



Training for Track Maintenance 4/6 “Safe Maintenance”

From 5th March to 21st March 2014

Lecture by Kiyoshi MIYAMOTO,
Track Expert, JICA Study Team

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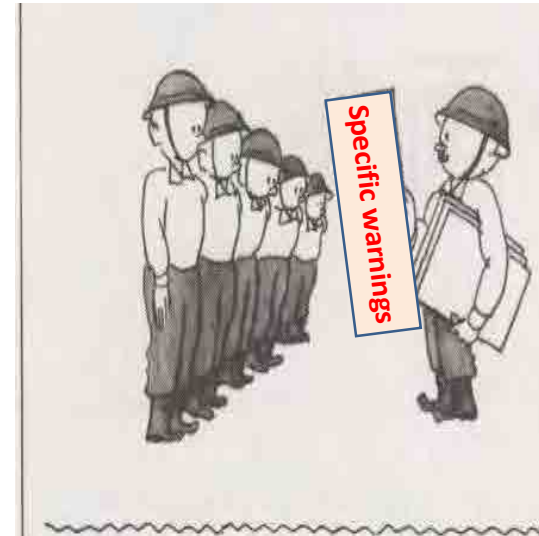
Study for Safety Operation and Management of Railway
in the Republic of Ghana 2012 to 2013

Safety Maintenance Contents

1. Attitude before starting to work.
2. Attitude before entering into the track.
3. Attitude during the work
4. Attitude for loading and unloading track materials
5. Attitude for using track trolley

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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

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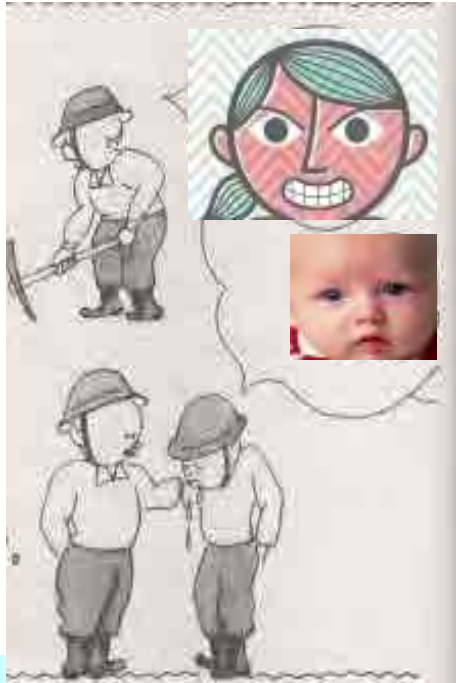
- ③ Group leader should check his watch, consult station master with the condition of train operation and tell his subordinates its condition well
- ④ Group leader should check their clothes
- ⑤ Group leader should check track machines and tools



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Workers

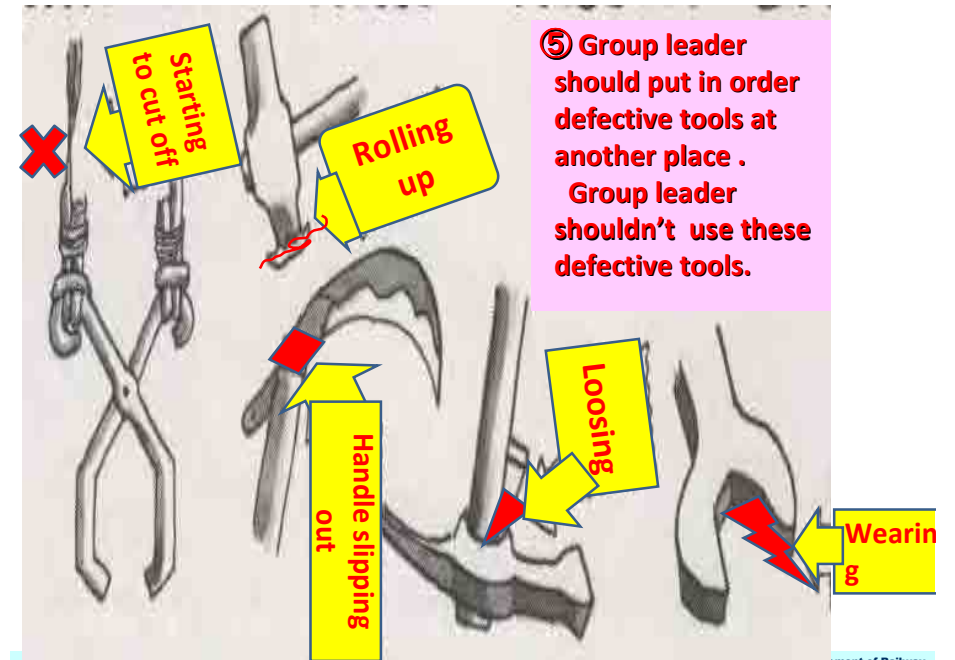
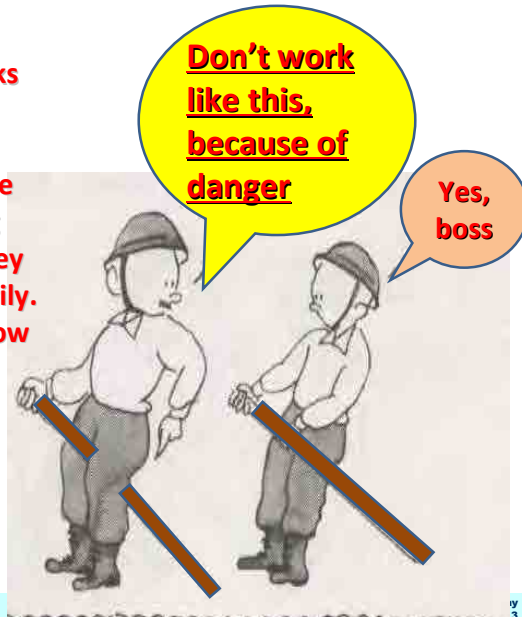
- ① Workers should clear up their worries earlier, after consulting them with their fellow workers or bosses.
- ② Workers should not bring their family happenings into their work place.



Group Leader

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

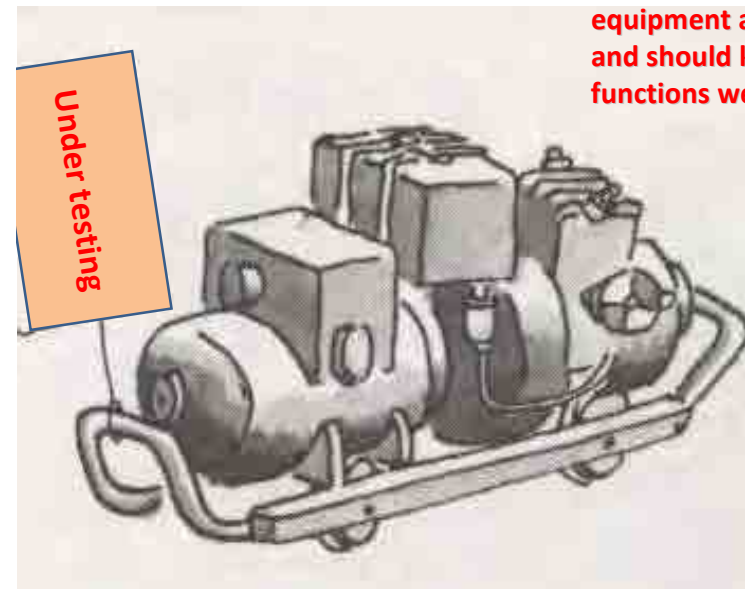
- ② Group leader should advise his subordinates about cares to their works concerning about basic movements.
- ③ Group leader should give his subordinates training of works about which they don't carried out ordinarily.
- ④ Group leader should show his subordinates work examples and give kind instruction to them



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

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



Management of Railway : of Ghana 2012 to 2013

2. Attitude before entering into the track.

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



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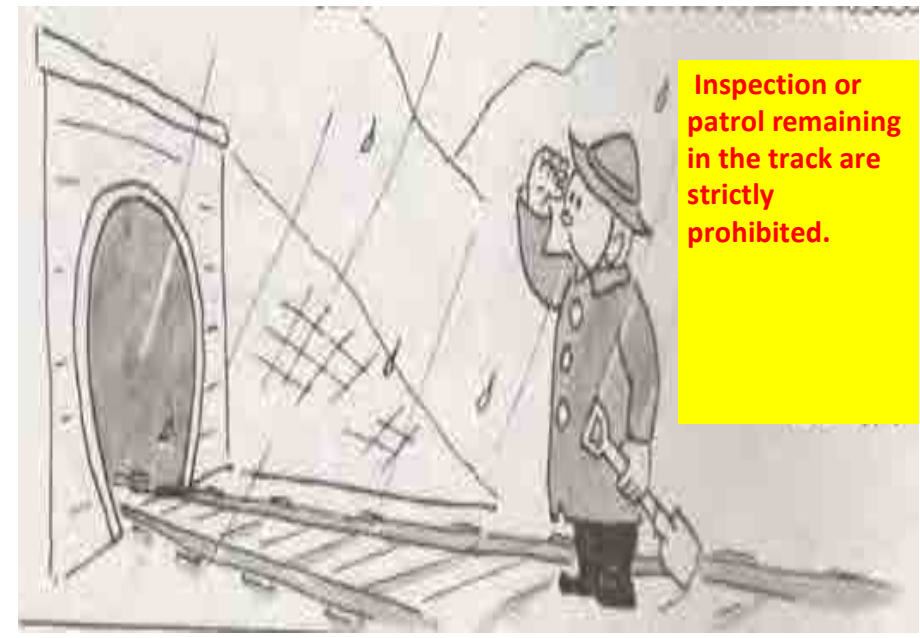
When we walk on the track, we should walk at the roadbed shoulder and should be careful of the coming train in front and behind

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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.



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in the Republic of Ghana 2012 to 2013



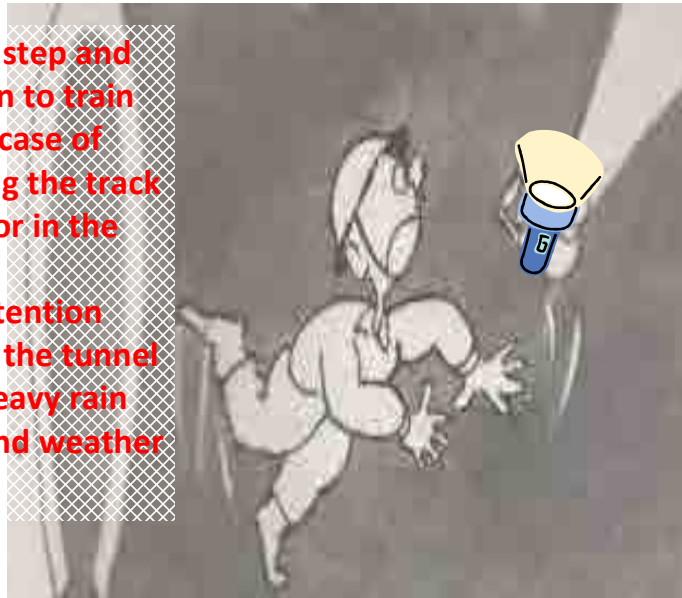
Confirm the train operation with the Station master and check the train operation by the timetable.

To guess the train operation by yourself is strictly prohibited.



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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.

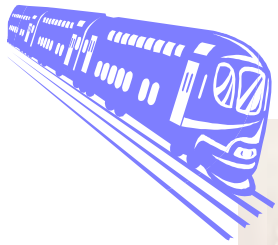


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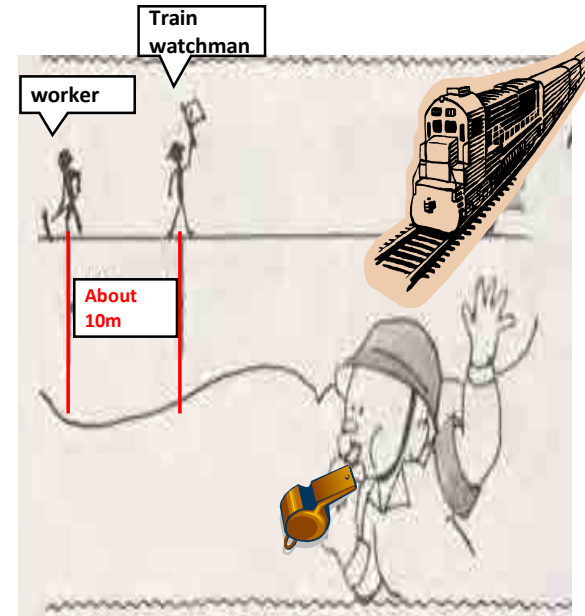
Let's confirm the timetable once more before entering into the tunnel or bridge



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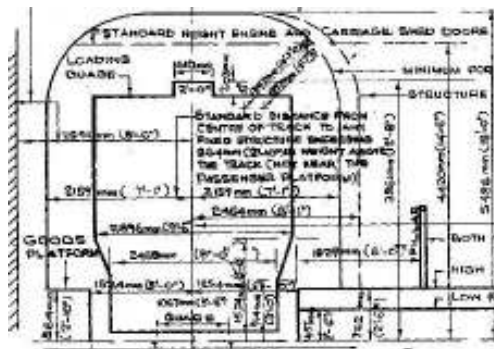
Let's confirm the train operation before beginning the track work



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

Arrange the train watchman during track work

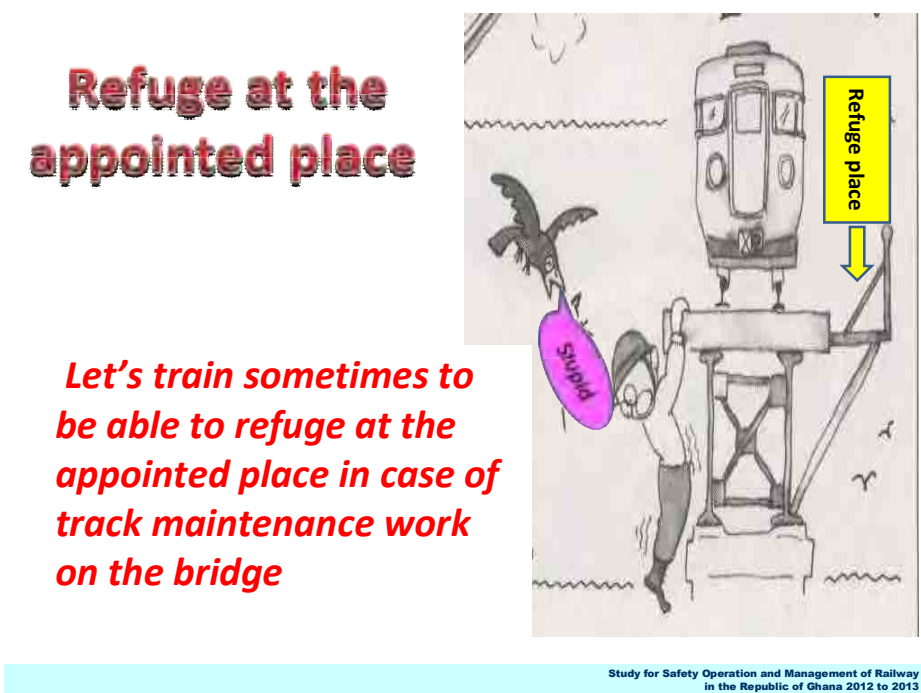
Remind that the structure gauge is very important gauge for the safety of the track maintenance workers.



Very dangerous!!!

To think hard in the track is strictly prohibited





Works In the tunnel

Light the work place sufficiently before beginning track maintenance work

Gas

Be careful for the shortage of oxygen.

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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.

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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.

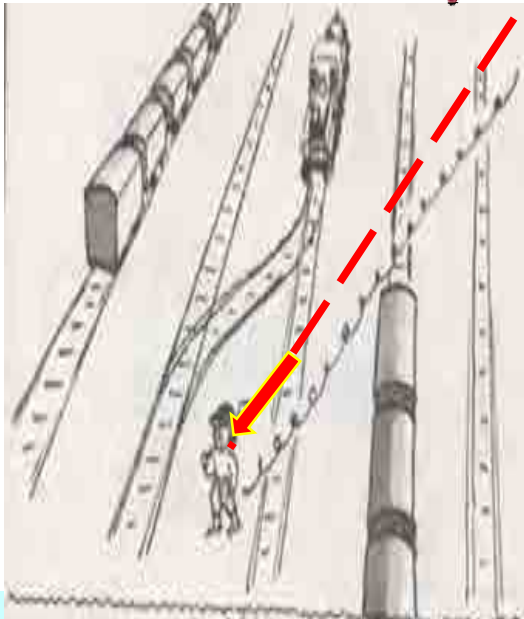
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Confirm the approaching train of each track in case of crossing the tracks

Danger!!

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Slow and steady wins the race



It is dangerous to cross the tracks diagonally in the yard

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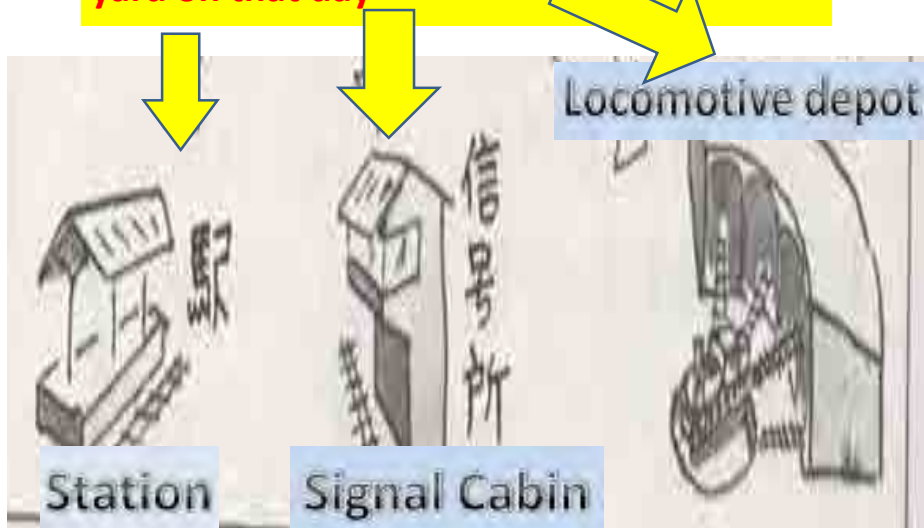
3. Attitude during the work



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

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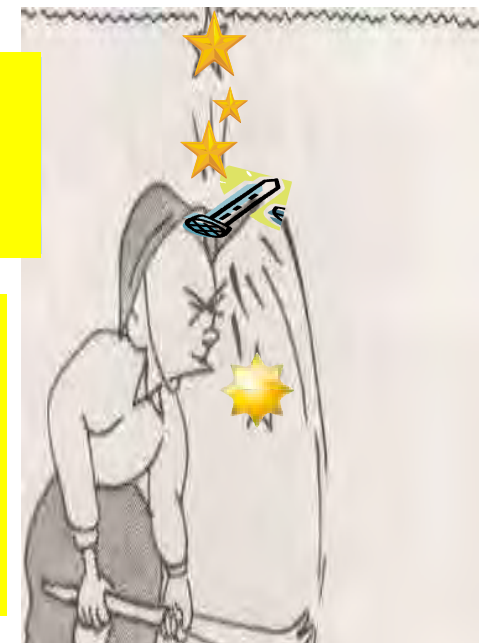
Before beginning track works at the yard, confirm the shunting work diagram of the yard on that day



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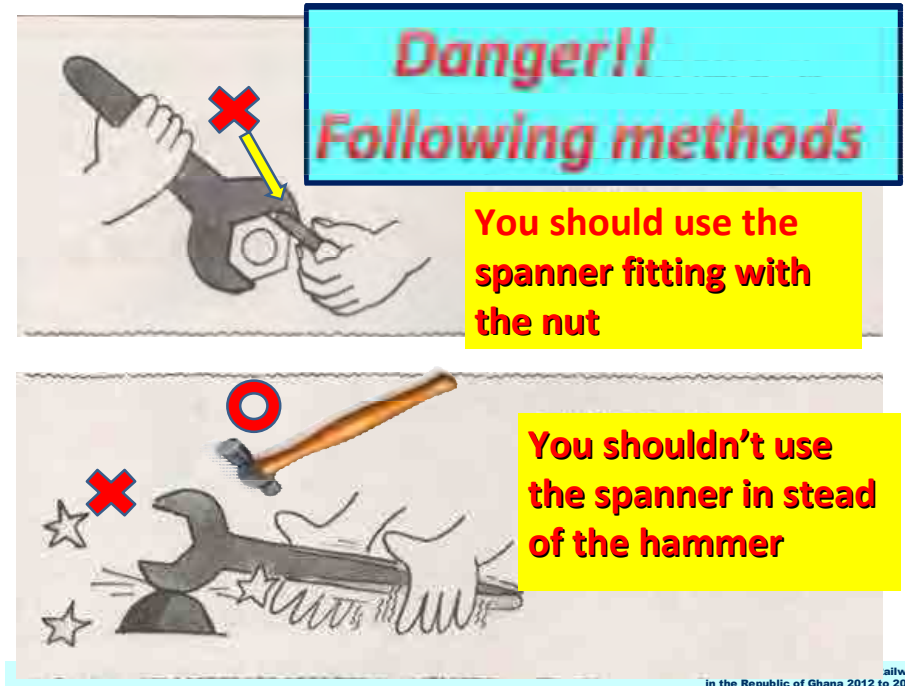
Don't pull out the dog-spike with full power from the beginning of this work.

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



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Handle of the hammer was broken and jumped up!?

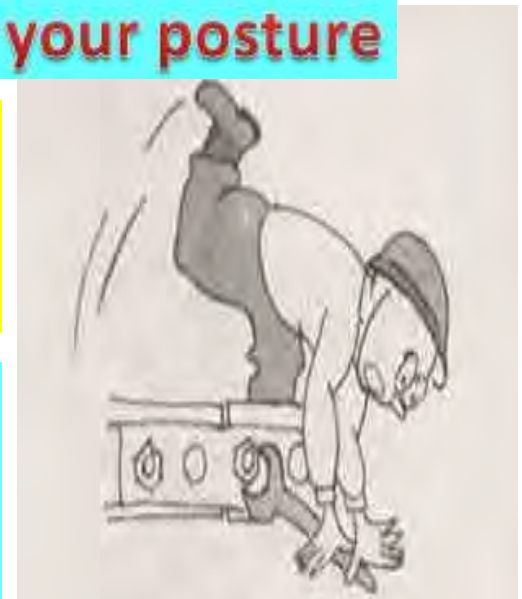
You should use the hammer after you check the installation part of the handle into the hammer



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**



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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



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

Resping

Roaring

Jarring

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.

Time table

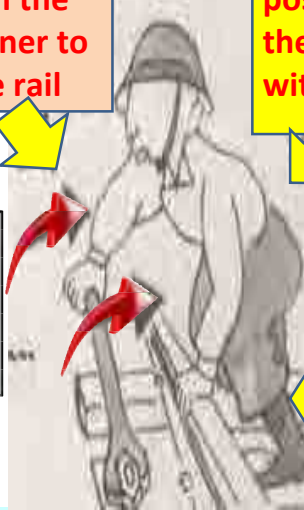
Method of using spanner

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.



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

Pay attention for slipping!!



in the Republic of Ghana 2012 to 2013



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.

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

Very dangerous!!

Let's think about what is dangerous.



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Don't imitate the work like this picture

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



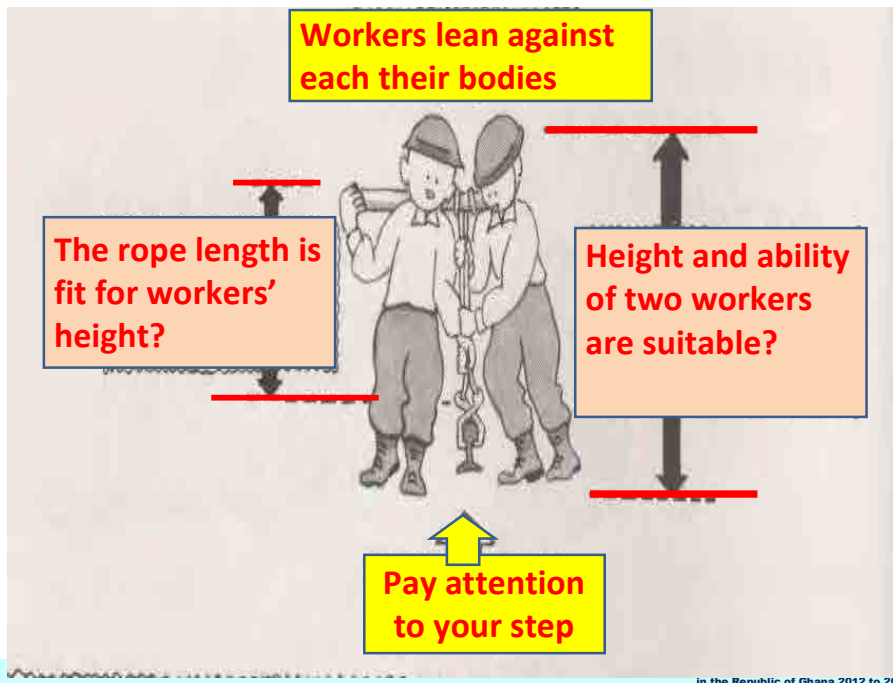
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Workers lean against each their bodies

The rope length is fit for workers' height?

Height and ability of two workers are suitable?

Pay attention to your step

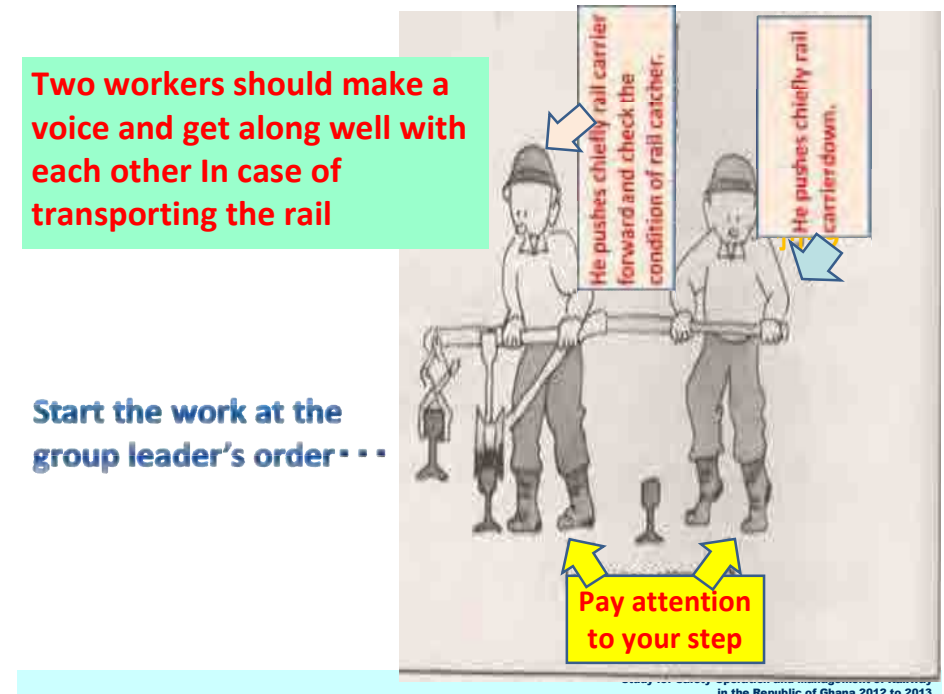


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Two workers should make a voice and get along well with each other In case of transporting the rail

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

Pay attention to your step



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Skilful worker only can handle the rail by a crowbar

Don't touch the opposite side rail end while skilful worker is handling

Don't push out the rail before taking out the fish plate completely

Pay attention not to catch your hand between rail and bender

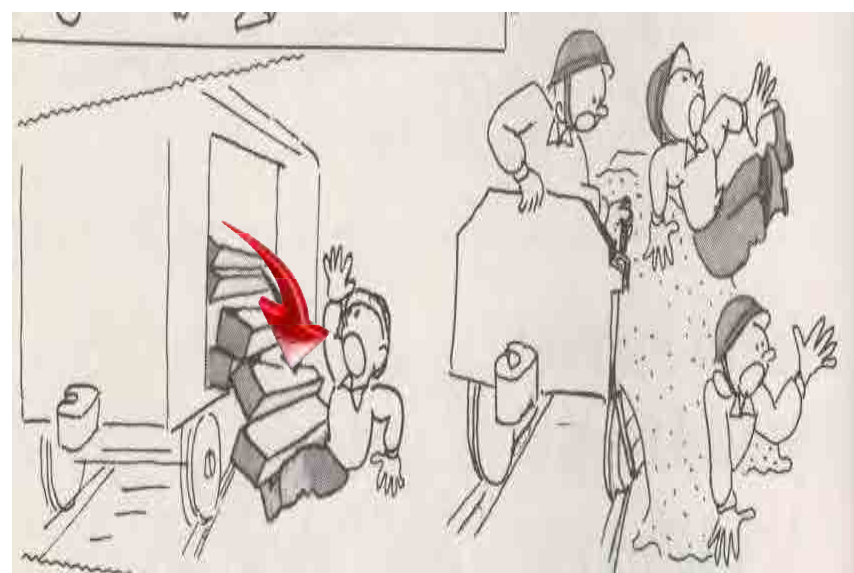
Rail bender

Set the bender at right angles

Was the support plate put correctly?

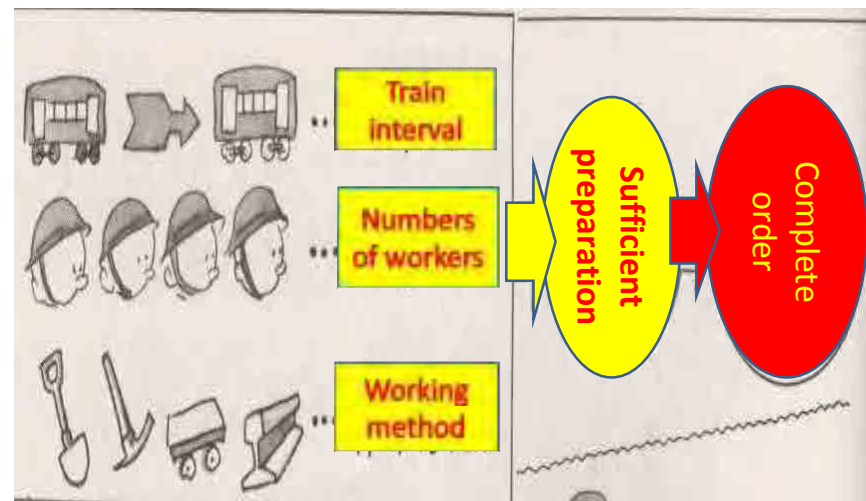
Bender correspond to the type of rail?

Don't imitate the work like this picture

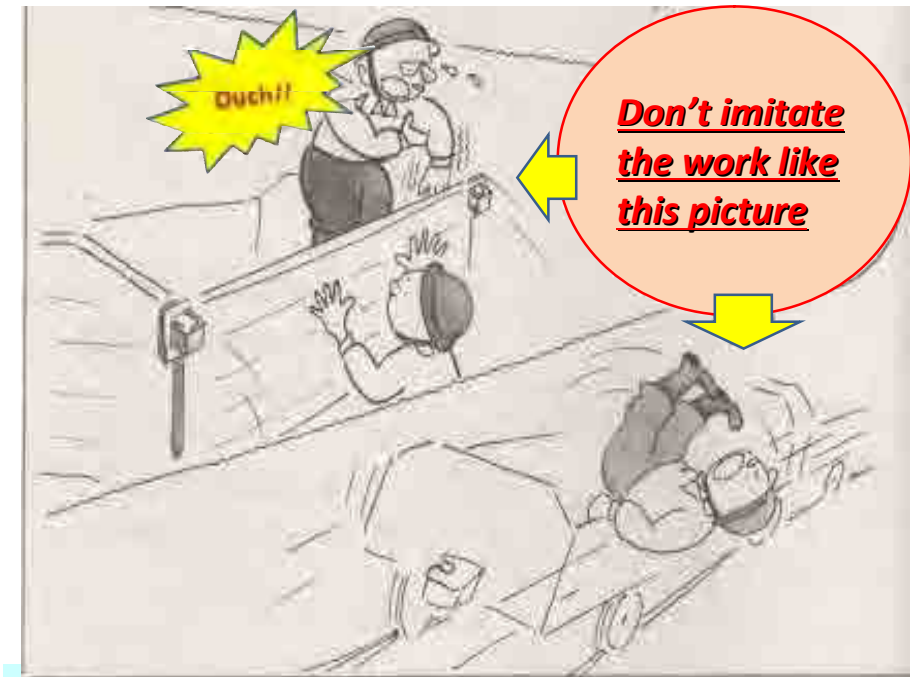


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4. Attitude for loading and unloading track materials



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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

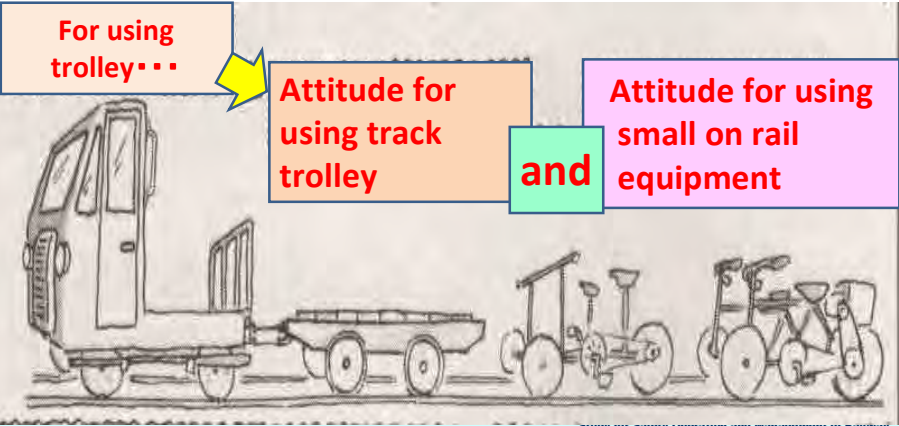
The accident like this picture happens in case where you don't unload track materials uniformly



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5. Attitude for using track trolley

Before using:
Check especially brake condition



For using trolley...

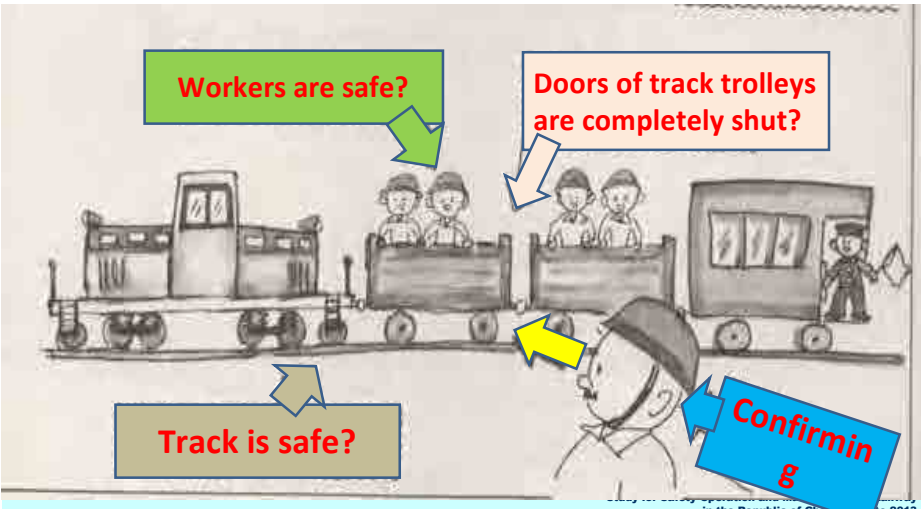
Attitude for using track trolley

and

Attitude for using small on rail equipment

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



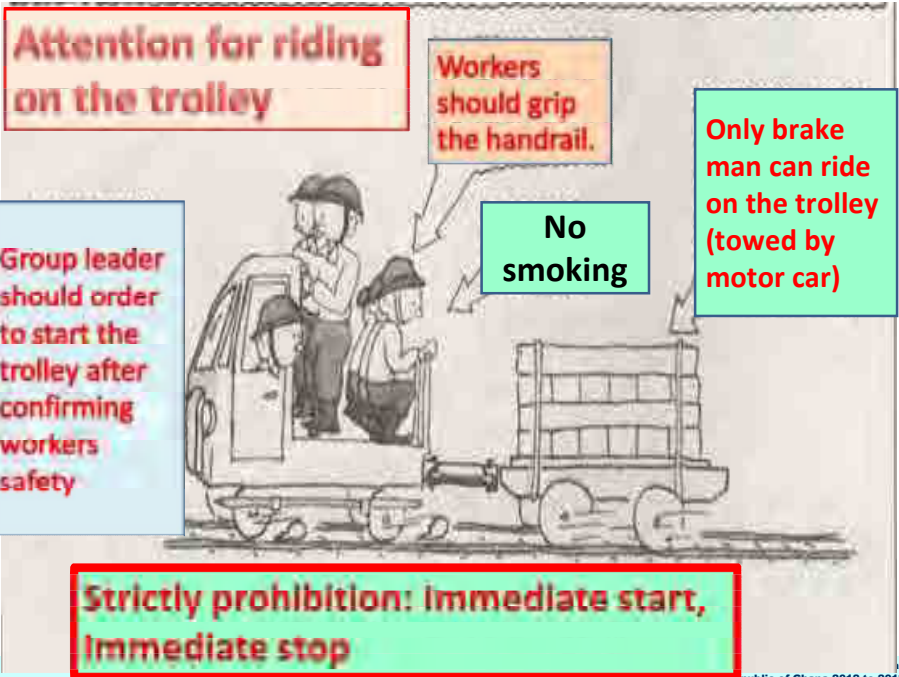
Workers are safe?

Doors of track trolleys are completely shut?

Track is safe?

Confirming

In the Republic of Ghana 2012 to 2013



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

In the Republic of Ghana 2012 to 2013

Attention for brake distance in case of rainy weather

Ordinary brake distance

Brake distance in case of rainy weather increases 60% more than ordinary one

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Level crossing

Starting

Station

Long bridge

Tunnel

Whistle whenever necessary

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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 !!

Bolt with pin

Coupling bar

Bolt with pin

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Dismantling the trolley

Wheels should be handled with 2 workers

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

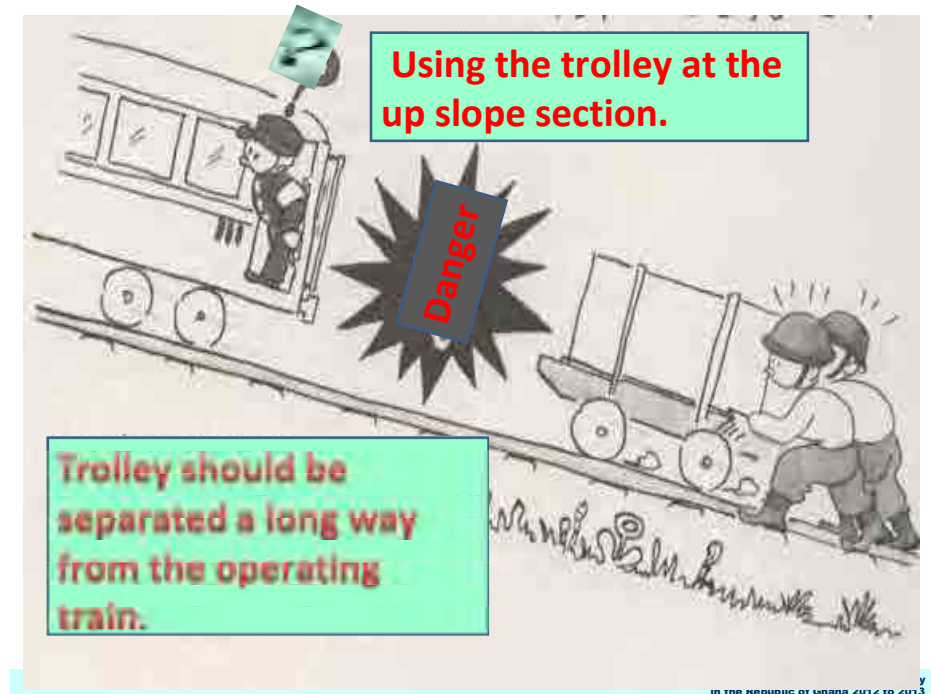
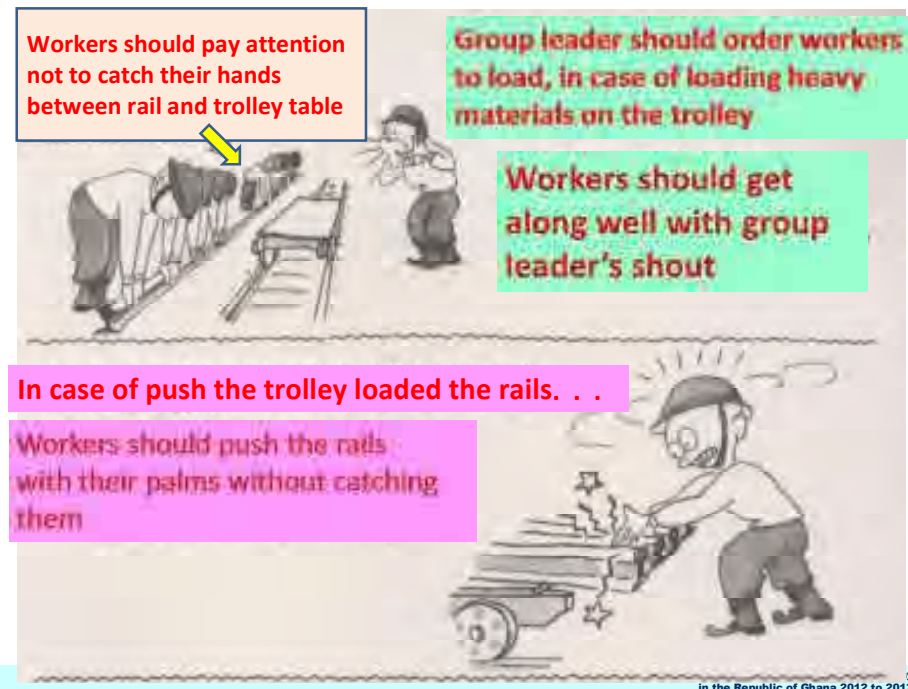
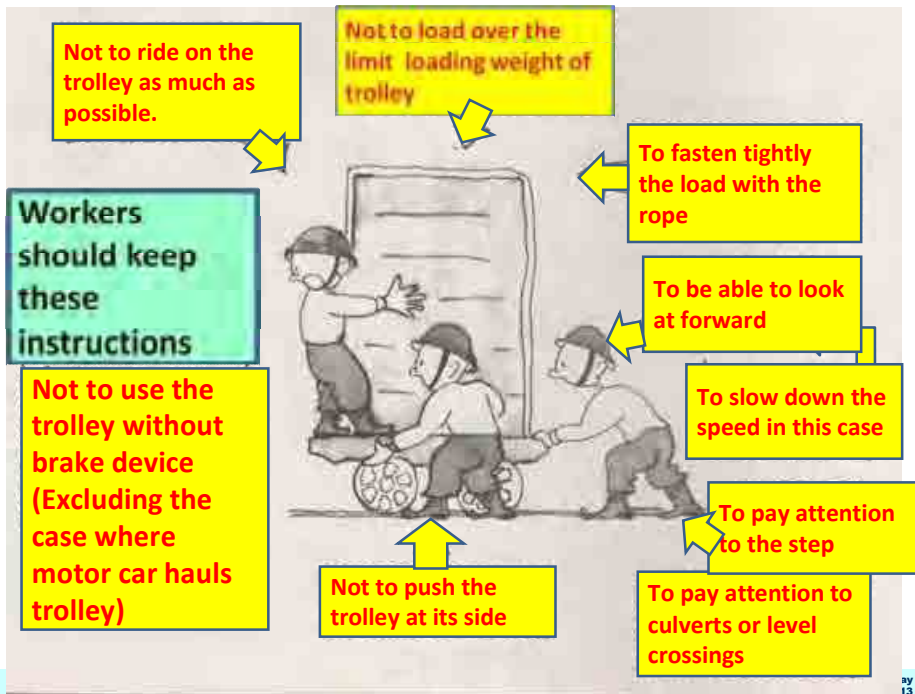
Trolley table with 4-Numbers of workers should be adjusted according to the size

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!!

in the Republic of Ghana 2012 to 2013





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



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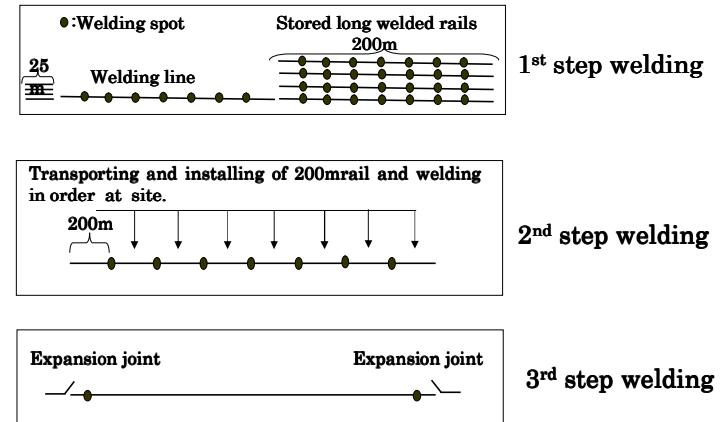
- 1) Installing Method of the long welded rail
- 2) Classification of rail welding investigation
 - Flash Butt welding machine
 - Gas Pressure welding machine
 - Enclosed arc welding equipment
 - Thermit welding equipment
- 3) Investigation standards of finishing treatment of welded joint by Japan Railways



Long welded rail



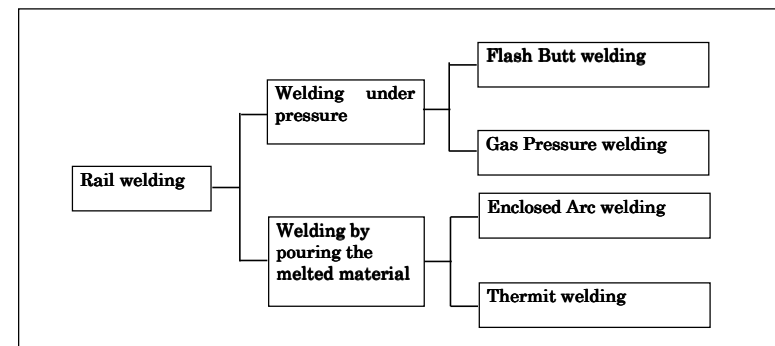
Installing Method of the long welded rail



Long welded rail



Classification of rail welding Investigation

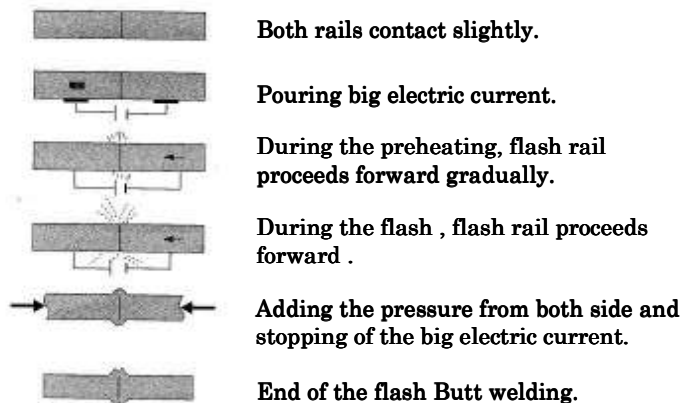


1. Flash Butt Welding machine



On rail Flash Butt Welding machine

Progress flow of Flash Butt welding



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.

Characteristics of flash butt welding

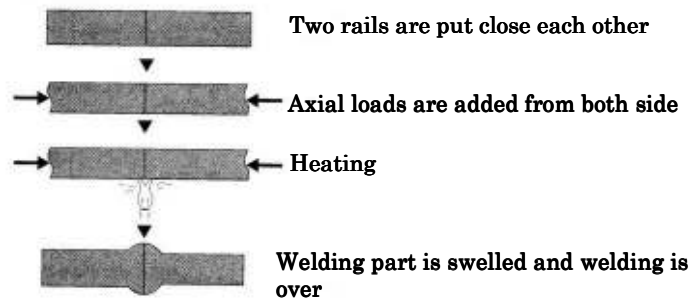
Demerit

- 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



Progress flow of Gas Pressure welding



Characteristics of gas pressure welding

Merit	<ol style="list-style-type: none"> 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°C and 1300°C. 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	<ol style="list-style-type: none"> 1) The length of rail is shortened because the joint is welded by adding high pressure.

3. Enclosed arc welding equipment



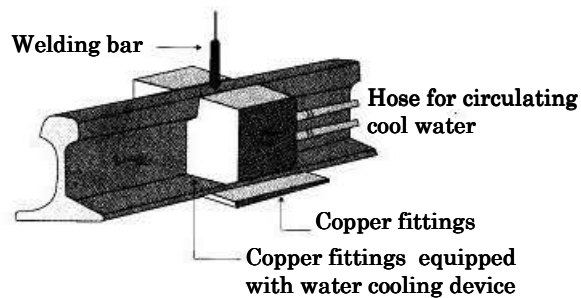
Method of Enclosed Arc welding

- 1) The gap of two rails which are welded should be kept 17 ± 3 mm.
- 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 filled 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



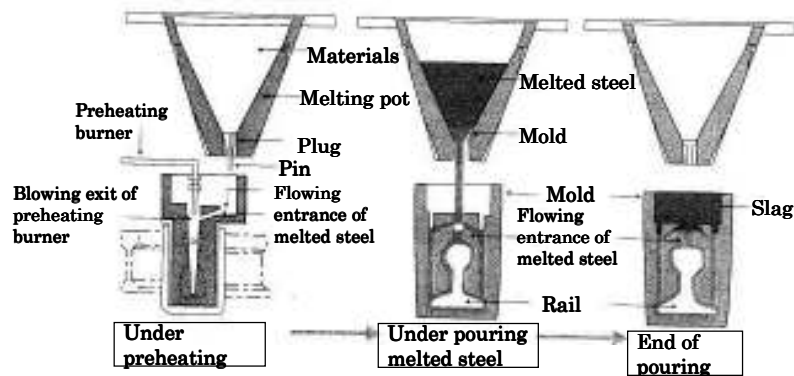
Progress flow of Thermit welding

- 1) The gap of two rails which are welded should be kept $25 \pm 1\text{mm}$.
- 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 Iron oxide) should be installed into this pot.
- 4) Chemical reaction occurs as soon as materials are lighted.
 $(2\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow 4\text{Al}_2\text{O}_3 + 2\text{Fe} (\Delta H = -851\text{kJ/mol.}), \text{ or } 2\text{Fe}_3\text{O}_4 + 8\text{Al} \rightarrow 4\text{Al}_2\text{O}_3 + 9\text{Fe} (\Delta H = -3348\text{kJ/mol.}))$
- 5) Melted steel is born and its melted steel is poured into the mold.

Characteristics of Thermit welding

Merit	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1) Quality and reliability of this welding 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	$-0.1 \leq \delta \leq +0.5$	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	$-0.5 \leq \delta \leq +0.5$		
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.

Study for Safety Operation and Management of Railway in the Republic of Ghana 2012 to 2013



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

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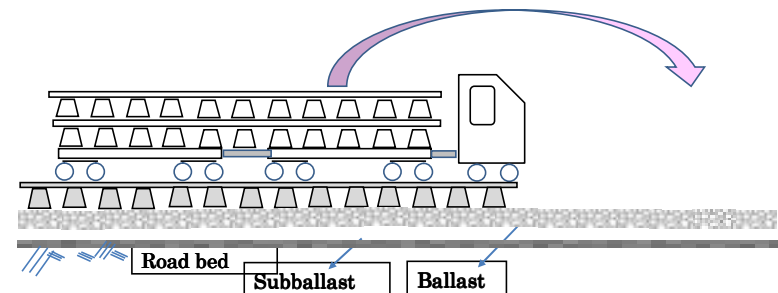
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Installing method of PC sleepers



Track panel method



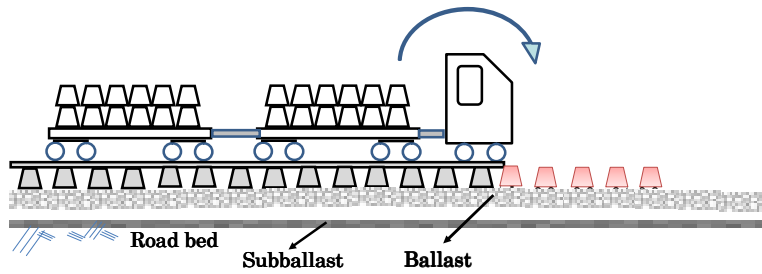
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Installing method of PC sleepers



Individually installing method



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Installing method of PC sleepers



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

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Installing method of PC sleepers



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

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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)

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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)



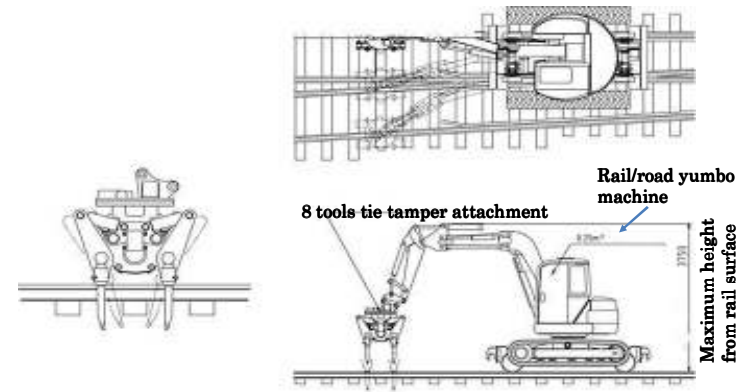
Installing method of PC sleepers



.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)



Installing method of PC sleepers



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)
Longitudinal level	(± 4)
Alignment	(± 4)
Twist	(± 4)



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.

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.



Training for Civil/Bridge Maintenance

From 5th March to 21st March 2014

**Lecture by Osamu OHKAWA,
Civil/Bridge Expert, JICA Study Team**

Training Plan

Date	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



I. Training Plan



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



Training Plan		
	Bridge training	Remarks
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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)	"	"

2. Current Situation of the bridge

5

Steel bridge in the suburbs of Butuah

Current situation



Freight train



High water level

7

Steel Bridge in the Suburbs of Dunkuwa

Current situation



Freight train wreck



4

6

Steel bridge in the suburbs of Butuah

Current situation



Corrosion



5

8



Section loss



Soil deposits
Big crack



Big crack

Current situation



Box culvert

Current situation



Big crack Flaking



Big crack



Collapsed abutment



Collapsed abutment



Corrosion



Corrosion



Corrosion
Garbage



Corrosion



Broken Parapet by Shoe movement



Flaking



Big Crack

Big Crack



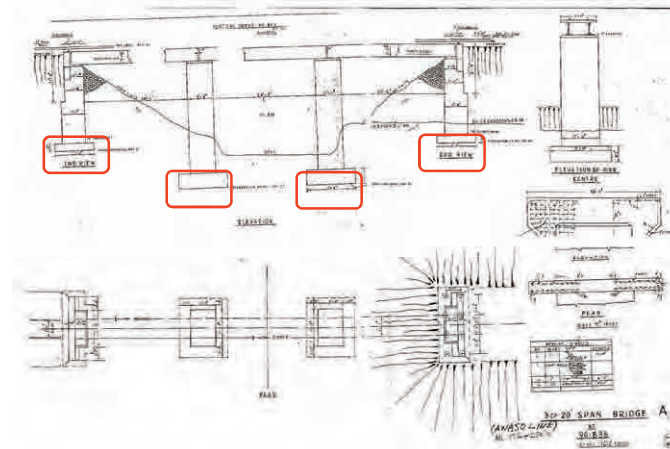
Scouring (Retaining wall)



Scouring (Box culvert)
In Burkina Faso



Revetment



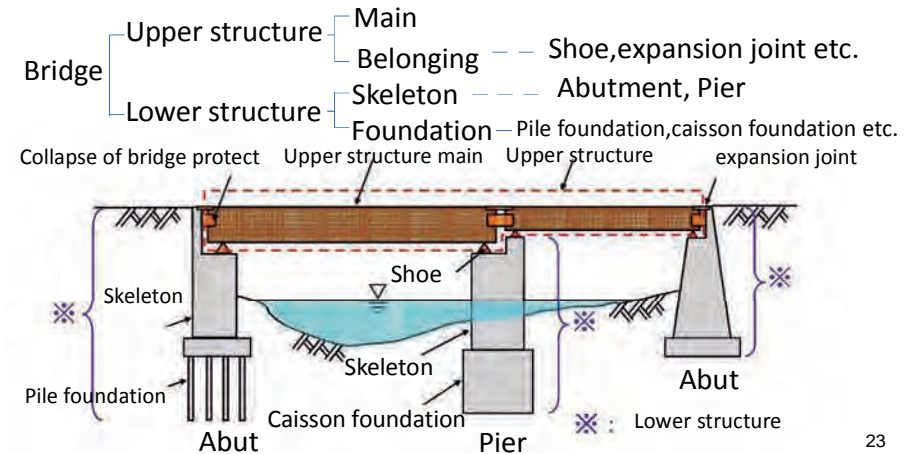
There isn't a columnar section, and bearing bed is not clear

□ : Small size

Not clear,
please rewrite

3. Basic Knowledge of Bridge

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



Basic Knowledge of Bridge

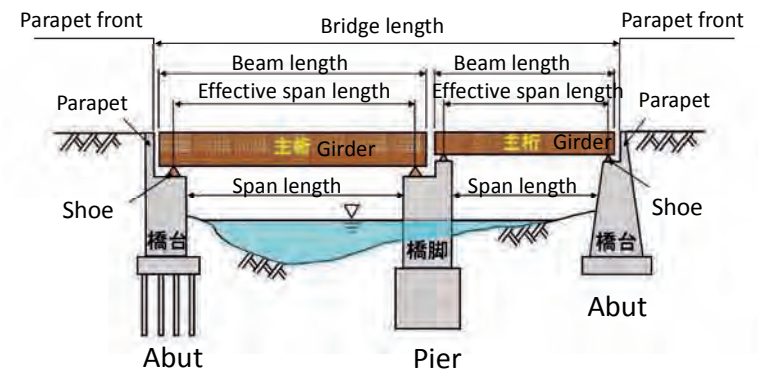
① Basic construction of Bridge

② Type of Bridge

③ Name and function of structure member

① Basic 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

25

② Type of Bridge

[Beam bridge]



▪ I girder bridge



▪ T girder bridge



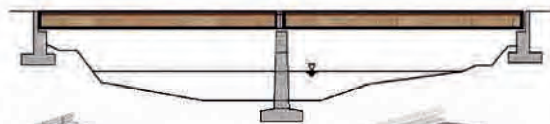
▪ Box girder bridge

27

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)

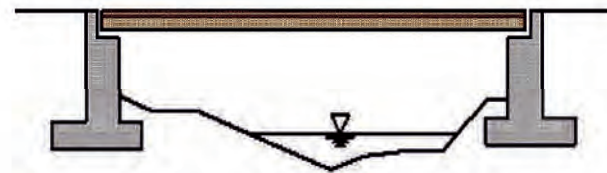
14

26

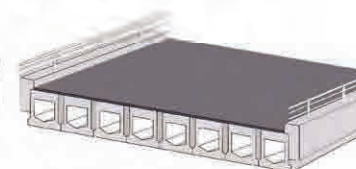
② Type of Bridge

[Slab bridge]

○ Bridge adopted slab in principal structure, no girder



▪ Hollow slab bridge



15

28

② Type of Bridge [Slab bridge]



• PC pretension slab bridge

• PC posttension hollow slab bridge



29

② Type of Bridge [Rigid frame bridge]

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



16

30

Type of Bridge [Rigid frame bridge]



• Steel rigid frame bridge



• PC π style rigid frame bridge

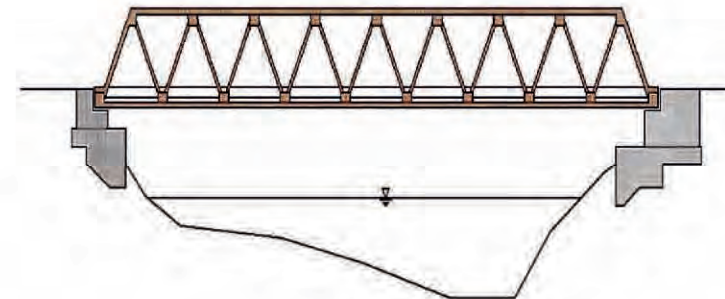


• PC rigid frame box girder bridge

31

② Type of Bridge [Truss bridge]

○ Principal structure of bridge is truss



17

32

② Type of Bridge

[Truss bridge]



▪ Cantilever steel truss bridge (through style)



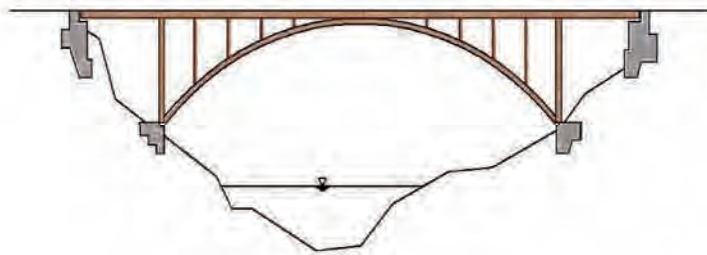
▪ Steel truss bridge (through style)

33

② Type of Bridge

[Arch bridge]

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



18

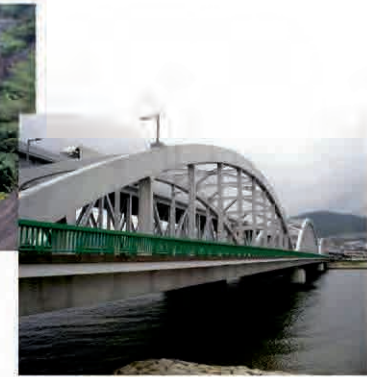
34

② Kind of Bridge

[Arch bridge]



▪ Steel longer arch bridge (deck style)



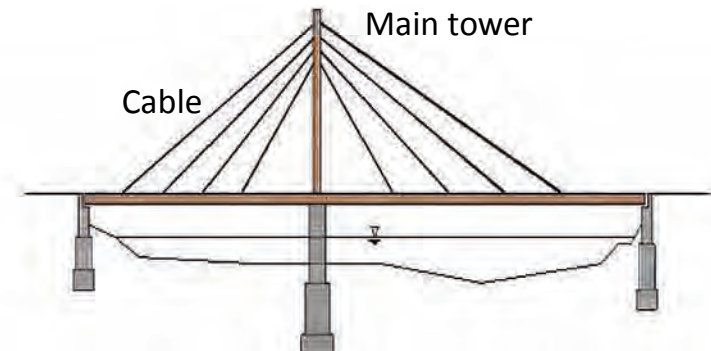
▪ Steel roze arch bridge (through style)

35

② Type of Bridge

[Cable stayed bridge]

○ Bridge supported by cable which stretched diagonally from main tower



19

36

② Type of Bridge

[Cable stayed bridge]



37

② Type of Bridge

[Suspension bridge]

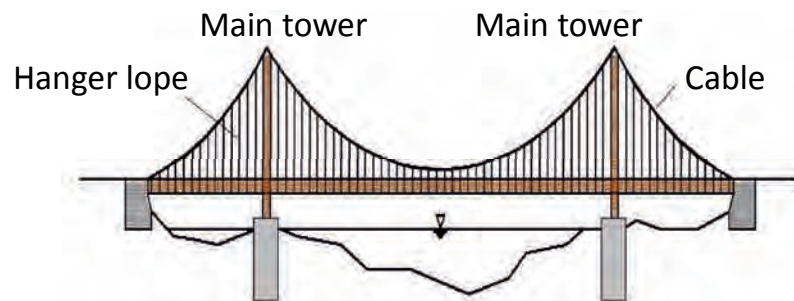


39

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



20

38

③ Name 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

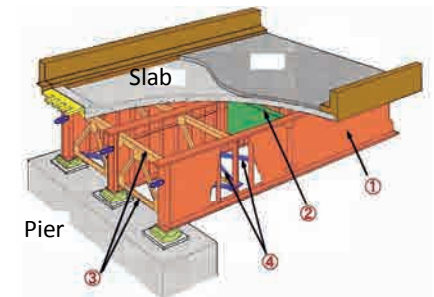
Cross beam is a member to connect girder for support load by many girder

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)



21

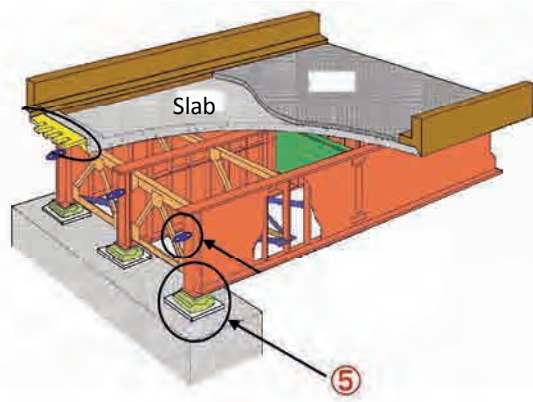
40

③ Name and function of structure member

[Superstructure]

⑤ Shoe

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



41

③ Name and function of structure member

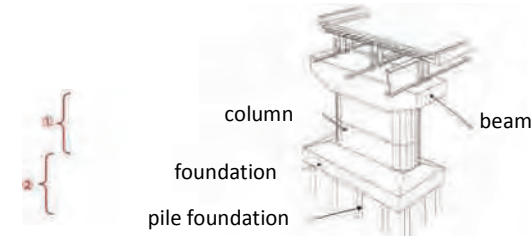
[Substructure]

① Pier

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

② Foundation

Foundation support load under abutment or pier and communicate to ground



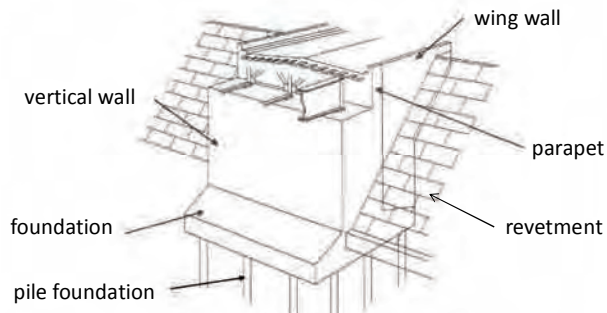
43

③ Name and function of structure member

[Substructure]

• Abutment

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

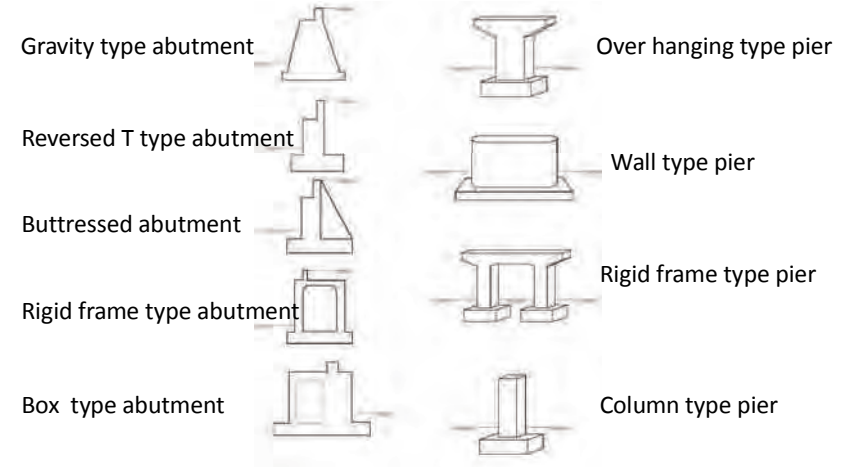


22

42

③ Name and function of structure member(Reference)

[Type of abutment] [Type of pier]



23

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4. Point of Bridge Inspection, Method of Inspection, Explanation of Bridge account book

Point of Bridge Inspection

① About management of Bridge

② Inspection

① About 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

① About 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

② Inspection

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

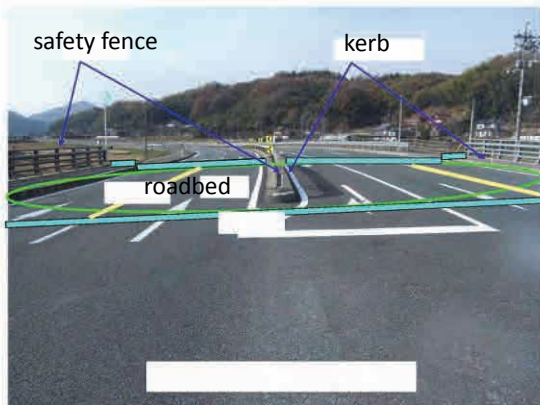
- ① detail condition of beam, slab than check point 1
- ② detail condition of shoe than check point 1
- ③ detail condition of abut, pier and foundation than check point 1

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

49

② Inspection (Flow of bridge inspection)

- 2 We confirm deformation from bridge front



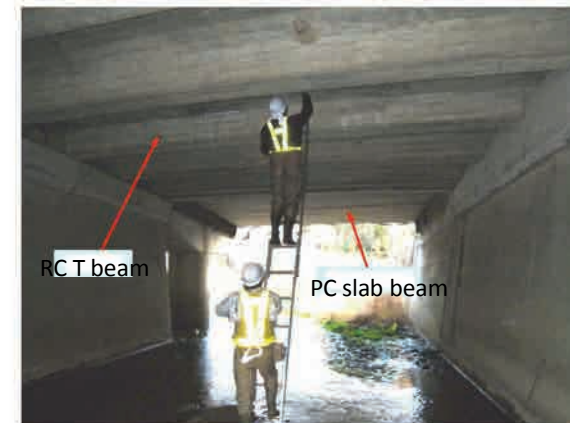
It is fundamental to look the bridge as starting point back

26

50

② Inspection (Flow of bridge inspection)

- 3 We confirm deformation of beam bottom



27

52

② Inspection (Flow of bridge inspection)

- 2 We confirm deformation from bridge side



It is fundamental to look the bridge as starting point left

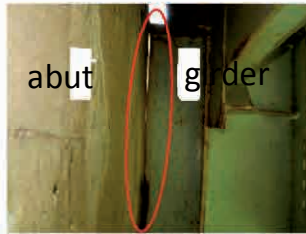
51

② Inspection

[Point of Inspection]

○ Abnormally of expansion joint

◆ Check point 2



abut girder

Clash with abut and beam



Abnormal movement



Shoe settlement

53

② Inspection

[Point of Inspection]

○ Abnormally of expansion joint

◆ Check point 2



Corrosion of beam end



Corrosion of shoe

Corrosion is caused by poor drainage

28

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② Inspection

[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



55

② Inspection

[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



56

29

54

② Inspection

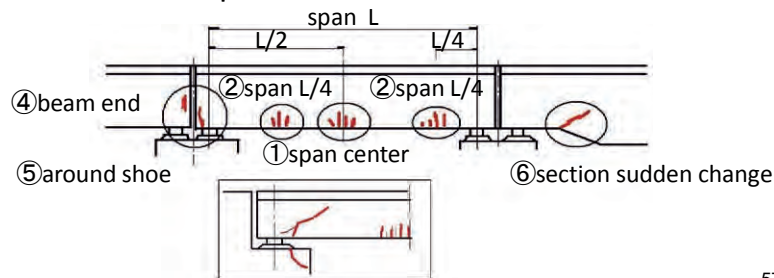
[Point of Inspection]

6) Condition of beam and slab

◆ Check point 1

• Where is the crack occur easily ?

• In case simple beam



57

② Inspection

[Point of Inspection]

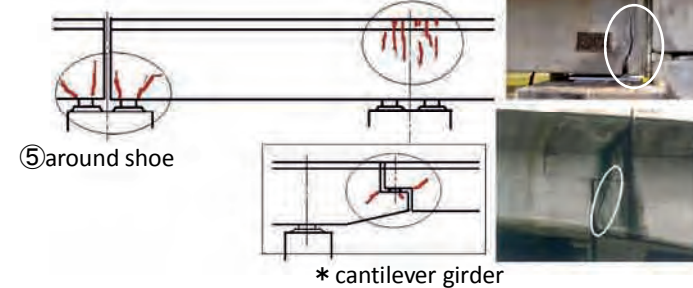
6) Condition of beam and slab

◆ Check point 1

• Where is the crack occur easy ?

• In case continuous beam

③ intermediate support

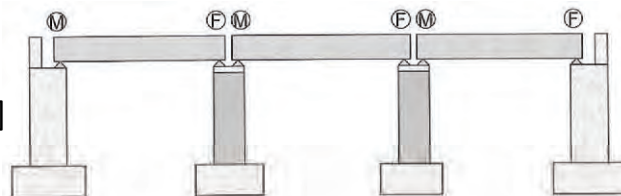


* cantilever girder

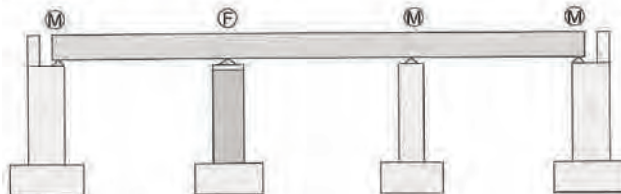
59

<Reference> Simple beam and Continuous beam

[Simple beam]



[Continuous beam]



58

30

② Inspection

[Point of Inspection]

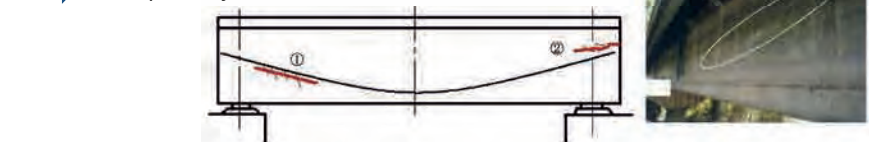
• In case PC beam (posttensioning beam)

6) Condition of beam and slab

◆ Check point 1

• Where is the crack occur easy ?

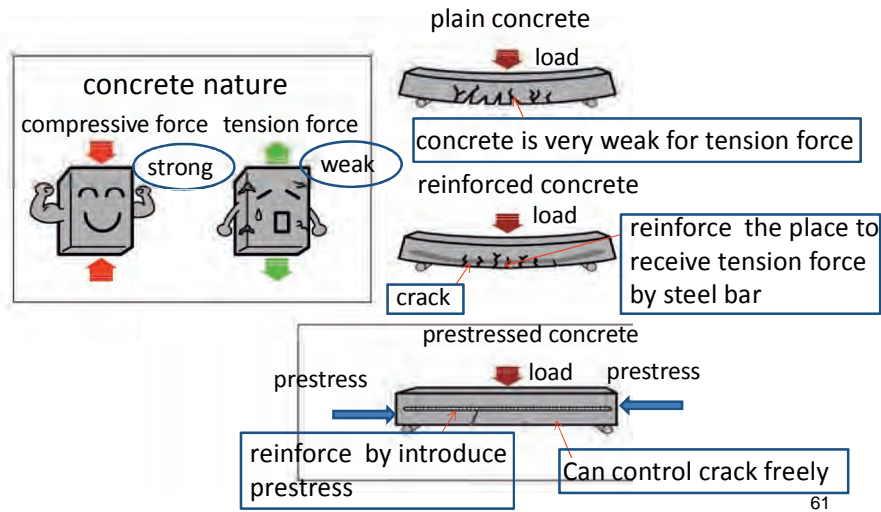
① Crack along sheath ② Crack by compression stress at anchorage zone
 → Grout poor injection



31

60

<Reference> PC beam (prestressed concrete beam)



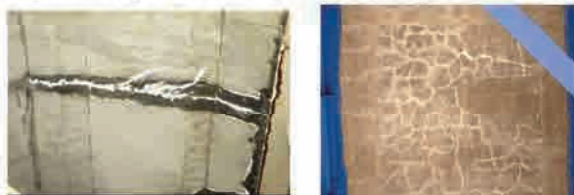
② Inspection

[Point of Inspection]

6) Condition of beam and slab

◆ Check point 1

- Where is the crack occur easy ?
- In case slab



② Inspection

[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

① wall handrail and kerb out side ③ girder side, lower side

- The place where receive influence of flying salt

② lower side of slab end and kerb drip

④ girder lower side 63



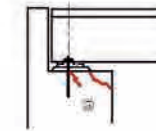
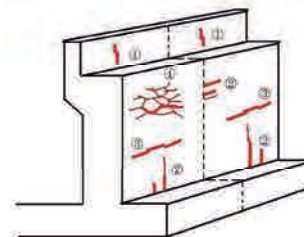
② Inspection

[Point of Inspection]

7) Condition of abut, pier and foundation

◆ Check point 1

- Where is the crack occur easily?
- In case abutment

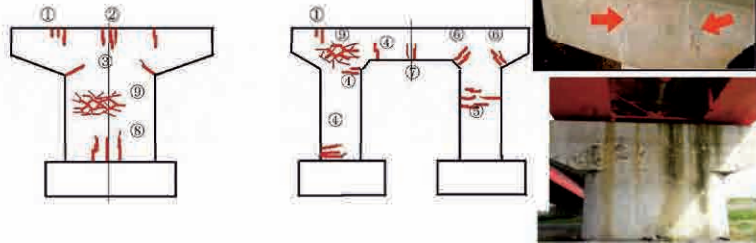


② Inspection [Point of Inspection]

7) Condition of abut, pier and foundation

◆ Check point 1

- Where is the crack occur easy ?
- In case pier



65

② Inspection[reference]

[How to take picture of photo recording]

① panoramic photo



② bridge name and history plate



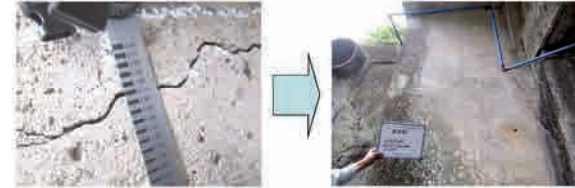
34

66

② Inspection[Reference]

[How to take picture of photo recording]

③ Take photography include damage position and healthy part



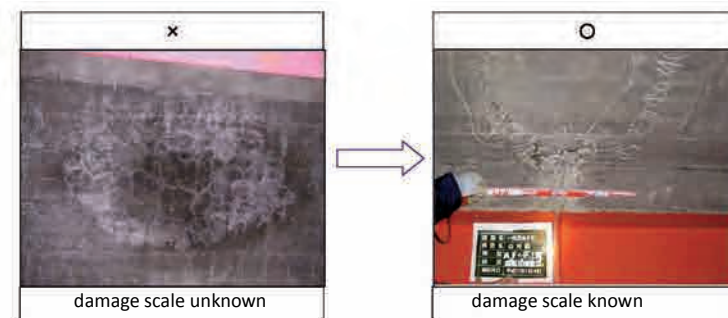
④ Take photography with tool can understand damage scale



67

② Inspection[Reference]

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

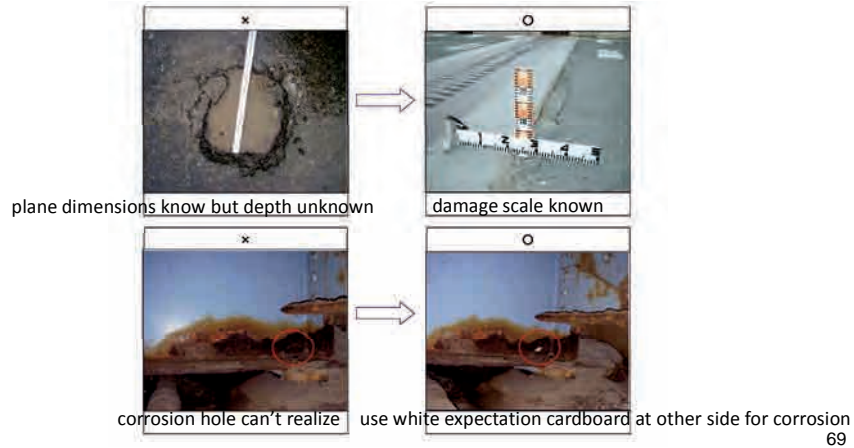


35

68

② Inspection[Reference]

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



69

71

② Inspection[Reference]

[Clothes of the time of the inspection, belongings]



36

70

① Protective measure of bridge



Concrete block

Wire mat

37

72

Superstructure Abutment



Concrete block

Foot protection



Start meeting



Inspection by ladder

② Scene of Bridge Inspection



Chalking of crack



Marking of stripping



Marking of stripping



Mobile lift



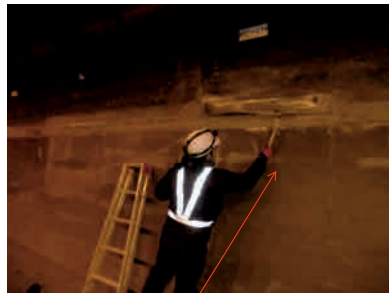
Marking of stripping



Mobile lift



Chalking of crack



Inspection of float by hammer



Photography



Inspection of float by hammer



Inspection of float by hammer



Mobile lift



Mobile lift



Mobile lift



Mobile lift



Mobile lift



Measurement of length

③ Japanese Railway



Prestressed concrete girder(5spans)



Prestressed concrete girder(5spans)

Steel deck plate girder(10 spans)



Abutment



Steel deck plate girder(10 spans)

Pier

Steel deck plate girder(10 spans)



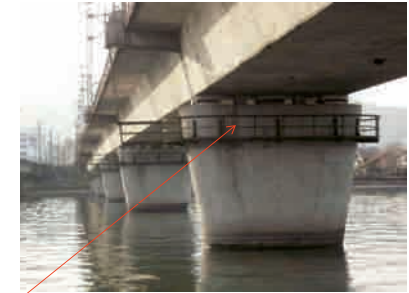
Passenger carriage



Freight train



Staging



Staging



Staging



Shinkansen



Shinkansen

6. My farewell speech

Instruments



Calipers



Crack gauge



Rust collecting electric tool



Level gauge



Camera

Bridge Lodger

Bridge ledger style-1

【Bridge summary】

Bridge name	Tehara bridge				Construction date	2000/10/10		Jurisdiction	GRCL
Track name	Tokaido line	Section	Starting point side	Takoradi	Mile post	from	00km00m		
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			Substructure	Engineering manual	Design seismic coefficient	0.2
Line division	Up line	Plane shape	Right bridge	Skew bridge		Construction company			
Design load	KS16	Plane alignments(m)	Superstructure				A company		
Materials	Steel RC	Longitudinal slope(%)	Substructure		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 division	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						

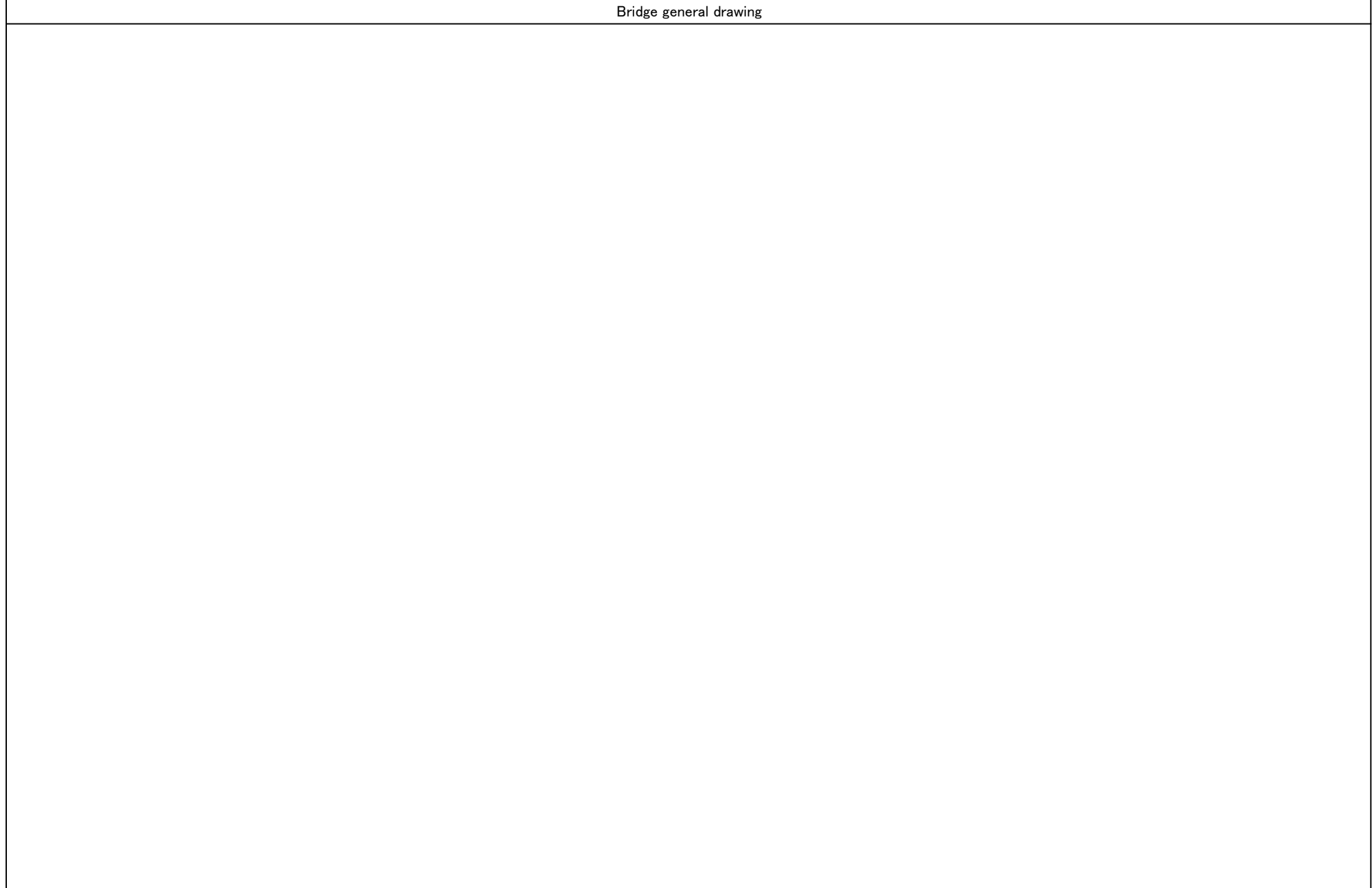
Important notice

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		

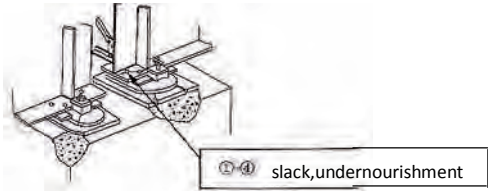
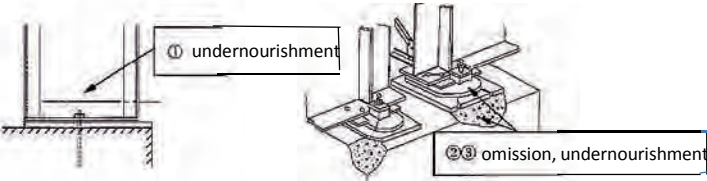
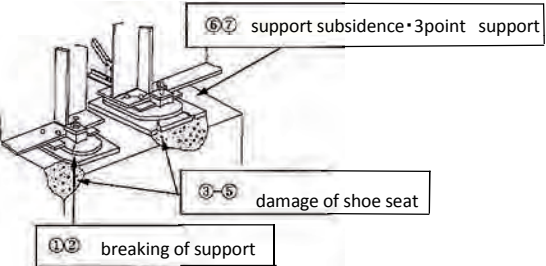
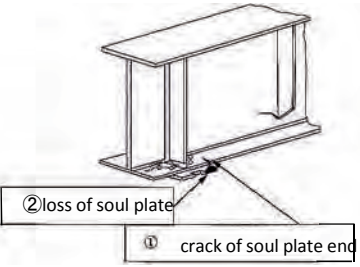
Bridge photograph		
Side whole view	Starting point bridge surface whole view	Girder placement situation
Abut・Pier whole view	Shoe situation	Handrail close view,others

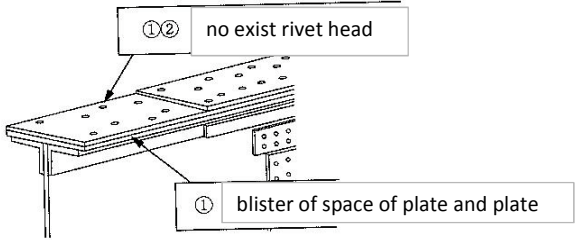
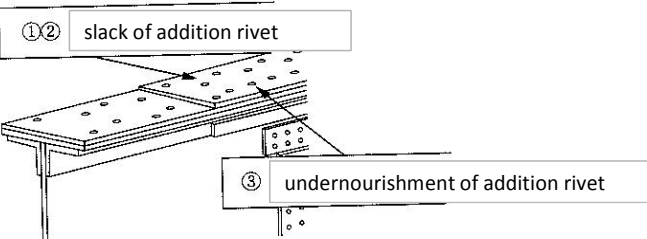
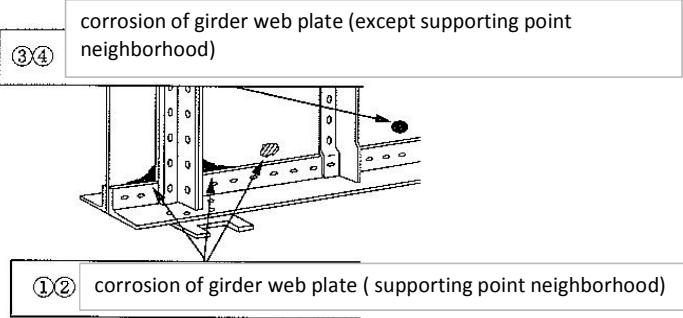
Bridge ledger style-5
 【Bridge photograph-2】

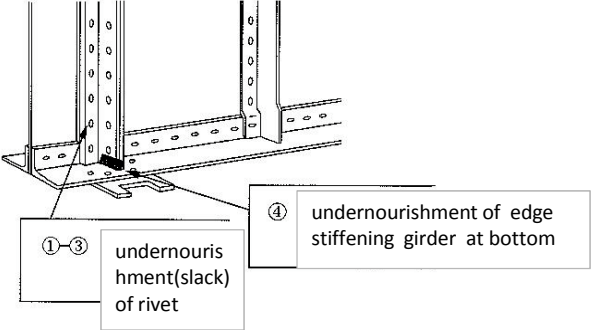
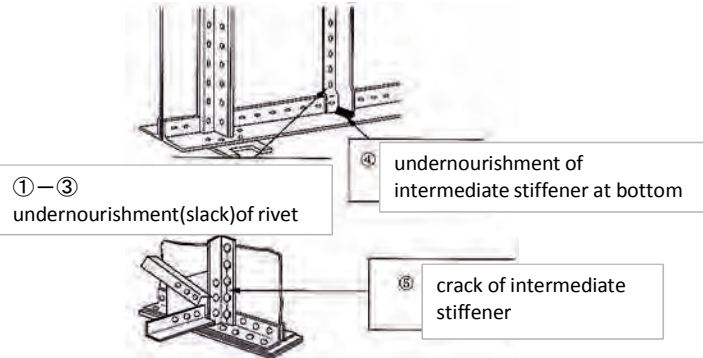
Bridge name	Tehara bridge	Index number	2
Management number	8632001052		

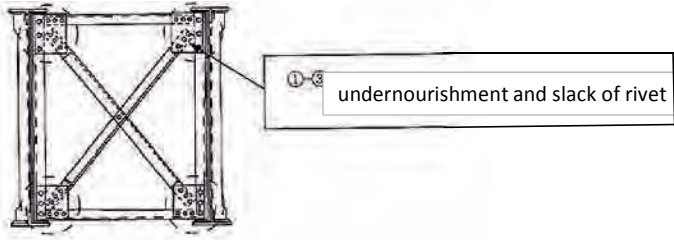
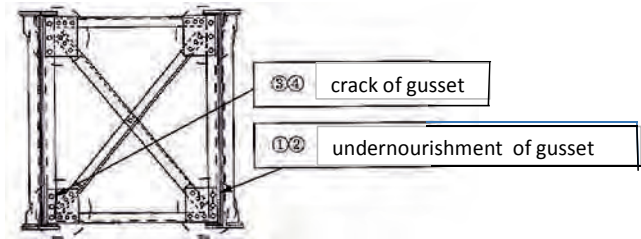
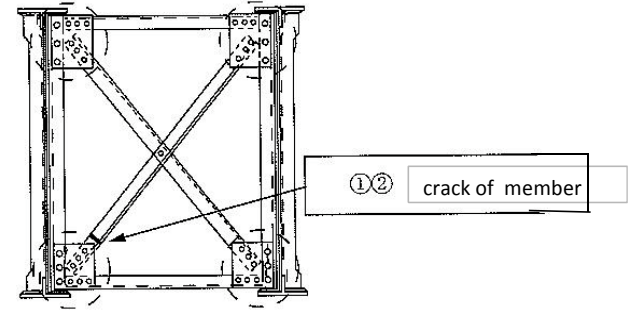
Bridge photograph		
Others(1)	Others(2)	Others(3)
Others(4)	Others(5)	Others(6)

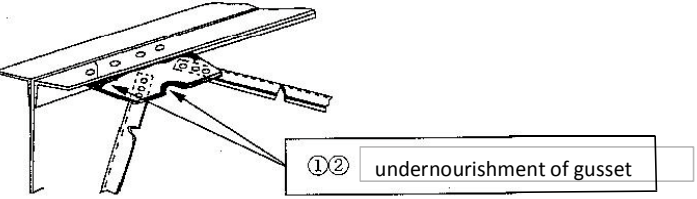
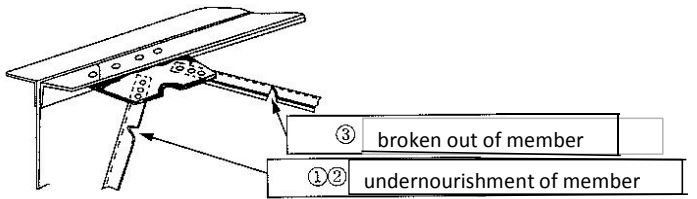
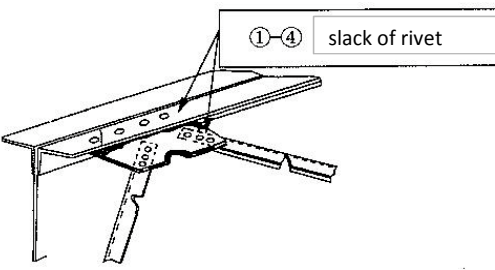
Diagnosis	State of the structure
	Threatened security to safe driving, to travelers, the public and normal service of the train; or fear of the deformation
A	AA There is deformation threatening the security of driving, the travelers, the public and normal service of trains which urgently needs attention
	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	<p>•Rivet and bolt at soul plate installation part</p> 	<p>①Slack of rivet and bolt(half under of the whole)</p> <p>②Slack of rivet and bolt(half over of the whole)</p> <p>③Undernourishment of rivet and bolt(half under of the whole)</p> <p>④Undernourishment of rivet and bolt(half over of the whole)</p>	<p>A2 (B)</p> <p>A1 (A2)</p> <p>B</p> <p>A2 (B)</p>
	<p>•Anchor bolt part</p> 	<p>①Undernourishment of lower flange or soul plate at anchor bolt installation part</p> <p>②Undernourishment of anchor bolt</p> <p>③Omission of anchor bolt</p>	<p>B</p> <p>A1,A2 (B)</p> <p>A1 (A2)</p>
	<p>•Support and shoe seat</p> 	<p>①Breaking of support(30% under of the whole)</p> <p>②Breaking of support(30% over of the whole)</p> <p>③Part missing</p> <p>④Damage of shoe seat(part crack)</p> <p>⑤Damage of shoe seat(deformation take support subsidence)</p> <p>⑥Support subsidence</p> <p>⑦3point support</p>	<p>A2</p> <p>A1</p> <p>B</p> <p>A2(B)</p> <p>AA(A1,A2)</p> <p>AA(A1,A2)</p> <p>AA(A1,A2)</p>
	<p>•Soul plate part</p> 	<p>①Crack which right angle direction occurred at base metal from end of soul plate</p> <p>②Loss of soul plate</p>	<p>A1</p> <p>B</p>

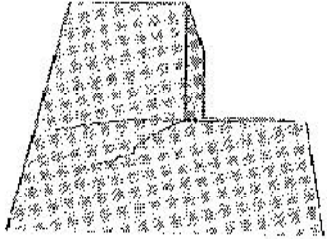
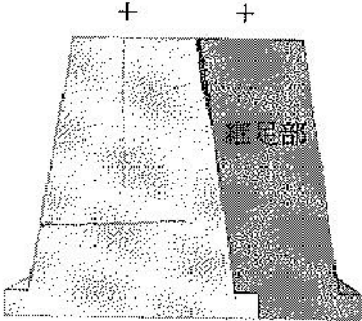
Member	Deformed example	Judgment standard	Judgment
1.Girder	<p>•Flange spell rivet</p> 	<p>①Generally, no exist rivet head and can see blister between plate and plate</p> <p>②Partially, no exist rivet head</p>	<p>A2 (B)</p> <p>B (C)</p>
	<p>•Flange addition rivet</p> 	<p>①There is slack 30% over of group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

Member	Deformed example	Judgment standard	Judgment
2.Stiffening girder	<p data-bbox="358 228 562 248">•Edge stiffening girder</p>  <p data-bbox="450 528 674 619">①-③ undernourishment(slack) of rivet</p> <p data-bbox="696 496 1021 555">④ undernourishment of edge stiffening girder at bottom</p>	<p data-bbox="1090 228 1883 272">①When there is undernourishment and slack in one-third of all rivet head of the lower flange side</p> <p data-bbox="1090 280 1883 325">②When there is undernourishment in one-third of almost rivet head of the lower flange side</p> <p data-bbox="1090 333 1883 378">③When there is undernourishment in one-third of about half rivet head of the lower flange side</p> <p data-bbox="1090 386 1722 406">④When there is undernourishment at bottom of edge stiffening girder</p>	<p data-bbox="1915 228 2002 248">A1(A2)</p> <p data-bbox="1915 280 2002 301">A2(B)</p> <p data-bbox="1915 333 2002 354">B</p> <p data-bbox="1915 386 2002 406">A2(B)</p>
	<p data-bbox="358 659 562 679">•Intermediate stiffener</p>  <p data-bbox="383 879 707 938">①-③ undernourishment(slack)of rivet</p> <p data-bbox="719 847 1066 906">④ undernourishment of intermediate stiffener at bottom</p> <p data-bbox="741 959 1032 1034">⑤ crack of intermediate stiffener</p>	<p data-bbox="1090 659 1543 679">①When there is slack at part of cross flange exist</p> <p data-bbox="1090 711 1570 732">②When there is slack at part of cross flange no exist</p> <p data-bbox="1090 767 1758 788">③When there is undernourishment at rivet head half degree of the group</p> <p data-bbox="1090 823 1767 844">④When there is undernourishment at bottom of the intermediate stiffener</p> <p data-bbox="1090 879 1821 900">⑤When there is crack at stiffening girder angle steel which installed cross frame</p>	<p data-bbox="1915 659 2002 679">A1(A2)</p> <p data-bbox="1915 711 2002 732">A2(B)</p> <p data-bbox="1915 767 2002 788">C</p> <p data-bbox="1915 823 2002 844">A2(B)</p> <p data-bbox="1915 879 2002 900">A1</p>

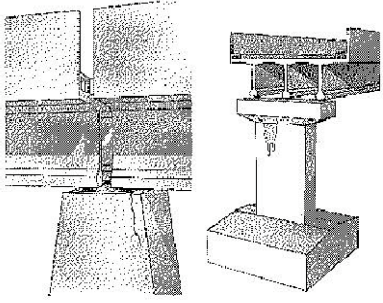
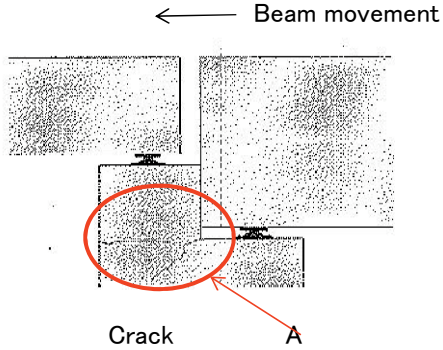
Member	Deformed example	Judgment standard	Judgment
3.Cross frame	<p>•Cross frame installation rivet</p> 	<p>①Slack of rivet by support subsidence etc</p> <p>②Slack by undernourishment of rivet(all number)</p> <p>③Slack by undernourishment of rivet(part number)</p>	<p>A2</p> <p>A2</p> <p>B</p>
	<p>•Cross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

Member	Deformed example	Judgment standard	Judgment
4. Transverse stiffener	<p>• Transverse stiffener gusset</p>  <p>①② undernourishment of gusset</p>	<p>① It is an obstacle to transmission of power</p> <p>② The existing stage, it isn't an obstacle to transmission of power</p>	<p>A2</p> <p>B</p>
	<p>• Transverse stiffener member</p>  <p>③ broken out of member</p> <p>①② undernourishment of member</p>	<p>① It is remarkable undernourishment at beam edge</p> <p>② It is undernourishment at intermediate part</p> <p>③ It is broken out</p>	<p>B</p> <p>C</p> <p>A1</p>
	<p>• Transverse stiffener installation rivet</p>  <p>①-④ slack of rivet</p>	<p>① The slack was given at beam edge(all number)</p> <p>② The slack was given at beam edge(part number)</p> <p>③ The slack was given at intermediate part(all number)</p> <p>④ The slack was given at intermediate part(part number)</p>	<p>A2</p> <p>B</p> <p>A2</p> <p>C</p>

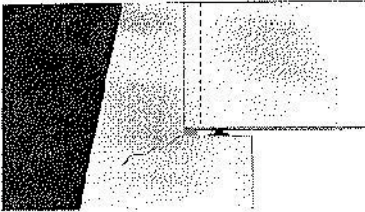
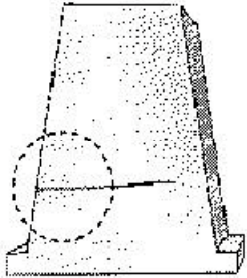
Judgment of healthy index (Plain concrete structure)

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Plain concrete	Crack Stripping	•Parapet	<ul style="list-style-type: none"> •Cracking position, width and depth •Presence of anchor bolt transformation •Presence of crack anchor bolt near by  <p>Crack</p>	<ul style="list-style-type: none"> •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 	<p>A</p> <p>A</p> <p>A</p> <p>A</p> <p>A,B</p>
		•Skeleton	<ul style="list-style-type: none"> •Presence of crack •Presence of stripping  <p>Crack of skeleton</p>	<ul style="list-style-type: none"> •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 	<p>A</p> <p>A</p> <p>B</p> <p>B</p> <p>C</p>

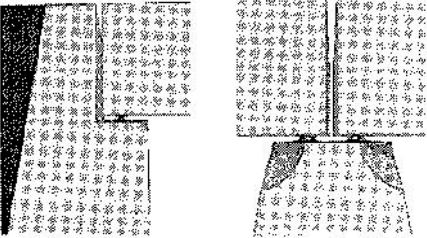
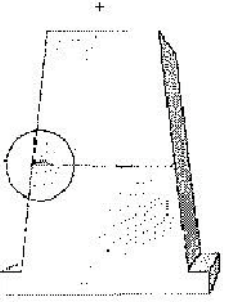
Judgment of healthy index (Pier・Abut(1))

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Abut Pier	Crack	<ul style="list-style-type: none"> • Bridge seat of pier 	<ul style="list-style-type: none"> • Cracking position and width • Presence of crack for vertical direction • Progressive confirmation(Mark by paint) • State of steel bar corrosion  <p style="text-align: center;">Crack</p>	<ul style="list-style-type: none"> • 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 	<p style="text-align: center;">AA</p> <p style="text-align: center;">A</p> <p style="text-align: center;">B</p>
		<ul style="list-style-type: none"> • Lower end portion of higher bridge at A 	<ul style="list-style-type: none"> • Presence of crack at joint and back • Presence of contact of beam • Progressive confirmation(Mark by paint) • State of steel bar corrosion  <p style="text-align: center;">Crack A</p>	<ul style="list-style-type: none"> • There is crack width 0.2mm degree over for horizontal direction • There is crack width 0.2mm below for horizontal direction 	<p style="text-align: center;">A</p> <p style="text-align: center;">B</p>

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

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Abut Pier	Crack	<ul style="list-style-type: none"> Parapet 	<ul style="list-style-type: none"> Presence of contact of beam Presence of horizontal crack at parapet lower end portion Progressive confirmation(Mark by paint) <p style="text-align: center;">Beam movement ←</p>  <p style="text-align: center;">Crack</p>	<ul style="list-style-type: none"> 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 	<p style="text-align: center;">A</p> <p style="text-align: center;">B</p>
		<ul style="list-style-type: none"> Skeleton 	<ul style="list-style-type: none"> Presence of surface crack <p style="text-align: center;">+</p>  <p style="text-align: center;">Crack of skeleton</p>	<ul style="list-style-type: none"> There is crack width 0.2mm degree over for horizontal direction There is crack width 0.2mm below for horizontal direction 	<p style="text-align: center;">A</p> <p style="text-align: center;">B</p>

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

Structure	Classification of deform	Survey point	Survey item	Example of judgment	Judgment
Abut Pier	Stripping of concrete	<ul style="list-style-type: none"> Bridge seat Front interval shoe seat and bridge seat 	<ul style="list-style-type: none"> Range of stripping Presence of stripping nearby shoe Confirmation of exposed steel bar  <p style="text-align: center;">Stripping at head</p>	<ul style="list-style-type: none"> Steel bar is exposed at stripping point entire Steel bar is exposed at part of the stripping point 	AA,A A,B
		<ul style="list-style-type: none"> Skeleton 	<ul style="list-style-type: none"> Size and depth of stripping Confirmation of exposed steel bar  <p style="text-align: center;">Stripping of skeleton</p>	<ul style="list-style-type: none"> 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

§ 1. Design conditions

1.1 General conditions

Because only steel bridge L=32'0" (9.754m) of ESUASO was available by a design drawing I calculate about this steel bridge.

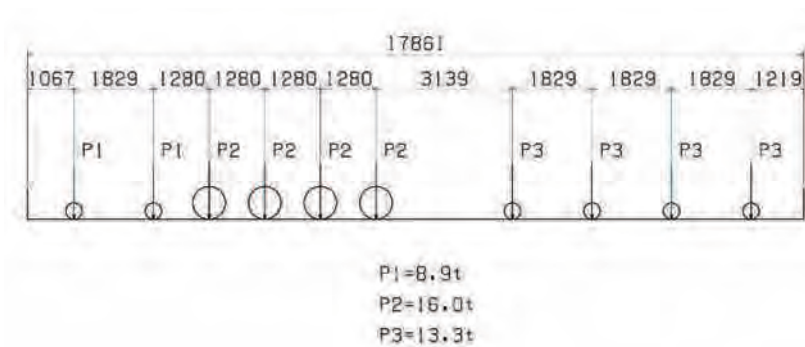
The steel class is equal to SS400.

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

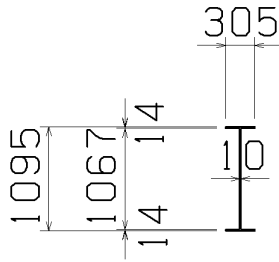
Allowable bending compression stress (Unit : N/mm²)

Steel class	SS400,SM400,SMA400 STK400,STKR400
$\frac{A_w}{A_c} \leq 2$	$l / b \leq 4.5$: 161 $4.5 < l / b \leq 30$: $161 - 2.8 (l / b - 4.5)$
$\frac{A_w}{A_c} > 2$	$l / b \leq 9 / K$: 161 $9 / K < l / b \leq 30$: $161 - 1.4 (K \cdot l / b - 9)$
<p>A_w : Total sectional area (mm²) of the web plate A_c : Total sectional area (mm²) of the compression flange l : Distance (mm) between the fixed points of the compression b : Compression flange width (mm) K : $\sqrt{\quad}$</p>	

§ 2. Load calculation

2.1 Steel materials dimension

■ No corrosion



I-1095 × 305 × 10 × 14

A = 192.10 cm²

A_w = 106.70 cm²

A_c = 42.70 cm²

W = 150.70 kg/m

Z_x = 6406 cm³

Section dimension

Geometrical moment of area

Division	Expression	A (mm ²)	y (mm)	A · y (mm ³)
<i>Ufl</i>	305 X 14	4270	1088.0	4645760
<i>Web</i>	10 X 1067	10670	547.5	5841825
<i>Lfl</i>	305 X 14	4270	7.0	29890
Σ		19210		10517475

Geometrical moment of area G = 10517475 mm³

Centroid position (from bottom) $y_{\ell} = G/A = 547.5$ mm

Principal moment of inertia for the centroid

Division	Expression	I _o (mm ⁴)	e (mm)	A · e ² (mm ⁴)
<i>Ufl</i>	1/12 X 305 X 14 ³	69743	540.5	1247438868
<i>Web</i>	1/12 X 10 X 1067 ³	1012306469	0.0	0
<i>Lfl</i>	1/12 X 305 X 14 ³	69743	540.5	1247438868
Σ		1012445955		2494877736

Principal moment of inertia I = I_o + A · e² = 3507323691 mm⁴

Centroid position (from upper) $y_u = 547.5$ mm

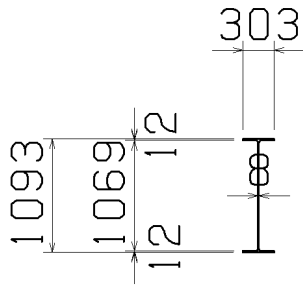
Section modulus

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

Modulus of elasticity

E = 200 kN / mm²

■ Corrosion is 1mm case



$$I-1093 \times 303 \times 8 \times 12$$

$$A = 158.24 \text{ cm}^2$$

$$A_w = 85.52 \text{ cm}^2$$

$$A_c = 36.36 \text{ cm}^2$$

$$W = 150.70 \text{ kg/m}$$

$$Z_x = 5378 \text{ cm}^3$$

Section dimension

Geometrical moment of area

Division	Expression	A (mm ²)	y (mm)	A · y (mm ³)
<i>Ufl</i>	303 X 12	3636	1087.0	3952332
<i>Web</i>	8 X 1069	8552	546.5	4673668
<i>Lfl</i>	303 X 12	3636	6.0	21816
Σ		15824		8647816

$$\text{Geometrical moment of area } G = 8647816 \text{ mm}^3$$

$$\text{Centroid position (from bottom) } y_\ell = G/A = 546.5 \text{ mm}$$

Principal moment of inertia for the centroid

Division	Expression	lo (mm ⁴)	e (mm)	A · e ² (mm ⁴)
<i>Ufl</i>	1/12 X 303 X 12 ³	43632	540.5	1062221949
<i>Web</i>	1/12 X 8 X 1069 ³	814407673	0.0	0
<i>Lfl</i>	1/12 X 303 X 12 ³	43632	540.5	1062221949
Σ		814494937		2124443898

$$\text{Principal moment of inertia } I = I_o + A \cdot e^2 = 2938938835 \text{ mm}^4$$

$$\text{Centroid position (from upper) } y_u = 546.5 \text{ mm}$$

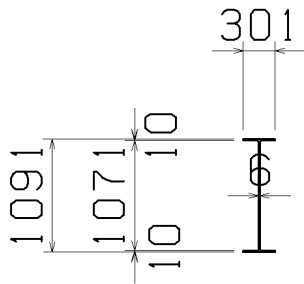
Section modulus

$$Z = I / y_u = 2938938835 / 546.5 = 5378 \text{ cm}^3$$

Modulus of elasticity

$$E = 200 \text{ kN} / \text{mm}^2$$

■ Corrosion is 2mm case



I-1091 × 301 × 6 × 10
 A = 124.46 cm²
 A_w = 64.26 cm²
 A_c = 30.10 cm²
 W = 150.70 kg/m
 Z_x = 4350 cm³

Section dimension

Geometrical moment of area

Division	Expression	A (mm ²)	y (mm)	A · y (mm ³)
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) $y_{\ell} = G/A = 545.5$ mm

Principal moment of inertia for the centroid

Division	Expression	I _o (mm ⁴)	e (mm)	A · e ² (mm ⁴)
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 = I_o + A · e² = 2372974928 mm⁴

Centroid position (from the u y_u) = 545.5 mm

Section coefficient

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

Modulus of elasticity

E = 200 kN / mm²

2.2 Load calculation

(1) Steel beam dead weight

$$W_1 = 0.01921 \text{ m}^2 \times 7850 \text{ kg/m}^3 \times 9.8 \times 10^{-3} = 1.5 \text{ kN/m}$$

(2) Train load + Impact

Impact coefficient

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

Here

$$K_a = 2.0$$

V : Maneuvering speed of the train 40km/h

L : Bridge girder span 9.754m

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

$$= 0.101 + 0.134 = 0.235$$

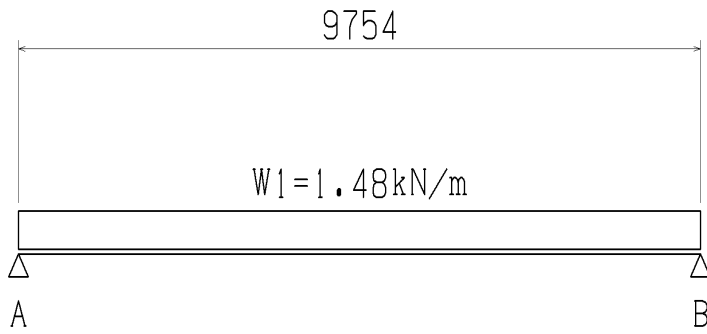
$$P_1 = 4.45 \text{ t} \times (1 + 0.235) \times 9.8 = 53.86 \text{ kN}$$

$$P_2 = 8.0 \text{ t} \times (1 + 0.235) \times 9.8 = 96.82 \text{ kN}$$

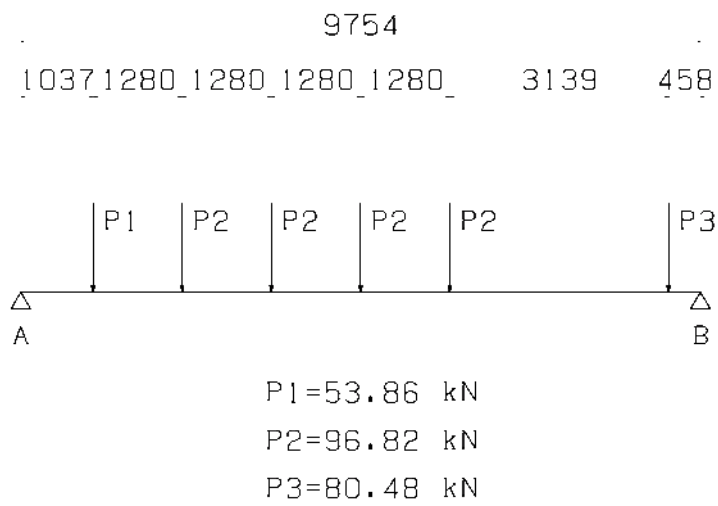
$$P_3 = 6.65 \text{ t} \times (1 + 0.235) \times 9.8 = 80.48 \text{ kN}$$

2.3 Figure of load

(1) Deadweight



(2) Train load + Impact



(3) Viewpoint

The viewpoint divide 4 equally of the span.

*** 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 θ z)			支点バネ値 (X Y θ z)		
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)	θ z 変位 (ミリラジアン)	X反力 (kN)	Y反力 (kN)	θ z 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)	(moment) モーメント (kN.m)	(shearing force) せん断力 (kN)	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)	(moment) モーメント (kN.m)	(shearing force) せん断力 (kN)	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	

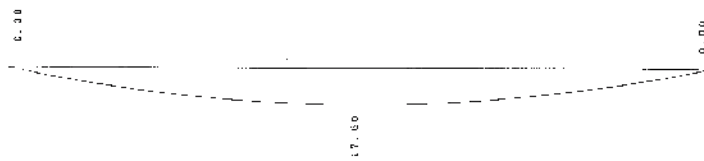
部材着目点の断面力

*** 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)	(moment) モーメント (kN.m)	(shearing force) せん断力 (kN)	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	

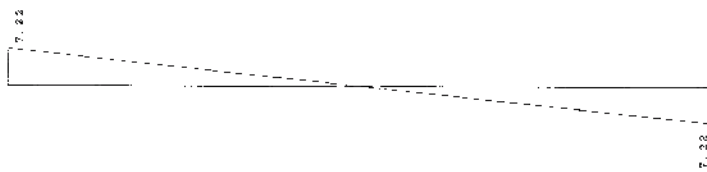
ESUASO

CASE 1 死荷重 (dead load)

モーメント図
(moment diagram)



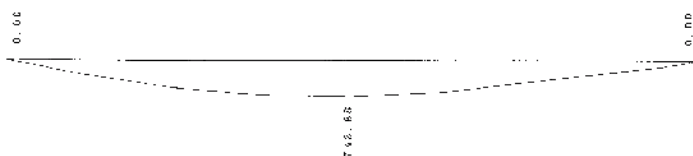
せん断力図
(shearing force diagram)



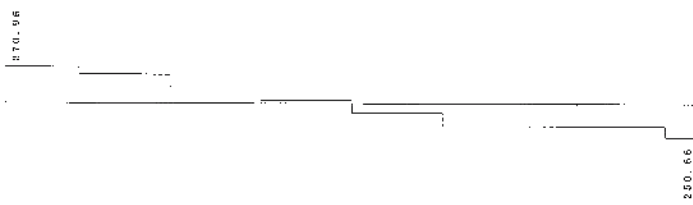
ESUASO

CASE 2 列車+衝撃荷重 (train + impact load)

モーメント図
(moment diagram)



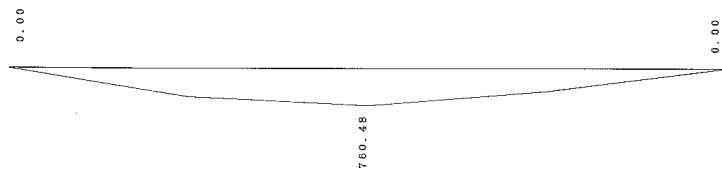
せん断力図
(shearing force diagram)



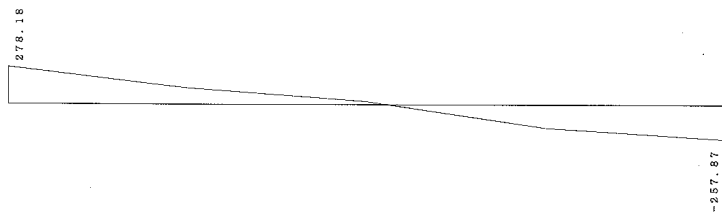
ESUASO

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

- 1) Training Program**
- 2) Portable type brake tester for single car “Instruction manual”**
- 3) Air brake test manual**
- 4) Diameter gauge for the wheel manual**
- 5) Tread wear measuring device “Instruction manual”**
- 6) Digital tire measuring instrument “Flange gauge Manual”**

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 Axle & wheels and Brake system.

2. Subject

- 1) How to use basic measuring instruments.
 - Vernier caliper • Digital multi meter (Tester) • Insulation tester (Megohmmeter)
- 2) How to measure basic dimension of axle 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

			Subject	Contents	Place
17/Mar~23/Mar			Arrangement and preparation for training		
1 st	24 /Mar.	AM	<ul style="list-style-type: none"> ➤ Basic measure instrument ➤ Axle and wheel set 	<ul style="list-style-type: none"> • How to use basic measuring instruments. • How to measure basic dimension of axle and wheel set. 	Location
		PM	<ul style="list-style-type: none"> ➤ Brake system 	<ul style="list-style-type: none"> ➤ How to check brake system 	
2 nd	25 /Mar.	AM	- ditto -	- ditto -	Carriage & Wagon
		PM			
3 rd	26 /Mar.		reserve		
4 th	27 /Mar.		reserve		

End

