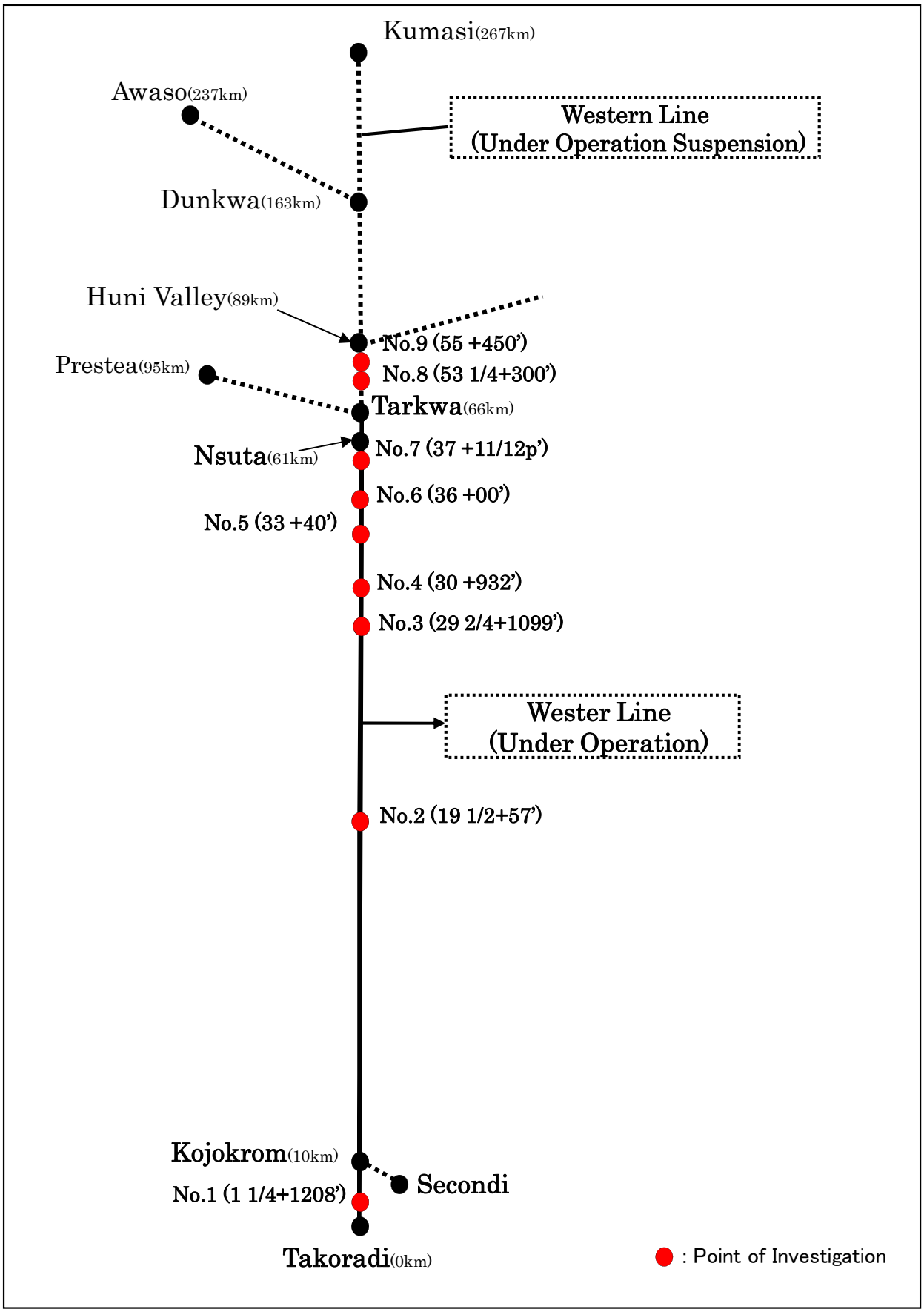
APPENDIX 2

Bride Inspection Ledger

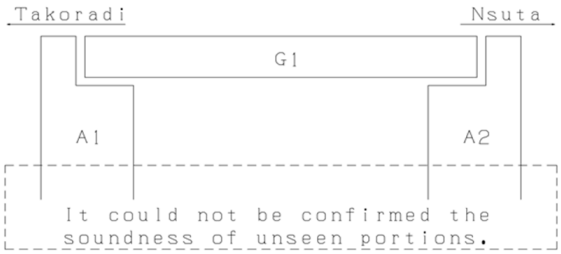
Map of Bridge Site Investigation



BRIDGE WEST LINE (TAKORADI～NSUTA)					
No	MILEAGE	TYPE	SPAN	LENGTH	REMARKS
1	1 1/4 + 1208'	Steel deck plate girder	1	66' 00″	
2	19 1/2 + 57'	Steel deck plate girder	1	20' 00″	
3	29 2/4 + 1099'	Steel deck plate girder	1	30' 00″	
4	30 + 932'	Steel through plate girder	3	63' 8 3/4″	
5	33 + 40'	Steel through plate girder	1	63' 00″	
6	36 + 00'	Steel deck plate girder	2	29' 8″	
7	37 + 11/12p'	Steel deck plate girder	1	29' 00″	

BRIDGE WEST LINE (HUNI VALLEY)					
No	MILEAGE	TYPE	SPAN	LENGTH	REMARKS
8	53 1/4 + 300'	Steel deck plate girder	1	23' 00″	
9	55 + 450'	Steel deck plate girder	1	23' 00″	

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		03/10/2012
Bridge No.		1	Mileage		1 1/4 + 1208'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 66' 00" × 1(span) = 66' 00"			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Notice			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Notice			Notice
Comment		The whole bridge gets rusty. The corrosion of the lower flange is severe, and a section loss is seen because clearance under girder is No loss of rivet are seen. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

(Photo2)

(Photo3)

(Photo4)

(Photo5)

(Photo6)

(Photo7)

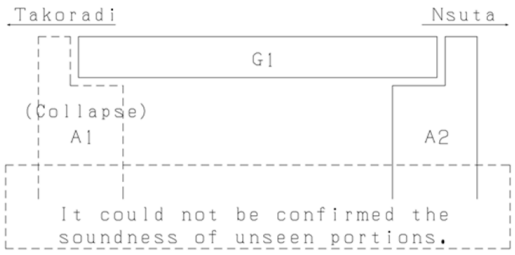
(Photo8)

(Photo9)

(Photo10)

(Photo11)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		10/10/2012
Bridge No.		2	Mileage		19 1/2 + 57'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 20' 00" × 1(span) = 20' 00"			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Notice			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Repair(Partial or All)			Repair(Partial or All)
Comment		Abutment of Takoradi side (A1) is collapsed by scouring. Superstructure was modified by using wood sleepers as substructure. The whole bridge gets rusty. No loss of rivet are seen. No rust fluid is not seen in the superstructures. It is desirable to to remove the girder and to restore the roadbed as the embankment as soon as possible.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

(Photo2)

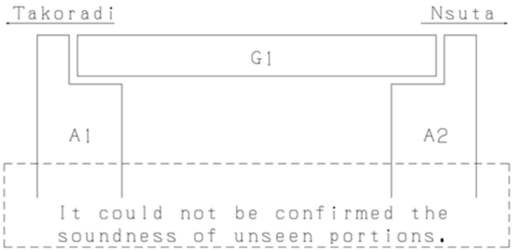
(Photo3)

(Photo4)

(Photo5)

(Photo6)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		11/10/2012
Bridge No.		3	Mileage		29 2/4 + 1099'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 30' 00" × 1(span) = 30' 00"			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Notice			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Notice			Notice
Comment		The whole bridge gets rusty. No loss of rivet are seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

(Photo2)

(Photo3)

(Photo4)

(Photo5)

(Photo6)

(Photo7)

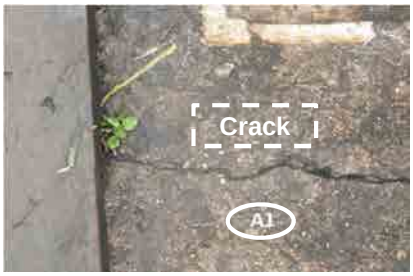
(Photo8)

(Photo9)

(Photo10)

(Photo11)

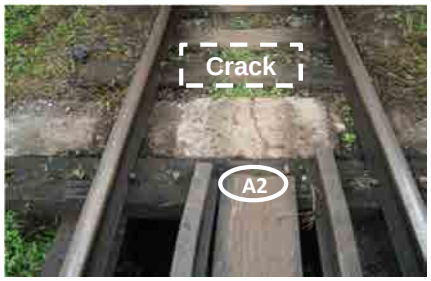
(Photo12)



(Photo13)

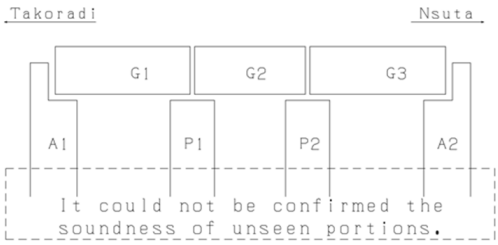
(Photo14)

(Photo15)



(Photo16)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		12/10/2012
Bridge No.		4	Mileage		30 + 932'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel through plate girder 63' 8 3/4" × 3(span) = 189' 26 1/4"			
Type of Substructure		Plain concrete abutment , Plain concrete pier			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1	Girder 2	Girder 3	
		Usual	Usual	Usual	
		Rusty	Rusty	Rusty	
		Corroded	Corroded	Corroded	
		Cracked	Cracked	Cracked	
		Unstable	Unstable	Unstable	
	Handling	Notice	Notice	Notice	
Evaluation of Substructure	Condition	Abut 1	Pier 1	Pier 2	Abut 2
		Usual	Usual	Usual	Usual
		Exposed Bar	Exposed Bar	Exposed Bar	Exposed Bar
		Cracked	Cracked	Cracked	Cracked
		Flaked	Flaked	Flaked	Flaked
		Scoured	Scoured	Scoured	Scoured
		Unstable	Unstable	Unstable	Unstable
	Handling	Notice	Notice	Notice	Notice
Comment		The whole bridge gets rusty. No loss of rovet and splice plate is seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

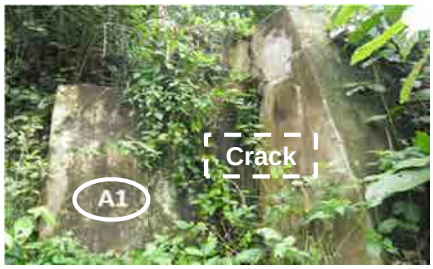
(Photo2)

(Photo3)

(Photo4)

(Photo5)

(Photo6)



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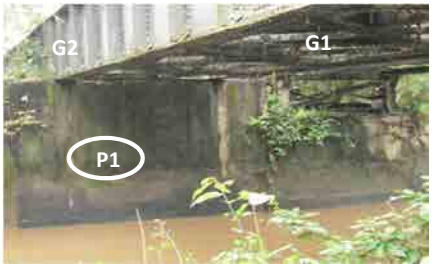

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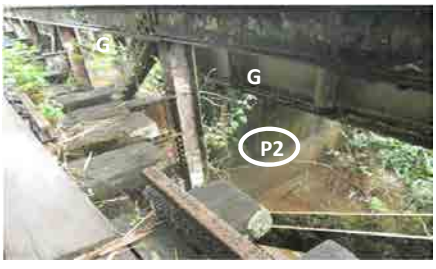
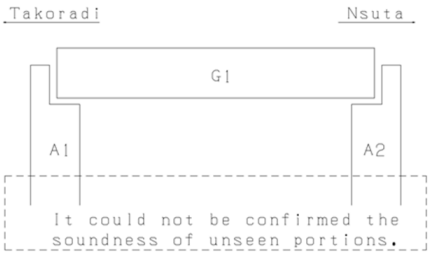


(Photo9)

(Photo10)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		16/10/2012
Bridge No.		5	Mileage		33 + 40'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel through plate girder 63' 00" × 1(span) = 63' 00"			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Notice			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Notice			Notice
Comment		The whole bridge gets rusty. No loss of rivet are seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. Concreat in the front of para-pet by moving shoe is broken. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

(Photo2)

(Photo3)

(Photo4)

(Photo5)

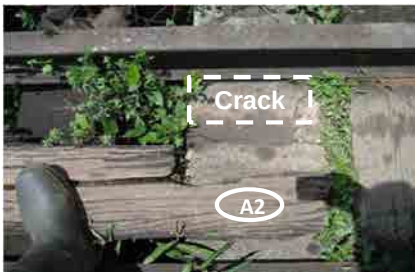
(Photo6)

(Photo7)

(Photo8)

(Photo9)

(Photo10)



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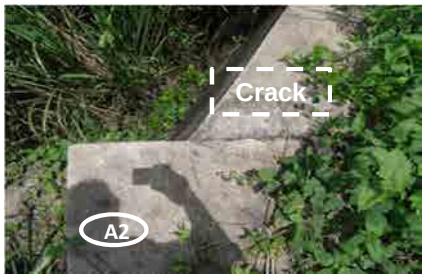
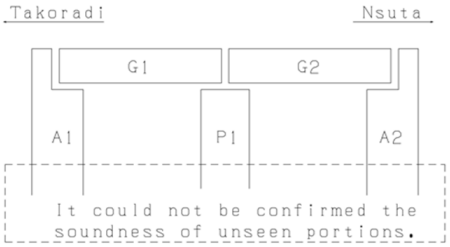


(Photo12)

(Photo13)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		15/10/2012
Bridge No.		6	Mileage		36 + 00'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 29' 8″ × 2(span) = 58' 16″			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1	Girder 2		
		Usual	Usual		
		Rusty	Rusty		
		Corroded	Corroded		
		Cracked	Cracked		
		Unstable	Unstable		
	Handling	Notice	Notice		
Evaluation of Substructure	Condition	Abut 1	Pier 1		Abut 2
		Usual	Usual		Usual
		Exposed Bar	Exposed Bar		Exposed Bar
		Cracked	Cracked		Cracked
		Flaked	Flaked		Flaked
		Scoured	Scoured		Scoured
		Unstable	Unstable		Unstable
	Handling	Notice	Notice		Notice
Comment		The whole bridge gets rusty. No loss of rivet are seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

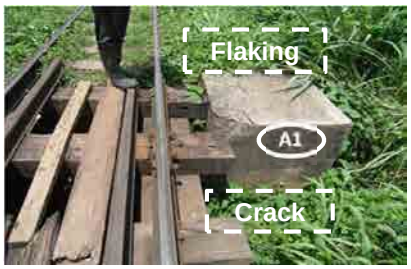
(Photo2)

(Photo3)

(Photo4)

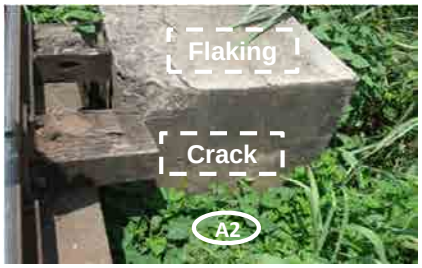
(Photo5)

(Photo6)



(Photo7)

(Photo8)



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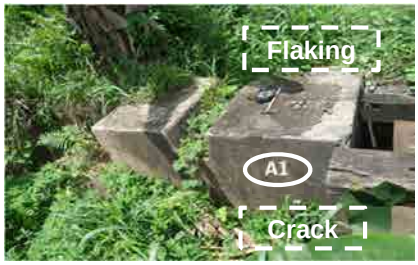


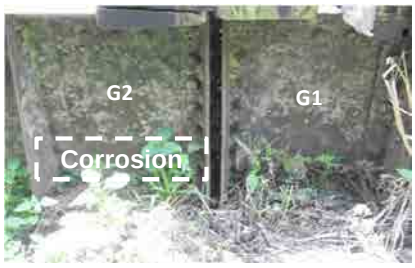
(Photo10)

(Photo11)

(Photo12)

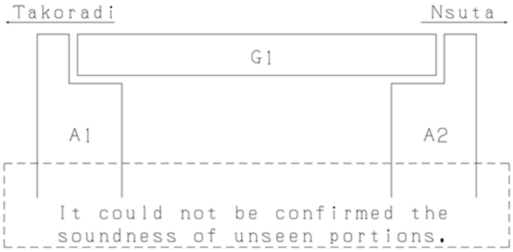
(Photo13)

(Photo14)



(Photo15)

INVESTIGATION RECORD SHEET FOR BRIDGE

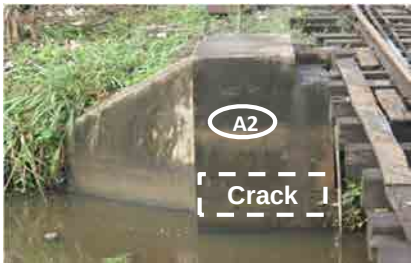
Line Name		Western Line	Date of Survey		12/10/2012
Bridge No.		7	Mileage		37 + 11/12p'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 29'00″ × 1(span) = 29'00″			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Notice			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Notice			Notice
Comment		Since clearance under girder is small, there is a possibility that the girder lower surface is immersed in water during the flood. The whole bridge gets rusty. No loss of rivet are seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

(Photo2)

(Photo3)

(Photo4)



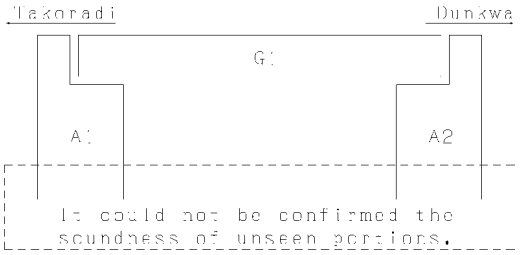
(Photo5)

(Photo6)

(Photo7)

(Photo8)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		18/10/2012
Bridge No.		8	Mileage		53 1/4 + 300'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 23' 00" × 1(span) = 23' 00"			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Nothing			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Nothing			Nothing
Comment		The whole bridge gets rusty. No loss of rivet are seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

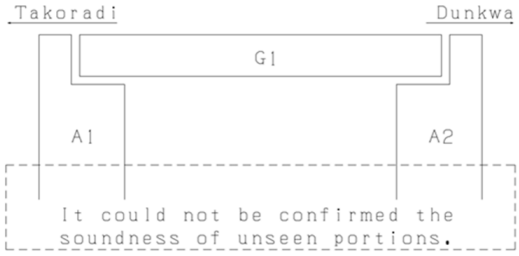
(Photo2)

(Photo3)

(Photo4)

(Photo5)

INVESTIGATION RECORD SHEET FOR BRIDGE

Line Name		Western Line	Date of Survey		18/10/2012
Bridge No.		9	Mileage		55 + 450'
Chief Civil Engineer		William Acken	Inspector	GRCL: Mr.Amissah JICA Study Team: Osamu Ohkawa	
Type of Superstructure (Bridge Length &Number of Spans)		Steel deck plate girder 23' 00" × 1(span) = 23' 00"			
Type of Substructure		Plain concrete abutment			
Photograph					
Diagram					
Evaluation of Superstructure	Condition	Girder 1			
		Usual			
		Rusty			
		Corroded			
		Cracked			
		Unstable			
	Handling	Nothing			
Evaluation of Substructure	Condition	Abut 1			Abut 2
		Usual			Usual
		Exposed Bar			Exposed Bar
		Cracked			Cracked
		Flaked			Flaked
		Scoured			Scoured
		Unstable			Unstable
	Handling	Nothing			Nothing
Comment		The whole bridge gets rusty. No loss of rivet are seen. Big horizontal cracks thought to be the dry shrinkage is seen on the front of para-pet and the skeleton of the A1and A2 abutment. No rust fluid is not seen in the superstructures.			
Overall Evaluation		Level-1 (Ordinary)	Level-2 (Notice)	Level-3(Small Emergency)	Level-4(Large Emergency)

(Photo1)

(Photo2)

(Photo3)

(Photo4)

(Photo5)

(Photo6)

APPENDIX 3

Workshop Attendance List

Workshop on Study for Safety Operation and Management of Railway in the Republic of Ghana
27th September 2012, Accra

No.	Name	Organization	Position
1	Emmanuel Opoku	GRDA	Ag. Chief Exective
2	G.J Bracke	GRDA	Board Member
3	A.A Sadigue	GRDA	Project Director
4	J.E Odotei	GRDA	Board Member
5	Sam K. Barnes	GRDA	Board Member
6	M.K Dzimah	GRCL	Chief Mech/Elect Engineer
7	Emmanuel Toff Gozo	GRCL	Ag.Traffic Engineer
8	William Acken	GRCL	Ag. Chief Civil Engineer
9	Derrick Anedeme	MoFEP	Assistant Economics Officer/Bilateral
10	Benjamin W-Kissi	MoFEP	Officer / Budged Division
11	Francis Mensah	MoFEP	Desk offecer
12	Siisi E Ocrem	MoT	Director M&E
13	Akwasi Prempeh	MoT	Planning and Officer
14	Edward Agbodjan	MoT	Asst. Planning Officer
15	Doreen Anner	MoT	Asst. Director/Administration
16	J.K Fang	Ghana Bauxite Company	General Manager
17	J.K Nsiah	Ghana Bauxite Company	Board Secretary
18	Michele Nemesi	Team Engineering	Ghana Reprehensive
19	Brozio Tonini	Team Engineering	Transport Engineer
20	Y Amoyaw Osei	Team Engineering	Director
21	Konina Out Okhne	Team Engineering	consultant
22	Puneet Kumar	RITES (India)	Group General Manager, Expotech Division
23	A. Jha	RITES (India)	General Manager (T&S)

APPENDIX 4

Workshop Presentation Materials

Workshop in Ghana

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

27 September 2012

JICA Study Team

Table of Contents

1. Workshop agenda

1. Today's Workshop

◆Agenda:

- About Workshop
- Outline of the JICA study

Session 1: Organization and Management

Session 2: Train operation

Session 3: Track

Session 4: Civil structures/Bridges

Session 5: Rolling Stock

- Introduction of Indian railway system on safety operation

Note: The time will be set aside for question and answers after every session.

2. About Workshop

1. Workshop / Objectives

■ **Objective:**

- ➢ Sharing the reorganization of the current situation and the improvement goals with stakeholders
- ➢ Suggestions on setting goals for safety improvement and reinforcing systems

2. Workshop / Main topics

■ **Main Topics:**

- ➢ Current situation and issues of the Western Line (Takoradi – Tarkwa – Dunkwa - Awaso)
- ➢ Introduction of Japanese and Indian railway systems for safety operation
- ➢ Suggestions on setting goals, which the Ghana Railway can actually reach, for safety improvement and reinforcing systems

3. Workshop / Schedule

Date	27th September	
AM	8	
	9	●9:00–9:05 Opening speech : JICA Ghana Office
		●9:05–9:10 Opening speech : GRDA
		●9:10–9:20 Outline of this Study
		●9:20–9:50 Railway operation and organization
	10	●9:50–10:20 Train operation
		●10:20–10:50 Short break
	11	●10:50–11:20 Track
		●11:20–11:50 Civil structures/Bridges
		●11:50–12:20 Rolling stock
	12	●12:20–13:20 Lunch break

3. Workshop / Schedule

PM	13	●13:20-13:30 Speech : JICA India office
		●13:30-15:00 Introduction of Indian railway system on safety operation
	14	
		●15:00-15:30 Q&A
	15	●15:30-15:40 Closing speech : JICA head office Tokyo
		●15:40- Meeting with Ghana government
	16	
Site		JICA Ghana Office (Accra)

3. Outline of the JICA study

1. Tasks of the study

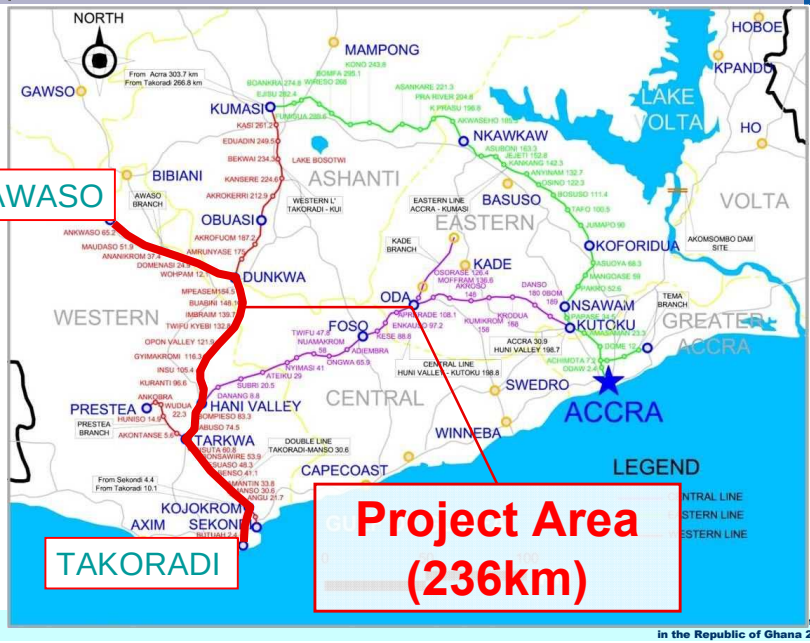
Objective of the Study

- Create appropriate maintenance for railway system
- Reduce of accidents, delay and suspension of train operation

Activities

- To grasp and analyze the present situation of the railway in Ghana
- To set up the improvement goals for maintenance of track and rolling stock
- To update the O&M plan
- To support the implementation of O&M plan

2. Project Area



3. Scope of Work (1)

To Grasp and Analyze the present situation of the railway in Ghana

Grasp, analyze and evaluate condition and deficiency of track bed, track and rolling stock based on analysis of existing data and site reconnaissance for the entire West Line

3. Scope of Work (2)

To set up the improvement goals for maintenance of track and rolling stock

Setting improvement goals

- No accidents due to causes that are the responsibility of the railway
- Reduction of transport disorder (suspension, delay etc)
- Improvement of safety consciousness etc

Holding Workshop

- Sharing the recognition of the present situation and challenges with GRDA/GRCL
- Setting goals for safety improvement and an enforcement system
- Introduction of railway operation in Japan and India

3. Scope of Work (3)

To update the operation and maintenance plan

To Update the O&M plan suitable for present status

- Regulations, method and structure of O&M Plan
- Record and recurrence prevention measures
- Capital expenditure plan

3. Scope of Work (4)

To update the operation and maintenance plan

Conformity of the current system and project

- ENGINEERING MANUAL
- Railway Act, 2008
- GRDA scheme of service
- Regional development projects of Ghana
- Improvement project of the railway facilities
- Modernization and expansion project for the railway network

3. Scope of Work (5)

To update the operation and maintenance plan

Cooperation with other donors' development project

- World Bank
  Organization enhancement of GRDA
- European Development Fund (EDF)
  Rehabilitation of the West Line and North Extension F/S
- Chinese Fund
  Railway Network Extension and Locomotive Procurement
- Others

3. Scope of Work (6)

To support the implementation of operation and maintenance plan

Thorough implementation of the education and training for safe operation and maintenance management

Classification	Training Item
Soft	The measures for human error prevention
	Planning and technique of O&M plan
	Usage of preservation equipment, Planning of maintenance plan
Hard	Planning and Techniques of track maintenance
	Planning and Techniques of track bed maintenance
	Planning and Techniques of bridge maintenance
	Planning and Techniques of rolling stock maintenance

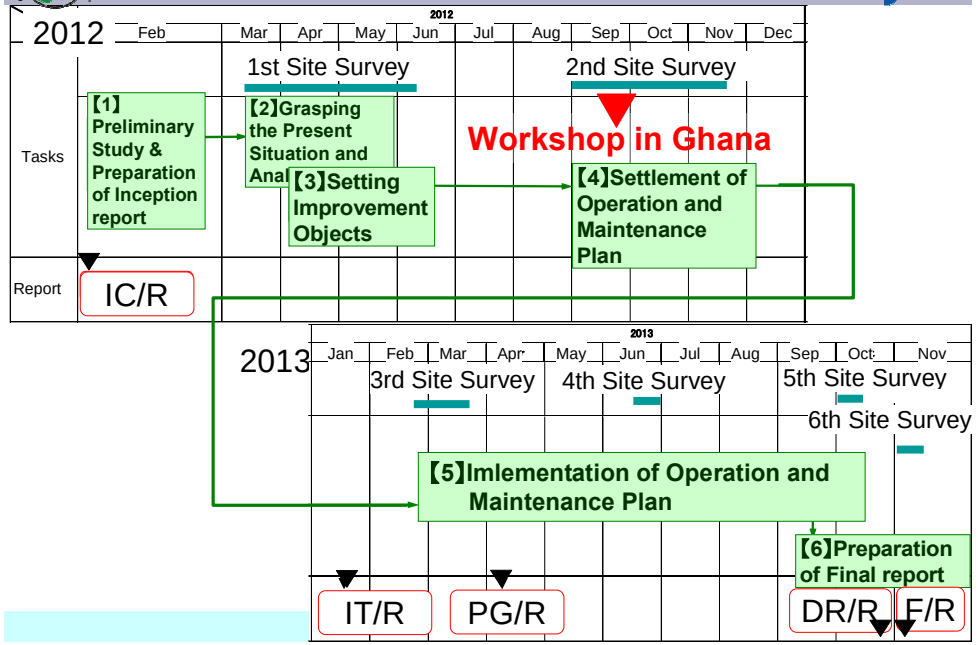
3. Scope of Work (7)

To support the implementation of operation and maintenance plan

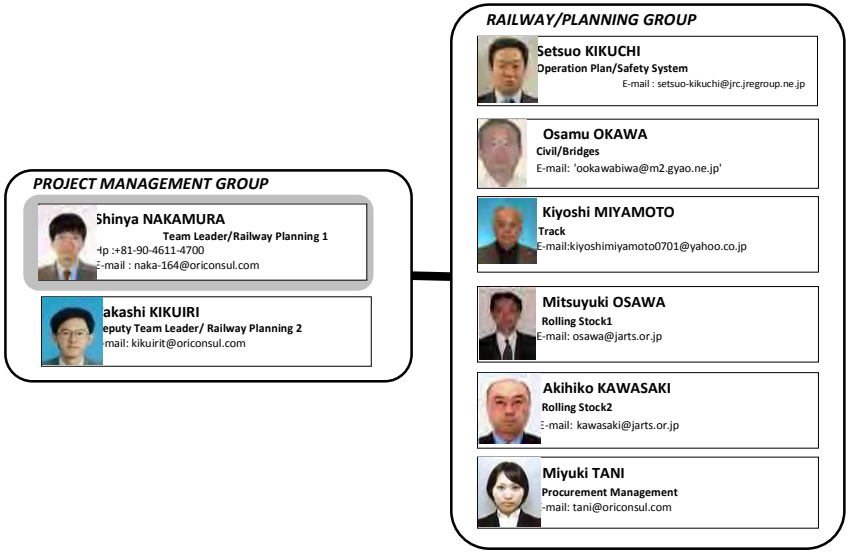
Monitoring and evaluation of the training results based on PDCA Cycle

Plan: Planning how to improve what
Do: Doing in accordance with the plan
Check: Checking and analyzing the contents done
Act: Acting to feedback improvement to the next plan

4. Study Schedule (Feb 2012 to Nov 2013)



5. Study Team Member



Thank you

Japan International Cooperation Agency (JICA)

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

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Japan International Consultants for Transportation Co., Ltd

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

Workshop Session 1
Organization and Management

27 September 2012
JICA Study Team
Deputy Team Leader/Railway Plan 2 : Takashi KIKUIRI

Table of Contents

1. Organization

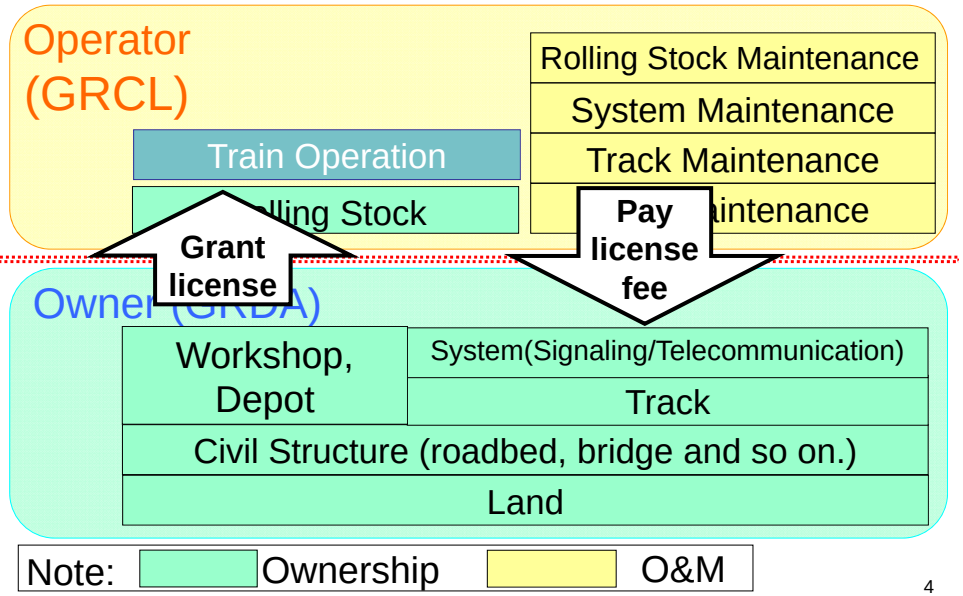
Establishment of Ghana Railway Development Authority (GRDA)

■ 14 Nov., 2008 **Railway Act, 2008 (Act 779)** passed by Parliament

Objective of Railway Act, 2008
"Implementation of Vertical Separation"

GRDA	Asset	Promote the development of railways and railway services
		Hold, administer and improve the railway asset
		Promote the development and management of suburban railways
Operator (GRCL)	Operation	Permission for railway operation
		There are no private companies taking part in operation. GRCL has remained the operator.

Railway Asset Ownership and Operation & Maintenance Scheme "in Ghana (present)"



License of Railway Operation and Service

■**Issue:**

As of 2012, Owner (GRDA) has not granted the license of railway operation and service to Operator (GRCL) yet.

➢ **Operator (GRCL) carry out railway operation and service without the license**

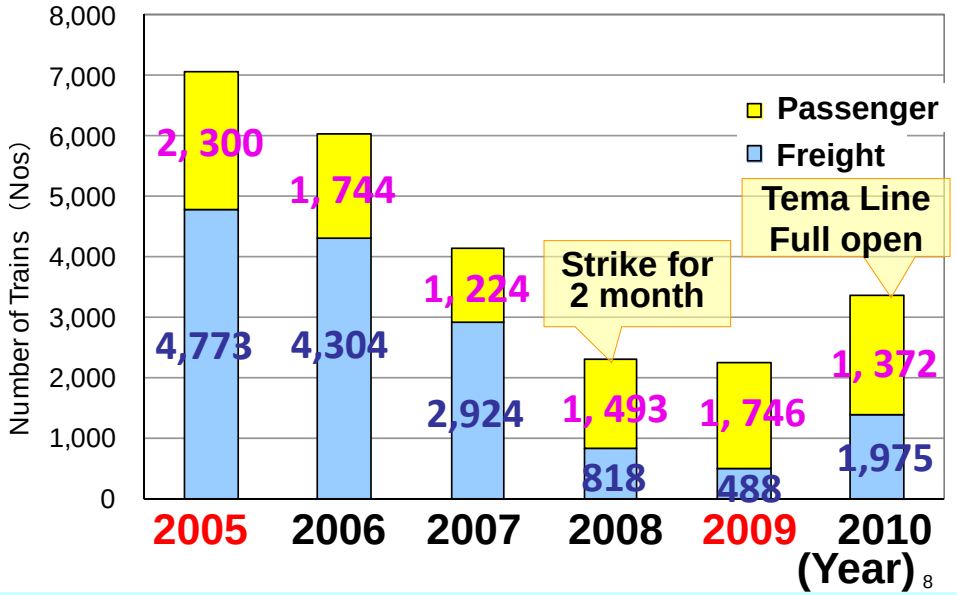
Railway Asset Ownership and Operation & Maintenance Scheme

■**Measures:**

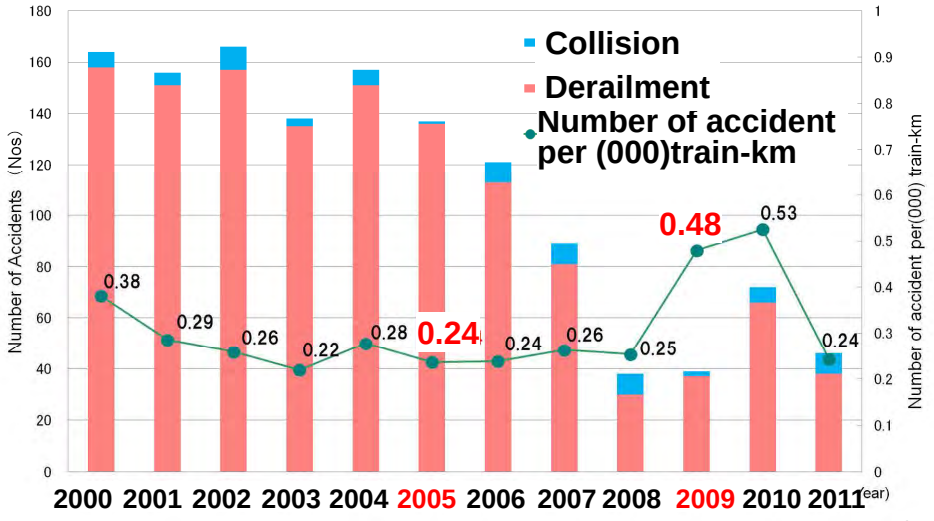
To contract with Operator (GRCL) railway operation and railway service and grant license as soon as possible

2. Budget of the Maintenance

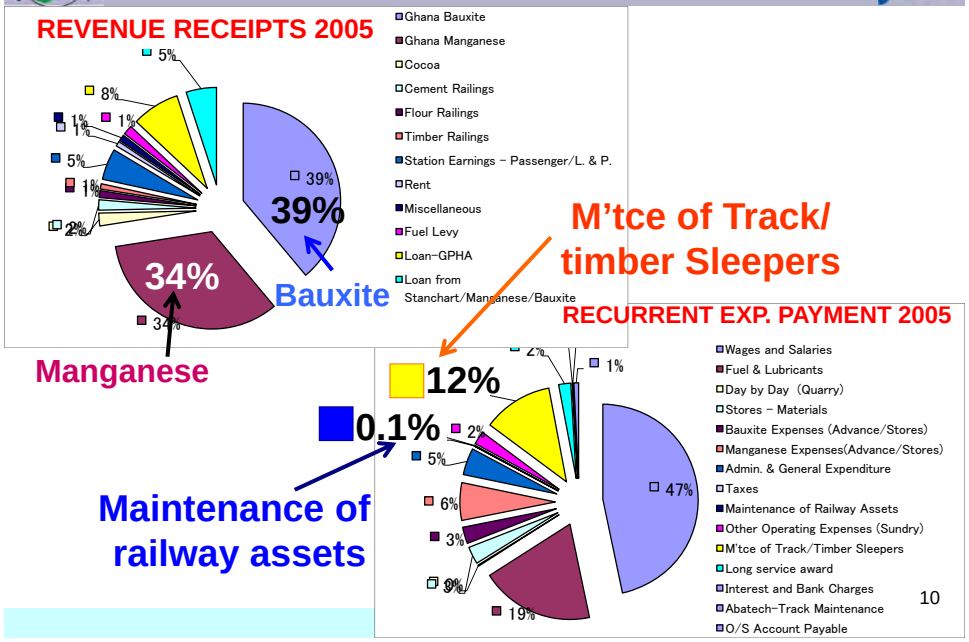
Number of Train Operation



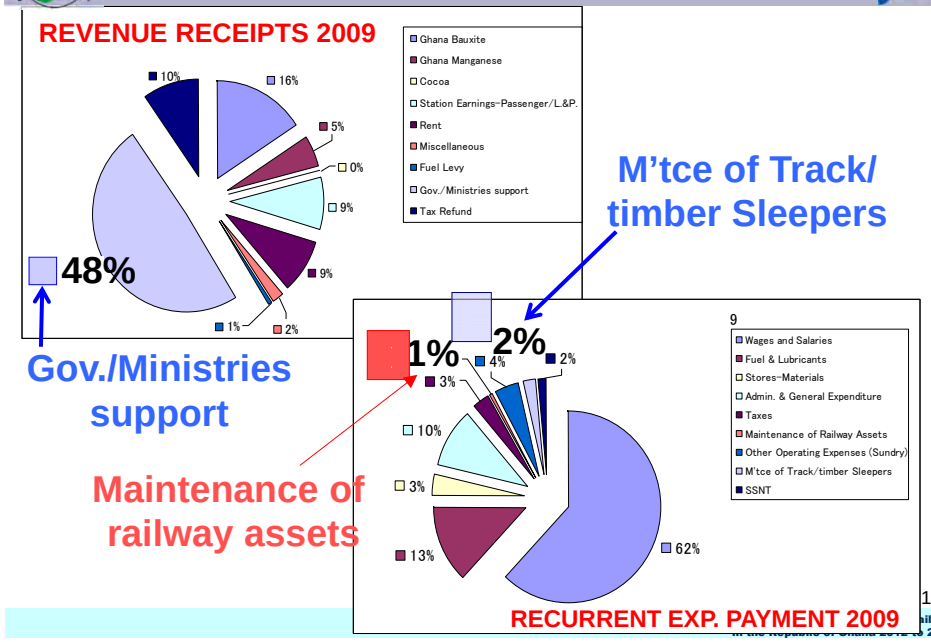
Number of Accidents



Maintenance Cost 2005



Maintenance Cost 2009



Budget Allocation for Maintenance

■**Issue**:

The budget for the maintenance of track/structure/rolling stock is inadequate. This obviously affects spare parts acquisition.

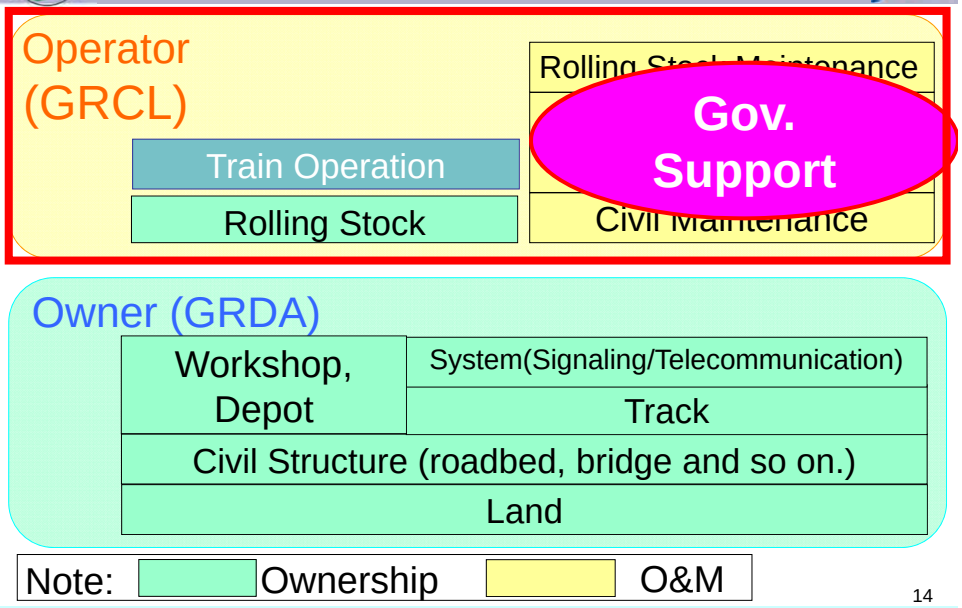
➢ **Accidents happen frequently because of lack of maintenance of aged assets.**

Budget Allocation for Maintenance

■**Measures:**

➢**To invest sufficient budget in maintenance of railway assets. Possibly, the GRDA (Government) should provide subsidy .**

Government Support for Maintenance Cost



3. Procurement Procedure

Procurement Procedure

■**Issue :**

Procurement procedure is complicated.
Operator (GRCL) lacks adequate budget to procure needed spare parts.

- Normal maintenance is delayed.
- Emergency maintenance cannot be done promptly.
- Plant and machinery break often and cannot be repaired.
- Operator (GRCL) is obliged to do cannibalization of assets.

Procurement Procedure

Operator(GRCL)

- Civil Engineering Department
- Mechanical/ Electrical Department
- Signal/ Telecom Department
- Other Department

↓ Procurement Plan

Controller of Supplies (COS)

↓ Check the prices of each items

Procurement Procedure before to get approval

↓

MD (Operator (GRCL))

↓

Ministry of Transport (MoT)

↓

Ministry of Finance and Economic Planning (MoFEP)

NOT approve	Approve
Operator (GRCL) could not procure the items	Procurement process can start

↓

Approval authorities for procurement (Procurement Act, 2003)

Operator(GRCL)

>5,000 Gh₵	> 5,000 ~ 25,000 Gh₵	> 25,000 ~ 800,000 Gh₵	< 800,000 Gh₵
Head of Entity (MD)			
	Entity Tender Committee		
		Ministerial Tender Board	
			Central Review Board

Procurement Procedure

■Measures:

➢To increase amount which Operator (GRCL) can decide to procure.

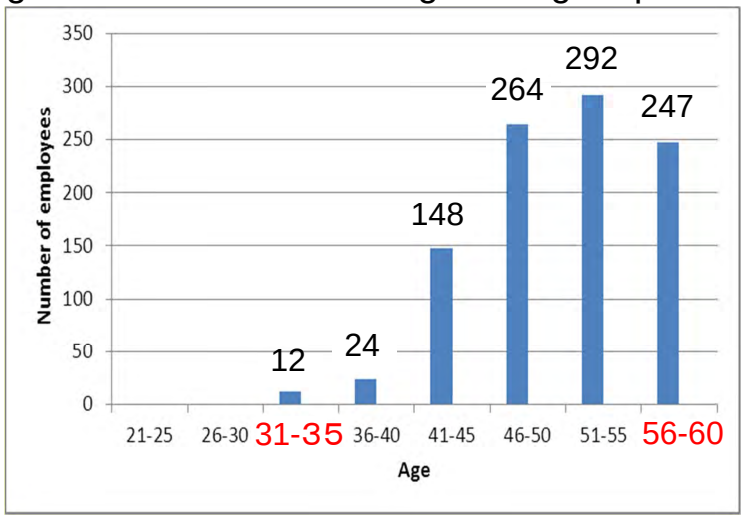
➢To simplify the procurement procedure to make GRCL operation efficient.

- GRCL should improve earning capacity to procure items in good time.
- GRCL should enter into partnership with other private organization.

4. Human Resource

Age Distribution

Age distribution of Civil Engineering department



No Young Generation

■Issue:

There is no younger generation because recruitment is not carried out for a long time and aging of organization is going.

➢ Loss of know-how about operation and maintenance

➢Scatter and Loss of data

Recruit and Training/Education

■Measures:

- ➢ Recruit younger professional to take over know-how from retiring elder professional
- ➢ Training/Education to young generation
- ➢ Dispatch to abroad for training

5. Poorly-motivated Worker

Poorly-motivated Worker

■Issue：

Daily maintenance work such as cutting grass in the track, drainage cleaning is insufficient.

Workers do not fully recognize the importance of daily maintenance work.

➢ Poor motivation of workers is one of the cause of assets aging.

Awareness

■Measures:

- ➢ Awareness training for workers
- ➢ Commendation and Incentive
- ➢ Preparation of daily maintenance work manual

6. Document Management by Conventional Means

Document Management by Conventional Means

■**Issue**:

Documents management is implemented without much use of computer basically by conventional means.

These documents is not unified format.

- **The required information may not be lack.**
- **It is hard to review the past performance statistically.**
- **It may be hard to accumulate and share know-how about train operation and maintenance.**

Report Writing Manual and Recording System

■**Measures:**

- **Preparation of Report Writing Manual**
- **Development of operation and inspection recording system with use of computer**

7. Improvement Goals

Organization

Short Term 2012~2013

- To contract railway operation and service with Operator (GRCL)
- To grant of license to Operator (GRCL)

Budget of Maintenance

Medium Term 2012~2015

- To secure sufficient budget for maintenance

Procurement Procedure

Medium Term 2012~2015

- Development of the scheme that Operator can procure the spear parts and maintenance facilities whenever they need.

Human Resource and Training/Education

Short Term 2012~

- Recruit younger professional
- Training/Education to young generation

Training school in Secondi

Short Term 2012~2013

- **Development of operation and inspection recording system with use of computer**

Thank you

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

Work shop Session 2; Train Operation

September 2012
JICA Study Team
Operation Plan/Safety system expert : Setsuo KIKUCHI

Table of Contents

1. Present Situation of The Railway in Ghana

Present Situation of the Ghana Railway: Train Operation

■ Site Survey at Derailment Points

①MAUDASO～ANKWASO（33M from DUNKWA) 22.MAY2012
②ANGU～KOJOKROM(13M ¾ from TAKORADI) 31.MAY.2012

Analysis of the site situation:

TRACK: **Joints of rails is different between right and left side and bad condition of connection.**

Rolling stock's wheels down at joints of rails and also lack of sleeper direct under the joint case the rolling stock's sink.

ROADBED: **Lack of ballast sleepers end** and **the caved-in are observed.**

Site Survey at Derailment Points

Rolling Stock's movement at derailment points

Irregular rolling happens wagon's right and left side case derailment easily.

Especially curves with severe cant is most dangerous.

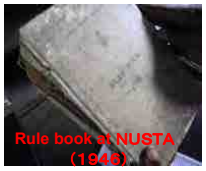
Rules and Regulations

◆GRCL's Rules and Regulations about Train Operation

- Rule Book
- Traffic Manual
- Staff Manual
- Appendix to Working Time Table
- Official Tariff
- Regulation for Train Signalling, Station Account Manual

For more than 40 years have passed after enactment , it is not suitable present situation.

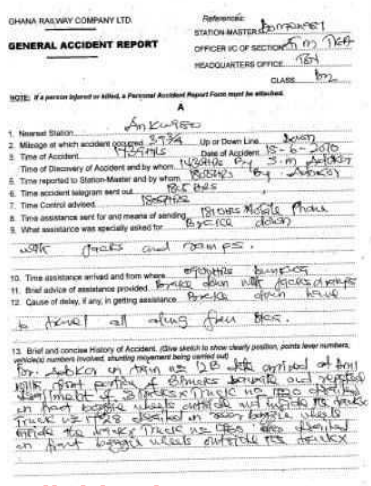
Management regulations is sloppy.



Accidents Records

◆GRCL's accident records obey Accident Manual

- Accident Diary
- Accident Records
- General Accident Report


GHANA RAILWAY COMPANY LTD.

GENERAL ACCIDENT REPORT

All data haven't been digitized

2. Issues and Measures

Issues of Operation Plan/Safety System

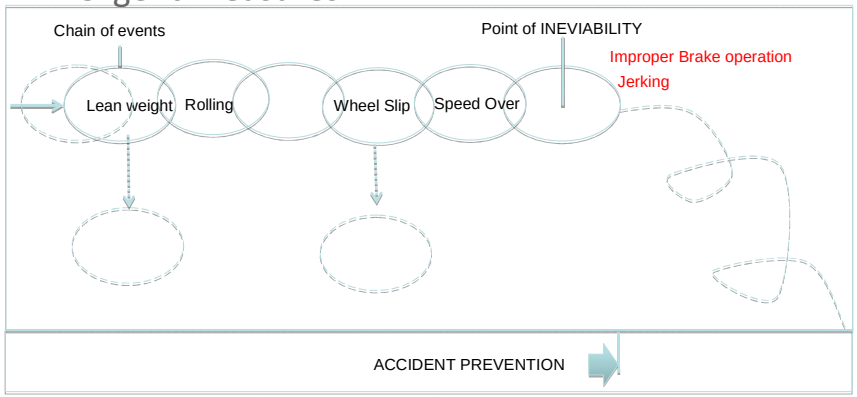
- Defective Track and Civil structures
- Defective Rolling Stocks
- Defective weight measure and weight balance
- Improper Traction capacity

→ ***Rush of Wheel Slip***
Irregular Rolling

WHEEL SLIP

Irregular rolling

Urgent Measures



(source: ICAO Accident Prevention Manual 1984)

Prevention of Wheel Slip

Prevention of Improper Movement

→ **REEXAMINE HAULING CAPACITY**
SAND BOX
WEIGHT MEASURE

3.Japanese System for Securing Safety in Railway

Japanese System for Securing Safety in Railway

Government (Ministry of Land, Infrastructure and Transport: MLIT)

- Standardization of facilities, rolling stocks, and operational handling
- Testing and licensing for power car operators (drivers)
- New and improvement facility inspection
- Regular-basis safety inspection
- On-the-spot investigation and cause finding in case of accident

Railway operator

- Establishment and strict usage of operation manuals
- Education and training of railway personnel in charge
- Maintenance management of facilities and rolling stocks and update of equipment
- Accident report to government and introduction of recurrence preventive measures

Users and general public

- Observance of transportation rules based on the provisions
- Prohibition obstructions including entry or level stone-throwing onto roadway, damage to signals or level crossing facilities by penal regulations
- Prohibition behaviors disturbing order in cars by penal regulations

Ministry of Land, Infrastructure, Transport and Tourism

Japan Transportation Safety Board

Railway Bureau

- Director - General
- Senior Deputy Director-General
- General Affairs DIV
- Trunk Railway DIV
- Urban Railway DIV
- Financial Affairs DIV
- Railway Industries Policy DIV
- Engineering Planning DIV
- Facilities DIV
- Safety Administrator

District Transport Bureau

Railway Department

Ensure the safety of railway

- Approval according to Railway Business
- Security audit
- Implementation of *UNYU management*
- Inspection of railway facilities

<Over view of the inspection 2008Y>

Rolling stock	446
Construction approval for Railway Facilities	1,199
Completion inspection for Railway facilities	141

Audit and Management of Safety Standard

(Source: MLIT HP)

Rules and Regulations

Railway Bureau

- Railway Business Act
- Railway Operation Act
- Ministerial Ordinance to Provide the Technical Standard on Railway
- Technical Regulatory Standards on Japanese Railways
- Explanation of Fire Prevention Standards for Underground Stations
- Environmental Quality Standards for Shinkansen Superexpress Railway Noise
- Nationwide Shinkansen Railway Development Act
- Order for Enforcement of The Nationwide Shinkansen Railway Development Act
- Ordinance for Enforcement of The Nationwide Shinkansen Railway Development Act
- Act on Special Provisions Concerning the Punishment for Conduct Impeding the Safety of the Train Operation on the Shinkansen Railway
- Ordinance for Enforcement of the Act on Special Provisions Concerning the Punishment for Conduct Impeding the Safety of the Train Operation on the Shinkansen Railway
- The Law Concerning Passenger Railway Companies and the Japan Freight Railway Company
- The Amendment to the Law concerning Passenger Railway Companies and Japan Freight Railway Company
- Policy Concerning Matters which the New Companies Must Consider in Conducting Their Business Operations
- The Japanese National Railways Restructuring Law

These are unofficial translations. Only the original Japanese texts of the laws and regulations have legal effect,and the translations are to be used solely as reference material to aid in the understanding of Japanese laws and regulations.

The Japanese date is here.(e-gov system)

(Source: MLIT HP)

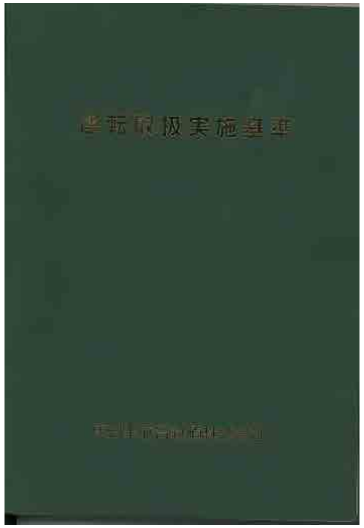
- Railway Business Act
- Railways Operation Act
- Ministerial Ordinance to Provide the Technical Standard on Railway

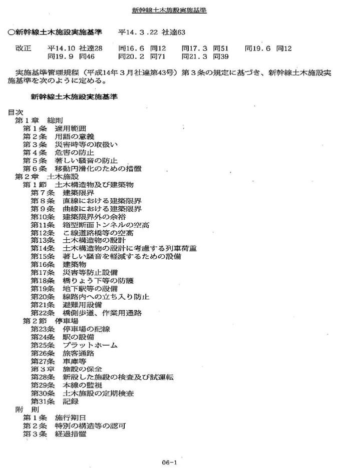
These are the bases of all rules and regulations of the company.

Structure :LAW, Ministerial Ordinance, Regulations of the private company (JR EAST)

Laws 法 律	Ministerial Ordinance 省 令	Regulations of the Private Company 社 内 規 程 等: 実施基準	規程(細則・手続等)
Railway Business Act 鉄道事業法 (鉄道事業等の運営の適正化、利用者の保護等) (Optimization of business management, Protection of the user)	鉄道事業法施行規則 鉄道施設等検査規則 鉄道事故等報告規則 鉄道事業等監査規則 Railway Accident Reporting Rules . .		鉄道施設設計業務実施要領 運転事故報告手続 Railway Accident Reporting Procedures . .
Railway Operation Act 鉄道営業法 (鉄道の建設、車両、運転、係員、運賃等) (Construction, Rolling Stock Train Operation, The person in charge),Fare	鉄道に関する技術上の基準を定める省令 Ministerial Ordinance to Provide the Technical Standard on Railway 動力車操縦者運転免許に関する省令 運転の安全の確保に関する省令	運転取扱実施基準 Handling Train Operation Performance Standards . . 新幹線運転取扱実施基準 (電車等)整備実施基準 車両構造実施基準 軌道施設実施基準 土木施設実施基準 電気設備実施基準 運転保安設備実施基準 運転安全規範	運転作業要領 列車運転速度表 Train Operation Task Procedure . .

■ Private Railway company's Standard





新幹線土木施設実施基準

○新幹線土木施設実施基準　平14．3．22 社達63

改正　平14.10 社達28　同16．6 同12　同17．3 同51　同19．6 同12
同19．9 同46　同20．2 同71　同21．3 同39

実施基準管理規程（平成14年３月社達第43号）第３条の規定に基づき、新幹線土木施設実施基準を次のように定める。

新幹線土木施設実施基準

目次
第１章　総則
第１条　適用範囲
第２条　用語の意義
第３条　災害時等の取扱い
第４条　危害の防止
第５条　著しい騒音の防止
第６条　移動円滑化のための措置
第２章　土木施設
第１節　土木構造物及び建築物
第７条　建築限界
第８条　直線における建築限界
第９条　曲線における建築限界
第10条　建築限界外の余裕
第11条　箱型断面トンネルの空高
第12条　こ線道路橋等の空高
第13条　土木構造物の設計
第14条　土木構造物の設計に考慮する列車荷重
第15条　著しい騒音を軽減するための設備
第16条　建築物
第17条　災害等防止設備
第18条　橋りょう下等の防護
第19条　地下駅等の設備
第20条　線路内への立ち入り防止
第21条　避難用設備
第22条　橋側歩道、作業用通路
第２節　停車場
第23条　停車場の配線
第24条　駅の設備
第25条　プラットホーム
第26条　旅客通路
第27条　車庫等
第３章　施設の保全
第28条　新設した施設の検査及び試運転
第29条　本線の監視
第30条　土木施設の定期検査
第31条　記録
附　則
第１条　施行期日
第２条　特別の構造等の認可
第３条　経過措置

06-1

Japanese System for Securing Safety in Railway : Train Operation

■ Definitions and Types of Railway Operation Accidents

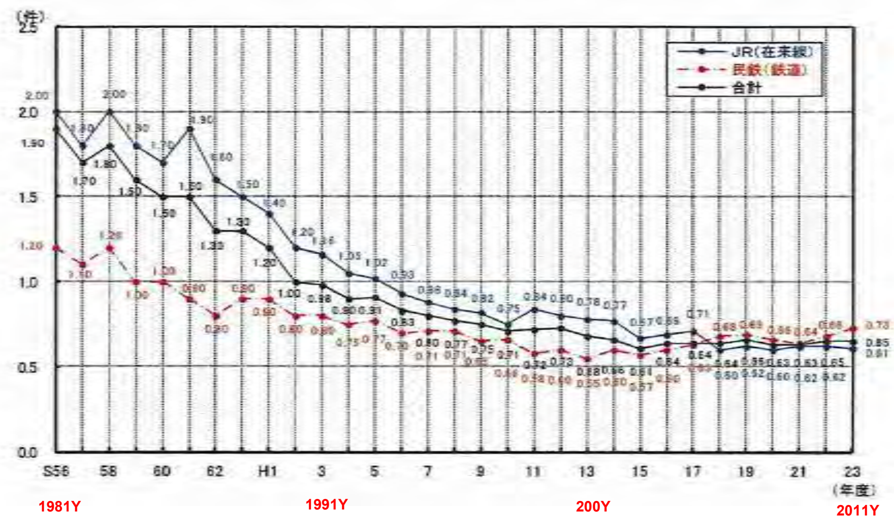
Obligated to immediately report any of accidents listed below to the government

Railway Operation Accident	Transportation Obstruction	Critical Incident
①Train accident **・Train collision** **・Train derailment** **・Train fire** **②Level crossing obstruction accident** **③Human obstruction accident** **④Property damage accident**	**① Delay of passenger train by 30 min. or more** **②Delay of freight train by 1 hr. or more** **③Cancelled operation of train**	**Situation where railway operation accident is likely to occur, including** **・Train moving forward when block handling is incomplete;** **・Another train's route obstruction by driving through signals;** **・Train overrun**

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

Japanese System for Securing Safety in Railway : Train Operation

Railway Accidents in Japan (N/million Km)

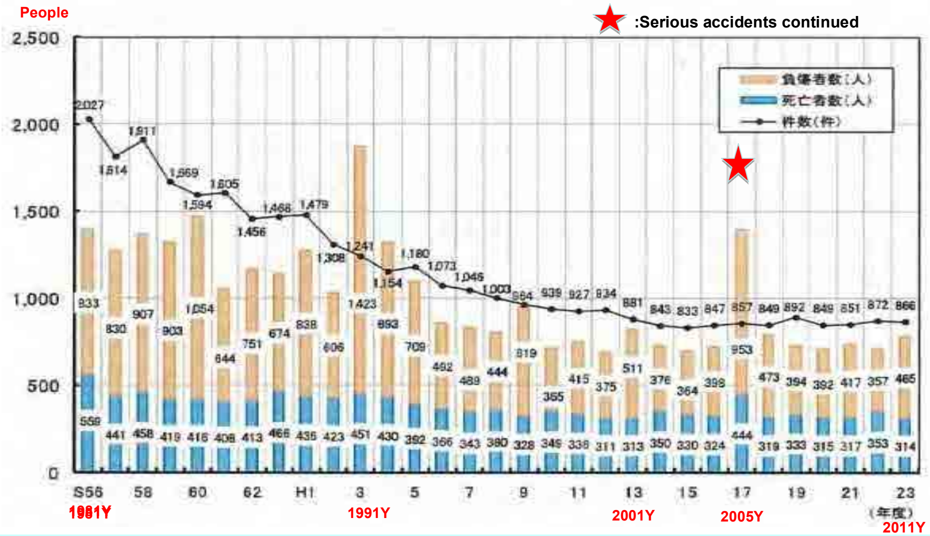


(Source: MLIT HP)

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

Japanese System for Securing Safety in Railway : Train Operation

Railway Accidents and Casualties in Japan



(Source: MLIT HP)

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

Amend The Railway Business ACT

- Introduction of transportation safety management
- Implementation of transportation safety management evaluation

Ensure the safety of railway transportation

Establishment of safety management of Railway Operators

- Creating and notification of SAFETY MANAFEMENT CODE
- Appointment and Notification of THE SAFETY MANAGER and THE OPERATION MANEGER

Monitoring by the User

- Publication of information relating to safety by Government
- Publication of The Safety report by Railway Operators

Government guidance and Supervision

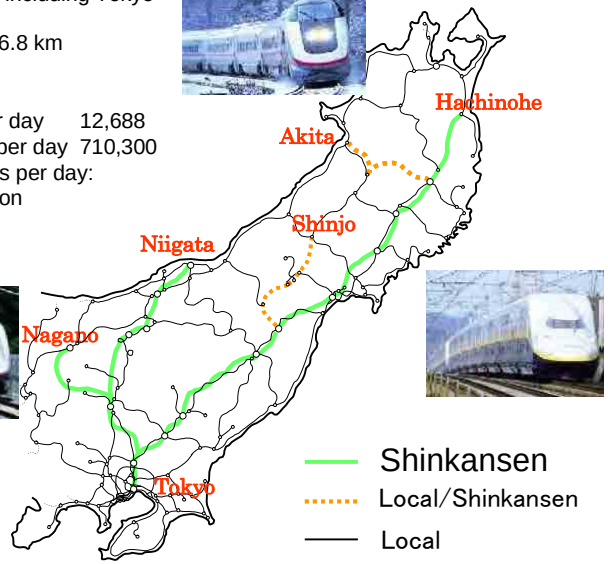
- Change Order of the safety management code
- Dismissal Order of the safety manager and the Operation manager
- Strengthened Penalties

(Source: MLIT HP)

Activities of the private Railway company

JR East Overview

- Service Area: Eastern Honshu including Tokyo
- Number of railway lines: 70
- Passenger Line Network: 7,526.8 km
- Number of stations: 1,705
- Train operations:
  - average number of trains per day 12,688
  - average number of train km per day 710,300
- Average number of passengers per day:
  - (2008) 16.86 million
- Units of Rolling Stock: 13,179
- Electrified lines: 5,512.7 km
- CTC installation: 6,992.1 km



Activities of the private Railway company

Settle on MEDIUM-TERM SAFETY PLAN

2013 Safety Vision Brochure

Overall view of the 2013 Safety Vision

Zero accidents involving passenger injury or fatality, and zero accidents involving employee fatality* (including those employees of both Group and partner companies)

Creating safety cultures
- Establishing JR East Group's safety cultures
- "The Sanpin Principle", "The Three Actualities Principle" as a standard for action
- Returning to the basics of the Challenge Safety Campaign

Our 7 new approaches!
- A focus on safety-related human resource development and system improvements
- The prevention of accidents before they occur through risk assessment

The 4 pillars of our 2013 Safety Vision

Taking concrete steps toward risk reduction
- New risk assessment and countermeasures
- Taking countermeasures against major accidents

Promoting priority improvement plans for safety equipment

Rebuilding our safety management systems
- Developing safety-related human resources
- Improving safety as a whole Group and thorough countermeasures against the three main categories of work-related accidents
- Improving the safety and stability of railway operations

* JR East aims to reduce accidents resulting in employee injury, which amount to approx. 200 accidents per year.

Pursuing "Ultimate Safety Levels"

(Source: JR East Group Sustainability Report 2011)

Activities of the private Railway company

Positively Investment in Equipment

Pursuing "Ultimate Safety Levels"

(Source: JR East Group Sustainability Report 2011)

Activities of the private Railway company

Training : Never Fade Unfortunately Past Accidents

Driving cab simulator

Accident History Exhibition Hall

Pursuing "Ultimate Safety Levels"

(Source: JR East Group Sustainability Report 2011)

Activity of securing safety in Japan

History of securing safety in railway is a trace of persistent efforts with reconsideration of accidents as a lesson

↓

Accident prevention by establishing operation manuals and observing rules

+

Prevention of accidents caused by human error through introduction of mechanization and backup facilities

//

Safety measures with integrated hardware and software

The main point at issues of Operation Plan/Safety System

- **Prevention of Wheel Slip**
- **Prevention of Improper Movement of Wagons**
- **Improvement of Accidents Records**

Thank you

Japan International Cooperation Agency (JICA)

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

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

Workshop Session 3
Track

27 September 2012
JICA Study Team
Track Expert : Kiyoshi MIYAMOTO

Table of Contents

1. Sleepers and Fastenings

Criteria for defective sleeper and fastening(1)

Sleepers(Wooden):

1. Sleepers which are not functional because of the rotten condition.
2. Sleepers of which parts are broken and are not functional because of the past derailment of vehicles.
3. Sleepers which the inside is assumed to be hollow by listening to the sound made when hit with hand hammer.
4. Plug holes - enlarged and not tight

Criteria for defective sleeper and fastening(2)

Fastenings:

1. Fastenings that are missing from the appointed place.
2. Fastenings that rise up from the base of the rail and are not functional as connectors between rail and sleeper.
3. Fastenings that are able to be easily pulled out by hand
4. Fastenings that come loose when hit with a hand hammer.

Defective sleepers

- Broken sleeper by the past derailment of vehicles.

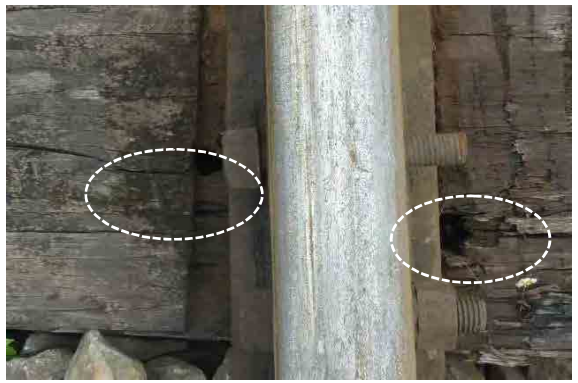
- Rotten sleepers.

Defective Fastenings

- Fastenings that rise up from the base of the rail

- Fastenings that can be pulled up easily by hand

Defective Fastenings (2)



Fastenings that is missing at the appointed place.

Result Example of the Inspection of Defective Sleepers and Fastenings

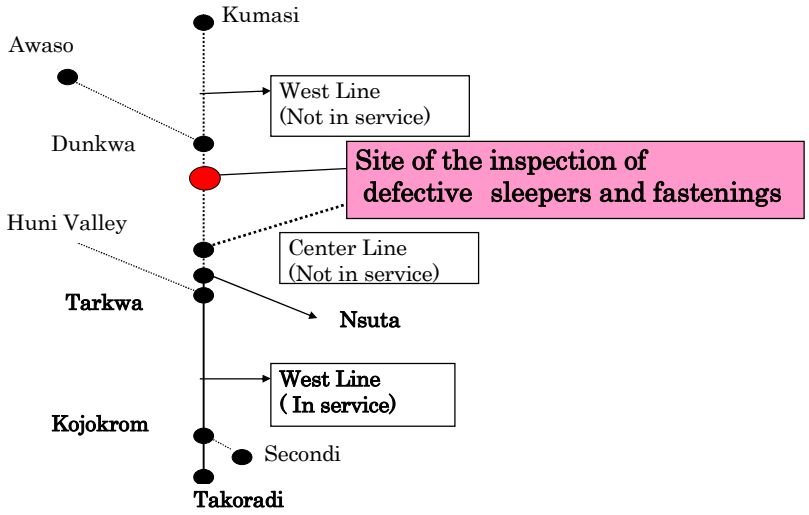
Result Example of the Inspection of Defective Sleepers and Fastenings （Imbraim～Buabin Section）

Defective Sleeper : ⊗

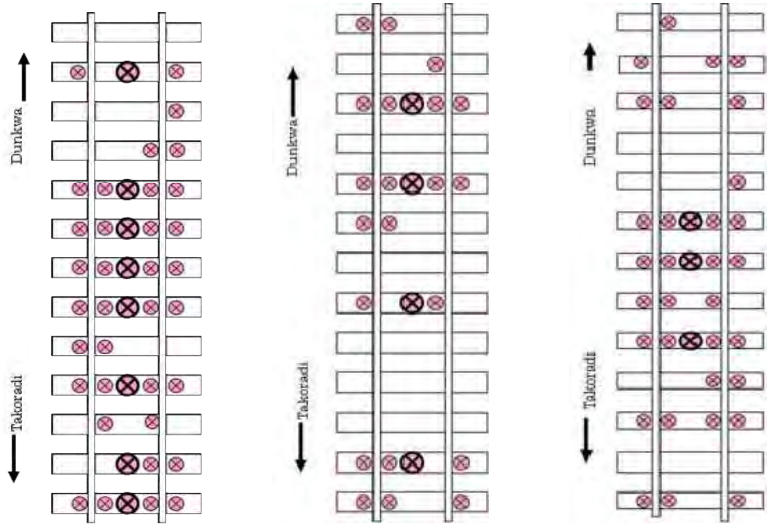
Defective Fastening : ⊗

Sound Sleeper and Fastening : Nothing

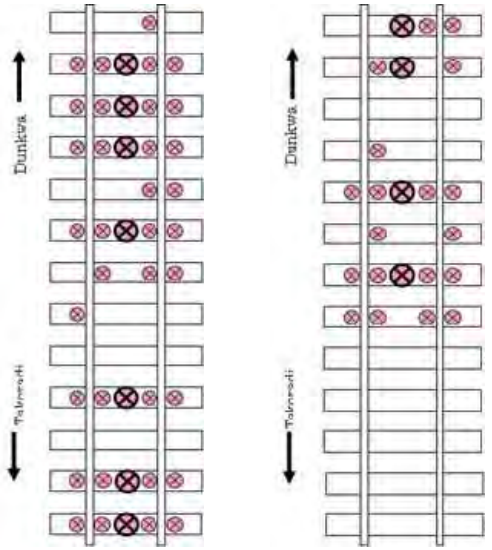
Site of the Inspection of Defective sleepers and Fastenings



Drawing of defective sleepers and fastenings (1)



Drawing of defective sleepers and fastenings (2)



Ratio of defective sleepers=43% (26/60)

Ratio of defective fastenings=59% (141/(60×4))

Japanese standard
Defective sleeper : ≤7%
Defective fastening: ≤5%

Current condition and recommendation (1)

Current condition

- Visual inspection by GRCL staff – Not enough

Recommendation

- Establishment of standard for defective sleeper and fastening
- Periodical inspection (Once a year- Japanese Standard)
- Make drawings for controlling defective materials.
- This action should be carried out as soon as possible Between Takoradi and Nsuta .

Level of Urgency ★★★ (Urgent)

Current condition and recommendation (2)

Current condition

- Regular maintenance postponed due to lack of materials

Recommendation

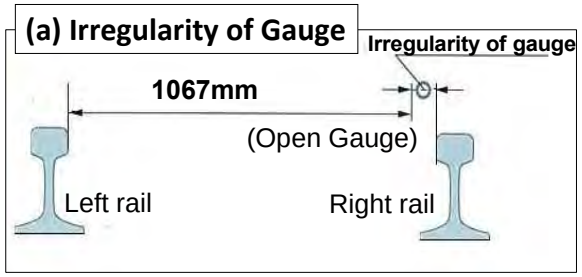
- There must be adequate materials to make regular maintenance possible .
- Immediate action must be taken to repair the Takoradi-Nsuta section which is currently operational.

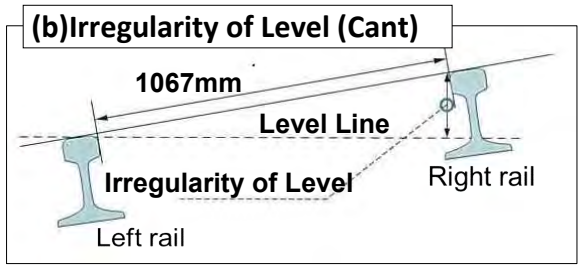
Level of Urgency ★★★ (Urgent)

Track Irregularity

2 . Track Irregularity

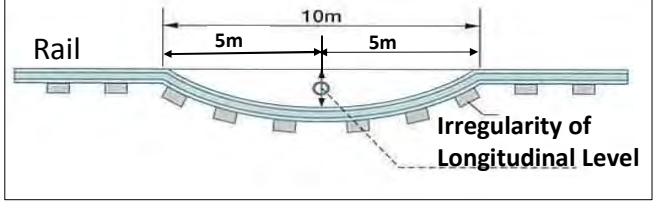
Irregularity of Track (1)



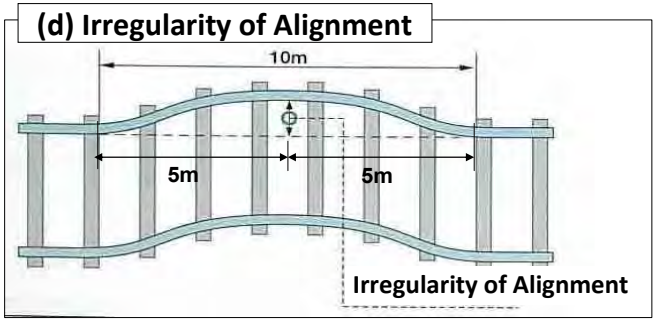


Irregularity of Track (2)

(C)Irregularity of Longitudinal Level

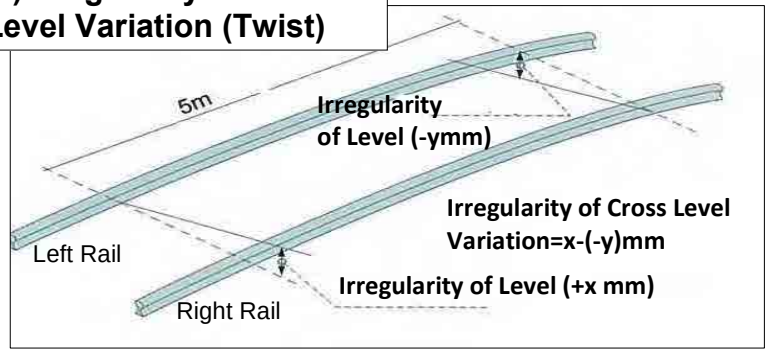


(d) Irregularity of Alignment



Irregularity of Track (3)

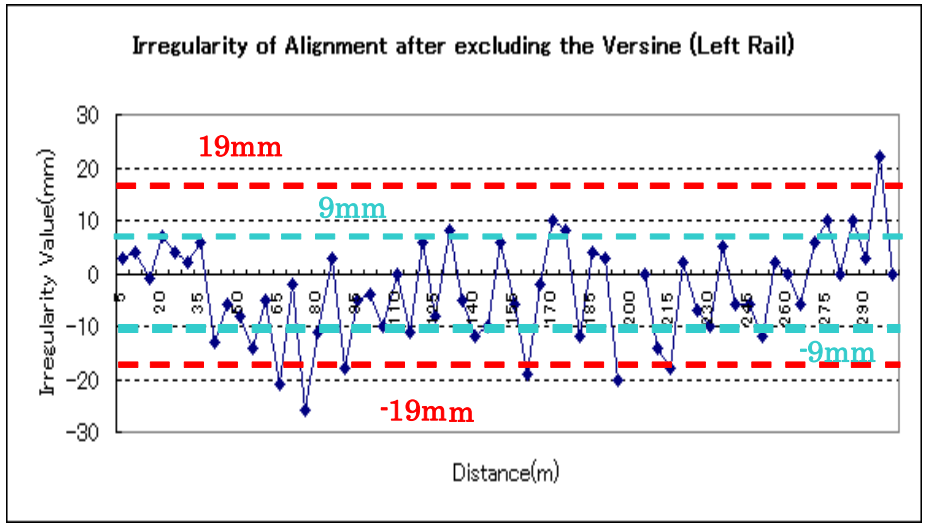
(e) Irregularity of Cross Level Variation (Twist)



Twist=(x-(-y)) /5m=(x+y) /5m

Measuring the track irregularity

Irregularity of Alignment of the site between Bonsawire and Nsuta (27/Apr./2012)



Standard of Maintenance Limit Decided by Japan Railway (1)

Kind of irregularity	gauge	Level	Longi-tudinal Level	Align-ment	Cross Level variation
Tolerable Limit For Regular maintenance	+6 - 4	±9			———
Tolerable Limit for Urgency	———	———	±19		±18

Standard of Maintenance Limit Decided by Japan National Railway (2)

Tolerable Limit of Track Irregularity for Regular Maintenance

(Remark)
- When the track irregularity is over the blue dotted line, maintenance work has to be done at some time
- Maintenance work result is reported by ordinary channels

Standard of Maintenance Limit Decided by Japan Railway (2)

Tolerable limit of track irregularity for urgency

(Remark)
- When the track irregularity is over the red dotted line, maintenance work has to be done immediately within three weeks
- The maintenance work result has to be reported to the director of maintenance section of area control branch division.
- If maintenance work is not carried out within three weeks, train speed has to be reduced.

Current condition and Recommendation (1)

Current condition

- Visual Inspection by GRCL staff.- Not enough
- Tolerable track irregularity limit is not clear.

Recommendation

- Establishment of the tolerable track irregularity standard (It is preferable to adopt the standard of Japanese 3rd class line for the time being.)
- Periodical inspection to measure track irregularity (4 times a year - Standard of Japanese 3rd class line)

Level of Urgency ★★★ (Urgent)

Current condition and Recommendation (2)

Current condition

- Regular maintenance postponed due to lack of fund.

Recommendation

- There must be adequate funds to make regular maintenance possible.
- Immediate action must be taken to repair the Takoradi-Nsuta section which is currently operational.

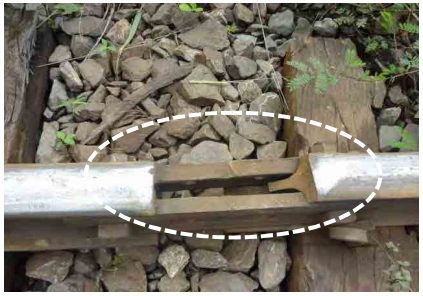
Level of Urgency ★★★ (Urgent)

Other Issues and measures

3. Other Issues and measures

Defective rails

Wheel burn (Kojokrom ～ Angu section)



Joint gap is wider than 100mm, and end of right side rail is chipped(Kojokrom ～ Angu section)

Rail Joint and Condition of Ballast and Formation

The rail joint structure is not correct (Dunkwa～ Awaso section)

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

Current condition and recommendation (1)

Current condition

(Rail)
Wheel burns are found on the top of rail in several sections.

Recommendation

(Rail)
Wheel burns have to be eliminated as soon as possible by changing to new rail.

Level of Urgency ★★★ (Urgent)

Current condition and recommendation (2)

Current condition

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

Recommendation

(Rail Joint)
Pull back rail and insert full length rail or more than 5m length rail (-Japanese standard).

Level of Urgency ★★ (Moderate)

Current condition and recommendation(3)

Current condition

(Ballast and Formation)
1.Ballast under the sleeper is too short and width of formation is insufficient at several locations.

Recommendation

(Ballast and Formation)
1.The study of these locations has to be carried out.
2. In the section of Takoradi～Nsuta. The study has to be carried out as soon as possible
3. If defective locations are found, suitable counter-measure has to be implemented as soon as possible.

Level of Urgency ★★★ (Urgent)

Proposed Equipment for Keeping the Acceptable Maintenance Level

4. Proposed Equipment for Keeping the Acceptable Maintenance Level between Takoradi and Nsuta

Equipment for Inspection

	Equipment for inspection	
Item	Measurement device for gauge and level irregularity	Block of Measuring for Longitudinal level and alignment irregularities
Purpose	Measurement of track irregularity	Measurement of longitudinal level and alignment irregularities
Required quantity	4 set (2 set to each DST)	8 pieces (4 pieces to each DST)
Cost	JPY 280,000 (1 set is JPY 70,000)	(It is possible to make the same block equipment in Ghana)

DST: District Superintendent of Track (Takoradi and Tarkwa DST)
JPY: Japanese Yen

The Machine for Conveyance and Maintenance

	The machine for conveyance	The machine for maintenance	
Item	Gang Trolley with crane	Tie Tamper	Generator for tie tamper
Purpose	Conveyance of track materials.	Maintenance for track	Power source of the tie tamper
Required quantity	2 gang trolleys (1 gang trolley to each DST)	2 set (1 set to each DST)	2 set (1 set to each DST)
Cost	Tens of millions of JPY	JPY 1.8 million (1 set is JPY 0.9 million)	JPY 0.8 million (1 set is JPY 0.4 million)

DST: District Superintendent of Track (Takoradi and Tarkwa DST)
JPY: Japanese Yen

Measure for Gauge with Sprit Level

Gang Trolley

Tie Tamper and Generator

Tie Tamper

Generator

Thank you

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

Workshop Session 4
Civil Structures / Bridges

27 September 2012
JICA Study Team
Civil / Bridge Expert : Osamu OKAWA

Table of Contents

1. Present Situation of Civil Structures / Bridge

Number of Bridges in Relation to the Construction Years

Structure \ Generation	1901	1922	1923	1927	1945	1949	1954	Ignorance
Over head conc./steel	0	0	0	1	0	0	1	1
Girder/Steel	0	0	0	0	0	1	0	0
Steel	0	1	0	0	0	0	0	1
Rivet(Abandoned)	0	1	0	0	0	0	0	0
Rivet Weded Plate	1	1	11	0	8	0	0	3
Con.	0	1	0	0	0	0	0	0
Rivet Steel Joint	0	1	0	0	8	0	0	1
Weded Plate	0	0	0	0	5	0	0	0
Trust Girder	0	0	0	0	2	0	0	0
Total	1	5	11	1	23	1	1	6

Number of Culverts in Relation to the Construction Years

Structure \ Generation	1916-1920	1921-1925	1926-1930	1931-1935	1936-1940	1941-1945	1946-1950	1951-1955	1956-1960	1961-1965	1966-1970	1971-1975	1976-1980
Concrete Box	0	56	0	0	1	102	36	72	6	19	11	8	0
Concrete Pipe	0	15	0	0	0	113	4	2	2	1	2	1	1
Concrete Drain	0	6	0	0	0	0	0	2	0	0	0	0	0
Concrete Arch	0	22	0	0	0	0	5	11	1	1	1	1	0
Underground Subway	0	1	0	0	0	0	0	1	0	0	0	0	0
Armco Pipe	0	49	0	0	1	9	6	10	5	8	6	2	0
Pipe Culvert	0	4	0	0	0	0	0	0	0	0	0	0	0
Steel Pipe	0	40	0	0	0	3	9	18	2	1	0	2	0
Earthen Ware	0	3	0	0	0	0	0	0	0	0	0	0	0
Total	0	196	0	0	2	227	60	116	16	30	20	14	1

Superstructure

Steel Bridge in the Suburbs of Butuah

Corrosion

Steel Bridge in the Suburbs of Butuah

Section loss

Soil deposits

Steel Bridge in the Suburbs of Manso

Corrosion

Corrosion

Steel Bridge in the Suburbs of Manso

Corrosion

Corrosion

Japanese Steel Bridge
26 years after painting,
but still good condition

Substructure

Box Culvert in the Suburbs of Butuah

Crack Flaking

Crack

Situation of Collapse of the Abutment in the Suburbs of Manso

Collapse

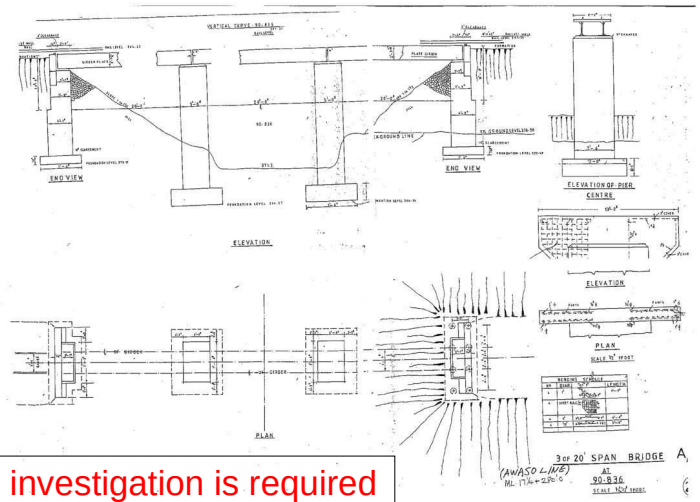
Flaking

Crack

Crack

Scouring

Structural Drawing of the Bridge



Soil investigation is required for bridge design

Drainage

Situation of Problems with Drainage due to Accumulated Soil and Garbage Deposits

Accumulated soil

Situation of Problems with Drainage due to Accumulated Soil and Garbage Deposits

Accumulated soil

Deposit of garbage

Banking and Cutting

In the Banking Area, Cracking and Landslides

Cracking and landslide

In the Banking Area, Deep Landslide Collapse

Deep landslide collapse

In the Cutting Area, Landslide Soil and Rock

Landslide soil

Landslide rock

2. Issues and Measures

Superstructure

Measures

- Watch the progress of the rust and the situation of encrustation and deposits regularly.
- Remove the rust and repainting with durable materials.
- Remove the soil and garbage deposits in the shoes.
- Remove the loose rivets and replace them with high tensile bolts.

Level of Urgency

☆☆☆ (Measures must be carried out urgently)

Substructure

Measures

- Watch flaking of concrete and progression of crack.
- Hit the surface of the concrete with a hammer and determine the degree of floating.
- Strengthen visual checks on the abutment (collapse) of Manso.

- For the abutment of Manso, construct a temporary support and pile sand bags to prevents the inflow of water.
- For cracks and flaking of the concrete, carry out the injection method.

Level of Urgency

☆☆☆ (Measures must be carried out urgently)

Drainage

Measures

- Remove of accumulating soil in the station yard outside.
- Repair of the broken drainage system and improve water flow.
- Dig out the drains filled with soil and revive the function of the drainage system.
- Remove garbage in the drainage system regularly.

Level of Urgency

☆☆☆ (Measures must be carried out urgently)

Banking and Cutting

Measures

- Watch for defects in the banking and cutting and signs of collapse regularly.
- Watch for defects in the banking and cutting immediately after heavy rain.
- When there is a risk of the collapse, the train service must be limited.

- In the banking area, infiltrated water must be prevented from entering the banking.
- In the cutting area, remove the risk of the collapse beforehand.

Level of Urgency

☆☆☆ (Measures must be carried out urgently)

3. Recommendations

- Judgment of the structure diagnosis by Japanese standards.

↓

- The kinds of measures include:

① Watching ② Repair, Reinforcement ③ Restrictions

④ Reconstruction

(Reference1) Judgment Division of the State of the Structure and a Standard Diagnosis

Diagnosis		State of the structure
A		Threatened security to safe driving, to travelers, the public and normal service of the train; or the fear of deformation
	AA	**There is deformation threatening the security of driving, the travelers, the public and normal service of trains that urgently needs attention.**
	A1	There is gradual deformation, and the stability of the structure is declining, which might be further affected by heavy rainfall, 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 level A.
C		Slight deformation.
S		Normal condition.

(Reference2) Relationship Standard Diagnosis and the Degree of Deformation

Diagnosis		Influence on security such as driving preservation, travelers and the public	Degree of Deformation	Measures
A	**AA**	**Threatened**	**Serious**	**Implement measures urgently**
	A1	Threats in the near future Threats at the time of action of the external force at abnormality	Deformation in progress with decline in performance	Implement measures Immediately
	A2	Threats in the future	Deformation with the fear of decline in performance	Implement measures at some stage
B		It will become diagnosis A if it progresses	It will become diagnosis A if it progresses	Observation if necessary
C		There is no influence under the present condition	Minimal	Investigate at the time of inspection as needed from time to time
S		There is no influence	Nothing	Nothing

Recommendations

- Considering luck of budget and rehabilitation in near future using Chinese fund
  ① Watching ② Repair, Reinforcement and
  ③ Restrictions
  must be carried out as first measures.
- Establishment of Reporting Format

Specific Examples

① Watching
: Measuring cracks with crack gauge
: Measuring structure slant with level gauge
: Measuring thickness of steel materials with calipers

② Repair, Reinforcement
: Removing the rust with a rust collecting electric tool and painting
: Reinforcement using steel plate
: Enlargement of foundations

③ Restrictions
: Speed and Weight

List of Instruments

①Check tools

Calipers: Measure thickness of steel material

Crack gauge: Measure quantity of displacement of cracking in the concrete structure

Laser distance meter: Measure span of bridge

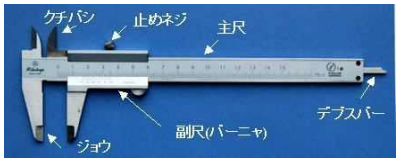
Rust collecting electric tool : Remove rust

Level gauge: Measure level

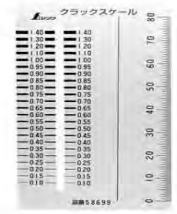
②Recording tools

Camera

Instruments
(Target : Current operating section Takoradi to Nusta)



Calipers(n=3)



Crack gauge(n=5)

Rust collecting electric tool(n=3)

Level gauge(n=5)

Laser distance meter (n=2)

The system of the inspection

Spanner man

↓

Superintendent of tracks

← Report the problem

↓

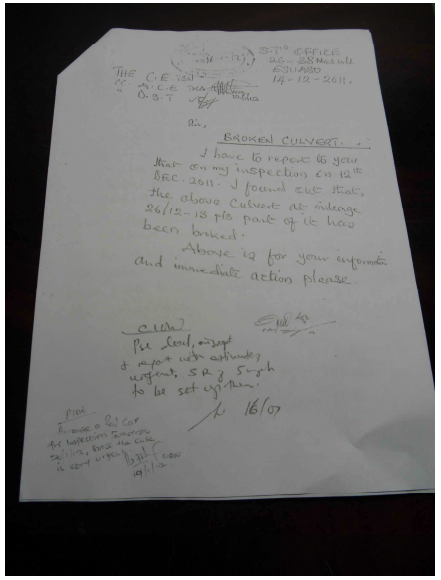
Chief inspector of works

- Report the details of the inspection
- Report the necessary materials, equipment

↓

Chief civil engineer

Report of the inspection



Formatting and digitalization are necessary