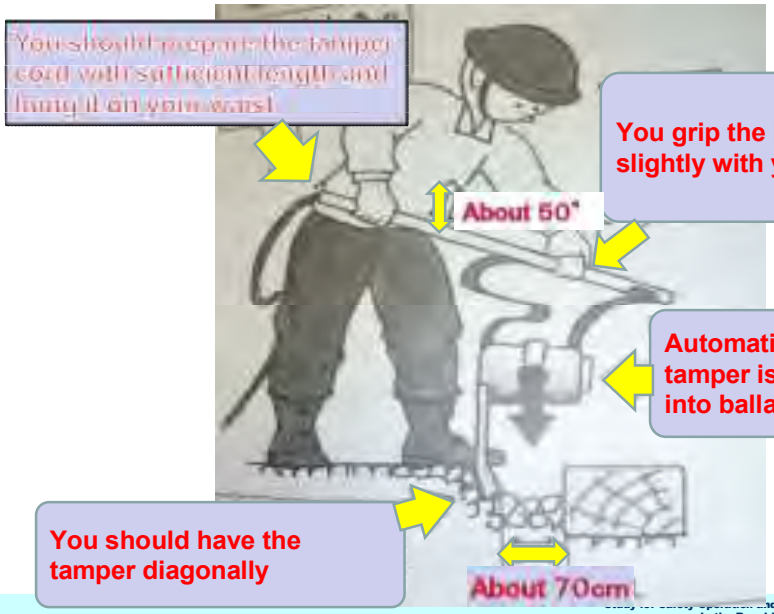
- 8 spots/sleeper(Ordinary)
- 8 or 4 workers / sleeper

② Beginning of tie tamper tamping



Each worker shouts the number and switch on the tie tamper in order.

③ Posture arrangement



You grip the handle slightly with your hand

Automatically tamper is installed into ballast

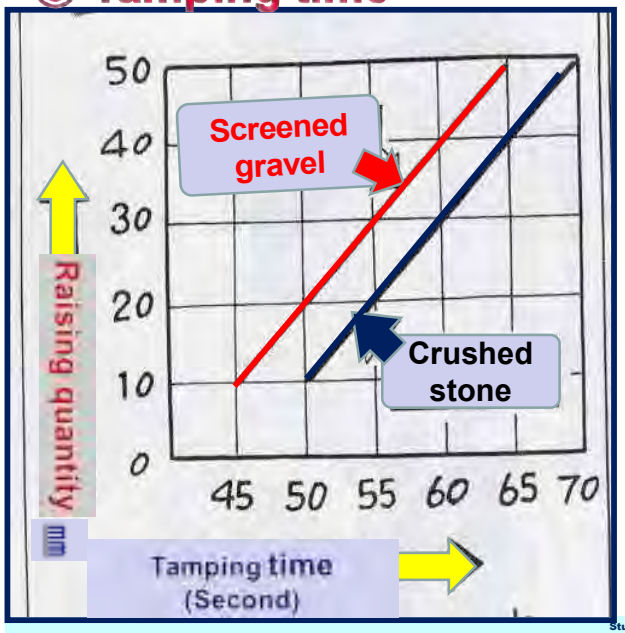
You should have the tamper diagonally

④ Moving of tie tamper tamping

Don't push the handle with your hand

You Level the tie tamper after the font part of tamping bar come under the sleeper.

⑤ Tamping time

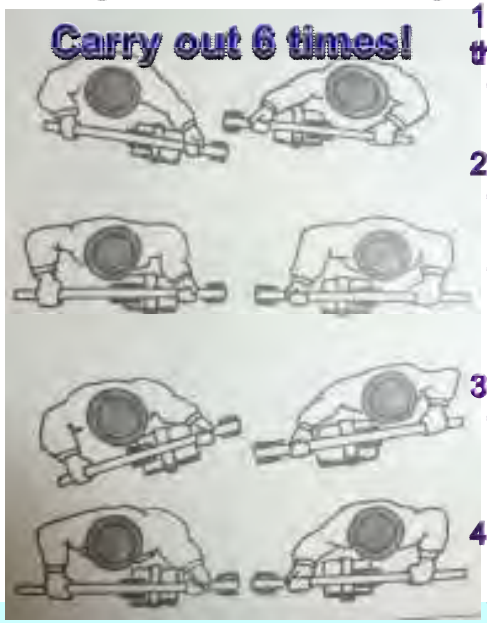


Tamping time per one time is like the left hand table.
50~60 seconds are standards

⑥ Tamping range

You should tamp 6 times per one place and its order and range are shown on the drawing above.

⑦ Operation of tamper handle



1) At the posture arrangement, they have their tamper handles parallel.

2) The condition which their tamper handles are level after the front end of the tamper bar comes under sleeper.

3) The condition which their tamper handles are parallel at the next tamping.

4) They repeat 1) ~ 3) movement and carry out 6 times tamping.