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

Training for Track Maintenance 4/6
"Safe Maintenance"

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

0

1. Attitude before starting to work.

① Group leader should check the health and family conditions of his subordinates before ordering them their works.
② Group leader should order his subordinates specific warnings about the works

Safety Maintenance

Contents

③ Group leader should check his watch, consult station master with the condition of train operation and tell his subordinates its condition well
④ Group leader should check their clothes
⑤ Group leader should check track machines and tools

Workers

① Workers should clear up their worries earlier , after consulting them with their fellow workers or bosses.

② Workers should not bring their family happenings into their work place.

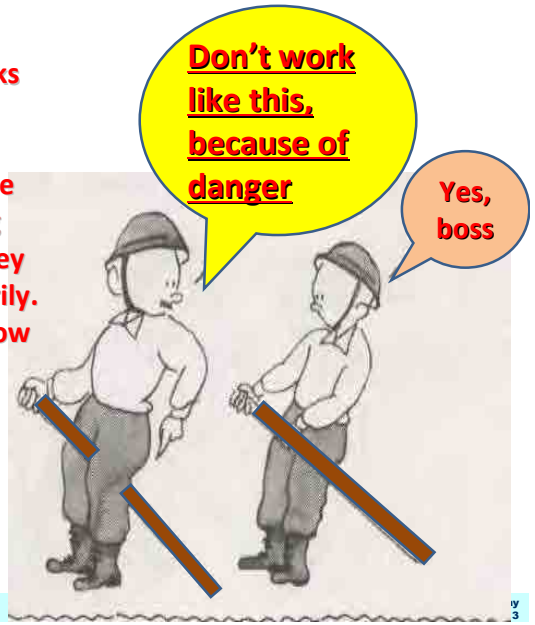
Group Leader

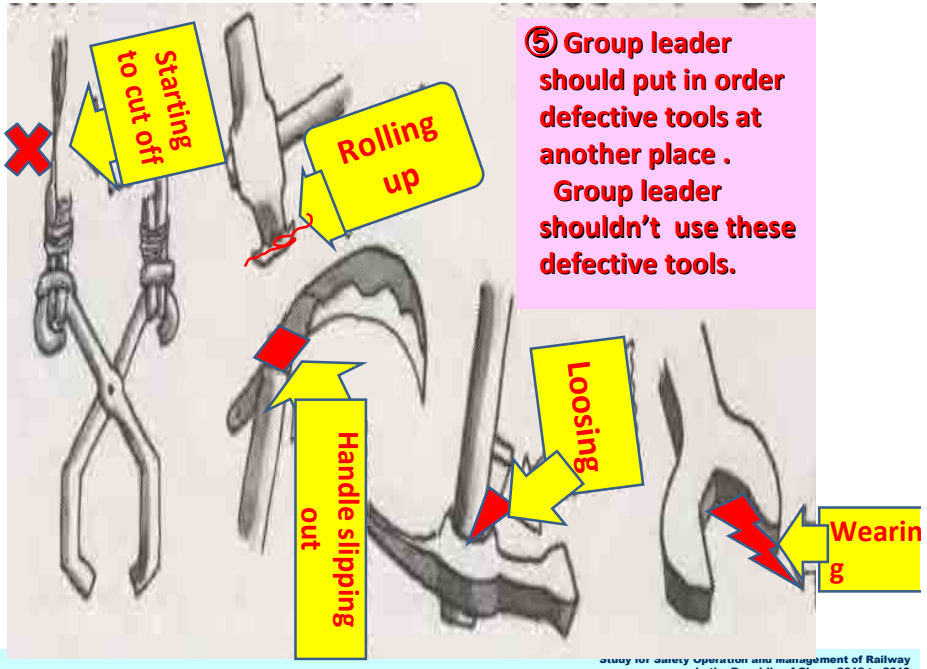
① Group leader should actively listen to worries of his subordinates .

② Group leader should advise his subordinates about cares to their works concerning about basic movements.

③ Group leader should give his subordinates training of works about which they don't carried out ordinarily.

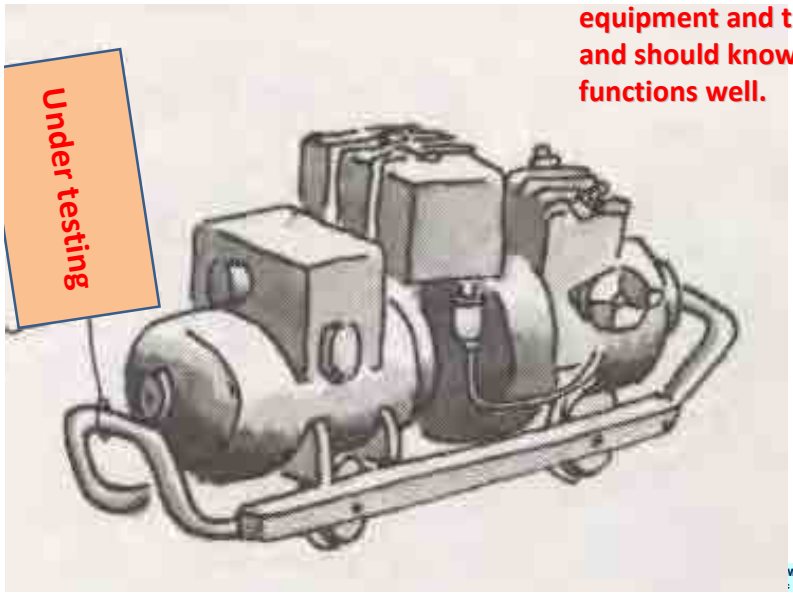
④ Group leader should show his subordinates work examples and give kind instruction to them





⑤ Group leader should put in order defective tools at another place . Group leader shouldn't use these defective tools.

⑥ Group leader should examine all new equipment and tools and should know their functions well.



2. Attitude before entering into the track.

⑦ Group leader should check his watch, consult station master with the condition of train operation

When we walk on the track, we should walk at the roadbed shoulder and should be careful of the coming train in front and behind

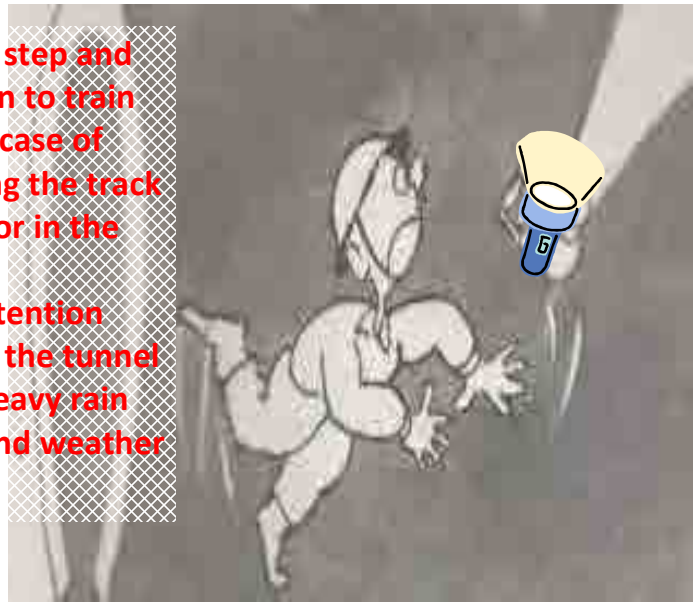
Let's wear the clothes not to cover eyes and ears in case of working and patrolling the track in the rainy and windy weather.

Inspection or patrol remaining in the track are strictly prohibited.

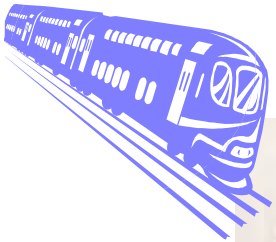
Confirm the train operation with the Station master and check the train operation by the timetable.

To guess the train operation by yourself is strictly prohibited.

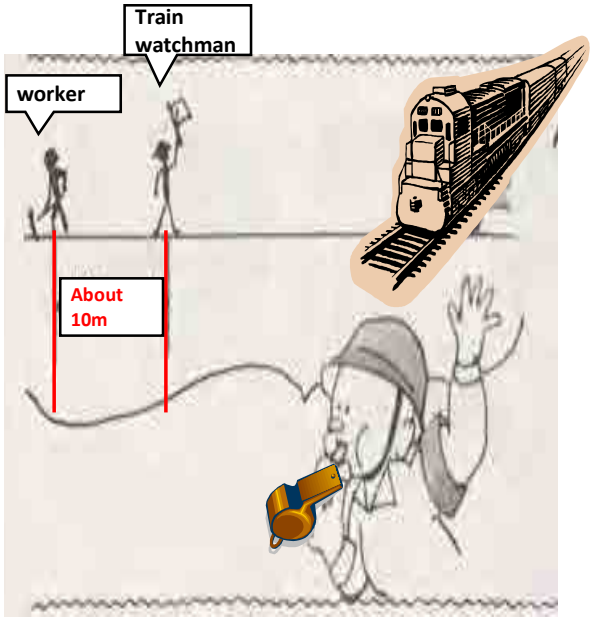
Watch your step and pay attention to train approach in case of walking along the track in the night or in the tunnel.
Pay more attention especially in the tunnel and in the heavy rain or strong wind weather in the night.



Let's confirm the timetable once more before entering into the tunnel or bridge



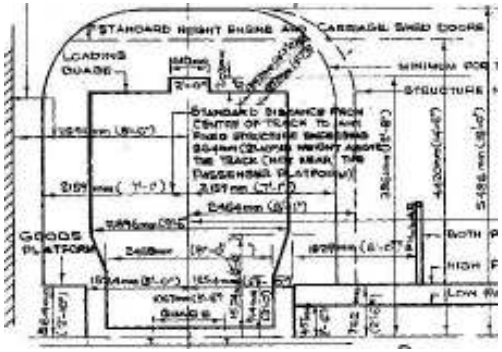
Let's confirm the train operation before beginning the track work



Confirm the refuge place and refuge method away from the passing train before beginning track work

Arrange the train watchman during track work

Remind that the structure gauge is very important gauge for the safety of the track maintenance workers.



To think hard in the track is strictly prohibited

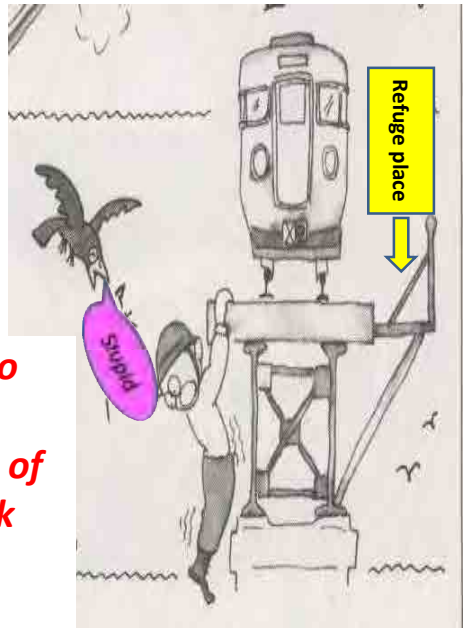
Oh!! Danger!!
The refuge between tracks is dangerous.

Let's take refuge at roadbed shoulder as much as possible.

Oh!!
My God!!

It's too late!!
Be careful for the load shifting and canvas rope of freight train!!

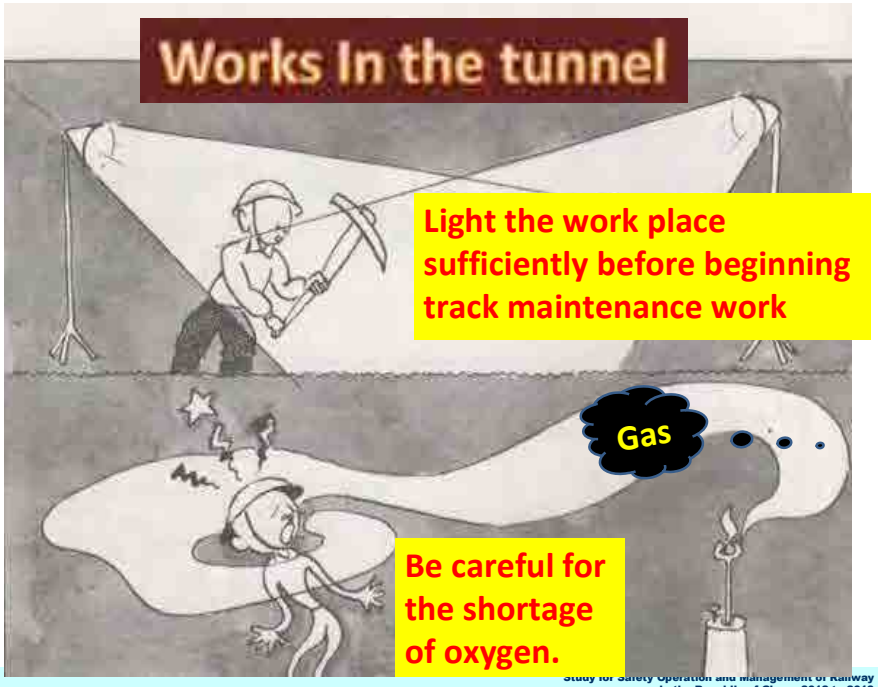
Refuge at the appointed place

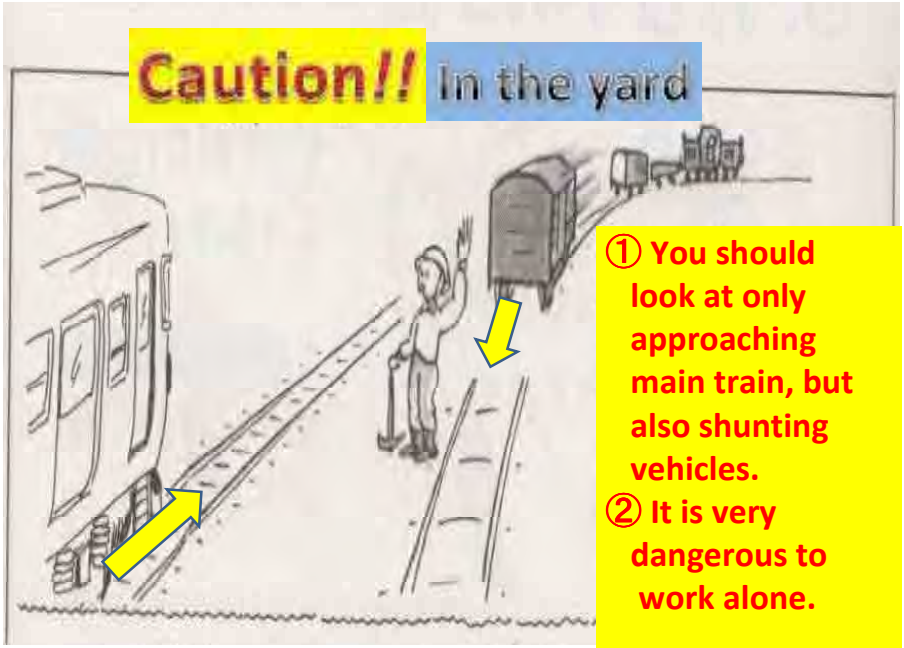


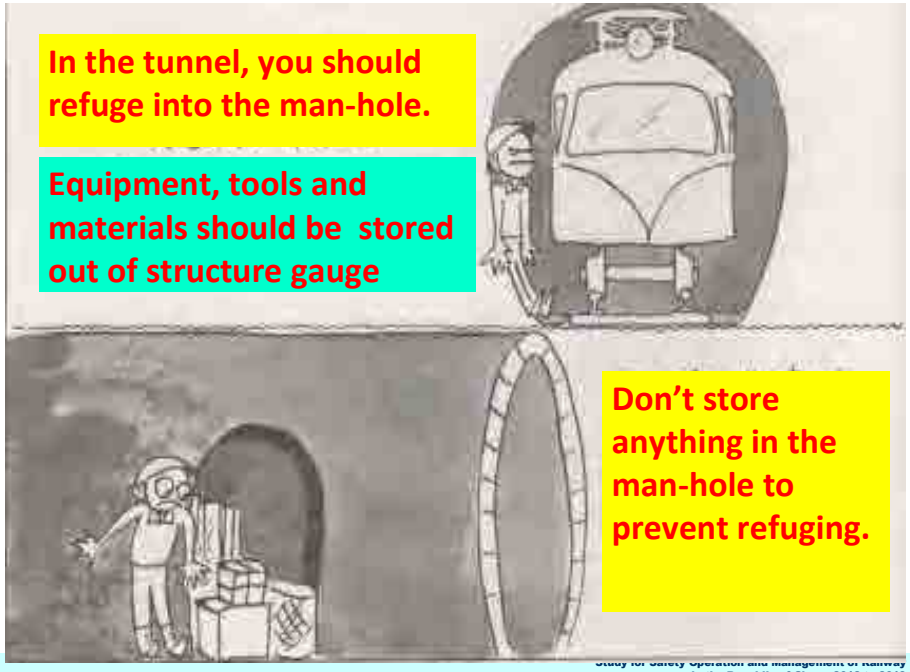
Let's train sometimes to be able to refuge at the appointed place in case of track maintenance work on the bridge

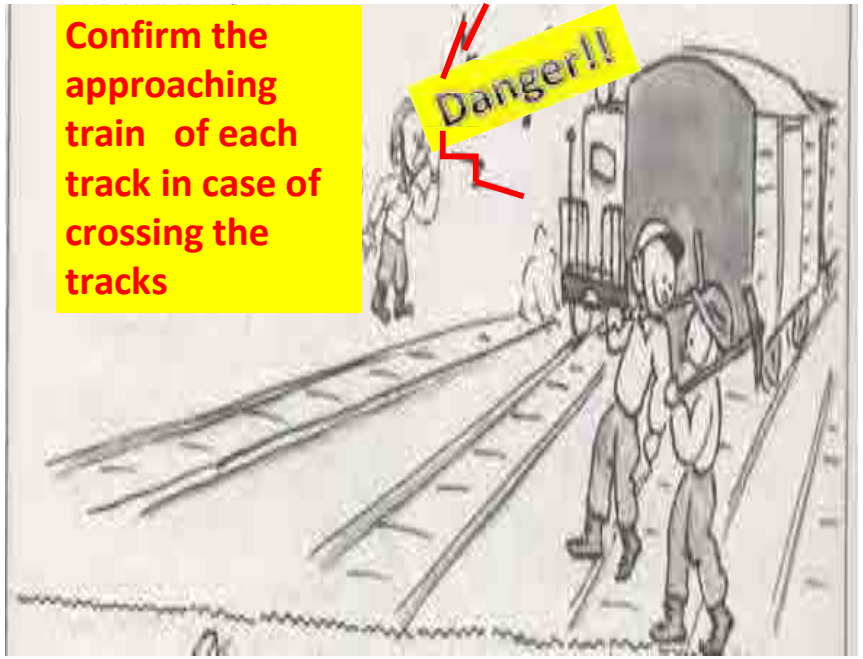
Wait a minute !!

Look carefully right and left before entering into the track

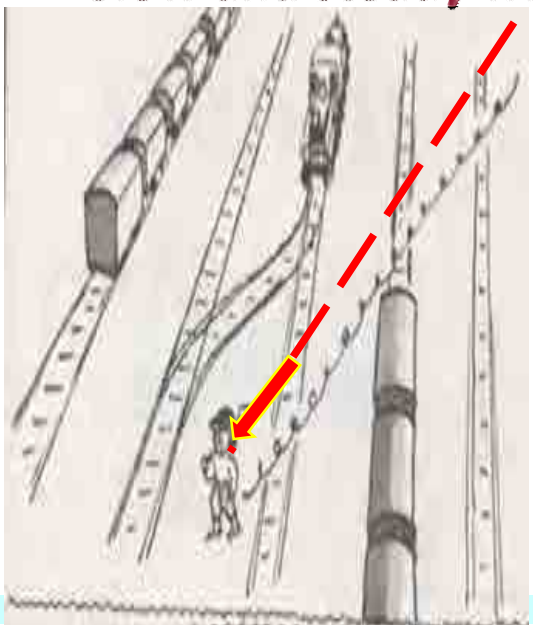

Works In the tunnel
Light the work place sufficiently before beginning track maintenance work
Gas
Be careful for the shortage of oxygen.


Caution!! In the yard
① You should look at only approaching main train, but also shunting vehicles.
② It is very dangerous to work alone.


In the tunnel, you should refuge into the man-hole.
Equipment, tools and materials should be stored out of structure gauge
Don’t store anything in the man-hole to prevent refuging.


Confirm the approaching train of each track in case of crossing the tracks
Danger!!

Slow and steady wins the race

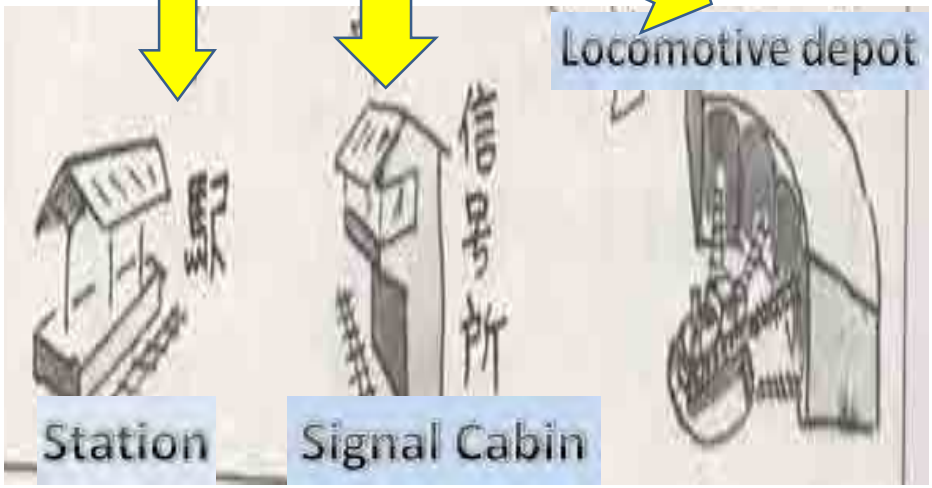


It is dangerous to cross the tracks diagonally in the yard

3. Attitude during the work

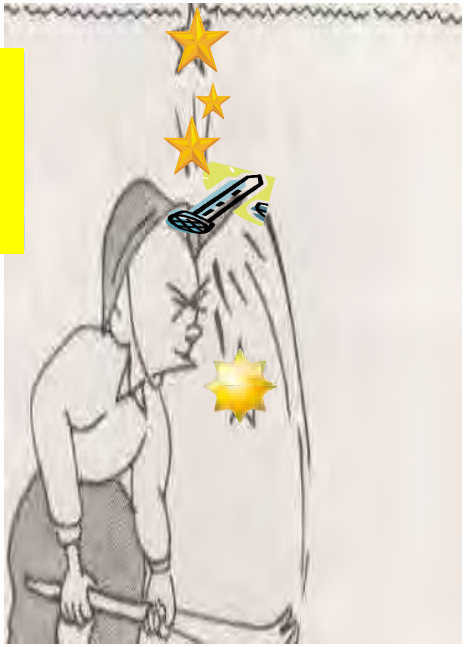
It is insufficient to drive the dog-spike beforehand. The tip part of dog-spike should be driven fully into the timber sleeper.

Before beginning track works at the yard, confirm the shunting work diagram of the yard on that day

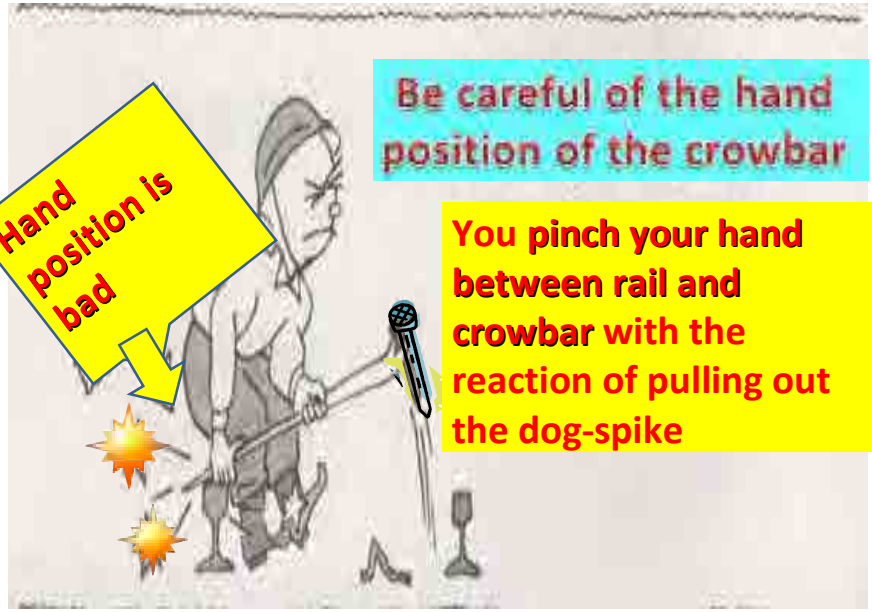


Don't pull out the dog-spike with full power from the beginning of this work.

After pulling the dog-spike from the timber sleeper about 90%, you should pull out it gradually with the pick of crowbar

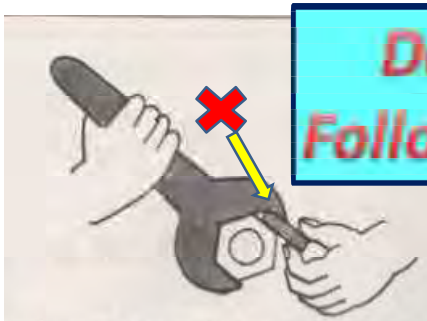


Be careful of the hand position of the crowbar

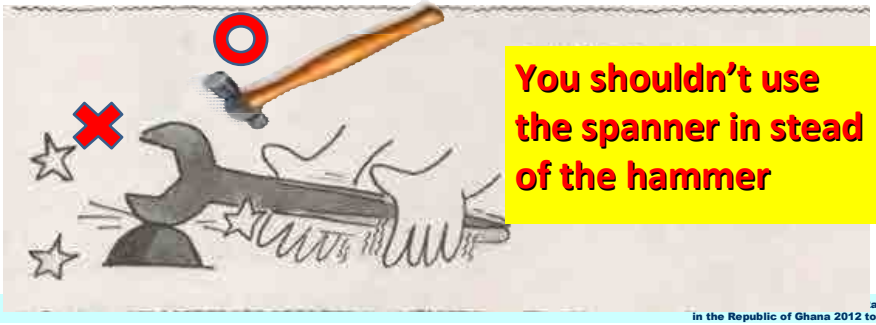


You pinch your hand between rail and crowbar with the reaction of pulling out the dog-spike

Danger!! Following methods



You should use the spanner fitting with the nut



You shouldn't use the spanner in stead of the hammer

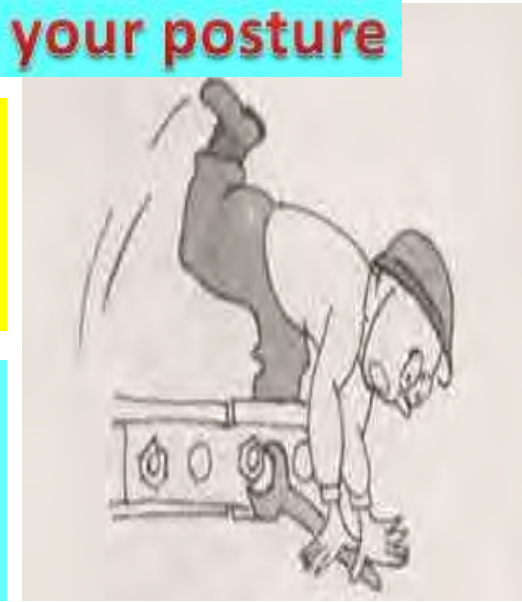
Handle of the hammer was broken and jumped up*!?*

You should use the hammer after you check the installation part of the handle into the hammer

Be careful of your posture

When the spanner came off from the nut, you should be careful of your posture not to fall to the ground.

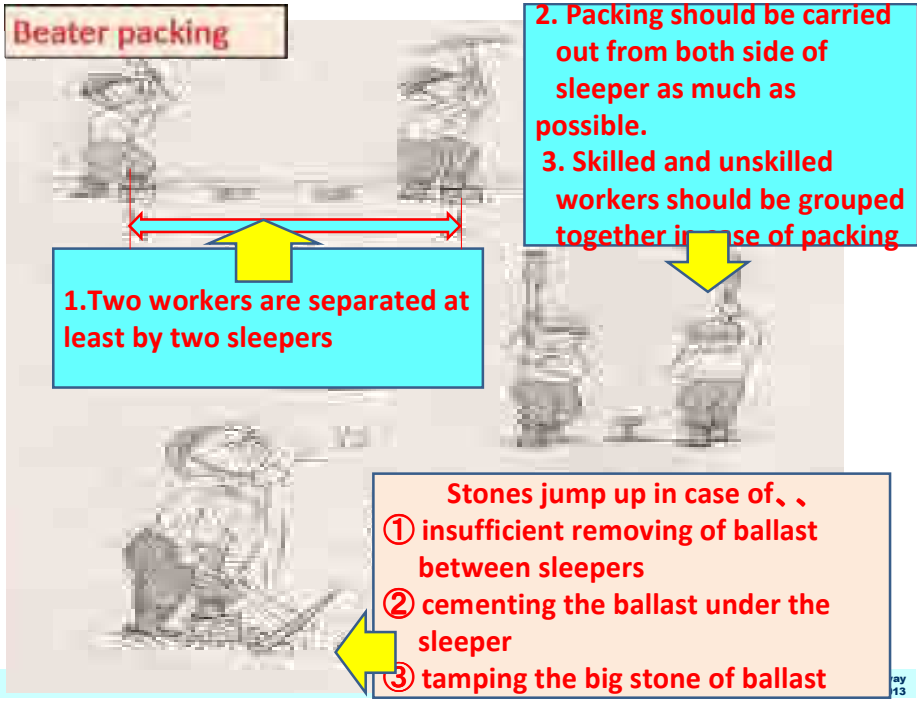
Keep your waist lower and keep your weight put both legs



Strict prohibition・・・
The work like this picture

You should use
cutting tool
to take off the bolt
being stuck with rust

Beater packing



1.Two workers are separated at least by two sleepers

2. Packing should be carried out from both side of sleeper as much as possible.
3. Skilled and unskilled workers should be grouped together in case of packing

Stones jump up in case of、、
① insufficient removing of ballast between sleepers
② cementing the ballast under the sleeper
③ tamping the big stone of ballast

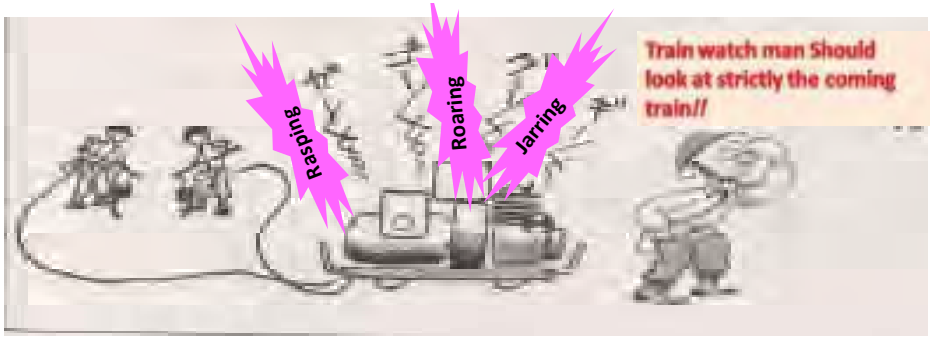
Excavating the ballast

Don't excavate outer and inner gauge ballast between sleepers at the same time.

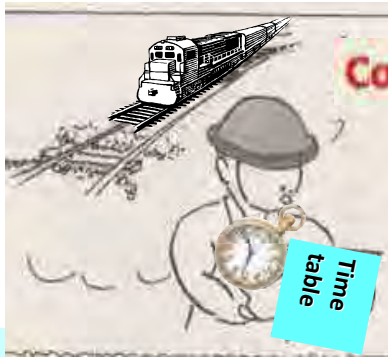
If the angle of your shovel to the ballast is acute, you can hardly scoop up the ballast.

Pay attention especially for removing the ballast under the rail

Removing the ballast



Train watch man Should look at strictly the coming train!!



Confirm the train window!!

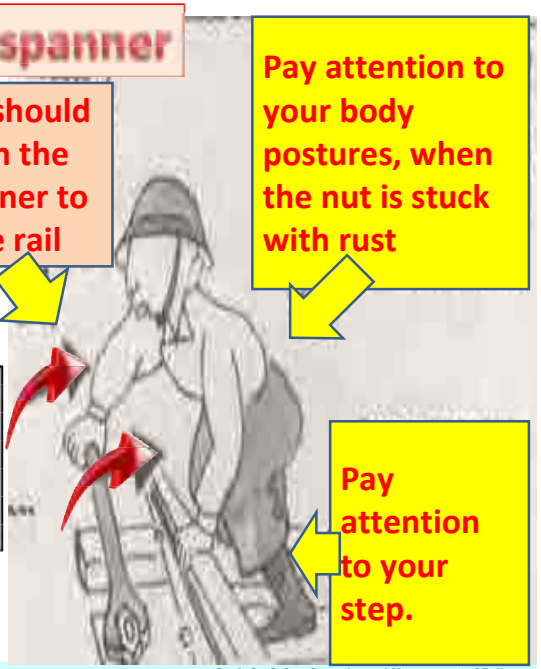
You should confirm the train window, even if you go to change only one sleeper.

Method of using spanner

You should turn the spanner to the rail

Pay attention to your body postures, when the nut is stuck with rust

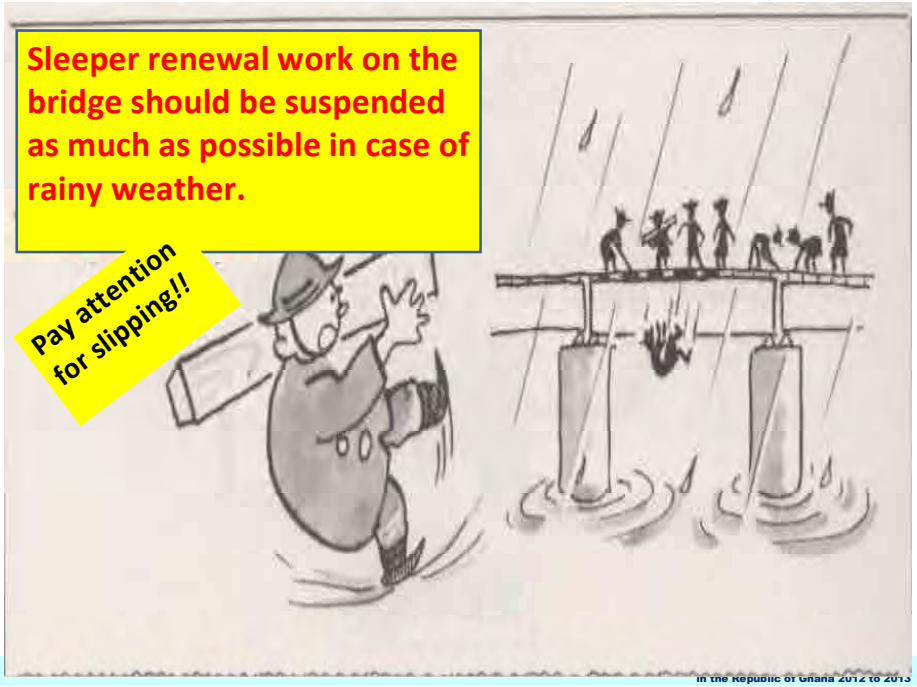
1. Turn it horizontally.
2. Turn it to the rail
3. Pay attention to your body and step

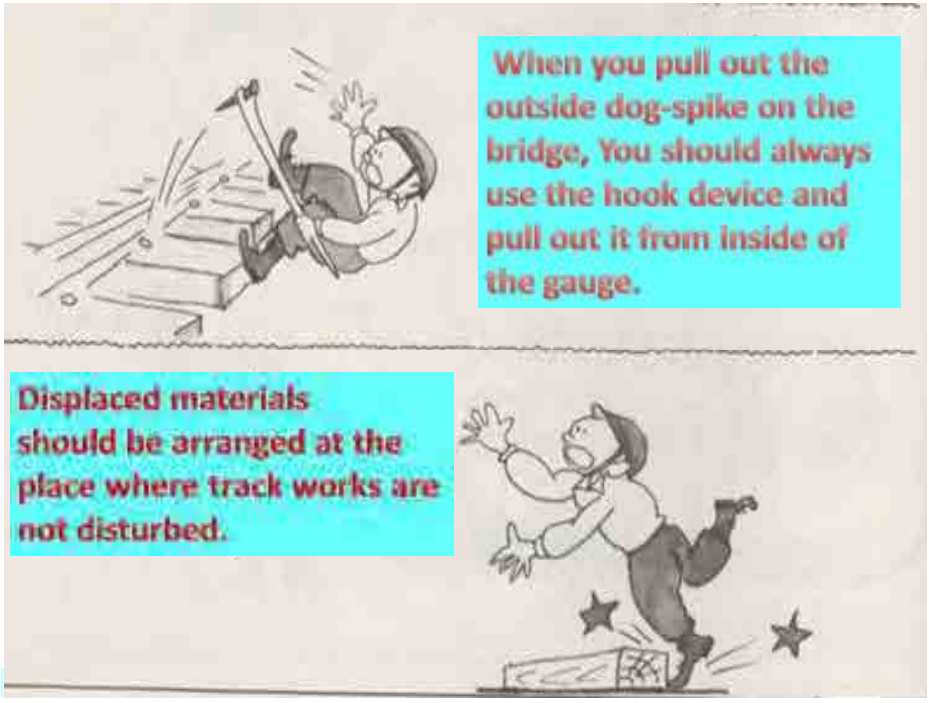


Pay attention to your step.

Sleeper renewal work on the bridge should be suspended as much as possible in case of rainy weather.

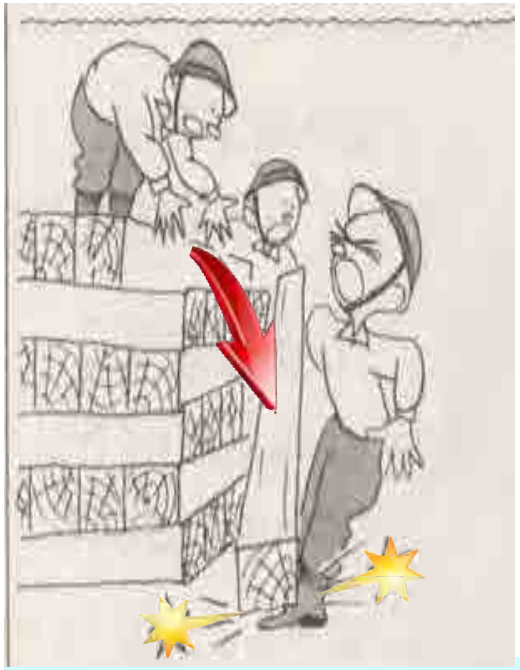
Pay attention for slipping!!





When you pull out the outside dog-spike on the bridge, You should always use the hook device and pull out it from inside of the gauge.

Displaced materials should be arranged at the place where track works are not disturbed.



Workers should make a loud voice each other in case of handing over the sleepers.
Especially pay attention to hand over the creosoted sleepers because of slipping them easily.

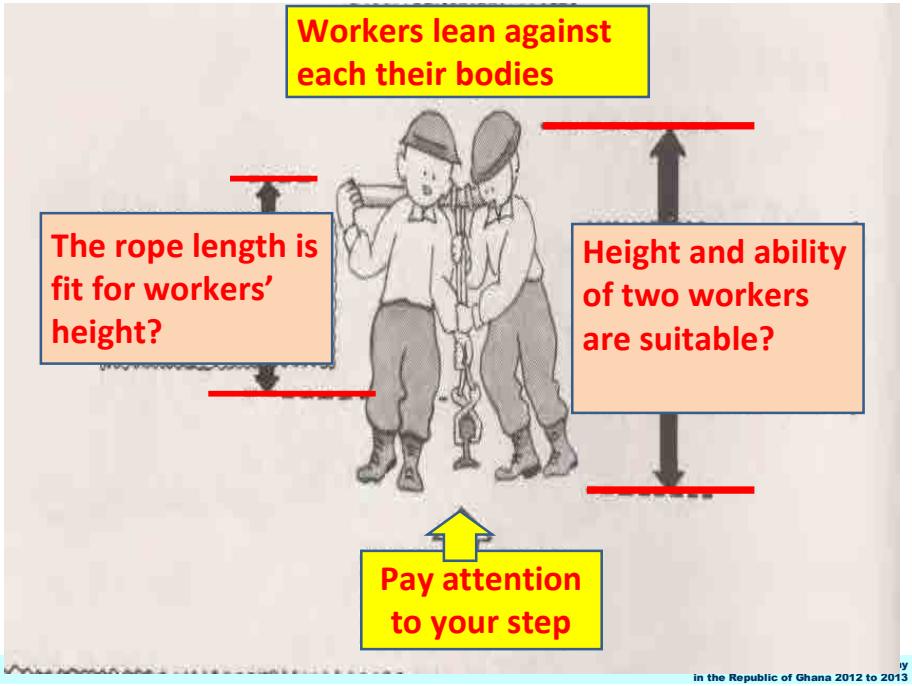
This picture shows the work of pulling out old sleeper with two workers.

Very dangerous!!

Let's think about what is dagerous.

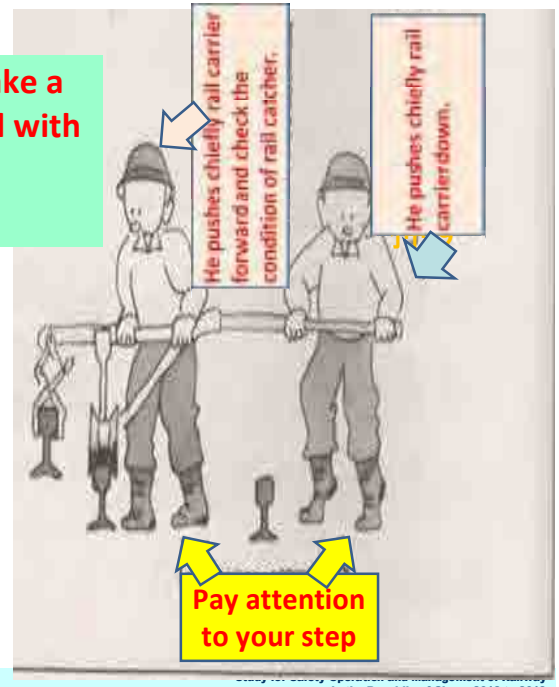
Don't imitate the work like this picture

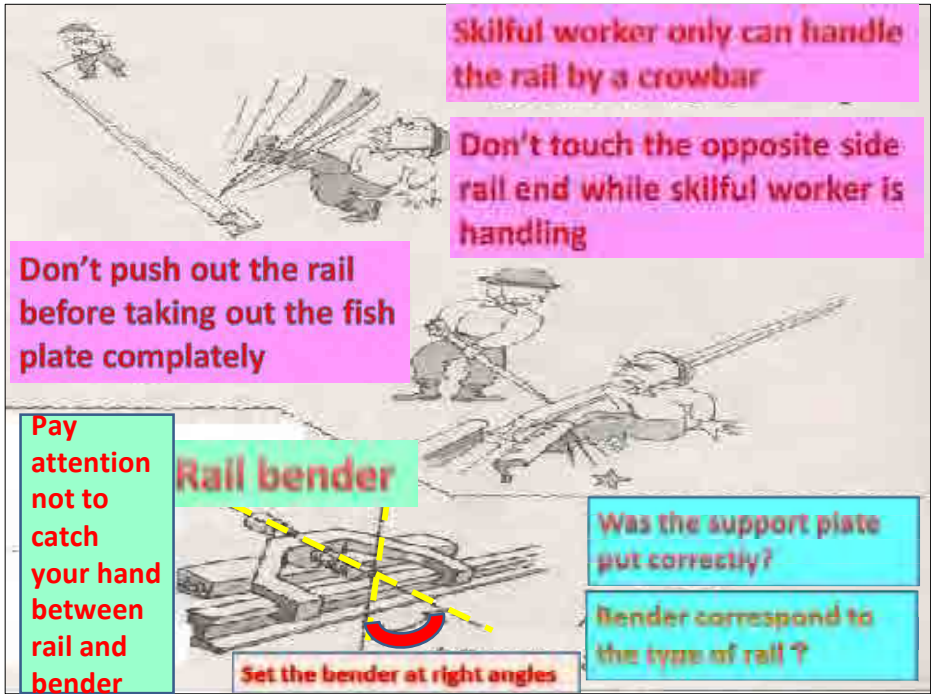
Rail carrier isn't the car on which workers can ride.



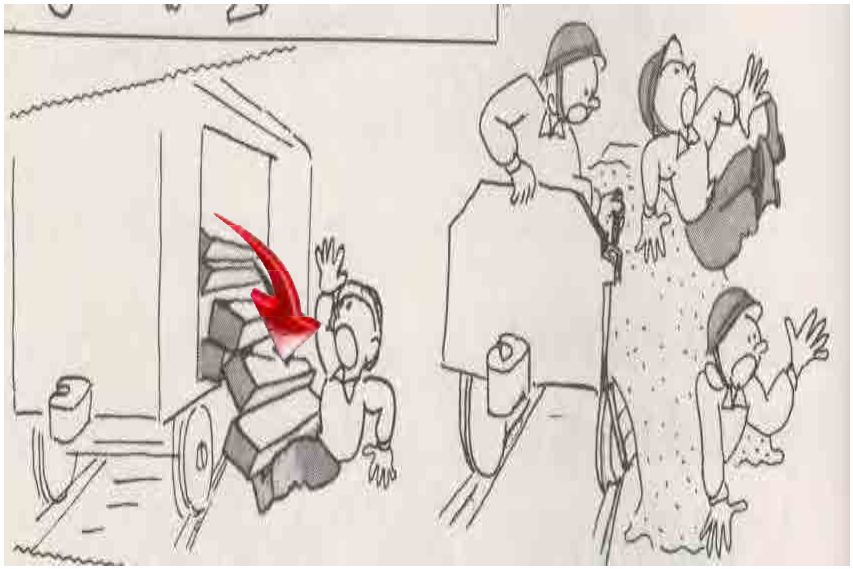
Two workers should make a voice and get along well with each other In case of transporting the rail

Start the work at the group leader's order・・・

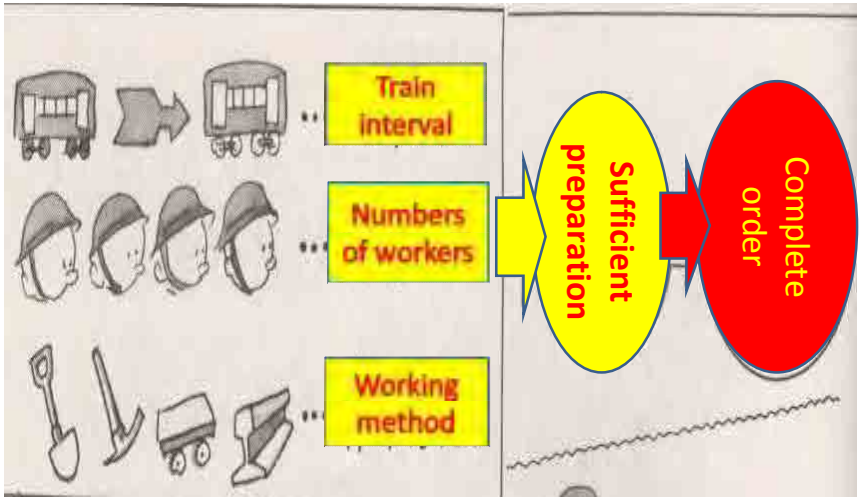


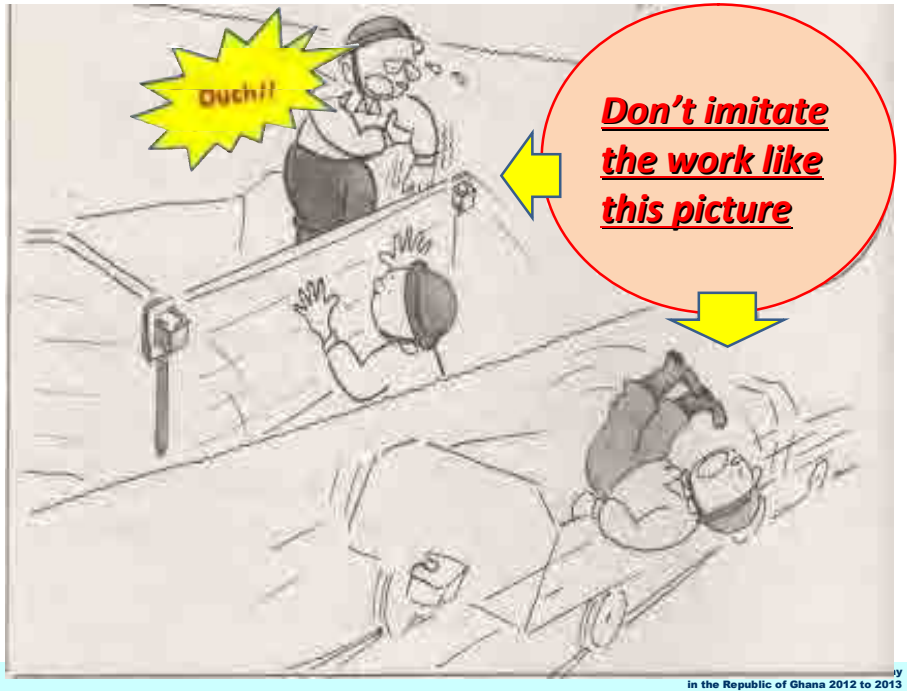


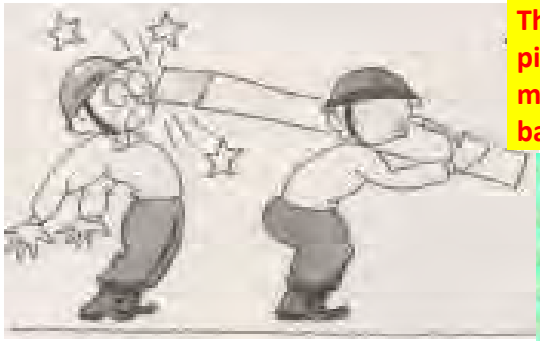
Don't imitate the work like this picture



4. Attitude for loading and unloading track materials







The accident like this picture happens because man hasn't the eyes at his back

Let's carry track materials on your shoulder, after taking into consideration about the range of your movement

The accident like this picture happens in case where you don't unload track materials uniformly

5. Attitude for using track trolley

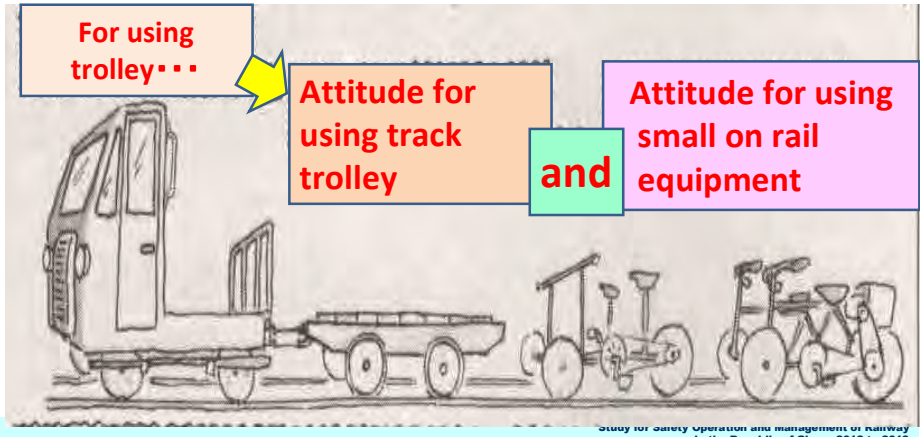
Before using:
Check especially brake condition

For using trolley・・・

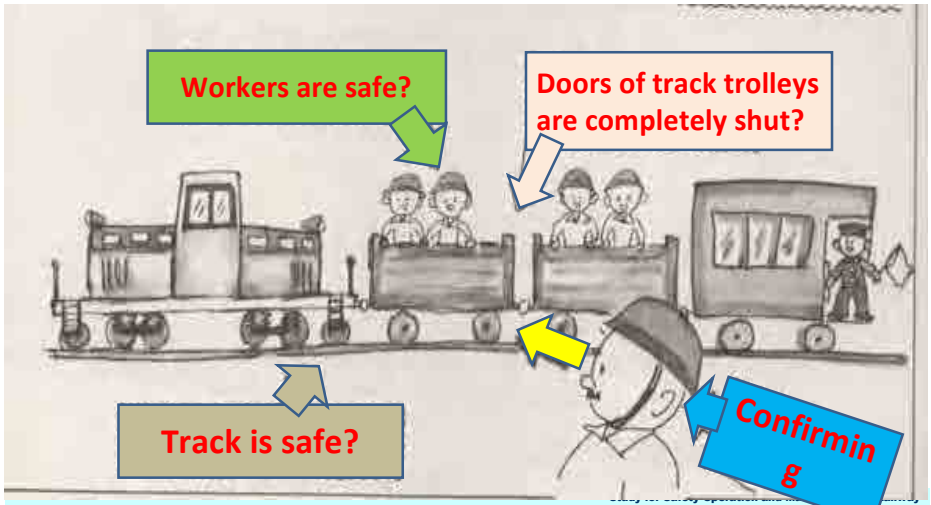
Attitude for using track trolley

and

Attitude for using small on rail equipment



Let's confirm the track and equipements after unloading track materials//



Attention for riding on the trolley

Workers should grip the handrail.

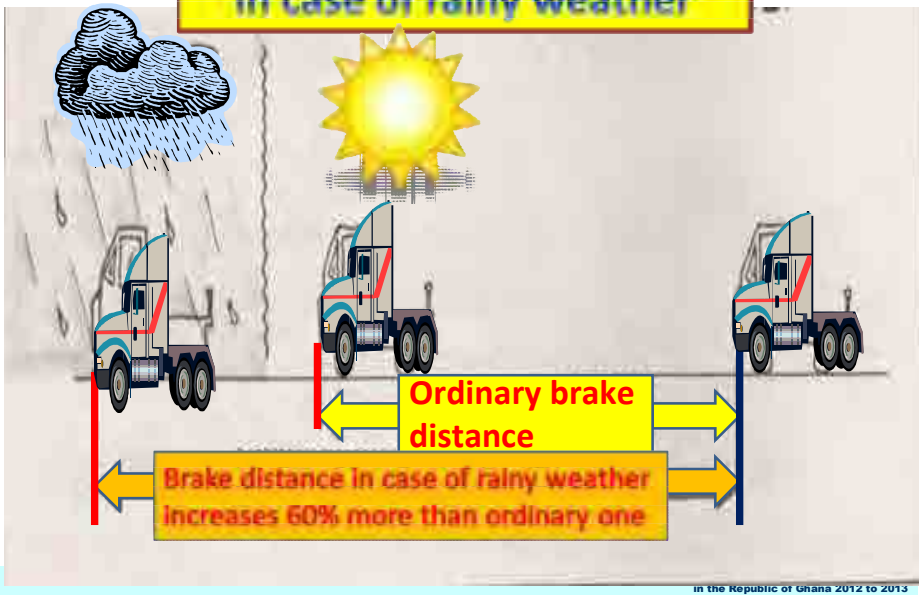
Only brake man can ride on the trolley (towed by motor car)

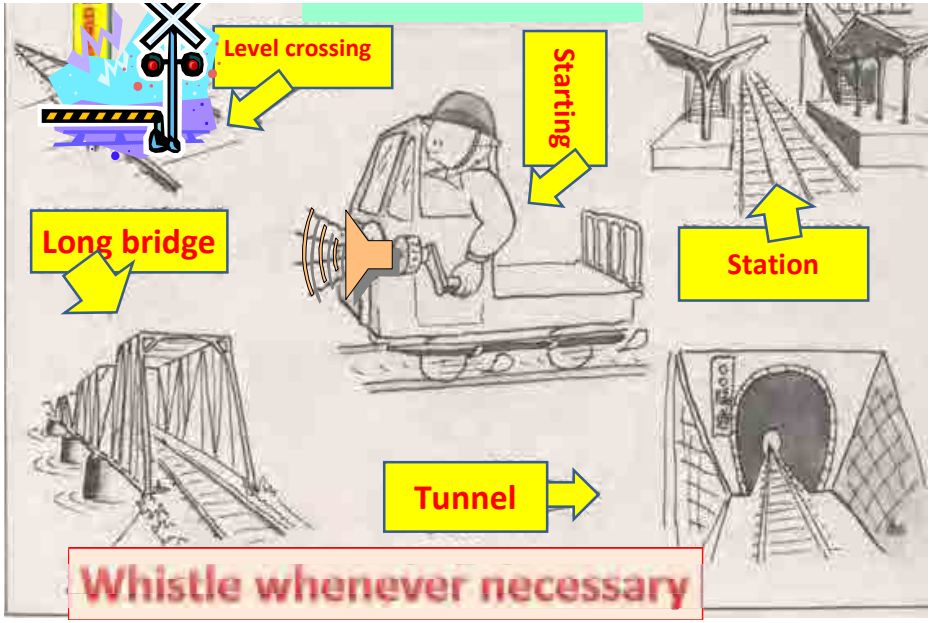
Group leader should order to start the trolley after confirming workers safety

No smoking

Strictly prohibition: Immediate start, Immediate stop

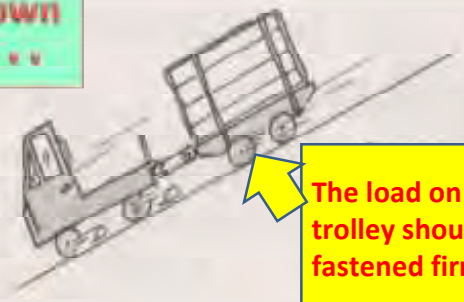
Attention for brake distance in case of rainy weather





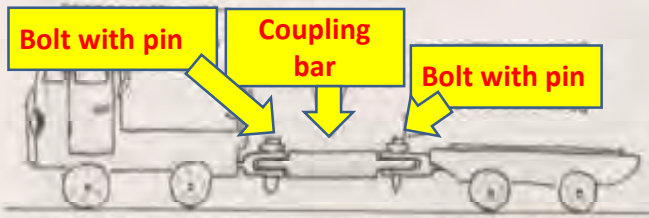
In case of going down the slope section・・・

Motor car should be located ahead of trolleys on the down slope section



The load on the trolley should be fastened firmly

Don't use the rope or wire for coupling trolleys !!



Dismantling the trolley

Wheels should be handled with 2 workers

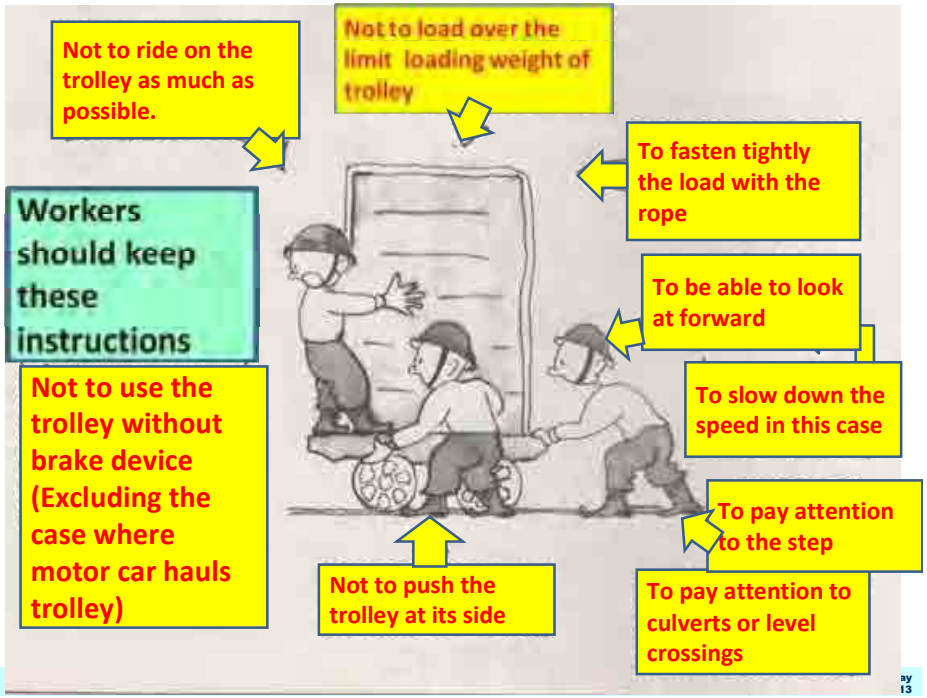
Pay attention to your steps. Don't forget to install the stop blocks

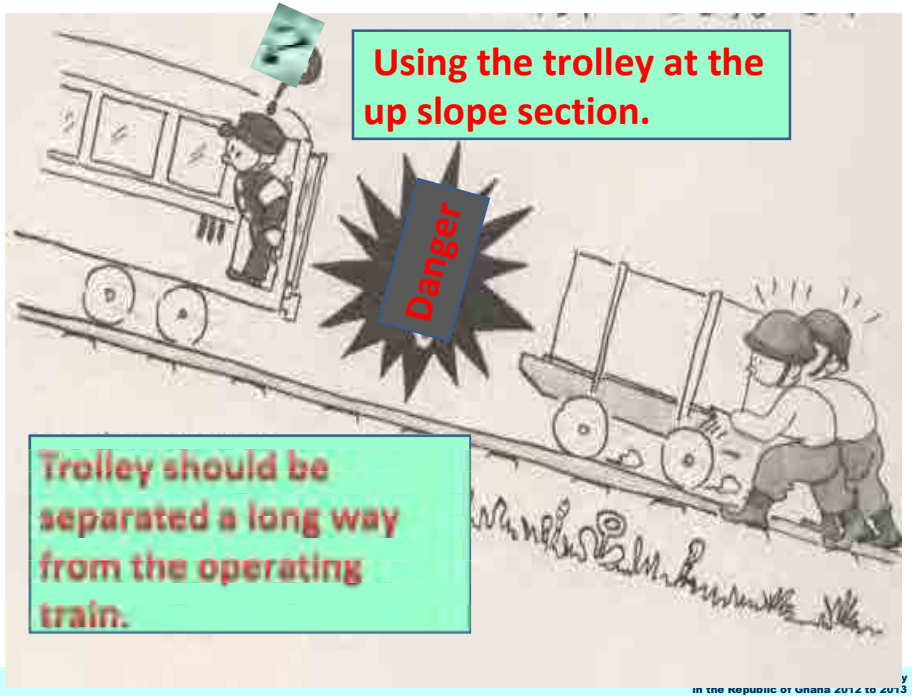
Trolley table with 4. Numbers of workers should be adjusted according to the size

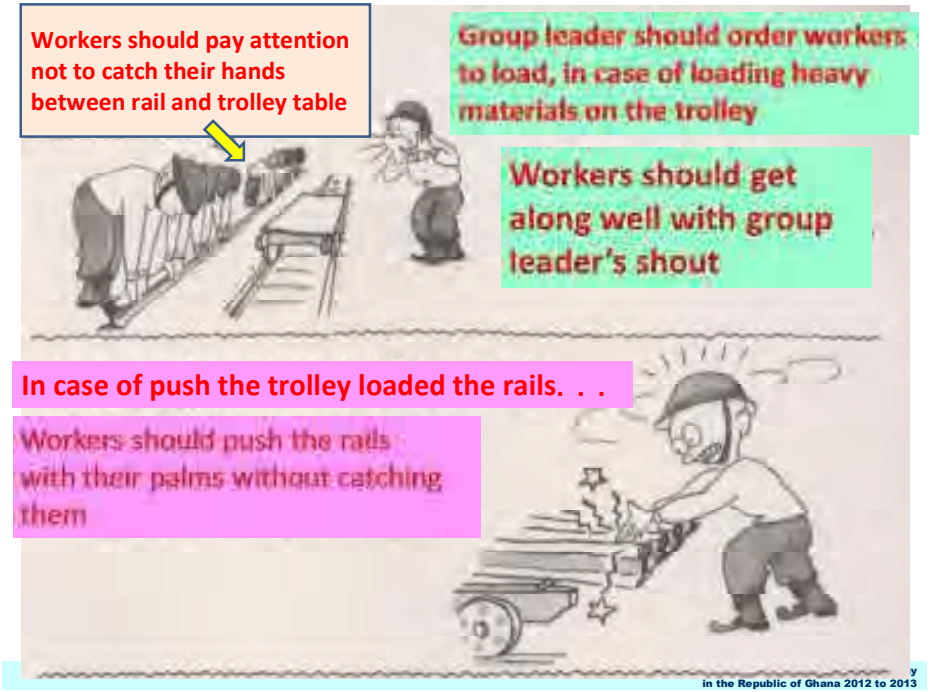
Trolley is running by himself・・・

The load should be loaded from the side of trolley

The incident like this picture occurred without the stop block!!


Not to ride on the trolley as much as possible.
Not to load over the limit loading weight of trolley
To fasten tightly the load with the rope
Workers should keep these instructions
To be able to look at forward
Not to use the trolley without brake device (Excluding the case where motor car hauls trolley)
To slow down the speed in this case
To pay attention to the step
Not to push the trolley at its side
To pay attention to culverts or level crossings


Using the trolley at the up slope section.
Danger
Trolley should be separated a long way from the operating train.


Workers should pay attention not to catch their hands between rail and trolley table
Group leader should order workers to load, in case of loading heavy materials on the trolley
Workers should get along well with group leader's shout
In case of push the trolley loaded the rails. . .
Workers should push the rails with their palms without catching them

Training for Track Maintenance 5/6
"Long Rail Maintenance"

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

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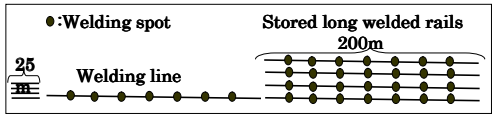
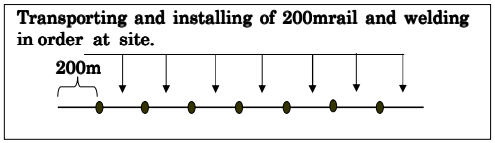
Long welded rail

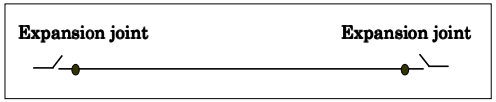
Installing Method of the long welded rail



1st step welding



2nd step welding



3rd step welding

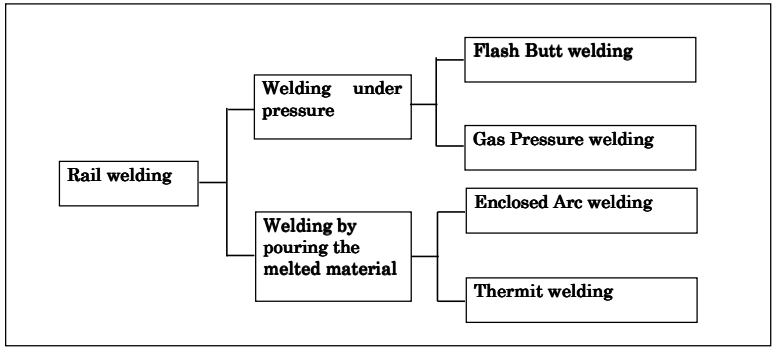
Long welded rail

Contents

1) Installing Method of the long welded rail
2) Classification of rail welding investigation
   - Flash Butt welding machine
   - Gas Pressure welding machine
   - Enclosed arc welding equipment
   - Thermit welding equipment
3) Investigation standards of finishing treatment of welded joint by Japan Railways

Long welded rail

Classification of rail welding Investigation



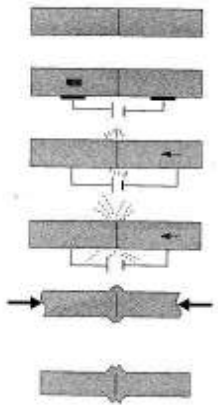
1. Flash Butt Welding machine

On rail Flash Butt Welding machine

Characteristics of flash butt welding

Merit	1) The strength of the weld joint is high 2) As this welding machine consists of high precision equipment, welding is done almost automatically. 3) The reliability of this weld joint is high because man power work doesn't be added. 4) The material cost by one weld joint is low. 5) The welding time by one weld joint takes short time.

Progress flow of Flash Butt welding



Both rails contact slightly.

Pouring big electric current.

During the preheating, flash rail proceeds forward gradually.

During the flash , flash rail proceeds forward .

Adding the pressure from both side and stopping of the big electric current.

End of the flash Butt welding.

Characteristics of flash butt welding

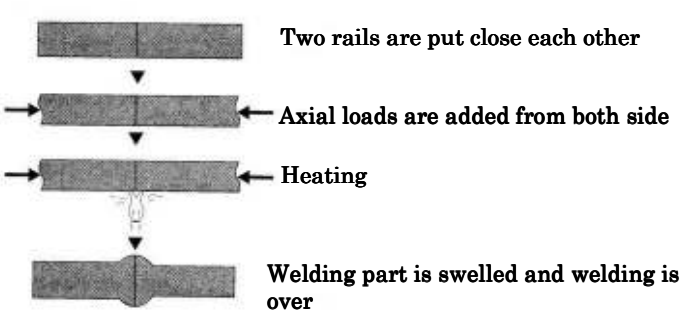
Demerit	1) The cost of equipment is high because large scale of electric power equipment and pressure adding equipment are needed. 2) The length of rail is shortened because the joint is welded by adding high pressure.

2. Gas Pressure welding machine

Characteristics of gas pressure welding

Merit	1) The strength of the weld joint is kept the same strength of main body rail, because the temperature of the weld joint is kept between 1200℃and 1300℃. 2) This welding machine consists of comparatively simple equipment and is portable. Therefore, this welding machine is suitable for 2nd step welding. 3) The material cost by one weld joint is low.
Demerit	1) The length of rail is shortened because the joint is welded by adding high pressure.

Progress flow of Gas Pressure welding



3. Enclosed arc welding equipment

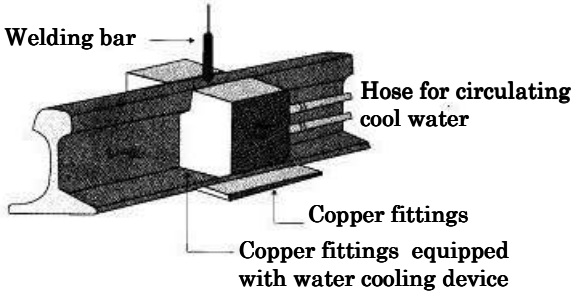
Method of Enclosed Arc welding

1) The gap of two rails which are welded should be kept 17±3mm.
2) Rail joint part should be covered with the copper fittings equipped with water cooler device.
3) In order to occur the arc between welding bar and rails, big electric current is flushed.
4) The welding bars are being melted and the gap of rail is fulled with them.

Characteristics of Enclosed Arc welding

Merit	1) The strength of the weld joint is high 2) As this welding method is done by melting the welding bar, the length of rail is not shortened.
Demerit	1) This welding method is complex, so the quality of welding depends on the skill of the welder. 2) The welding time by one weld joint takes long time. (About 30 minutes) 3) The power supply equipment is needed.

Lay out drawing of Enclosed Arc welding



4. Thermit welding equipment

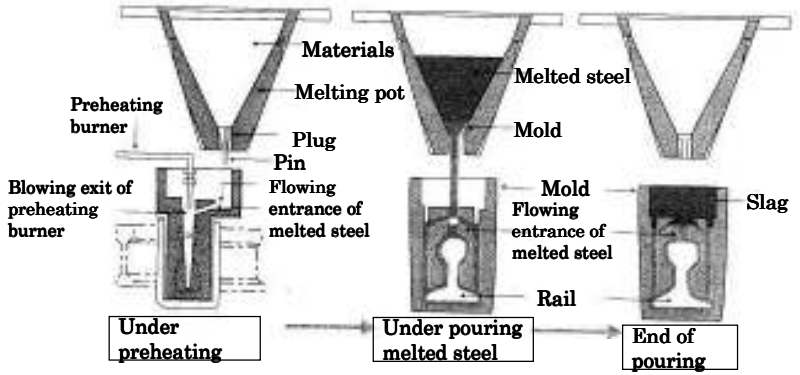
Progress flow of Thermit welding

1) The gap of two rails which are welded should be kept 25±1mm.
2) Rail joint part should be covered with the mold.
3) Melting pot should be put on the mold and materials (Powder of Aluminum and Ion oxide) should be installed into this pot.
4) Chemical reaction occurs as soon as materials are lighted.
($2Fe_2O_3 + 2Al \rightarrow 4Al_2O_3 + 2Fe$ (ΔH=-851kj/mol.), or
$2Fe_3O_4 + 8Al \rightarrow 4Al_2O_3 + 9Fe$ (ΔH=-3348kj/mol.))
5) Melted steel is born and its melted steel is poured into the mold.

Characteristics of Thermit welding

Merit	1) As this welding method is done by pouring the melted steel into the rail gap, the length of rail is not shortened. 2) The welding time by one weld joint takes short time. 3) As the equipment are simple, light and portable, this welding machine is suitable for 3rd step welding.
Demerit	1) Quality and reliability of this wielding method is slightly lacking. 2) The material cost by one weld joint is high.

Progress flow of Thermit welding



JR standards of finishing treatment of welded joint (mm)

longitudinal level irregularity	-0.1 ≦δ≦+0.5	δ : irregularity measured with 1m span measure	Notice: passing grade is that welded joint has to be finished within standards mentioned at the left side columns and at the same time, no weld defect is found with the investigation method used magnet powder
alignment irregularity	-0.5 ≦δ≦+0.5		
investigation with magnet powder	no weld defect		

Long welded rail

Inspection after finishing the welding work

1) Inspection of rail surface irregularity with the scale.
2) Inspection of rail surface failure with the dye penetrant testing method.
3) Inspection of inner rail failure with the ultrasonic rail flow detector by using probe block.

Training for Track Maintenance 6/6
"PC Sleepers Maintenance"

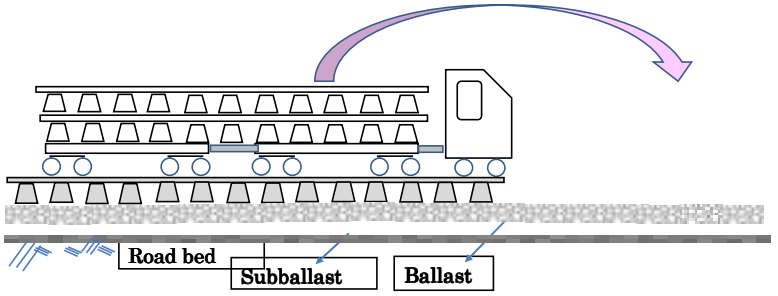
From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

0

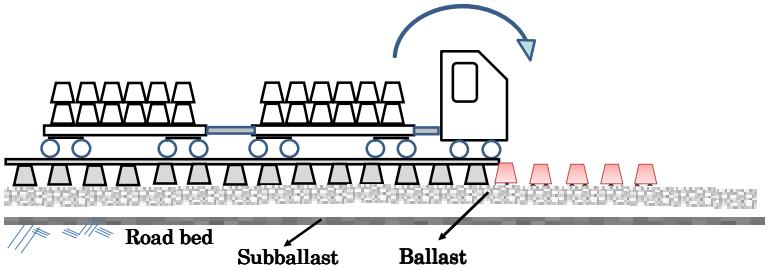
Installing method of PC sleepers

Track panel method



Installing method of PC sleepers

Individually installing method



Installing method of PC sleepers

Sand was leveled by the workers. (Example of Thai railways' rehabilitation works)

Installing method of PC sleepers

In the rehabilitation work of Thai railways, sand was used as the sub ballast

Installing method of PC sleepers

Sand was leveled and tamped by vibration equipment. Water stopping sheet was spread under the sand.(Example of Thai railways' rehabilitation works)

Installing method of PC sleepers

Ballast was installed after finishing sub ballast work.(Example of Thai railways' rehabilitation works)

Installing method of PC sleepers

The bucket of road/rail Yumbo machine is changed to the attachment for changing sleeper. (Japanese Railway Company uses this type)

Installing method of PC sleepers

Concrete sleeper (Two block concrete sleeper type, not PC sleeper) was installed by the concrete sleeper renewal machine after finishing ballast work. (Example of Thai railways' rehabilitation works)

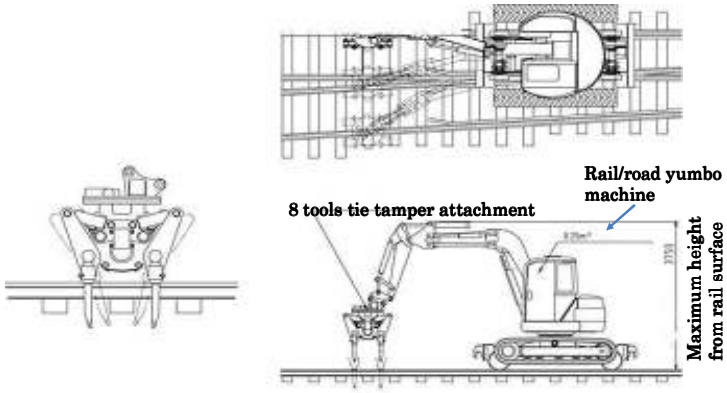
Installing method of PC sleepers

.Installing PC sleeper by machine (Japanese Railway Company)

Installing method of PC sleepers

.Installing PC sleeper by man power (Japanese Railway Company)

Installing method of PC sleepers



Drawings of 8 tools tie tamper

Installing method of PC sleepers

8 tools tamping equipment which is changed from the bucket attachment of road/rail Yumbo machine

Installing method of PC sleepers

PC sleepers were transported by the trolleys to the site.(Example of Thai railways' rehabilitation works)

Track irregularity tolerance of Japan Railways after finishing track construction

Track irregularity tolerance of Japan Railways after finishing track construction (Unit : mm)	
Gauge	(+1) (- 3)
Cross level	(±4)
Longitudi-nal level	(±4)
Alignment	(±4)
Twist	(±4)

Thank you

Japan International Cooperation Agency (JICA)

Oriental Consultants Co., Ltd.
Japan International Consultants for Transportation Co., Ltd.

Oriental Consultants Co., Ltd.

Japan International Consultants for Transportation Co., Ltd

Installing method of PC sleepers

Track irregularity tolerance of Japan Railways after finishing track construction

- Note:
  1) These values show ones measured by track inspection car, and values of parenthesis show statical ones.
  2) These values don't contain values of super elevation, gauge widening and versine of the curve. And twist irregularity value doesn't also contains super elevation tapering.
  3) Track tolerance standards for sidings are applied in the same way to 4th class lines.

Training for Civil/Bridge Maintenance

From 5th March to 21st March 2014

Lecture by Osamu OHKAWA,

Civil/Bridge Expert, JICA Study Team

Training Plan

	Bridge training	Remarks
March 5 (Wed)	Explanation of the training plan,Present conditions explanation of the Ghana bridge,Basic knowledge of bridge	Training room
March 7 (Fri)	Basic knowledge of bridge	〃
March 10 (Mon)	Point of bridge inspection,Method of inspection,Explanation of account book	〃
March 11 (Tue)	〃	〃
March 12 (Wed)	〃	〃
March 13 (Tue)	Field exploration	Neighborhood of Butuah St.
March 14 (Fri)	〃	〃
March 17 (Mon)	〃	Neighborhood of Manso St.
March 18 (Tue)	〃	〃
March 19 (Wed)	Making of account book(Use PC)	Training room
March 20 (The)	〃	〃
March 21 (Fri)	〃	〃

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

Bridge Maintenance Training

Ghana Railway

March 2014
JICA Study Team
Expert : Osamu OHKAWA

- Training plan
- Current situation of bridges
- Basic knowledge of bridge
- Point of bridge inspection and method
- Explanation of account book

I. Training Plan

Training Plan		
	Bridge training	Remarks
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March 19 (Wed)	Making of account book(Use PC)	Training room
March 20 (The)	〃	〃
March 21 (Fri)	〃	〃

2. Current Situation of the bridge

5

Steel Bridge in the Suburbs of Dunkuwa

Current situation

Freight train wreck

6

4

Steel bridge in the suburbs of Butuah

Current situation

Corrosion

8

5

Steel bridge in the suburbs of Butuah

Current situation

7

Steel bridge in the suburbs of Butuah

Section loss

Soil deposits

Big crack

9

Steel bridge in the suburbs of Butuah

Big crack

10

6

Box culvert in the suburbs of Butuah

Current situation

Box culvert

11

Box Culvert in the suburbs of Butuah

Current situation

Big crack

Flaking

Big crack

12

7

Steel bridge in the suburbs of Manso

Collapsed abutment

Collapsed abutment

13

Steel bridge in the suburbs of Manso

Corrosion

Corrosion

Garbage

15

Steel bridge in the suburbs of Manso

Corrosion

14

8

Broken Parapet

Broken Parapet by Shoe movement

16

9

Flaking and crack of the concrete

Flaking

Big Crack

Big Crack

17

Revetment in the suburbs of Accra

Revetment

19

Scouring of Foundation

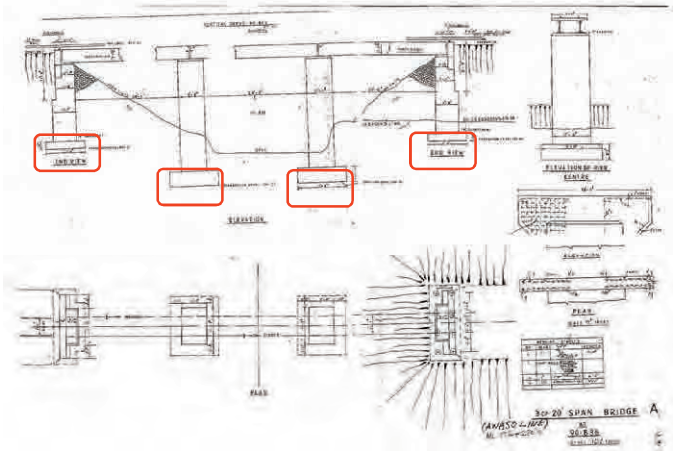
Scouring (Retaining wall)

Scouring (Box culvert)
In Burkina Faso

18

10

Working drawing



There isn't a columnar section, and bearing bed is not clear

▭ : Small size

Not clear, please rewrite

20

11

3. Basic Knowledge of Bridge

Basic Knowledge of Bridge

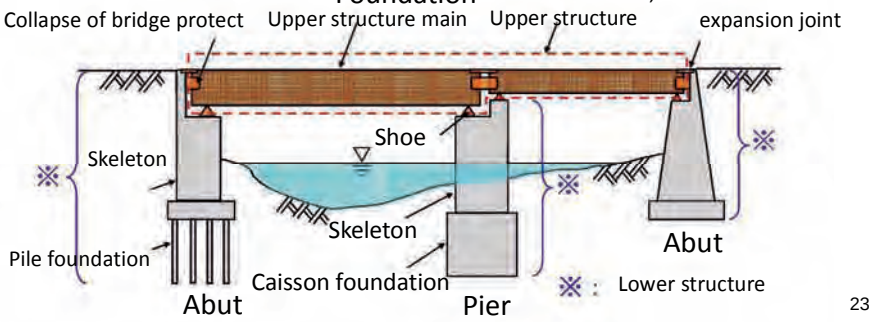
① Basic construction of Bridge

② Type of Bridge

③ Name and function of structure member

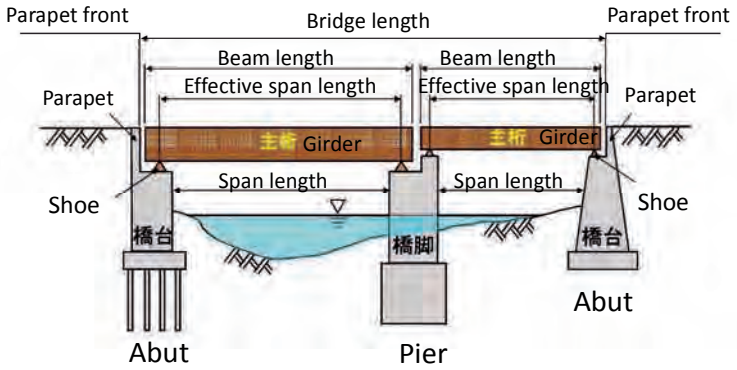
①Basic construction of Bridge [Structure name to construct Bridge]

- Bridge
  - Upper structure
    - Main
    - Belonging — Shoe,expansion joint etc.
  - Lower structure
    - Skeleton — Abutment, Pier
    - Foundation — Pile foundation,caisson foundation etc.



①Basic construction of Bridge [Length about Bridge]

Bridge length — — — Length between parapet front of both ends abut
Beam length — — — Length of girder
Effective span length — — — Length between shoe
Span length — — — Length between abut(pier) and abut(pier) of lower structure



② Type of Bridge

[Main 7 Types of Bridges]

- Beam bridge
- Slab bridge
- Truss bridge
- Rigid frame bridge
- Arch bridge
- Cable stayed bridge
- Suspension bridge

② Type of Bridge

[Beam bridge]

- I girder bridge

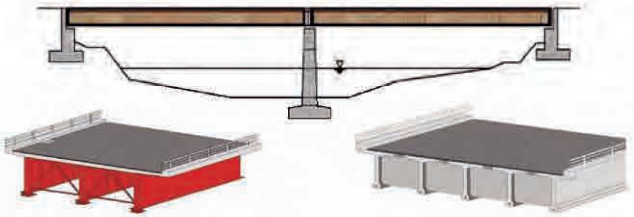
- T girder bridge

- Box girder bridge

② Type of Bridge

[Beam bridge]

○Bridge adopted girder in principal structure



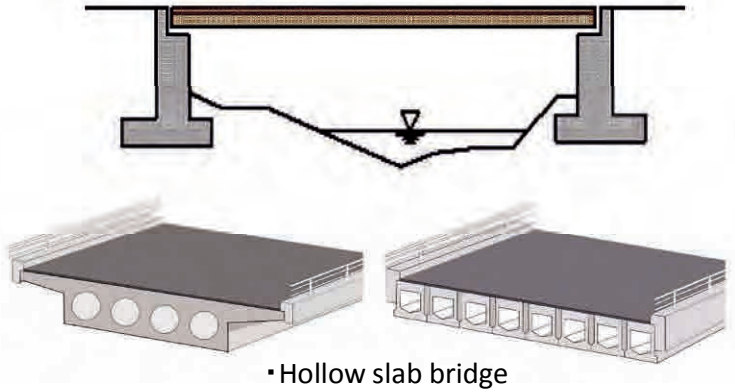
- I girder bridge(Steel bridge)
- T girder bridge(Concrete bridge)

- Box girder bridge(Steel bridge)
- Box girder bridge(Concrete bridge)

② Type of Bridge

[Slab bridge]

○Bridge adopted slab in principal structure , no girder



- Hollow slab bridge

② Type of Bridge

[Slab bridge]

・PC posttension hollow slab bridge

・PC pretension slab bridge

Type of Bridge

[Rigid frame bridge]

・PC π style rigid frame bridge

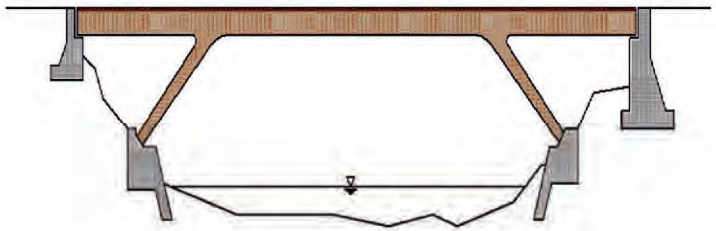
・Steel rigid frame bridge

・PC rigid frame box girder bridge

② Type of Bridge

[Rigid frame bridge]

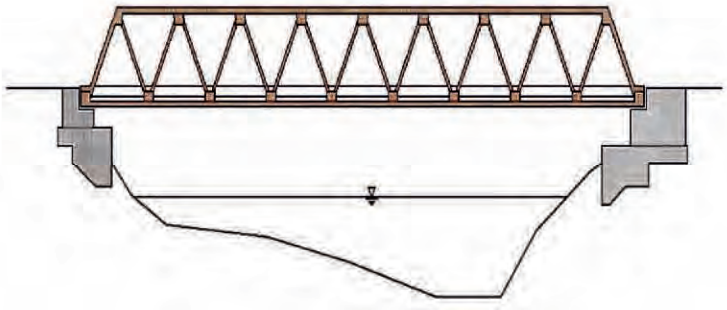
○ Structure of the bridge is monolithic for the pier and principal girder



② Type of Bridge

[Truss bridge]

○ Principal structure of bridge is truss



② Type of Bridge

[Truss bridge]

・Cantilever steel truss bridge (through style)

・Steel truss bridge (through style)

②Kind of Bridge

[Arch bridge]

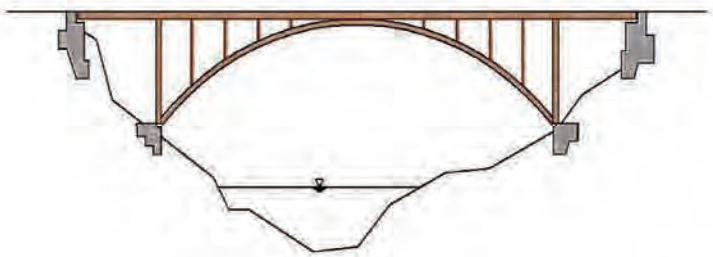
・Steel langer arch bridge (deck style)

・Steel roze arch bridge (through style)

② Type of Bridge

[Arch bridge]

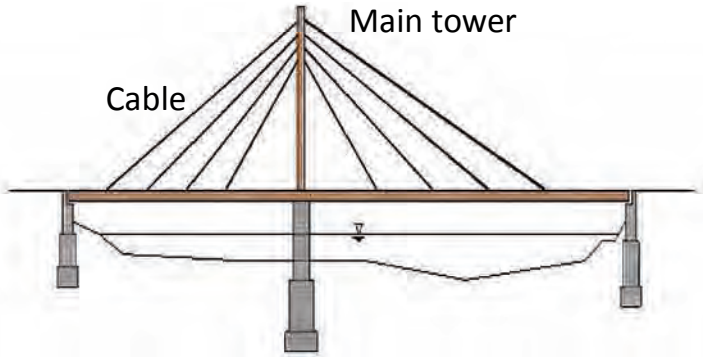
○ principal structure of arch bridge is an arch in compression at the lower part of bridge



② Type of Bridge

[Cable stayed bridge]

○ Bridge supported by cable which stretched diagonally from main tower



② Type of Bridge

[Cable stayed bridge]

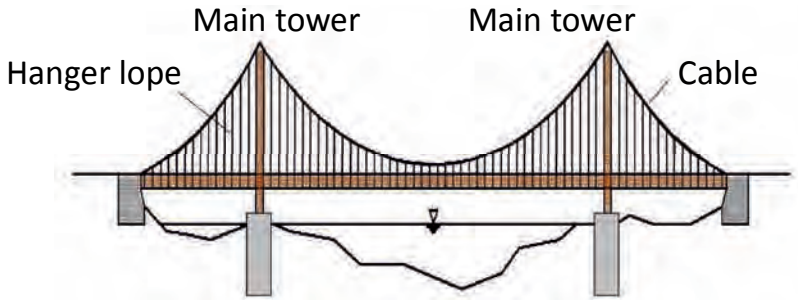
② Type of Bridge

[Suspension bridge]

② Type of Bridge

[Suspension bridge]

○ A suspension bridge is a type of bridge in which the deck is hung below suspension cables on vertical suspenders. Main cable is anchored at the both ends



③Name and function of structure member

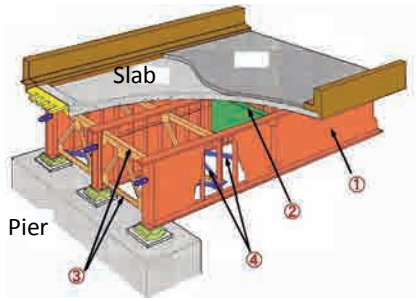
[Superstructure]

① girder

Girder is strained between abut or pier, support car load on the slab and communicate force to abut or pier

② cross beam

Cross beam is a member to connect girder for support load by many girder



③ cross frame

Cross frame is a member to connect girder mutually vertical or almost vertical for resist lateral load of wind or earthquake etc. (no exist concrete bridge)

④ cross ?

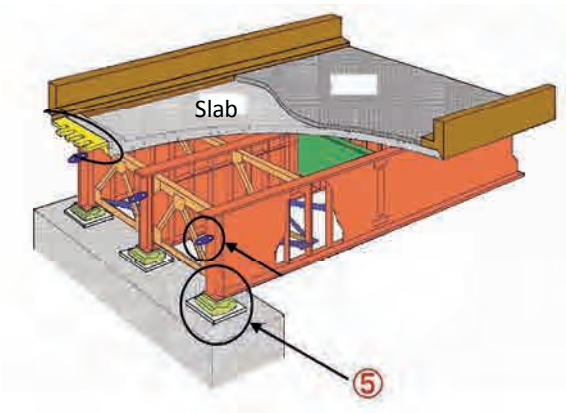
Cross ? is a member to connect girder mutually horizontally or almost horizontally for resist lateral load of wind or earthquake etc. (no exist concrete bridge)

③Name and function of structure member

[Superstructure]

⑤Shoe

Shoe support superstructure and communicate load from superstructure to substructure (abut or pier)

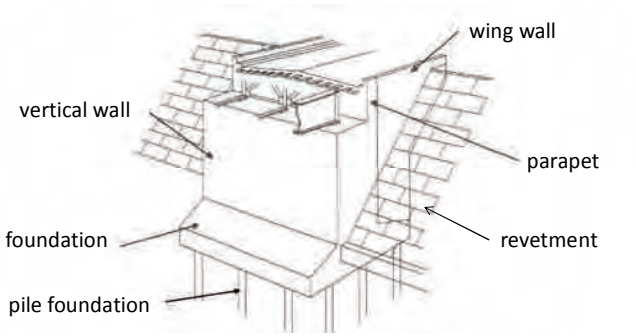


③Name and function of structure member

[Substructure]

・Abutment

Abutment is located both ends of bridge and support load from superstructure and back earth



③Name and function of structure member

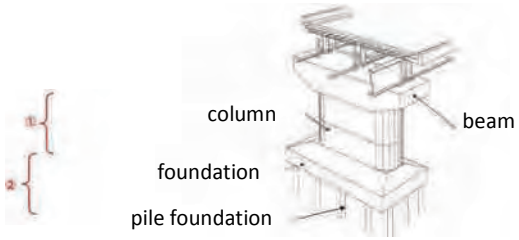
[Substructure]

①Pier

Pier is located middle between bridge and support load from superstructure. Name is「P1」「P2」etc.

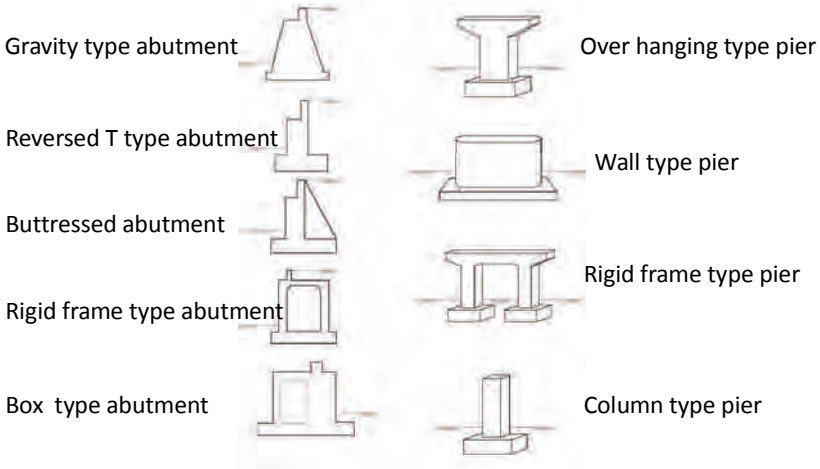
②Foundation

Foundation support load under abutment or pier and communicate to ground



③Name and function of structure member(Reference)

[Type of abutment] [Type of pier]



4. Point of Bridge Inspection,

Method of Inspection,

Explanation of Bridge account book

45

Point of Bridge Inspection

①About management of Bridge

②Inspection

46

①About management of bridge

[Management of bridge]

- ○ Secure traffic which is safety and smooth
- ○ Secure durability and strength as structure
- ○ Prevent third-party damage

For prevent accident or dropping of bridge

- ・Early detection of danger which becomes obstacle of traffic
- ・Early detection of unusual and injury of bridge

→ Appropriate repair and reinforcement

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①About management of bridge

[Kind of main inspection]

Daily inspection	Routinely inspection Visual inspection when go to road patrol or site
Regular inspection	Inspection which decide frequency Inspection by proximity visual to grasp in detail unusual and injury of bridge
Abnormality inspection	Inspection which to do the time disaster of earthquake, typhoon and heavy rain and abnormality Inspection for confirm bridge safety

inspection → Early detection of unusual and injury of bridge → prevent accident or dropping of bridge

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②Inspection

1. First, we watch big field of vision
2. We watch details

Check point 1

1) condition of handrail
safety fence and kerb
2) condition of pavement of bridge
3) condition of expansion joint
4) condition of drainage
5) condition of load light, road signpost
6) condition of beam, slab
7) condition of abut, pier and foundation

1)～5): inspection from bridge surface

6)～7): distant view visual from side and under of bridge

Check point 2

① detail condition of beam, slab than check point 1

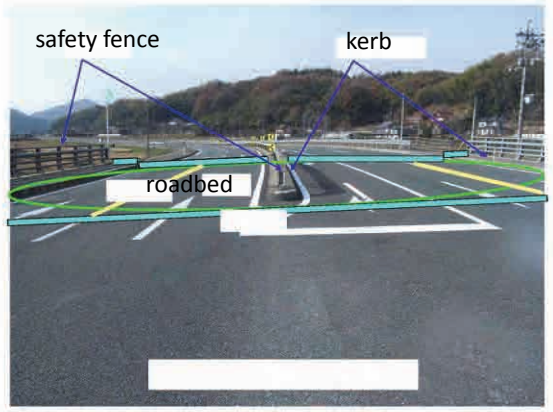
② detail condition of shoe than check point 1

③ detail condition of abut, pier and foundation than check point 1

①～③: proximity view visual from side and under of bridge

②Inspection (Flow of bridge inspection)

2 We confirm deformation from bridge front



It is fundamental to look the bridge as starting point back

②Inspection (Flow of bridge inspection)

2 We confirm deformation from bridge side

It is fundamental to look the bridge as starting point left

②Inspection (Flow of bridge inspection)

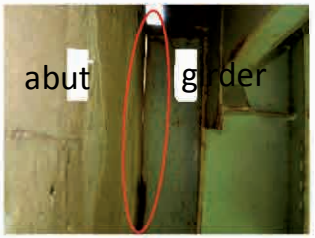
3 We confirm deformation of beam bottom

②Inspection

[Point of Inspection]

○ Abnormally of expansion joint

◆Check point 2



Clash with abut and beam

Abnormal movement

Shoe settlement

②Inspection

[Point of Inspection]

○ Abnormally of expansion joint

◆Check point 2

Corrosion of beam end

Corrosion of shoe

Corrosion is caused by poor drainage

②Inspection

[Point of Inspection]

6) Condition of beam and slab

◆Check point 1

・Is there corrosion in steel bridge case ？

◆Check point 2

・Spread and depth of corrosion

②Inspection

[Point of Inspection]

6) Condition of beam and slab

◆Check point 1

・Is there crack, exposed steel bar in concrete bridge case ？

◆Check point 2

・Crack width, shape, interval

・Size of exposed steel bar

②Inspection

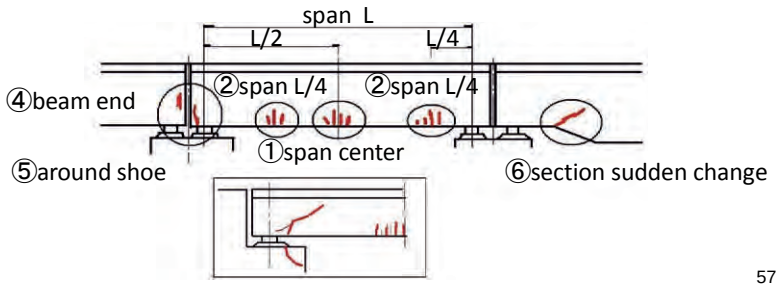
[Point of Inspection]

6) Condition of beam and slab

◆Check point 1

・Where is the crack occur easily ？

・In case simple beam



57

②Inspection

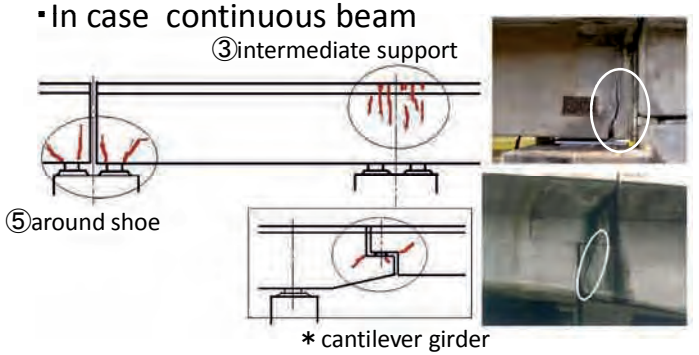
[Point of Inspection]

6) Condition of beam and slab

◆Check point 1

・Where is the crack occur easy ？

・In case continuous beam



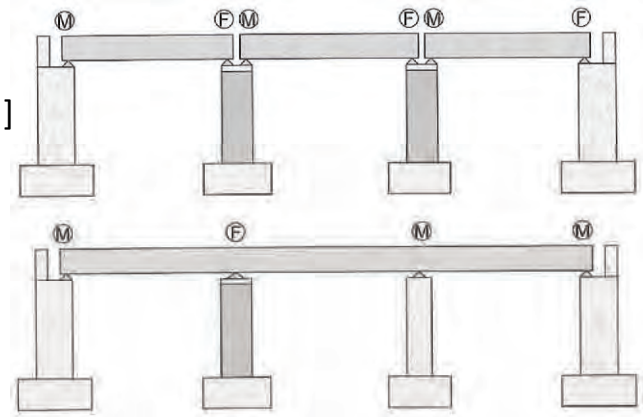
＊cantilever girder

59

<Reference> Simple beam and Continuous beam

[Simple beam]

[Continuous beam]



58

30

②Inspection

[Point of Inspection]

・In case PC beam(posttensioning beam)

6) Condition of beam and slab

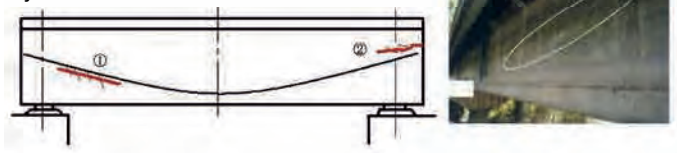
◆Check point 1

・Where is the crack occur easy ？

①Crack along sheath

⇨Grout poor injection

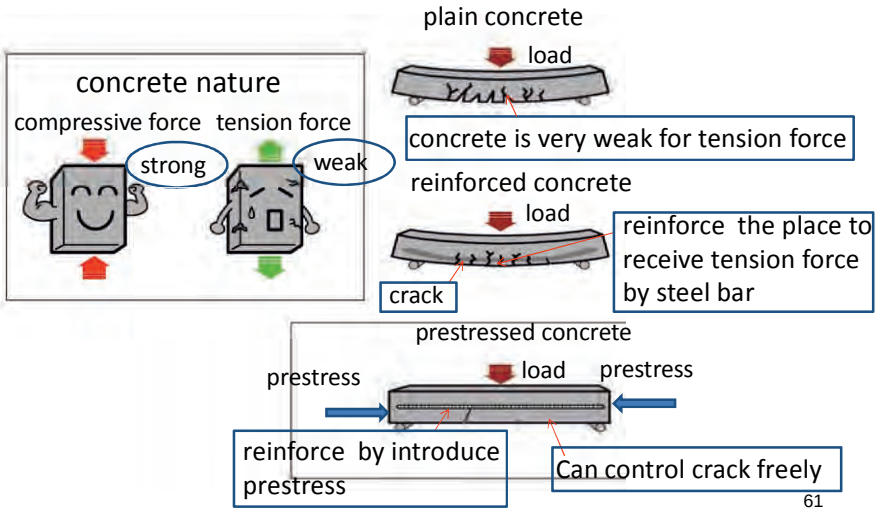
②Crack by compression stress at anchorage zone



60

31

<Reference> PC beam (prestressed concrete beam)



61

②Inspection
[Point of Inspection]

6) Condition of beam and slab

◆Check point 1

・Where is the splitting, steel bar exposure occur easily ？

・The place where receive influence of water

・The place where receive influence of flying salt

①wall handrail and kerb out side

③girder side, lower side

②lower side of slab end and kerb drip

④girder lower side

63

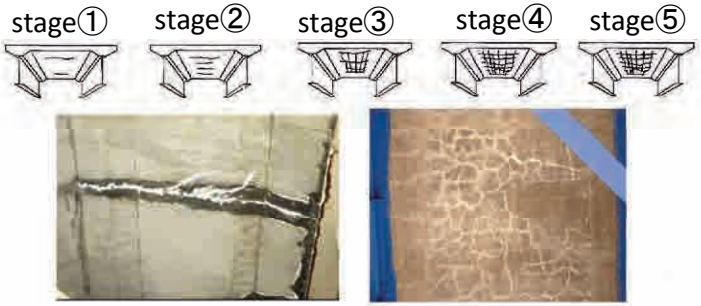
②Inspection
[Point of Inspection]

6) Condition of beam and slab

◆Check point 1

・Where is the crack occur easy ？

・In case slab



62

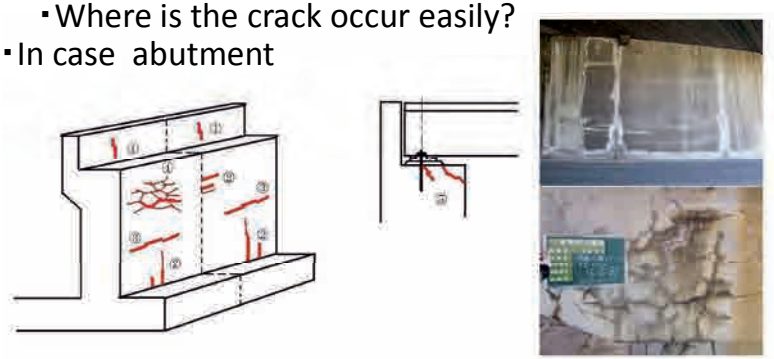
②Inspection
[Point of Inspection]

7) Condition of abut, pier and foundation

◆Check point 1

・Where is the crack occur easily?

・In case abutment



64

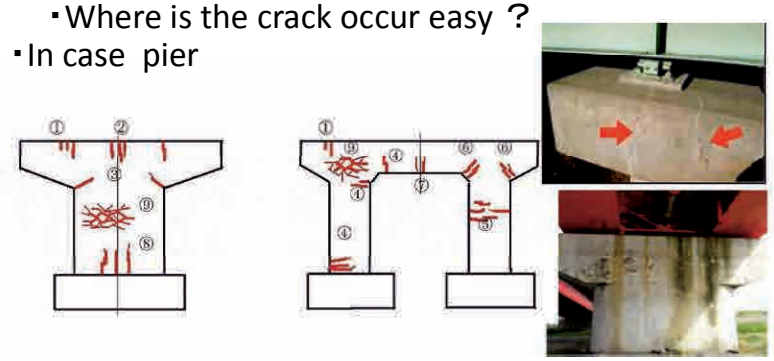
②Inspection
[Point of Inspection]

7) Condition of abut, pier and foundation

◆Check point 1

・Where is the crack occur easy ？

・In case pier



65

②Inspection[reference]

[How to take picture of photo recording]

① panoramic photo

② bridge name and history plate

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②Inspection[Reference]

[How to take picture of photo recording]

③Take photography include damage position and healthy part

④Take photography with tool can understand damage scale

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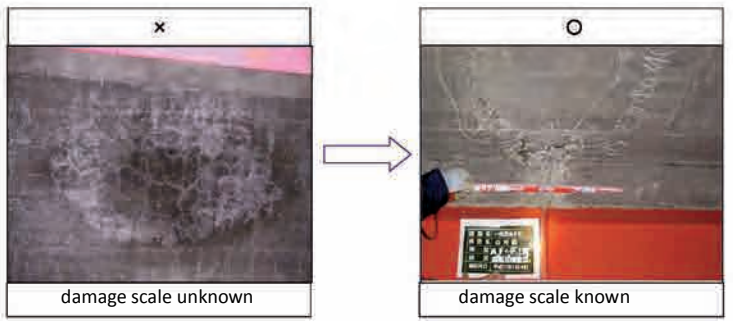
②Inspection[Reference]

[How to take picture of photo recording] (reference example)



68

②Inspection[Reference]

[How to take picture of photo recording] (reference example)

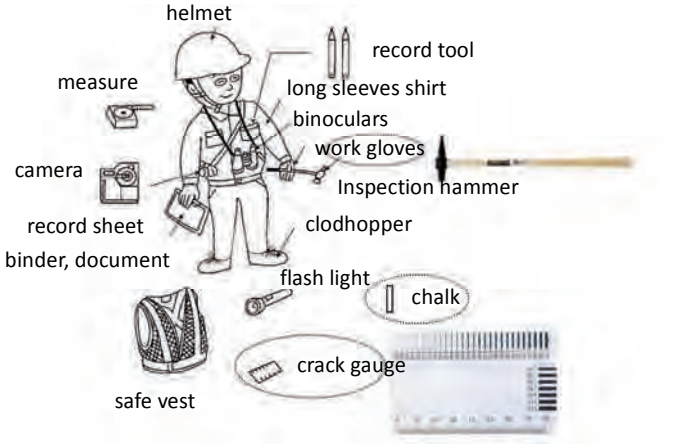
69

5. Reference(Japanese bridge)

71

②Inspection[Reference]

[Clothes of the time of the inspection, belongings]



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①Protective measure of bridge

72

Superstructure

Abutment

Concrete block

Foot protection

② Scene of Bridge Inspection

Start meeting

Inspection by ladder

Chalking of crack

Marking of stripping

Marking of stripping

Mobile lift

77

Marking of stripping

Mobile lift

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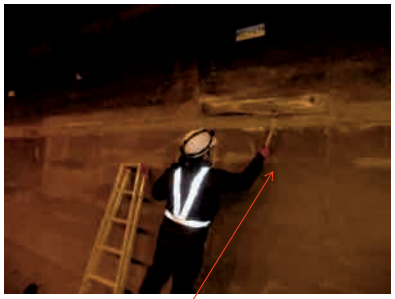
Chalking of crack



Inspection of float by hammer

78

Photography

Inspection of float by hammer

80

Inspection of float by hammer

Mobile lift

81

Mobile lift

Mobile lift

83

Mobile lift

Mobile lift

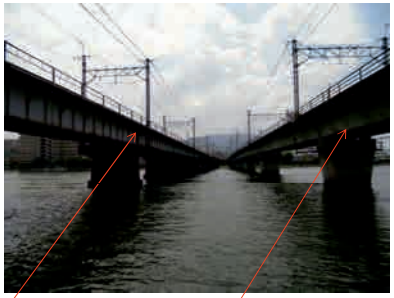
82

Measurement of length

84

③ Japanese Railway

85



Prestressed concrete girder(5spans)

Prestressed concrete girder(5spans)

Steel deck plate girder(10 spans)

87

Pier

Abutment

Steel deck plate girder(10 spans)

Steel deck plate girder(10 spans)

86

Passenger carriage

Freight train

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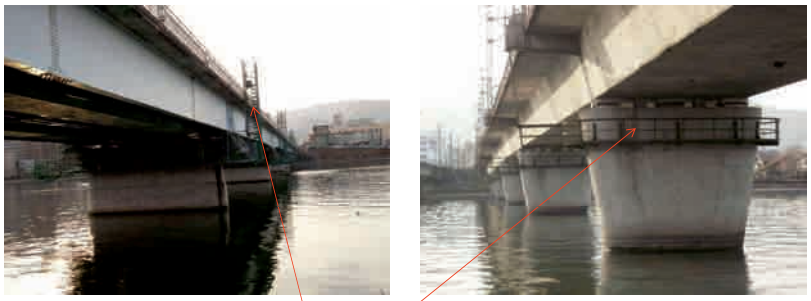
Staging

89



Staging

91

Staging

90

Shinkansen

92

Shinkansen

93

6. My farewell speech

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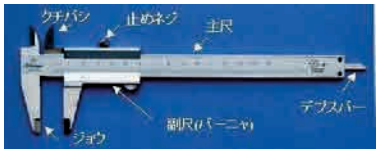
Instruments



Calipers

Crack gauge

Rust collecting electric tool

Level gauge

Camera

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Bridge Lodger

Bridge maintenance ledger

Rail structure maintenance ledger

Line name

Division	Classification	Name	Position	Section		Span length (m)	Bridge length (m)	Line division	Structure dimension						Construction date
				Starting side	Terminal side				Design load	Angle	Materials	Form	Girder height (m)	Foundation form	
Bridge	Beam bridge	Manso	0km0m	Takoradi	Manso	10.00	10.50	Up line	KS16	10°	Steel RC	Single track	h=2.5	Pile foundation	2000/10/10
	Truss bridge							Down line	KS13.5		Steel	Double track		Spread foundation	
	Slab bridge							Up・Down line			RC				

Bridge ledger style-1

【Bridge summary】

Bridge name	Tehara bridge				Construction date		2000/10/10	Jurisdiction	
Track name	Tokaido line	Section	Starting point side	Takoradi	Mile post	from	00km00m		GRCL
Management number	100		Terminal side	Manso		to	00km00m		

【Bridge dimension】

Bridge division	Main line bridge	Bridge form	Steel deck plate girder	Track class			First class	
Bridge classification	Beam bridge	Bridge length(m)	17.5	Design standard	Superstructure	Engineering manual	Train load	KS16
Form	Single track	Total span number	1				Design seismic coefficient	0.2
Line division	Up line	Plane shape	Right bridge Skew bridge		Substructure	Engineering manual		
Design load	KS16	Plane alignments(m)	Superstructure R=1000				Construction company	A company
Materials	Steel RC	Longitudinal slope(‰)	Substructure -5					B company
Girder height(m)	h=2.5	Skew angle	Right 15° 00′					
Foundation form	Pile foundation							

【Upper structure】

Main structure							Slab				
Structure number	Girder material division	Material strength	Span length(m)	Girder height(m)	Girder number-interval	Upper structure form	Slab material divisior	Material strength		Slab thickness(cm)	Slab form
1	Steel welded bridge				-	Steel deck plate girder	Concrete	24	N/mm^2	20	Casting place
2	Steel rivet bridge			-		Steel through plate girder	24 Concrete		N/mm^2	20	Casting place
3	RC bridge			-		Slab bridge			N/mm^2		
4					-				N/mm^2		

【Lower structure・Foundation structure】

Lower structure					Foundation structure		
Structure number	Material strength		Structure height(m)	Structure form	Structure form	Material strength	Pile diameter・Number・Pile length
A1	24	N/mm^2	h=3.50	Gravity type abutment	Pile foundation	30 N/mm^2	ϕ 1.00m ・n=6 ・l=10.00m
A2	24	N/mm^2	h=5.50	Reversed T type abutment		N/mm^2	
P1	24	N/mm^2	h=12.00	Square column		N/mm^2	
		N/mm^2				N/mm^2	

【Location】

Location

【Photograph】

Bridge photograph(whole view)	Photography date	2000/10/10

【Shoe】

Shoe	
Support number	Position-kind
A1	Start-Rubber bearing
A2	End-Line bearing

Bridge ledger style-2

【Painting history】

Management number		8632001052	Bridge name	Tehara bridge

Painting date						
Superstructure substructure division						
Span or skeleton number						
Primer undercoating paint						
Middle paint						
Final coating paint						
Painting method						
Painting color						
Painting company						

【Repair history】

Repair improvement date						
Superstructure substructure division						
Span or skeleton number						
Construction company						
Remarks						

Important notice

Bridge ledger style-3

【Bridge general drawing】

Management number	8632001052	Bridge name	Tehara bridge

Bridge general drawing

Bridge ledger style-4

【Bridge photograph-1】

Bridge name	Tehara bridge	Index number	1
Management number	8632001052		

Bridge photograph		
Side whole view	Starting point bridge surface whole view	Girder placement situation
Abut・Pier whole view	Shoe situation	Handrail close view,others

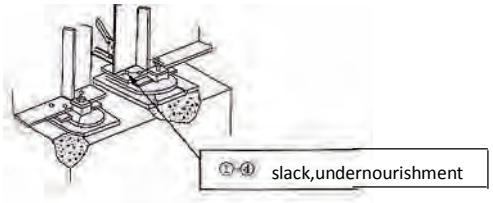
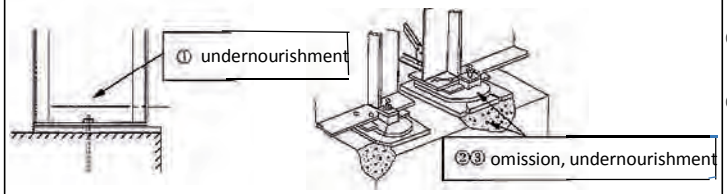
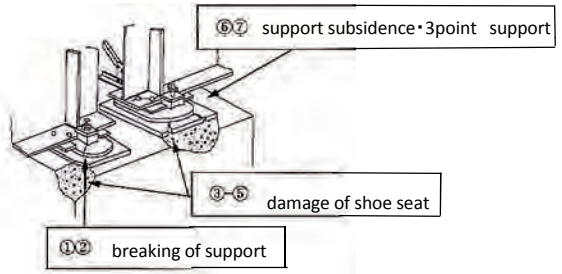
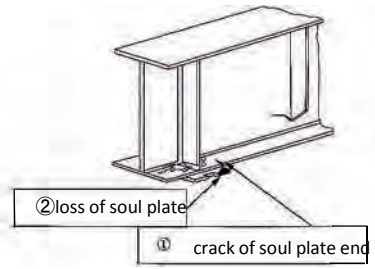
Bridge ledger style-5

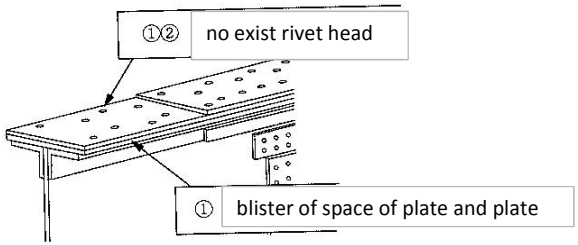
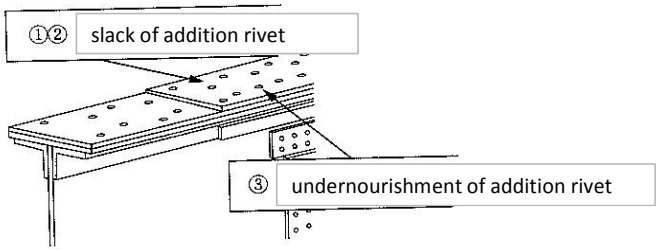
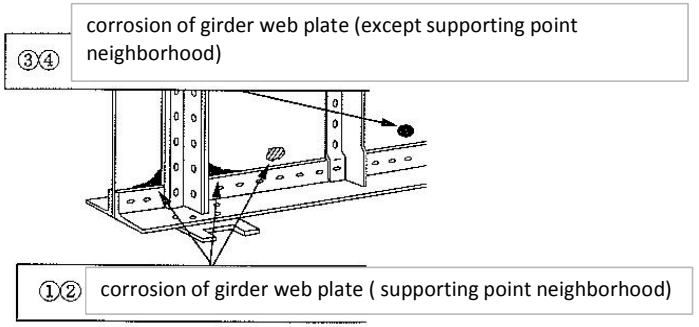
【Bridge photograph-2】

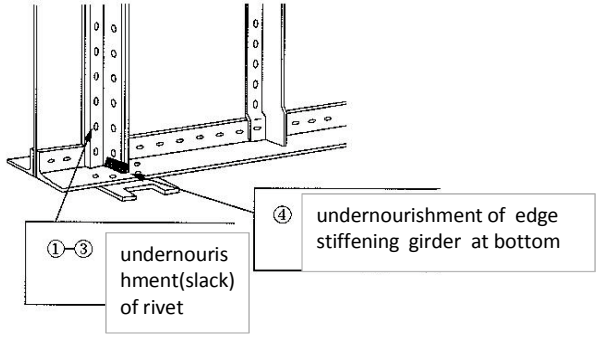
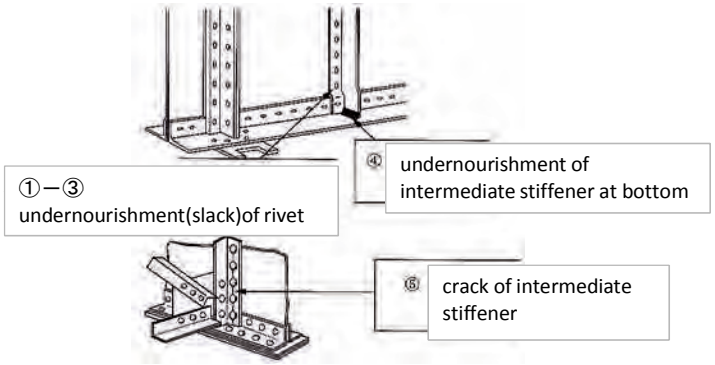
Bridge name	Tehara bridge	Index number	2
Management number	8632001052		

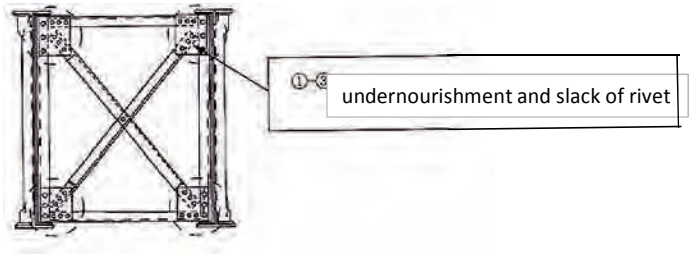
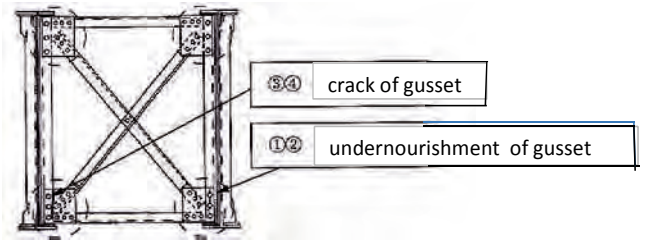
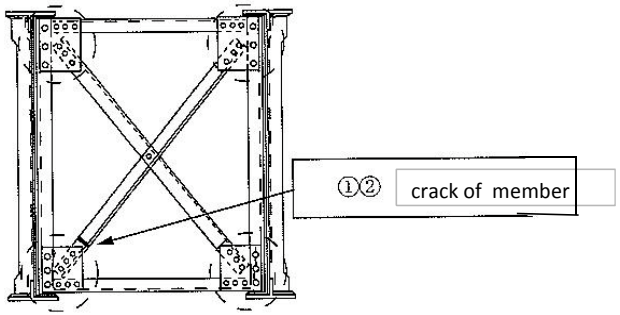
Bridge photograph		
Others(1)	Others(2)	Others(3)
Others(4)	Others(5)	Others(6)

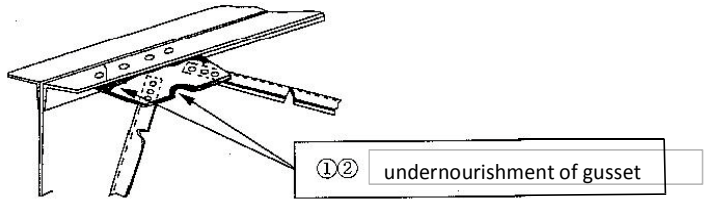
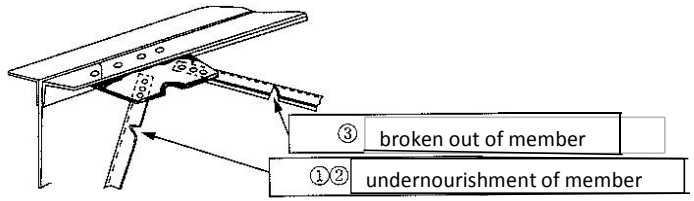
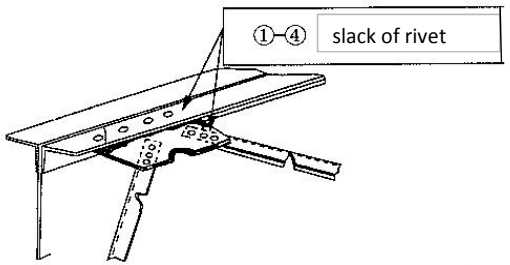
Diagnosis		State of the structure
A		Threatened security to safe driving, to travelers, the public and normal service of the train; or fear of the deformation
	AA	There is deformation threatening the security of driving, the travelers, the public and normal service of trains which urgently needs attention
	A1	There is gradual deformation, and the stability of the structure is reducing which might be further affected by a heavy rain, a flood or an earthquake
	A2	It is certain that the deformation will reduce the stability of the structure in the future
B		Future, deformation which might become diagnosis A
C		Slight deformation
S		Normal condition

Member	Deformed example	Judgment standard	Judgment
Support neighborhood	・Rivet and bolt at soul plate installation part  	①Slack of rivet and bolt(half under of the whole) ②Slack of rivet and bolt(half over of the whole) ③Undernourishment of rivet and bolt(half under of the whole) ④Undernourishment of rivet and bolt(half over of the whole)	A2 (B) A1 (A2) B A2 (B)
	・Anchor bolt part  	①Undernourishment of lower flange or soul plate at anchor bolt installation part ②Undernourishment of anchor bolt ③Omission of anchor bolt	B A1,A2 (B) A1 (A2)
	・Support and shoe seat  	①Breaking of support(30% under of the whole) ②Breaking of support(30% over of the whole) ③Part missing ④Damage of shoe seat(part crack) ⑤Damage of shoe seat(deformation take support subsidence) ⑥Support subsidence ⑦3point support	A2 A1 B A2(B) AA(A1,A2) AA(A1,A2) AA(A1,A2)
	・Soul plate part  	①Crack which right angle direction occurred at base metal from end of soul plate ②Loss of soul plate	A1 B

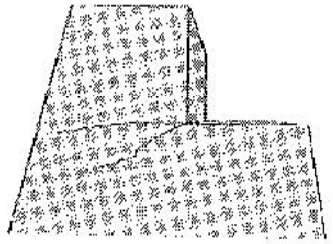
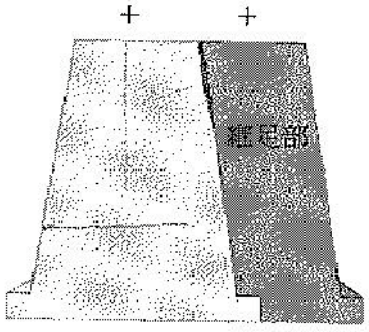
Member	Deformed example	Judgment standard	Judgment
1.Girder	・Flange spell rivet  	①Generally, no exist rivet head and can see blister between plate and plate ②Partially, no exist rivet head	A2 (B) B (C)
	・Flange addition rivet  	①There is slack 30% over of group ②There is slack 30% under of group ③There isn't rivet head 50% degree of group	AA A1(A2) A2(B)
	・Girder web plate  	①There is aperture continually at supporting point ②There is undernourishment partially at supporting point ③There is aperture continually at supporting point except ④There is undernourishment partially at supporting point except	A1 A2(B) A2(B) B,C

Member	Deformed example	Judgment standard	Judgment
2.Stiffening girder	・Edge stiffening girder  	①When there is undernourishment and slack in one-third of all rivet head of the lower flange side ②When there is undernourishment in one-third of almost rivet head of the lower flange side ③When there is undernourishment in one-third of about half rivet head of the lower flange side ④When there is undernourishment at bottom of edge stiffening girder	A1(A2) A2(B) B A2(B)
	・Intermediate stiffener  	①When there is slack at part of cross flame exist ②When there is slack at part of cross flame no exist ③When there is undernourishment at rivet head half degree of the group ④When there is undernourishment at bottom of the intermediate stiffener ⑤When there is crack at stiffening girder angle steel which installed cross frame	A1(A2) A2(B) C A2(B) A1

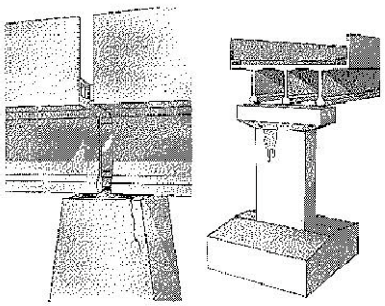
Member	Deformed example	Judgment standard	Judgment
3.Cross frame	・Cross frame installation rivet  	①Slack of rivet by support subsidence etc ②Slack by undernourishment of rivet(all number) ③Slack by undernourishment of rivet(part number)	A2 A2 B
	・Cross frame gusset  	①It is an obstacle to transmission of power ②The existing stage, it isn't an obstacle to transmission of power ③By excessive load ④By corrosion	A2 B A1 A2(B)
	・Cross frame member  	①By excessive load ②By corrosion	A1 A2(B)

Member	Deformed example	Judgment standard	Judgment
4.Transverse stiffener	・Transverse stiffener gusset  	①It is an obstacle to transmission of power ②The existing stage, it isn't an obstacle to transmission of power	A2 B
	・Transverse stiffener member  	①It is remarkable undernourishment at beam edge ②It is undernourishment at intermediate part ③It is broken out	B C A1
	・Transverse stiffener installation rivet  	①The slack was given at beam edge(all number) ②The slack was given at beam edge(part number) ③The slack was given at intermediate part(all number) ④The slack was given at intermediate part(part number)	A2 B A2 C

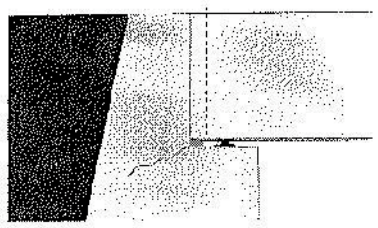
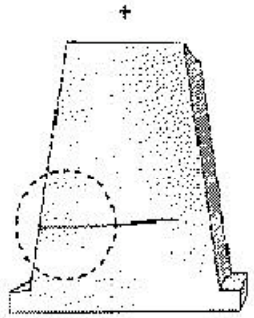
Judgment of healthy index (Plain concrete structure)

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Plain concrete	Crack Stripping	・Parapet	・Cracking position, width and depth ・Presence of anchor bolt transformation ・Presence of crack anchor bolt near by  Crack	・There is possibility of running out of relationship because deep crack at parapet lower end portion ・There is crack and float at front of anchor bolt ・There is stripping at front of anchor bolt ・There is transformation of anchor bolt ・Crack is deep at parapet lower end portion	A A A A A,B
		・Skeleton	・Presence of crack ・Presence of stripping  Crack of skeleton	・There is possibility of running out of relationship because deep crack ・There is big stripping ・The crack is deep but short ・It occurs many stripping ・There is stripping	A A B B C

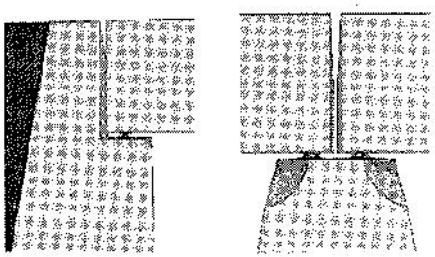
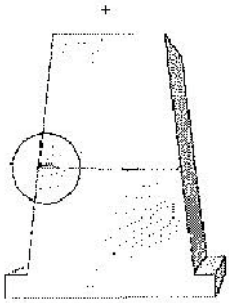
Judgment of healthy index （Pier・Abut(1)）

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Abut Pier	Crack	・Bridge seat of pier	・Cracking position and width ・Presence of crack for vertical direction ・Progressive confirmation(Mark by paint) ・State of steel bar corrosion  Crack	・There is possibility of failing bridge because progress width 0.5mm over ・It occurs many crack width 0.2mm degree over for vertical direction ・It occurs many crack width 0.2mm below for vertical direction	AA A B
		・Lower end portion of higher bridge at A	・Presence of crack at joint and back ・Presence of contact of beam ・Progressive confirmation(Mark by paint) ・State of steel bar corrosion ← Beam movement  Crack　　A	・There is crack width 0.2mm degree over for horizontal direction ・There is crack width 0.2mm below for horizontal direction	A B

Judgment of healthy index (Pier・Abut(2))

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Abut Pier	Crack	・Parapet	・Presence of contact of beam ・Presence of horizontal crack at parapet lower end portion ・Progressive confirmation(Mark by paint) Beam movement ←  Crack	・There is horizontal crack width 0.2mm degree over at parapet lower end portion ・There is horizontal crack width 0.2mm below at parapet lower end portion	A B
		・Skeleton	・Presence of surface crack  Crack of skeleton	・There is crack width 0.2mm degree over for horizontal direction ・There is crack width 0.2mm below for horizontal direction	A B

Judgment of healthy index (Pier・Abut(3))

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Abut Pier	Stripping of concrete	・Bridge seat Front interval shoe seat and bridge seat	・Range of stripping ・Presence of stripping nearby shoe ・Confirmation of exposed steel bar  Stripping at head	・Steel bar is exposed at stripping point entire ・Steel bar is exposed at part of the stripping point	AA,A A,B
		・Skeleton	・Size and depth of stripping ・Confirmation of exposed steel bar  Stripping of skeleton	・Steel bar is exposed at stripping point entire ・Steel bar is exposed and corroded 1m2 degree over ・Steel bar is exposed 1m2 degree below	AA,A A B

Calculation of design of the steel beam

Steel bridge L=32'0" (9.754m) of ESUASO

Contents

§ 1. Design conditions

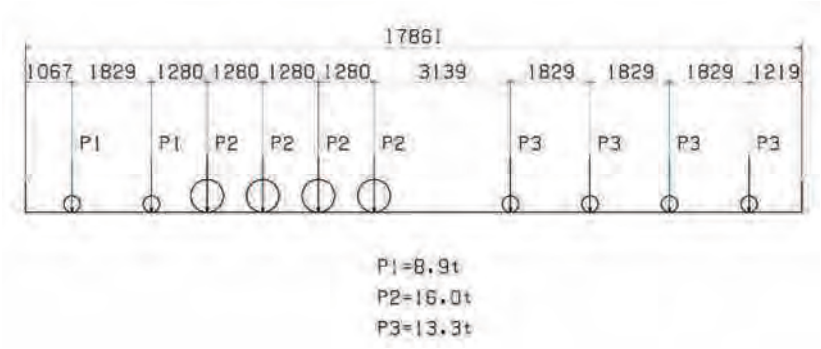
1.1 General conditions

Because only steel bridge L=32'0" (9.754m) of ESUASO was available by a design drawin
I calculate about this steel bridge.
The steel class is equal to SS400.
In consideration of quantity of section loss caused by the corrosion, I design capacity of m

1.2 Design load

■ Deadweight Steel materials 7850 kg/m3

■ Train load



Source: Ghana Railway

1.3 Specifications

Construction design standard explanation Steel railway bridge April, 1983

1.4 Allowable stress of structural steel

(Unit:N/mm2)

Kind of the stress \ Steel class	SS400 SM400 SMA400 STK400 STKR400
Compressive stress	161
Tensile stress	161
Shearing stress	92

■Buckling allowable stress

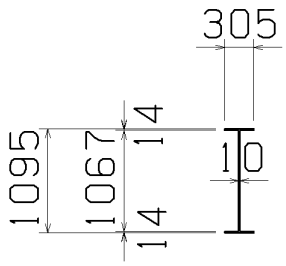
Allowable bending compression stres(Unit : N/mm2)

Steel class	SS400,SM400,SMA400 STK400,STKR400
$\frac{Aw}{Ac} \leqq 2$	$\ell / b \leqq 4.5$: 161 $4.5 < \ell / b \leqq 30$: $161 - 2.8 (\ell / b - 4.5)$
$\frac{Aw}{Ac} > 2$	$\ell / b \leqq 9 / K$: 161 $9 / K < \ell / b \leqq 30$: $161 - 1.4 (K \cdot \ell / b - 9)$
Aw : Total sectional area (mm^2) of the web plate Ac : Total sectional area (mm^2) of the compression flange ℓ : Distance (mm) between the fixed points of the compression b : Compression flange width (mm) K : $\sqrt{}$	

§ 2. Load calculation

2.1 Steel materials dimension

■ No corrosion



I-1095 × 305 × 10 × 14

A = 192.10 cm2

Aw = 106.70 cm2

Ac = 42.70 cm2

W = 150.70 kg/m

Zx = 6406 cm3

Section dimension

Geometrical moment of area

Division	Expression	A (mm2)	y (mm)	A･y (mm3)
Ufl	305 X 14	4270	1088.0	4645760
Web	10 X 1067	10670	547.5	5841825
Lfl	305 X 14	4270	7.0	29890
Σ		19210		10517475

Geometrical moment of area G = 10517475 mm3

Centroid position (from bottom) y_ℓ = G/A = 547.5 mm

Principal moment of inertia for the centroid

Division	Expression	Io (mm4)	e (mm)	A･e2 (mm4)
Ufl	1/12 X 305 X 14^3	69743	540.5	1247438868
Web	1/12 X 10 X 1067^3	1012306469	0.0	0
Lfl	1/12 X 305 X 14^3	69743	540.5	1247438868
Σ		1012445955		2494877736

Principal moment of inertia I = Io+A･e2 = 3507323691 mm4

Centroid position (from upper) yu = 547.5 mm

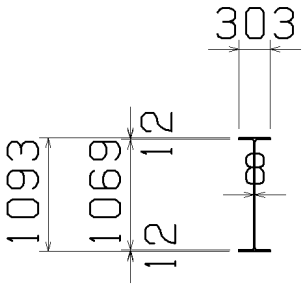
Section modulus

Z = I / yu = 3507323691 / 547.5 = 6406 cm3

Modulus of elasticity

E = 200 kN / mm2

■ Corrosion is 1mm case



I-1093 × 303 × 8 × 12

A	= 158.24	cm2
Aw	= 85.52	cm2
Ac	= 36.36	cm2
W	= 150.70	kg/m
Zx	= 5378	cm3

Section dimension

Geometrical moment of area

Division	Expression	A (mm2)	y (mm)	A・y (mm3)
Ufl	303 X 12	3636	1087.0	3952332
Web	8 X 1069	8552	546.5	4673668
Lfl	303 X 12	3636	6.0	21816
Σ		15824		8647816

Geometrical moment of area G = 8647816 mm3

Centroid position (from bottom) y_ℓ = G/A = 546.5 mm

Principal moment of inertia for the centroid

Division	Expression	Io (mm4)	e (mm)	A・e2 (mm4)
Ufl	1/12 X 303 X 12^3	43632	540.5	1062221949
Web	1/12 X 8 X 1069^3	814407673	0.0	0
Lfl	1/12 X 303 X 12^3	43632	540.5	1062221949
Σ		814494937		2124443898

Principal moment of inertia I = Io+A・e2 = 2938938835 mm4

Centroid position (from upper) yu = 546.5 mm

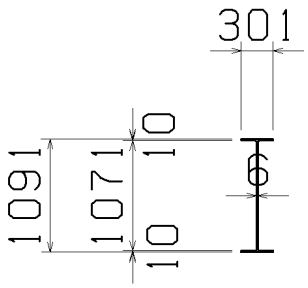
Section modulus

Z = I / yu = 2938938835 / 546.5 = 5378 cm3

Modulus of elasticity

E = 200 kN / mm2

■ Corrosion is 2mm case



I-1091×301×6×10

A =	124.46	cm2
Aw =	64.26	cm2
Ac =	30.10	cm2
W =	150.70	kg/m
Zx =	4350	cm3

Section dimension

Geometrical moment of area

Division	Expression	A (mm2)	y (mm)	A・y (mm3)
Ufl	301 X 10	3010	1086.0	3268860
Web	6 X 1071	6426	545.5	3505383
Lfl	301 X 10	3010	5.0	15050
Σ		12446		6789293

The first section moment G = 6789293 mm3

Centroid position (from bottom) y ℓ = G/A = 545.5 mm

Principal moment of inertia for the centroid

Division	Expression	Io (mm4)	e (mm)	A・e2 (mm4)
Ufl	1/12 X 301 X 10^3	25083	540.5	879342153
Web	1/12 X 6 X 1071^3	614240456	0.0	0
Lfl	1/12 X 301 X 10^3	25083	540.5	879342153
Σ		614290622		1758684306

The second section moment I = Io+A・e2 = 2372974928 mm4

Centroid position (from the u yu = 545.5 mm

Section coefficient

Z = I / yu = 2372974928 / 545.5 = 4350 cm3

Modulus of ela

E = 200 kN / mm2

2.2 Load calculation

(1) Steel beam dead weight

$W1 = 0.01921\ m2 \times 7850\ kg/m^3 \times 9.8 \times 10^{-3} = 1.5\ kN/m$

(2) Train load + Impact

Impact coefficient

$$i = \frac{KaV}{500\ L^{0.2}} + \frac{10}{65+L}$$

Here

Ka=2.0

V : Maneuvering speed of the train 40km/h

L :Bridge girder span 9.754m

$$i = \frac{2.0 \times 40}{500 \times 9.75^{0.2}} + \frac{10}{65 + 9.754}$$

$= 0.101 + 0.134 = 0.235$

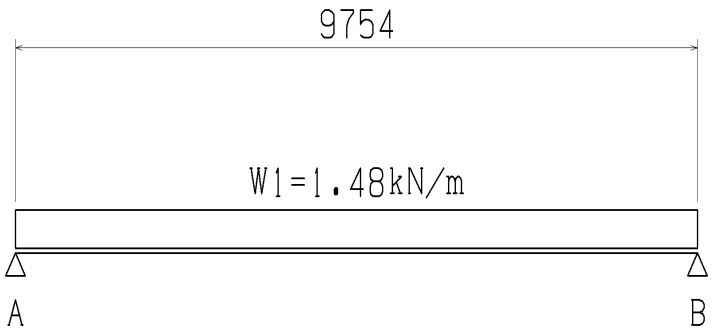
$P1 = 4.45\ t \times (1 + 0.235) \times 9.8 = 53.86\ kN$

$P2 = 8.0\ t \times (1 + 0.235) \times 9.8 = 96.82\ kN$

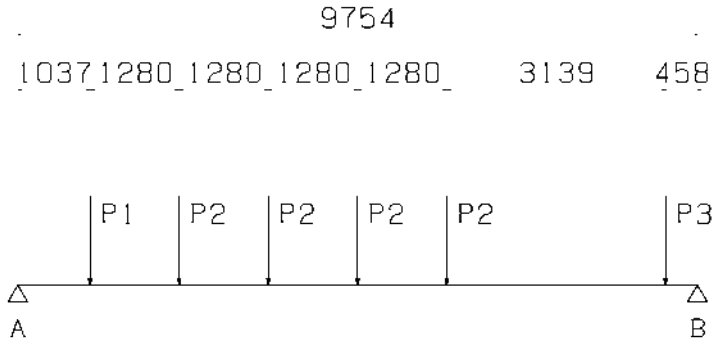
$P3 = 6.65\ t \times (1 + 0.235) \times 9.8 = 80.48\ kN$

2.3 Figure of load

(1) Deadweight



(2) Train load + Impact



P1=53.86 kN
P2=96.82 kN
P3=80.48 kN

(3) Viewpoint

The viewpoint divide 4 equally of the span.

§ 4. Computation result

```
*************************************************************************************************
*                                                                                               *
*                                                                                               *
*                                                                                               *
*                                                                                               *
*                         (plan frame analysis program)                                         *
*                              平面フレーム解析プログラム                                           *
*                                                                                               *
*                                  CRC／PLANEX                                                  *
*                                                                                               *
*                                  VERSION  6.02                                                *
*                                                                                               *
*                                                                                               *
*                     件  名                                                                     *
*                           ESUASO                                                              *
*                  ------------------------------------------------------------                 *
*                                                                                               *
*                                                                                               *
*                                                                        (株) CRCソリューションズ  *
*                                                                                               *
*************************************************************************************************
```


=== PLANE－X 入力データ === (input data)

```
    5   10       20       30       40       50       60       70       80
....+....*....+....*....+....*....+....*....+....*....+....*....+....*....+....*

TITLE               ESUASO
CONTROL                                 2
PRINT                                   1         1    1    1
PLOT          1    1                                             1      1    1
SPLOT                                                                        2.0
JOINT         1     0.000      0.000
              2     9.754      0.000
AUTM          1    1          1    1              1    2
SECTION       1     0.003507   0.01921
PROPERTY      1         200E6              1.0E-5
SUPPORT       1  001
              2  101
POINT         1      /         4
OUTPUT   MLOAD          1      3
         JLOAD          1      3
         PLOT           1      3
BAND     AUT
LOAD          1     CASE 1     死荷重 (dead load)
L             1                -1.48      -1.48
LOAD          2     CASE 2     列車+衝撃荷重 (train+impact load)
C             1                -53.86     1.037      -96.82     2.317
              1                -96.82     3.597      -96.82     4.877
              1                -96.82     6.157      -80.48     9.296
LOAD          3     MIX 1      応力度照査用 (stress intensity check)
MIX2     1.0            1      2
FINISH

....+....*....+....*....+....*....+....*....+....*....+....*....+....*....+....*
```

＊＊＊　平面フレーム　面内荷重解析　＊＊＊

節点番号のリナンバリングを行う

＝＝＝　節点データ　＝＝＝　　節点数＝　2

節点番号	X座標	Y座標	支承条件（X	Y	θz）	支点バネ値（X	Y	θz）
1	0.000	0.000	固定	固定	自由			
2	9.754	0.000	自由	固定	自由			

＝＝＝　部材データ　＝＝＝　　部材数＝　1

部材番号	i端節点	j端節点	結合条件（i端	j端）	(L) 部材長	(A) 断面積	(I) 断面二次	(E) ヤング率	水平バネ値	軸方向バネ値
1	1	2	剛結	剛結	9.754	0.00351	0.0192100	2.0000E+08		

＝＝＝　着目点情報　＝＝＝　　着目点数＝　5

部材番号	着目点数	着目点距離				
1	5	0.000	2.438	4.877	7.316	9.754

領域オーバーの為、作図が出来ません

荷重データ情報

荷重ケース番号（　1）　基本荷重ケース　　CASE 1　死荷重 (dead load)
　部材分布荷重（部材番号　1）　Y　全体系　（等分布）　W＝　-1.480　（全面載荷）

荷重ケース番号（　2）　基本荷重ケース　　CASE 2　列車＋衝撃荷重 (train+impact load)

部材集中荷重（部材番号						
1）	Y	全体系	Pw=	-53.860	Lp=	1.037
	Y	全体系	Pw=	-96.820	Lp=	2.317
	Y	全体系	Pw=	-96.820	Lp=	3.597
	Y	全体系	Pw=	-96.820	Lp=	4.877
	Y	全体系	Pw=	-96.820	Lp=	6.157
	Y	全体系	Pw=	-80.480	Lp=	9.296

荷重ケース番号（　3）　組み合わせケース　　MIX 1　応力度照査用
　組み合わせる荷重ケース数＝　2　　全体に対する割り増し率＝　1.0000
　1　＋　2

節点変位および支点反力

節点番号	X変位 (mm)	Y変位 (mm)	θz変位 (ミリ.ラジアン)	X反力 (kN)	Y反力 (kN)	θz反力 (kN.m)
＊＊＊　荷重ケース番号　1　＊＊＊　CASE 1　死荷重						
1	0.000	0.000	-0.015	0.000	7.218	0.000
2	0.000	0.000	0.015	0.000	7.218	0.000
＊＊＊　荷重ケース番号　2　＊＊＊　CASE 2　列車＋衝撃荷重						
1	0.000	0.000	-0.612	0.000	270.964	0.000
2	0.000	0.000	0.571	0.000	250.656	0.000
＊＊＊　荷重ケース番号　3　＊＊＊　MIX 1　応力度照査用						
1	0.000	0.000	-0.627	0.000	278.182	0.000
2	0.000	0.000	0.586	0.000	257.874	0.000

部材着目点の断面力および変位

＊＊＊ 荷重ケース番号　1 ＊＊＊ CASE 1　死荷重 (dead load)

部材番号	節点番号	着目点距離 (m)	モーメント (kN.m) (moment)	せん断力 (kN) (shearing force)	軸力 (kN)	変位X (mm)	変位Y (mm)
-- 1 --		(水平部材)	部材長＝ 9.754(m)				
	(1)	0.000	0.000	7.218	0.000	0.000	0.000
		2.438	13.201	3.609	0.000	0.000	-0.032
	(M-MAX)	4.877	17.601	0.000	0.000	0.000	-0.045
		7.316	13.201	-3.609	0.000	0.000	-0.032
	(2)	9.754	0.000	-7.218	0.000	0.000	0.000

部材着目点の断面力および変位

＊＊＊ 荷重ケース番号　2 ＊＊＊ CASE 2　列車+衝撃荷重 (train + impact load)

部材番号	節点番号	着目点距離 (m)	モーメント (kN.m) (moment)	せん断力 (kN) (shearing force)	軸力 (kN)	変位X (mm)	変位Y (mm)
-- 1 --		(水平部材)	部材長＝ 9.754(m)				
	(1)	0.000	0.000	270.964	0.000	0.000	0.000
		2.438	573.497	120.284	0.000	0.000	-1.328
	(M-MAX)	4.877	742.879	-73.356	0.000	0.000	-1.833
		7.316	451.834	-170.176	0.000	0.000	-1.262
	(2)	9.754	0.000	-250.656	0.000	0.000	0.000

部材着目点の断面力

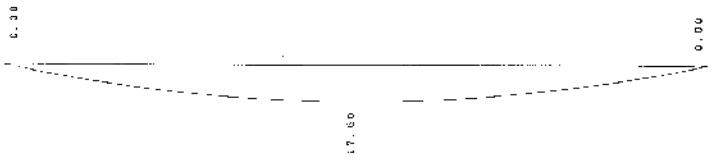
＊＊＊ 荷重ケース番号　3 ＊＊＊ MIX 1　応力度照査用 (stress intensity check)

部材番号	節点番号	着目点距離 (m)	モーメント (kN.m) (moment)	せん断力 (kN) (shearing force)	軸力 (kN)	変位X (mm)	変位Y (mm)
-- 1 --		(水平部材)	部材長＝ 9.754(m)				
	(1)	0.000	0.000	278.182	0.000	0.000	0.000
		2.438	586.698	123.893	0.000	0.000	-1.361
		4.877	760.480	23.464	0.000	0.000	-1.878
		7.316	465.035	-173.785	0.000	0.000	-1.294
	(2)	9.754	0.000	-257.874	0.000	0.000	0.000

ESUASO

CASE 1　　死荷重（dead load）

モーメント図
(moment diagram)

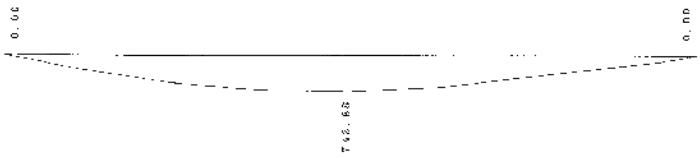


せん断力図
(shearing force diagram)

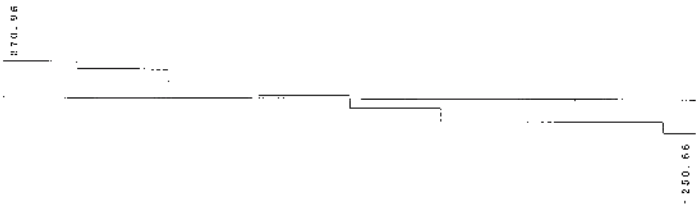
ESUASO

CASE 2　　列車＋衝撃荷重 (train + impact load)

モーメント図
(moment diagram)



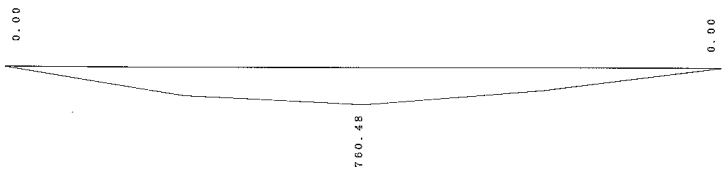
せん断力図
(shearing force diagram)



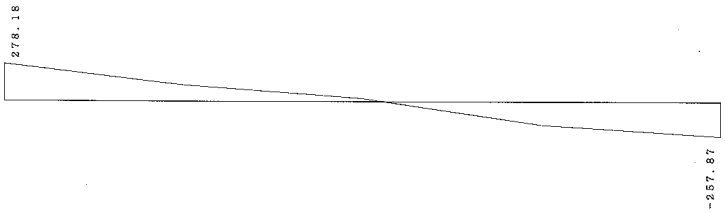
ESUASO

MIX 1　　応力度照査用 (stress intensity check)

モーメント図
(moment diagram)



せん断力図
(shearing force diagram)



Training for Rolling Stock Maintenance

From 24th March to 27th March 2014

Lecture by

Mitsuyuki OSAWA, Tadaaki TAKAO,

Rolling Stock Expert, JICA Study Team

Table of Contents

Training on Rolling Stock Maintenance

Rolling stock expert
Mitsuyuki OSAWA
Tadaaki TAKAO

1. Purpose of Training

There are a lot of items that to be inspected about rolling stock. They are described in detail on Suppliers' maintenance manual but they demand a lot of expense. So it is not realistic to perform them considering the situation of GRCL. Therefore this training focuses on subjects that cause fatal accidents, derailment and collision, which is about Axel & wheels and Brake system.

2. Subject

1) How to use basic measuring instruments.
   - Varnier caliper ・Digital multi meter (Tester) ・Insulation tester (Megohmmeter)
2) How to measure basic dimension of axel and wheel set.
   - Back gauge ・Flange gauge ・Digital diameter gauge ・Tread-Wear measuring device
3) How to check brake system
   - Portable type brake tester for single car

3. Training schedule

<table>
<tr><th colspan="3"></th><th>Subject</th><th>Contents</th><th>Place</th></tr>
<tr><td colspan="3">17/Mar~23/Mar</td><td colspan="3">Arrangement and preparation for training</td></tr>
<tr><td rowspan="2">1st</td><td rowspan="2">24 /Mar.</td><td>AM</td><td>➢ Basic measure instrument
➢ Axel and wheel set</td><td>• How to use basic measuring instruments.
• How to measure basic dimension of axel and wheel set.</td><td rowspan="2">Location</td></tr>
<tr><td>PM</td><td>➢ Brake system</td><td>➢ How to check brake system</td></tr>
<tr><td>2nd</td><td>25 /Mar.</td><td>AM
PM</td><td>- ditto -</td><td>- ditto -</td><td>Carriage & Wagon</td></tr>
<tr><td>3rd</td><td>26 /Mar.</td><td></td><td colspan="3">reserve</td></tr>
<tr><td>4th</td><td>27 /Mar.</td><td></td><td colspan="3">reserve</td></tr>
</table>

End