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NO 52

JAPAN INTERNATIONAL COOPERATION AGENCY
ROAD DEVELOPMENT AUTHORITY
MINISTRY OF HEALTH, HIGHWAYS
AND SOCIAL SERVICES

MASTER PLAN STUDY ON BRIDGE DEVELOPMENT IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

BRIDGE INSPECTION, MAINTENANCE AND REHABILITATION GUIDELINE

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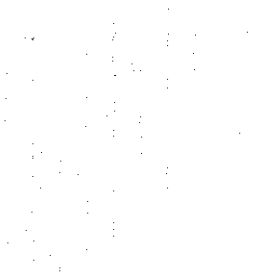

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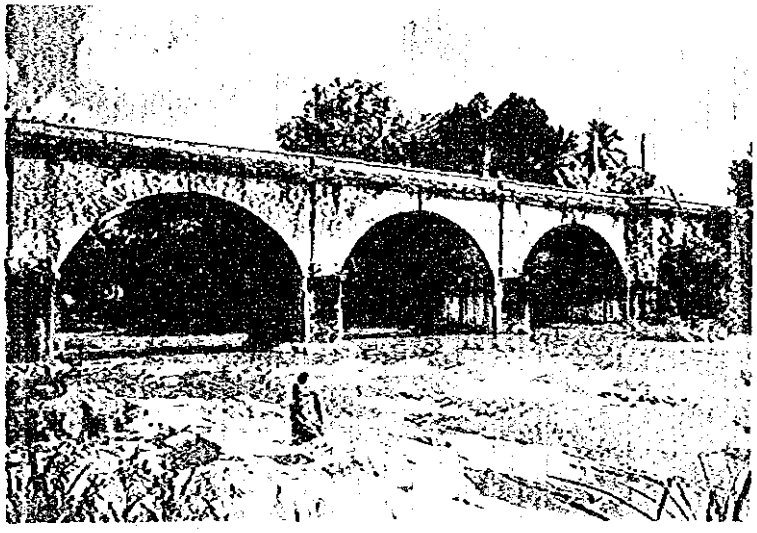

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BRIDGE INSPECTION, MAINTENANCE AND REHABILITATION GUIDELINE

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Abbreviation

AASHTO	:	American Association of State Highway and Transportation Officials
ADB	:	Asia Development Bank
Admin.	:	Administration
ADT	:	Average Daily Traffic
ARCH/BR	:	Brick Arch Bridge
ARCH/CO	:	Concrete Arch Bridge
ARCH/S	:	Steel Arch Bridge
ARCH/ST	:	Stone Arch Bridge
BAILEY	:	Bailey Bridge
Br.	:	Bridge
BS	:	British Standard
CAUSEWAY	:	Causeway Bridge
Con.	:	Concrete
Const.	:	Construction
Cov	:	Cover
DD	:	Detailed Design
Dept.	:	Department
E.E.	:	Executive Engineer
F/S	:	Feasibility Study
JICA	:	Japan International Cooperation Agency
JIS	:	Japanese Industrial Standard
MMC	:	Maintenance Management & Construction Division
N.A.	:	Not applicable
No.	:	Number
Nos.	:	Numbers
ODA	:	Official Development Assistance
OECF, OECFJ	:	Overseas Economic Cooperation Fund, Japan
PSC/POS	:	Prestressed Posttentioned Concrete Beam
PSC/PRE	:	Prestressed Pretensioned Concrete Beam
RCB	:	Reinforced Concrete Beam (Bridge)
RCC	:	Reinforced Concrete
RCDC	:	Road Construction and Development Corporation
RCS	:	Reinforced Concrete Slab (Bridge)

Rd.	:	Road
RDA	:	Road Development Authority
RECONST	:	Reconstruction
RED, Red	:	Re-decking
RC/BOX	:	Reinforced Concrete Box Culvert
Rs.	:	Rupees
RSJ/BUC	:	Buckle Plate over Rolled Steel Joist
RSJ/COR	:	Corrugated Plate over Rolled Steel Joist
RSJ/DEC	:	Deck Plate over Rolled Steel Joist
RSJ/RCS	:	Reinforced Concrete Slab over Rolled Steel Joist
RSJ/T	:	Timber Deck over Rolled Steel Joist
RST/BUC	:	Buckle Plate over Steel Girder
S/W	:	Scope of Works
SER. Ser.	:	Serial
SETT	:	Settlement
SPT	:	Standard Penetration Test
ST. TR/D	:	Steel Deck Truss
ST. TR/T	:	Steel Through Truss
STONE	:	Stone Bridge
TIMBER	:	Timber Bridge
UK	:	United Kingdom
VOC	:	VehicleOperation Cost
W	:	Width
WB	:	World Bank

CHAPTER 1 PREFACE

1.1 General

Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka ") is a peach-shaped island country of a total land area of 66,400 km^2 and consists of nine provinces.

Under the British rule from 1796 to 1947 Sri Lanka established the plantation-based economy by exporting traditional products (tea, coconuts and rubber) to European countries and Near and Middle East countries. In the course of establishment of the economy the inland traffic network was developed with growing material transport volume between the inland and coastal areas.

As of 1991 the total road length reached 97,375 km. with 5,262 bridges, and the road density (1.48 km/km^2) is equivalent to that of advanced countries. The ratio accounted for by the road traffic in the land traffic is 90% for goods and 82% for passengers. The road network plays an extremely important role in Sri Lanka.

The road section of the road network has been improved all over the country utilizing domestic resources and assistance from other countries. Concerning bridges, however, actual rehabilitation was made only for 20% or less of facilities requiring urgent rehabilitation, with remaining facilities left unattended because of budgetary and technical constraints. These unattended bridges become bottlenecks for the safety and smooth flow of the road traffic, and their rehabilitation is now the urgent tasks for Sri Lanka.

1.2 Background and Purposes of the Guideline

1.2.1 Background

Under such circumstances the Government of Sri Lanka in January 1990 requested Japan to conduct the Study for the Bridge Rehabilitation Project in Sri Lanka.

JICA organized in May, 1995 the Study Team and dispatched the Study Team to Sri Lanka to conduct the Study. The Study Team worked in close cooperation with the RDA counterpart team in accordance with the agreed Scope of Works.

The objectives of the Study are as follows:

(1) To formulate a bridge rehabilitation master plan with the completion date scheduled for 2010, which covers all bridges of the national highways A and bridges of the national highways B whose rehabilitation is deemed to be urgently required in Sri Lanka

(2) To formulate a guideline which Sri Lanka can utilize to establish her own bridge maintenance and rehabilitation manual

This bridge inspection, maintenance and rehabilitation guideline has been prepared to achieve the object (2) described above.

1.2.2 Purpose of Guideline

To maintain bridges in the sound state early detection and rehabilitation of bridges are essential. Overlooking any abnormality or damage in the early stage will allow such damage to grow further to result in accident. Periodical maintenance will minimize the overlooking and contribute to extension of the durable life of bridges and to early detection of damage through inspection.

It is necessary to inspect the bridge's present conditions correctly according to the established inspection procedure and to prepare and assess the inspection result on the basis of thorough recognition of the characteristics and deformation of the structure. Then the rehabilitation is executed according to the schedule and method established on the basis of the assessment result. The bridge maintenance and management must be executed periodically according to the maintenance procedure.

In order to put into effect the bridge rehabilitation master plan for principal roads for the target year 2010, Sri Lanka should establish the bridge maintenance and rehabilitation manual. The purpose of this guideline is therefore to summarize, in such a manner as to help Sri Lanka execute the plan, through a series of bridge maintenance and rehabilitation works, namely the inspection, assessment and maintenance and the rehabilitation.

The bridge maintenance and rehabilitation consists of inspection, maintenance and rehabilitation as shown in Figure 1.1.

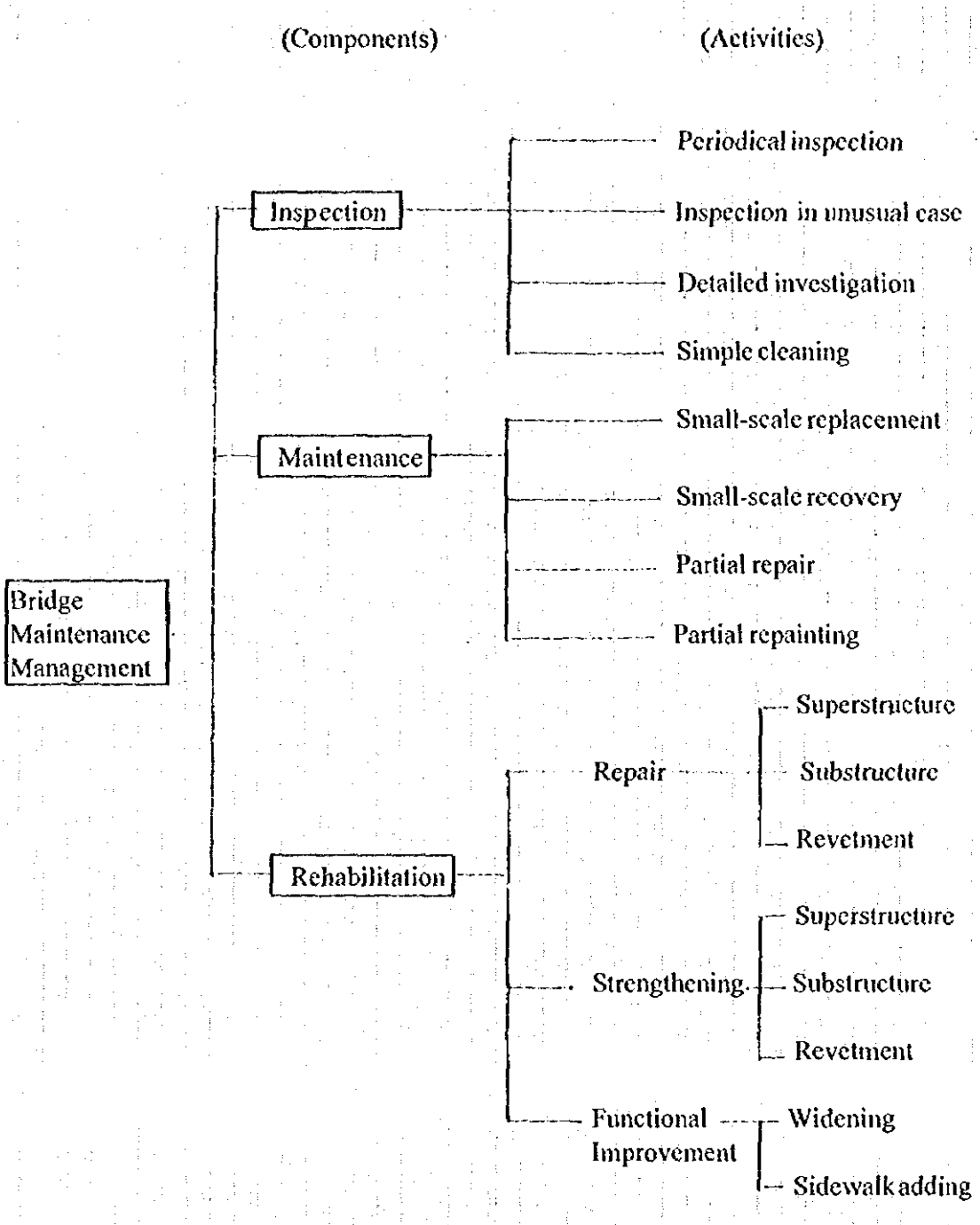


Figure 1.1 Definition and Functions of Maintenance Management

1.3 Composition of Guideline

The Inspection, Maintenance and Rehabilitation Guideline consists of following chapters:

Chapter 1 Preface

Chapter 2 Preparation and Filing of Documents and Inventory

This chapter describes collection, filing, and storage of design documents and related data which are the bases for maintenance and management of bridges. The Sri Lanka RDA has already been using the bridge inventory and inspection forms. But this chapter deals with the bridge inventory and inspection form which have been newly established in this Study for use in the future bridge maintenance and management

Chapter 3 Bridge Inspection Procedure

This chapter describes firstly the purpose of bridge inspection, scope and frequency of inspection and inspection items. Secondly this chapter deals with the materials, equipment and tools used for inspection, including the bridge inspection vehicle, scaffolding, etc.

Chapter 4 Bridge Assessment Procedure

This chapter describes the method to assess the damage to the bridges on the basis of the inspection results. This description includes the damage assessment criteria and assessment method.

Chapter 5 Bridge Maintenance Procedure

This chapter describes the method of maintenance carried out periodically for members of a bridge.

Chapter 6 Bridge Rehabilitation Procedure

This chapter describes the purpose of repair, strengthening and rehabilitation of bridges, criteria for selection of the repair, strengthening and rehabilitation methods and applicable methods.

Chapter 7 Maintenance Management System

This chapter describes the Bridge Maintenance Management system. The description covers organization, work flow and material and equipment.

CHAPTER 2 PREPARATION AND FILING OF DOCUMENTS AND INVENTORY

2.1 Standards and Specifications

The first thing to do in maintenance and rehabilitation of bridges is to collect, file and store the design standards and specifications.

Applicable documents include;

(1) Standards, manuals, etc.
Standard Specifications for Construction and Maintenance of Roads and Bridges, RDA

(2) Road Maintenance Manual, 1989 RDA (attached as an appendix)

(3) Related BS and AASHTO standards

(4) Bridge design conditions and material strength standards (for each published year)

(5) Manuals, guideline, standards and codes related to bridge design

(6) Standards for the road geometric design and data concerning the road and accessory works

2.2 Design Documents and Construction and Material Records

(1) Design documents

As a result of preliminary investigation the number of bridges for which the design documents were available was as small as 15 bridges (7%) for the total number of 206 bridges. It is essential that the design documents are filed from now on for bridge maintenance and management works.

The design documents provide data for confirmation of the shape, construction and stress condition of a bridge concerned. These documents can also provide data for identification of the cause of damage because they indicate the steel arrangement or member shape which are clues to find out the cause and they offer the basic data for the load test.

Data to be included in design documents are as follows:

(i) Design drawings

(ii) Design calculation sheets

(iii) Geological survey report (data which become necessary when the cause of damage is considered to be deformation of substructure or foundation)

(2) Construction record

The construction record provides data for the construction condition of bridges. Particularly in the case of a concrete bridge, faulty construction often leads to bridge damage. In this context understanding of the construction condition (method, etc.) has significant meaning.

Data to be included in the construction record are as follows:

a) Concrete bridges

1. Concrete placement condition and quality control record
2. Curing method
3. Age of concrete when forms are removed
4. Type of falsework, form and spacer
5. Girder erection method

b) Steel bridges

1. Welding method (plant, site)
2. Girder erection method
3. Painting record (including repainting)
4. Slab construction method

(3) Material records

The material record provides data for materials of a damaged bridge. Particularly in the case of concrete bridges the material is often the cause of damage, such as salt damage and alkali-aggregate reaction.

Data to be included in the materials record is shown below. If the bridge is old and no record is left, it is necessary to investigate the actual member and estimate the data.

a) Concrete bridges

1. Mixing proportion and strength of concrete
2. Type and place of production of aggregates
3. Type and manufacturer of cement
4. Type of admixtures
5. Type and manufacturer of steel
6. Various test results

b) Steel bridges

1. Welding materials
2. Painting materials (including repainting)
3. Various test results

2.3 Bridge Inventory and Inspection Form

Up to 1995 Sri Lanka RDA has used its own bridge inventory and inspection forms. After discussions with RDA concerning the forms which can be used for a long time in the future, the bridge inventory, bridge inspection form (concrete), bridge inspection form 2, photographs, and preliminary environmental examination form (Sheets 1, 2, and 3) as described in pages 2-5 to 2-11 were recommended by this Study.

It is recommended to assign the Engineering Services Division of RDA to take charge and to select persons in charge, so that they will be responsible for preparation and filing of documents.

Forms consist of the followings:

(1) Bridge inventory

(2) Inspection form

(3) Natural conditions data (meteorological, hydrological, topographic and geological) of bridges

(4) Data related to environment of bridges

2.4 Other Information

(1) Repair history and past inspection results

The repair history and past inspection results are important data not only for understanding of the history of repair and investigation, but also for identification of the cause of damage, because another defect may have appeared before occurrence of the damage. The repair itself may be responsible for the damage. Data can be also be used to confirm the effect of repair.

(2) Reference literature

Damages to bridges are similar to those of the past in many cases. Collection and filing of literature containing damage and investigation cases will prove helpful for detailed investigation.

(3) Local conditions

Concerning environmental conditions, including the air temperature, wind, corrosive environment, salt spray and local conditions (ambient state and subsurface conditions) and any useful data must be collected and filed.

(4) Traffic data

Data concerning the traffic volume on bridges concerned and traffic data including ratio of heavy vehicles must be collected from the traffic count files. Data on traffic will become important when dealing with damage caused by increased load and volume.

2.5 Renewal of Design Documents

In the case of revision or modification of above documents the location and date of such modification must be identified clearly. One copy of each old document must be filed instead of being thrown away, because they are necessary for maintenance and rehabilitation in the future.

Bridge Inventory

SER No. 65 91/2 km

NAME OF BRIDGE	CLASS OF ROAD	CROSSING: NAME OF RIVER OR ROAD	COMPLETED	MAINTENANCE BY
MANNHELLA BRIDGE	A 001	MA OYA	1894	C.E KAGALLE

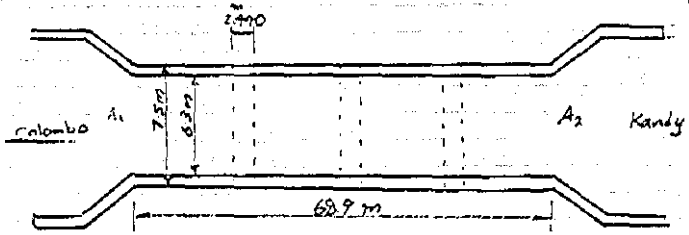
Design Information	Yes / (No)	Manufacture	Date of Preparation	Prepared by
			24.05.1995	H. R. E. S. GUNARATHNA V. S. CHANDRASIRI

Type of Bridge			Design Loading		Load Limitation	
	Superstructure	ARCH / BR				(No) / Yes t
	Substructure	Abutment: Dressed Stone	Design Standard	BS		
		Pier: Dressed Stone	Skew of Bridge	(Square) / Skew R L deg	R=	

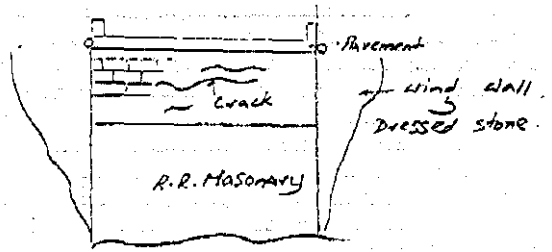
Length of Bridge		Span	Condition of Crossing					
	68.9 m	4 Spans		Road	Width m	Clearance m	Skew deg.	
Width of Bridge	Overall width m	Carriageway m	Pedestrianway m	(River)	Width of River m	Depth m	Free Board 7.5 m	Design Quantity m³ sec
	7.5	6.3	—					
Affixed articles	Telephone cable, Water Line							
Traffic Volume	1960 (year) 1995	Ratio of Heavy Vehicle % (year)	Others	Repair etc.				

Final Record of Repair	Pavement	Deck Slab	Main Beam	Painting	Expansion Joint	Bearing	Drainage	Railing	Curb	Affixed articles
	Others				Substructure					

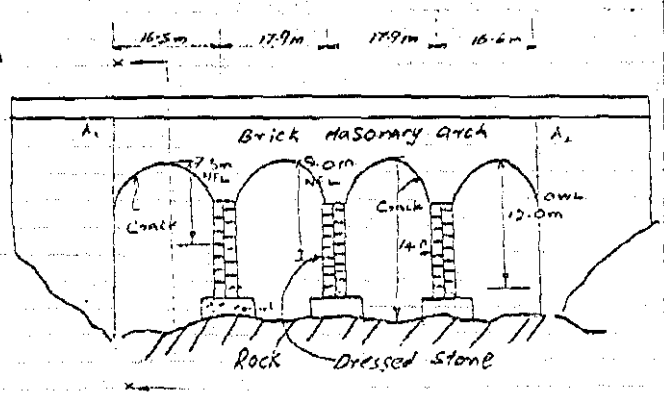
Plan



Cross Section X – X



Elevation



Surrounding condition

Result of Visual Inspection			Date of Inspection 24.05.1995		
Pavement	1	Bearing	—	Abutment	2
Curb	—	Expansion Joint	—	Pier	2
Railing	3	Drainage	2	Wing Wall	—
Deck Slab	—	Affixed Articles	1	River Bank	—
Main Beam	2			Approaches	—
Painting	—				
Others	—	Others		Others	
Superstructure	1.0	Bridge Accessary	—	Substructure	2.0
Overall Rating	2.0				

Rating

1. No damage detected on the basis of the inspection results.
2. Damage has been detected and a follow-up survey is required.
3. There is significant damage and a detailed survey needs to be carried out to establish whether repair work is to be carried out or not.
4. There is substantial damage and urgent repair is required or the bridge has to be closed to traffic or restriction on vehicle weight have to be imposed.

Comment

1. construct new foot ways for both side & treat the brick surface with some chemical
2. Alignment should be improved when a new bridge is constructed.

S-2

Photographs

5

NAME OF BRIDGE MAWANELLA BRIDGE	SER No. 85 - AA001 - 91/2 KM	Date of Inspection 24 · 05 · 1995

Front

Photo album No - 85 - 4

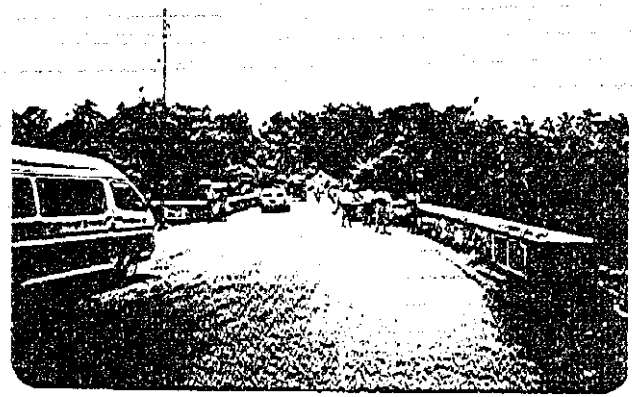
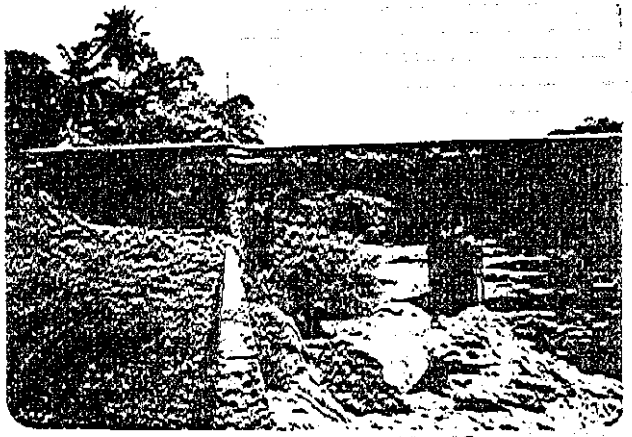


Photo album No -

Elevation

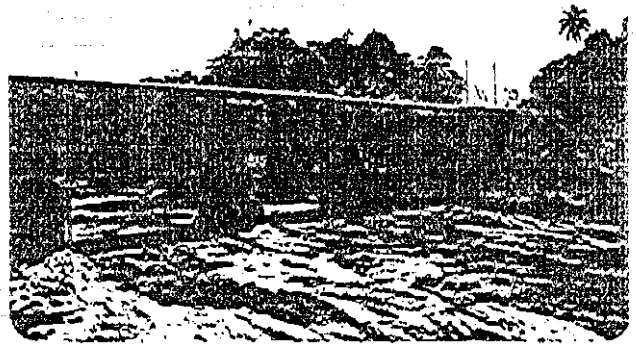
Photo album No - 85 - 5 ½



P1

Photo album No - 85 - 5 ½

3



P1

Bridge Inspection Form (~~Steel~~ Concrete Bridge) SER No. 85 (91/2 Km)

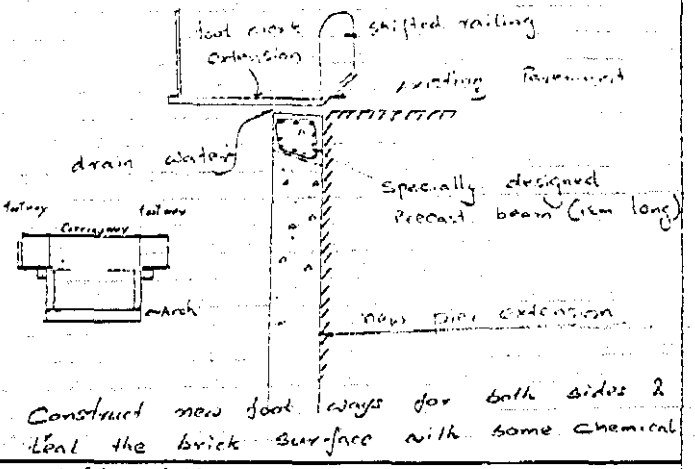
NAME OF BRIDGE	CLASS OF ROAD	CROSSING: NAME OF RIVER OR ROAD	COMPLETED	DATE OF INSPECTION	MAINTENANCE BY
HUNANGALA BRIDGE	A CD I	MA OYA	1894	24.05.1995	C.E. KAGALLE

	Component	Condition of Damage	Rating
Bridge surface	Pavement	Type Asphalt Concrete pavement / Condition: Good, Waving, Rutting, Crack, Pot hole, Others	1
	Curb	Type not Available / Condition: Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces	-
	Railing	Type R.C. Masonry / Condition: Good (Scaling) Cracking Spalling Exposure and corrosion of reinforcement, Wear of surfaces	3
Superstructure	Deck slab	Type / Condition: Good / 1 direction ✓ / 2 direction / Flaking / Rebar exposed / Others; 1.Minor 2.Intermediate 3.Major	-
	Main beam / Main structure	Type Brick masonry Arch. / Condition water leaking (Minor) / Good, Rust, Corrosion, Buckling, Excessive deformation, Rivet off, Others	1
	Diaphragm, Sway bracing, Lateral bracing	Type / Condition / Good, Rust, Corrosion, Buckling, Excessive deformation, Rivet off, Others	
	Painting	Condition	
Accessory	Expansion Joint	Type / Condition / (Invisible) Existed, Good, Abnormal sound, Clogged, Deformation, Gap, Others	-
	Bearing	Type / Condition : Sliding, Function of rotation / (Invisible) Existed, Good, broken, Anchor bolt , Abnormal displacement	-
	Drainage	Condition / (Clogged) Broken, Water leakage, Support Broken, Pipe broken Others	2
Substructure	Abutment Colombo A.	Type Dressed Stone / Condition : Leaning, Settlement, Sliding. / Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	2
	Abutment Kandy A.	Type Dressed Stone / Condition : Leaning, Settlement, Sliding. / Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	2
	Pier	Type Dressed Stone / Condition : Leaning, Settlement, Sliding. / Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	2
	Pier	Type Dressed Stone / Condition : Leaning, Settlement, Sliding. / Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	2
	Foundation	Type on rock (Spread) / Condition Good / Settlement, Leaning, Moving, Crack, Scouring, Others	1
	Wing wall	Type R.R. Masonary / Condition / Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces	2
	Embankment	River bank Good / Side bank Good / Back filling Good / Others	1
Others	Affixed article	Telephone cable, Water line	1
	Traffic sign		
	Approaches		
	Others		

Sketch and comments on major damage

1. Poor alignment
2. Growing plants on the bridge

Comments on rehabilitation method



Construct new foot ways for both sides & seal the brick surface with some chemical

Components of photographs taken

0 Black board(Name of Bridge)	5 Main beam	10 Abutment	15 Main damage	20
1 Front	6 Sway bracing	11 Abutment	16 Main damage	21
2 Road surface	7 Drainage	12 Pier	17 Main damage	22
3 Expansion joint	8 Bearing	13 Pier	18	23
4 Deck slab(Underface)	9 Elevation	14 Pier	19	24

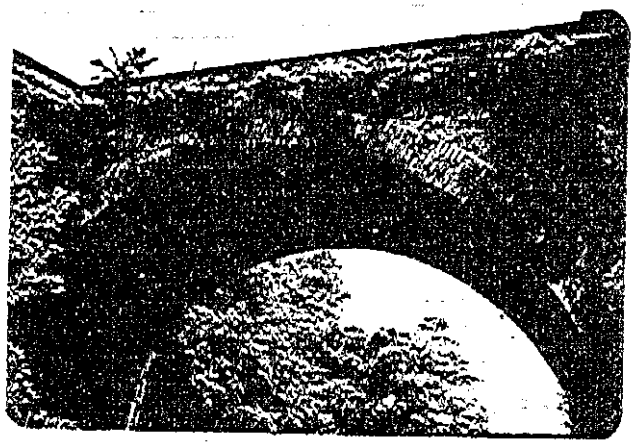
Rating
1. No damage detected on the basis of the inspection results.
2. Damage has been detected and a follow-up survey is required.
3. There is significant damage and a detailed survey needs to be carried out to establish whether repair work is to be carried out or not.
4. There is substantial damage and urgent repair is required or the bridge has to be closed to traffic or restriction on vehicle weight to be imposed.

Note : Further inspection shall be carried out on the "major damage" detected in this inspection.

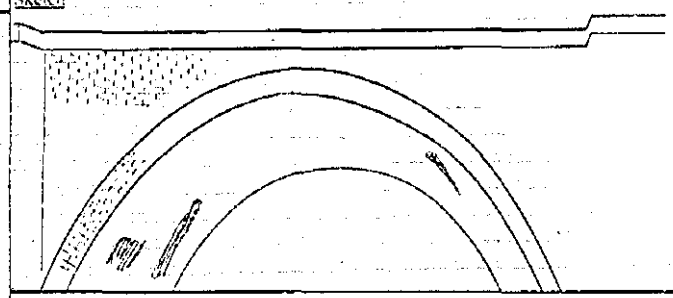
Bridge Inspection Form 2

NAME OF BRIDGE: MAWANELLA BRIDGE	SER No. 85 - AA001 - 91/2 km	Date of Inspection: 24.05.1995
LOCATION: A1-P1 ARCH	CONDITION: Water leakage	

Photo album No: 35 - 8



Sketch

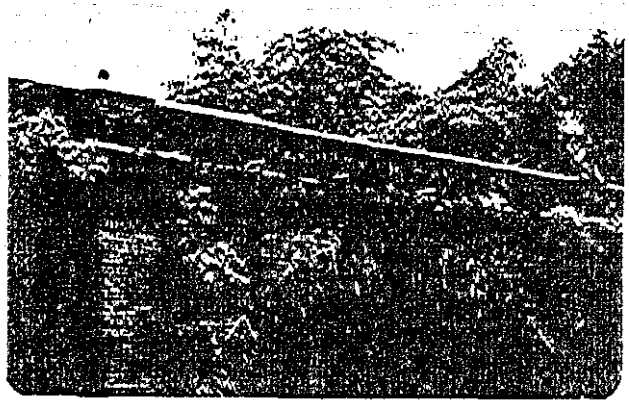


Comment

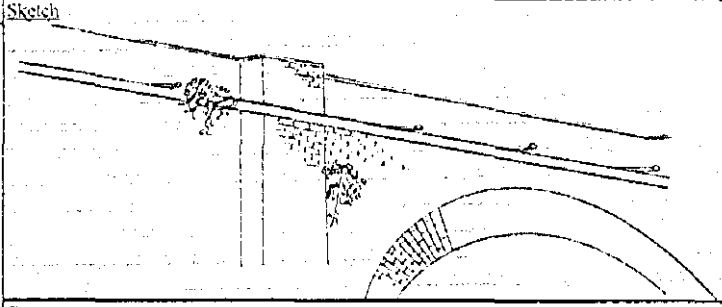
1. Water leaking through the deck.

LOCATION: Drain pipe (tree) | CONDITION:

Photo album No:



Sketch



Comment

1. Some trees grown on the brick surface. Treating the brick surface with a chemical (epoxy coat) can be done as a remedial measure.

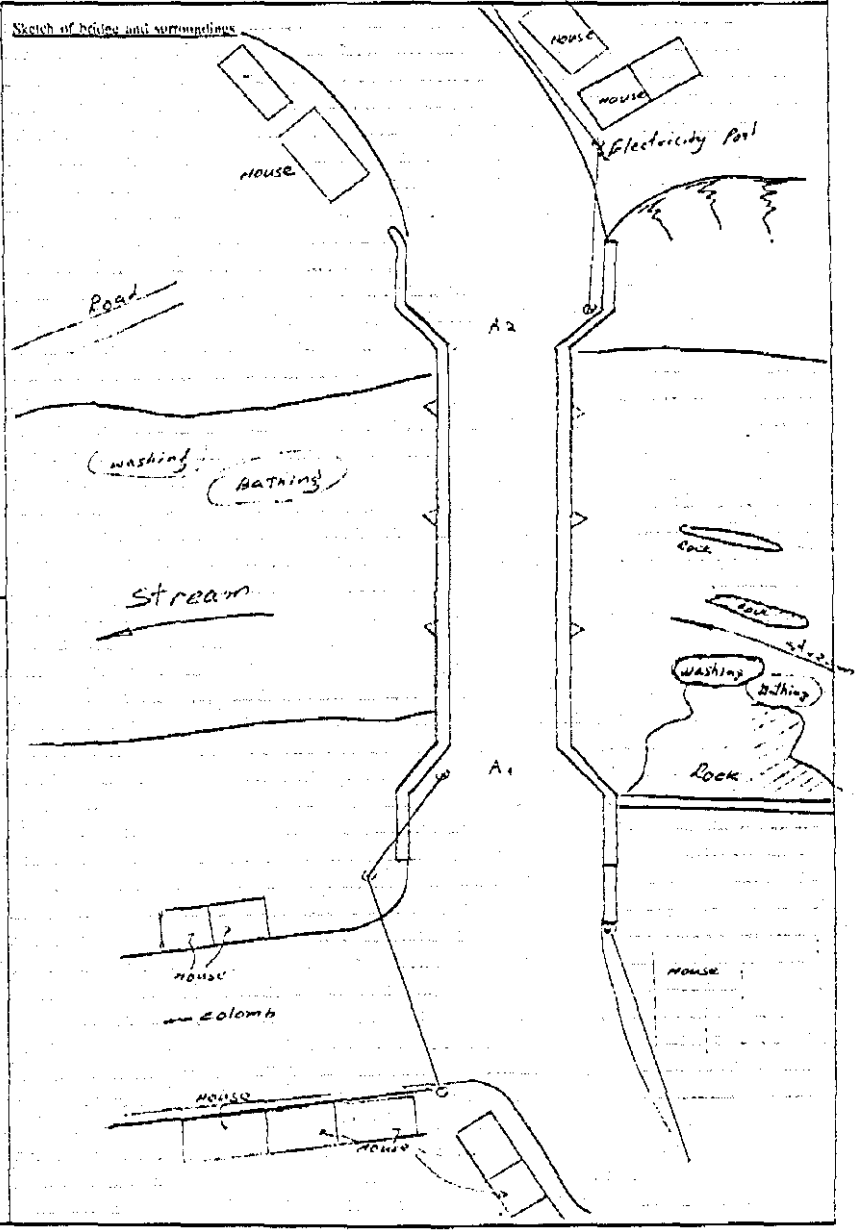
SER No.85

Preliminary Environmental Examination Form (Sheet 1)

NAME OF BRIDGE	CLASS OF ROAD	CROSSING UNDER THE BRIDGE	DATE OF EXAMINATION	NAME OF EXAMINER
MAWANELLA BR106	A001 9 1/2 km	MA Oya	24.05.1995	H. NAMBA

Item	Present condition	Potential environmental impact	Information to be gathered	Remarks
Resettlement	-Distribution of dwellings (near bridge and approach roads) ☑ Dense distribution ☐ Thin distribution ☐ No dwellings (please sketch in blank space on right) -Distribution of schools, hospitals, religious facilities (other important facilities) ☐ Exist (please show the position and name of the facilities in sketch on right) ☑ Do not exist	-Relocation of dwellings schools, *hospitals, religious facilities, or other* important facilities (due to bridge rehabilitation/construction) ☐ Likely ☑ *Likely in some cases* ☐ Unlikely ☐ Not clear -Effect of relocation on residents /community ☐ Major ☑ Small ☐ None ☐ Not clear	-Distribution map of dwellings, *important facilities* (e.g. large scale topographic map, town map) ☐ Available (please attach the map) ☑ Not available -Regional records of relocation in previous projects ☐ Have the records (please attach the details, e.g. project, number of resettled people, compensation) ☑ Have no record	
Remains and cultural assets	-Distribution of remains and cultural assets ☐ Exist (please show position in sketch on right) ☑ Do not exist ☐ Unknown -(If any,) Name, value, state of preservation:	-Effect of rehabilitation/construction of bridge on remains and cultural assets ☐ *Remains and cultural assets in the* rehabilitation/construction area ☐ Remains and cultural assets in surrounding area (some will have to be *destroyed*) ☑ No effect	-Distribution map of remains and cultural assets ☐ *Available* (please attach the map) ☑ Not available -Number of visitors (average annual visitors)	

Sketch of bridge and surroundings



SER N.85

Preliminary Environmental Examination Form (Sheet 2)

NAME OF BRIDGE	CLASS OF ROAD		CROSSING UNDER THE BRIDGE	DATE OF EXAMINATION	NAME OF EXAMINER
NANANGUA BRIDGE	A001	9½ Km	MA OYA	24.05.1995	M. NAMBA

Item	Present condition	Potential environmental impact	Information to be gathered	Remarks	Surrounding Conditions
Water rights and right of common	-Water rights (for river crossing under the bridge) ☐ Exist (please attach details) ☐ Do not exist ☑ Unknown -Right of common (for lands adjacent to bridge/approach roads) ☐ Exist (please attach details) ☐ Do not exist ☑ Unknown	-Effect on water rights, river use, right of common (due to bridge rehabilitation and construction) ☐ Major ☑ Small ☐ None ☐ Not clear	-River-use (for river crossing under bridge) ☐ Fishery (please attach detail, e.g. fishery right, species of fish) ☐ Mining (please attach details, e.g. mining right, types of minerals) ☐ Navigation (please attach details) ☐ Use of river water, i.e. water supply, agricultural, industrial (please attach details) ☑ Other use, e.g. (washing), (bathing), etc. (please attach details)		-Densely populated/inner-city area ☑ Yes ☐ No -Tourist area ☐ Yes ☑ No -Historical (or religious) area ☐ Yes ☑ No -National park (or any other area restricted for development) ☐ Yes ☑ No
Land-scape	-Distribution of scenic places/religious sites ☐ Exist (please show position and name in sketch on sheet 1) ☑ Do not exist ☐ Unknown -(If any,) name, value:	-Effect of bridge rehabilitation/construction on scenic places/religious sites ☐ Scenic places in rehabilitation/construction area ☐ Scenic places in surrounding areas ☑ No effect Scenic bridge ARCH/BR L=68.9m Tourist boat services available	-Distribution map of scenic places/religious sites ☐ Available (please attach map) ☑ Not available -Number of visitors (average annual visitors)		Photographs (landscape of bridge)
Others (traffic conditions)	-Traffic volume: 7060 year 1995 -Traffic congestion: -Traffic accidents:	-Traffic disturbance (associated with rehabilitation/construction work) ☑ Likely ☐ Likely in some cases ☐ Unlikely ☐ Not clear -Obstruction to public safety and lifestyle due to rehabilitation/construction work) ☑ Likely ☐ Likely in some cases ☐ Unlikely ☐ Not clear	-Traffic volume data ☐ Available (please attach data) ☑ Not available -Traffic accident data ☐ Available (please attach data) ☑ Not available -Pedestrian traffic data ☐ Available (please attach data) ☑ Not available		

SER No. 85

Preliminary Environmental Examination Form (Sheet 3)

NAME OF BRIDGE	CLASS OF ROAD	CROSSING UNDER THE BRIDGE	DATE OF EXAMINATION	NAME OF EXAMINER
MAWANELLA BRIDGE	AA601 – 91/2 km	MA OYA	24/05/1995	K. HARIYA

Photographs

Photo 4

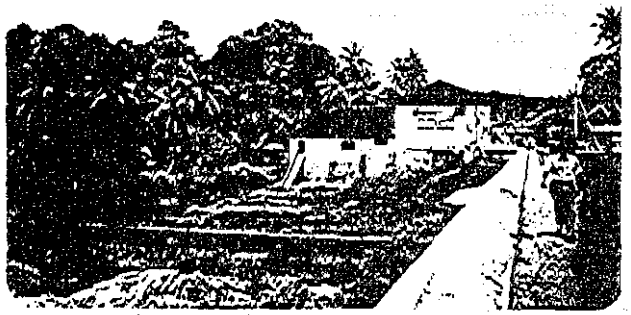
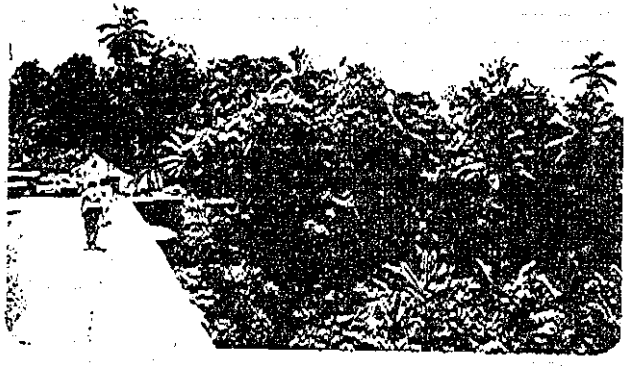
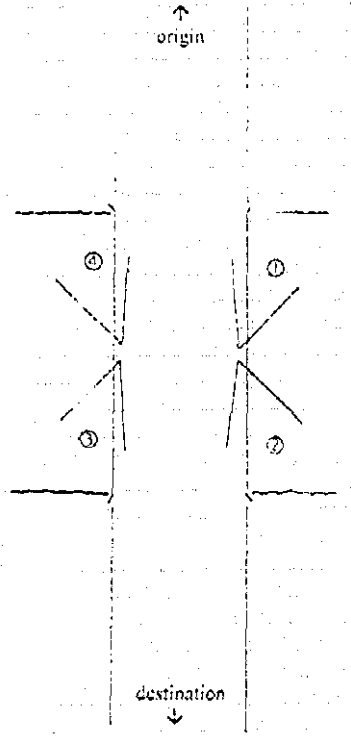


Photo 3



Location of photographs taken



(If location is changed, please plot location of photographs taken)

Photo 1

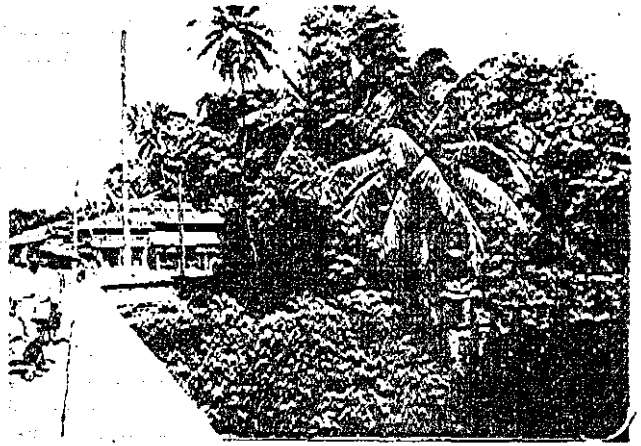
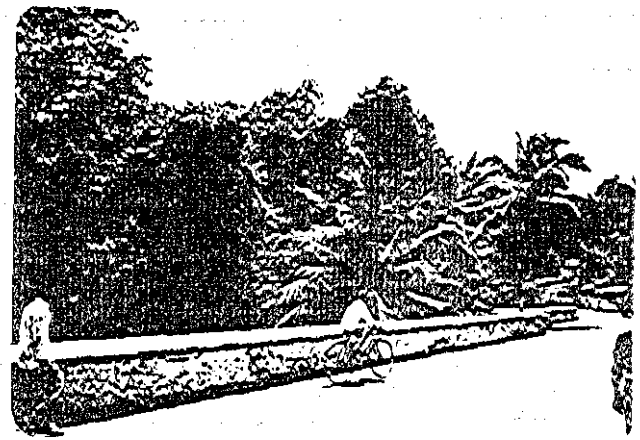
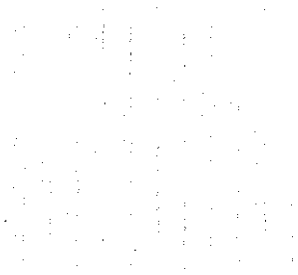


Photo 2





CHAPTER 3 BRIDGE INSPECTION PROCEDURE

3.1 General

In the course of preparation of Bridge Inspection Procedure "the Bridge Inspection Procedure (draft)" by Public Works Research Institute, Ministry of Construction, Japan, July 1988 was used as a basis, and modified to meet the existing conditions in Sri Lanka.

The inspection services described herein include periodical inspection, inspection in unusual case and detailed investigation, which are stipulated in this procedure. Since this procedure has been prepared principally for periodical inspection, the inspection method and details not stipulated in this procedure must be studied before execution in the case of inspection in unusual case and detailed investigation.

The first purpose is to grasp the present condition of bridges under control to detect early any damage affecting the safety and serviceability of bridges adversely, thereby enabling early and appropriate countermeasures and ensuring safe and smooth traffic.

The second purpose is to continue to understand the degree of damage and abnormality, which is indispensable for efficient maintenance and repair.

3.2 Type, Frequency and Execution System of Inspection

3.2.1 Type and Object of Inspection

The inspection is classified as follows:

(1) Periodical inspection

The periodical inspection is made to identity bridges conditions, visually and with simple inspection machinery and tools.

(2) Inspection in unusual case

This inspection is made mainly to confirm the safety of a specific bridge when disaster such as localized torrential downpour and landslide, etc. has occurred or these unusual cases are expected or when any abnormal defect is found.

(3) Detailed investigation

The detailed investigation is made using inspection machinery and tools to determine the necessity of repair and strengthening.

This investigation covers bridge members whose detailed investigation is judged necessary as a result of periodical inspection and inspection in unusual case. Through the detailed investigation the rehabilitation method is selected and finalized as discussed in Chapter 4.

The inspection will be made in the flow shown in Figure 3.1.

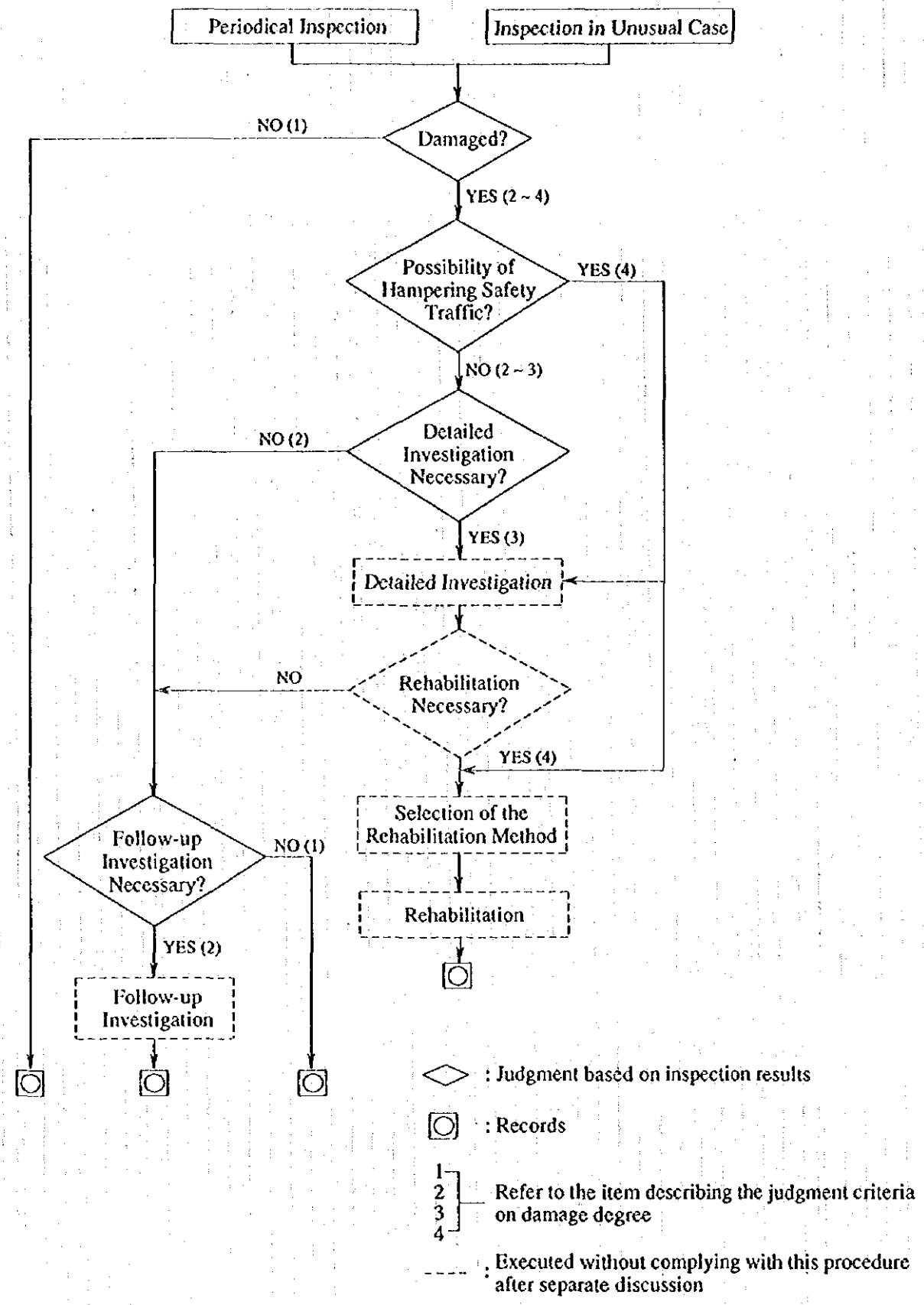


Figure 3.1 Inspection Flow

3.2.2 Inspection Frequency and Method

The standard inspection frequency and method are shown in Table 3.1.

Table 3.1 Inspection Frequency and Method

		Periodical inspection		Inspection in unusual case	Detailed investigation
		Remote visual inspection	Proximity visual inspection		
Inspection method		As a rule, this inspection will be made on foot or on boat if necessary.	As a rule, this inspection will be made on an inspection vehicle or work scaffolding or on boat if necessary.	Depending on the purpose	Depending on the purpose
Frequency		About once every two years	About once every ten years	As required	As required
Members	Superstructure	○	○	Depending on the purpose	Depending on the purpose
	Substructure	○	○		
	Bearing	○	○		
	Railings	○	○		
	Protection fence	○	○		
	Curbs	○	○		
	Curb stone	○	○		
	Median	○	○		
	Pavement	○	○		
	Expansion joint	○	○		
	Drainage facilities	○	○		
	Bridge falling preventive unit	○	○		
	Inspection facilities	○	○		
	Noise barrier	-	○		
	Lighting facilities	-	○		
	Traffic sign	-	○		
	Wing wall	○	○		
	Affixed articles	-	○		

Note) Symbols in the table have the following meanings:
○: Inspection to be made without fail
- : Inspection to be made if possible

Though inspection must be made on all members to understand their present state in detail, it takes substantial time and cost to carry out detailed investigation into all bridge members. With the existing inspection system and actual damage condition such detailed inspection is not appropriate. It is therefore necessary to inspect efficiently in order to determine the method and frequency.

The periodical inspection will be a combination of two kinds of inspections; remote and proximate visual inspections.

As a rule remote visual inspection will be made once every two years to detect early any damage possibly affecting the load carrying capacity, durability and serviceability to the substantial degree. This inspection will be made as a rule on foot, without using an inspection vehicle, by visually inspecting a bridge from a relatively long distance. If possible it is recommended to go as near as possible to the bridge for visual inspection at close range.

Proximity visual inspection will be made as a rule once every ten years to detect any damage, which may affect the load carrying capacity, durability, and serviceability adversely, in the early stage. Proximity visual inspection will be made while approaching the members by using the bridge inspection vehicle or scaffolding. In this case the inspection machinery and tools must be used if necessary. All members are included in the scope of proximity visual inspection. Affixed articles are originally considered not included in the scope of control of bridge administrator, but included in the scope of proximity visual inspection because their damage may affect the bridge adversely.

3.2 3 Periodical Inspection System

Name and Duties of Inspection Personnel

(1) Inspector

The inspector will control the inspection team, with due attention paid on the safety control, and understands the activities of each personnel while keeping close contact with the assistant inspector during inspection and investigation.

(2) Assistant inspector

The assistant inspector will assist the inspection work under instruction of the inspector. On detecting any defect or abnormality he will take record of the measurement result and practical defect/abnormality state using tools in compliance with the bridge inspection procedure. He will also take photographs.

(3) Inspection vehicle operator

The inspection vehicle operator will operate the inspection vehicle under instruction of the inspector.

(4) Traffic controller

The traffic controller will prevent traffic disturbance and ensure the safety of the inspection personnel during inspection. A driver for transportation of a inspector and others shall take this assignment.

Members of the Inspection Team

The members of the inspection team per bridge inspection vehicle will be determined as shown in Table 3.2.

Table 3.2 Members of the Inspection Team

	Inspection vehicle	Other facilities
Inspector	1 Note1)	1 Note 2)
Assistant inspector	2 Note 1)	2 Note 2)
Inspection vehicle operator	1 Note 1)	
Traffic controller		

Note 1) Bridge inspection vehicle: The members will be determined with due consideration of the required scope of inspection work and traffic condition for each bridge and equipment used.

Note 2) Other facilities: These facilities include an inspection passage, ladder, boat, and scaffolding for coating and the members will be determined with due consideration of the local conditions and inspection method (inspection items and tools).

3.3 Inspection Equipment and Tools

The inspectors must carry the necessary inspection machinery and tools appropriate to the type and content of the inspection work when the inspection is made.

To ensure effective inspection the equipment appropriate to the purpose must always be carried. The equipment used for inspection is shown below:

(1) Inspection instrument

Telescope, binoculars, test hammers (large and small), steel tape, vernier calipers, wire brush, string, crack gauge, pole, etc.

(2) Recording instrument

Camera (a whole set), chalk, white board, marking pen, scale, recording paper, etc.

(3) Ancillary inspection instrument

Ladder, traffic control tools, projector, rope, sticky tape, wire, pliers, flash light, inspection vehicles, cloth, cars, boat, etc.

For reference, tools used generally to each damagetype are listed in Table 3.3.

During detailed investigation the inspection using nondestructive test equipment may be employed to understand the degree of damage into more detail. Examples of nondestructive test methods for detailed investigation are shown in Table 3.4. Note that features of each method are described only briefly and thus application of individual methods require further study.

When these nondestructive test methods are used, it is necessary to study their applicability. It is also necessary to confirm the performance of the equipment before application of a method, because the performance and application scope vary depending on the equipment.

Table 3.3 Type of Damage and Applicable Equipment

Material	No.	Type of damage	Remote visual inspection	Proximity visual inspection
Steel	1	Corrosion	Visual	Visual, (thickness gauge), vernier calipers
	2	Crack	Visual	Visual, (flaw examination unit), test hammer
	3	Looseness	-	Visual, (torque wrench)
	4	Dislodgement	Visual	Visual
	5	Breakage	Visual	Visual
	6	Degraded coating	Visual	Visual, (test of adhesion)
Concrete	7	Crack	Visual, (photos)	Visual, crack gauge, photos, (video tape)
	8	Separation, exposure of reinforcing bar	Visual, (photos)	Visual, photos, (video tape)
	9	Free lime	Visual, (photos)	Visual, photos, (video tape)
	10	Honeycomb, cavity	Visual	Visual, test hammer, photos, (video tape)
	11	Wear, erosion	Visual	Visual, convex tape, pole
	12	Punching out	Visual	Visual
	13	Damage to steel plate weld	Visual (test hammer)	Visual, test hammer
	14	Crack in deck slab	Visual	Visual, crack gauge
Others	15	Abnormal expansion spacing	Visual	Visual, convex tape
	16	Diff. settlement, corrugation	Visual (convex tape, pole)	Visual, rules, convex tape, pole
	17	Pot hole	Visual (convex tape, pole)	Visual, rules, convex tape, pole
	18	Crack in pavement	Visual (convex tape, pole)	Visual, rules, convex tape, pole
	19	Rutting	Visual (convex tape, pole)	Visual, rules, convex tape, pole
	20	Others		
Common	21	Discoloration, degradation	Visual	Visual (Schmidt hammer), (neutralization test)
	22	Water leakage, flow	Visual	Visual
	23	Abnormal sound	Hearing	Hearing
	24	Abnormal vibration	Visual	Visual
	25	Abnormal deflection	Visual	Visual
	26	Deformation	Visual	Visual, string bob, convex tape
	27	Filling with sand	Visual	Visual
	28	Settlement	Visual	Visual (level)
	29	Moving	Visual	Visual, (survey)
	30	Inclination	Visual	Visual, string, convex tape
	31	Scour	Visual	Visual, string, pole
	32	Sectional reduction	Visual	Visual

( ) in the above table shows required tools.

Table 3.4 Typical Nondestructive Inspection Method

(1) Steel members

Method	Available data	Scope	Procedure	Advantages	Drawbacks
Ultra-sonic testing	- Applicable to detect member defects, particularly crack. Easy to identify defect locations	- Metallic, non-metallic, plastic and other materials which allow trans-mission of ultra-sonic wave Applicability not so restricted in terms of the shape of members	- Ordinary method, pulse reflection method	- Difficult to detect small defects, but applicability not restricted in terms of materials thickness - Easy to carry around - Abundant successful results - Economical	- Difficult to store the record - Skill necessary for measurement - Difficult to understand the damage shape - Low in sensitivity when the coating is thick
Magnetic particle exami-nation	- Applicable to detect crack in or around the member surface	- Magnetic materials (iron and steel)	- Ordinary method, Yoke methods	- Easy and superior in detection of crack	- Applicable only to magnetic materials such as iron and steel - Impossible to detect internal damage - Impossible to measure the crack depth
Ultrasonic method	Measurement of the thickness	- Metallic, non-metallic, and other materials which allow transmission of ultrasonic wave	Measurement of the thickness by causing resonance with ultrasonic wave	- Easy to measure - Abundant successful results	- Difficult to store the record - Low accuracy when the coating film is thick

(2) Concrete members

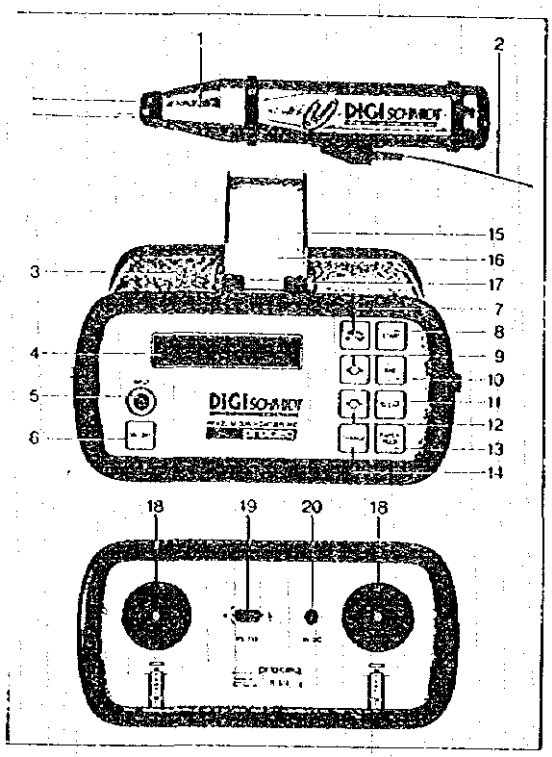
Method	Available data	Scope	Procedure	Advantages	Drawbacks
Schmidt hammer method	- Measurement of the concrete surface hardness - Estimation of concrete compressive strength	- Concrete Models Type N Type NR Type L Type P Type M		- Easy to measure - Applicable without regard to the shape and dimensions of objects	- Measurement possible only for the surface area - Relatively large variance in accuracy - Period in service must be taken into account
Ultra-sonic method	- Estimation of concrete compressive strength	- Applicable without much restriction in terms of concrete shape		- Easy to measure	- Not satisfactory in accuracy - Application restricted in terms of member thickness
Ultra-sonic method	- Crack, cavity and honey comb	- Concrete mortar, etc.	Measurement frequency is several 10 kHz, which is lower than that for measurement of steel members	- Easy to measure - No restriction in terms of the shape of object	- Skill necessary for judgment to a certain degree - Difficult to store the record - Size of defect can not be determined
Ultra-sonic method	- Estimation of concrete thickness	- Members in general		- Easy to measure	

3.3.1 Non Destructive Inspection Equipment

(1) Schmidt Hammer

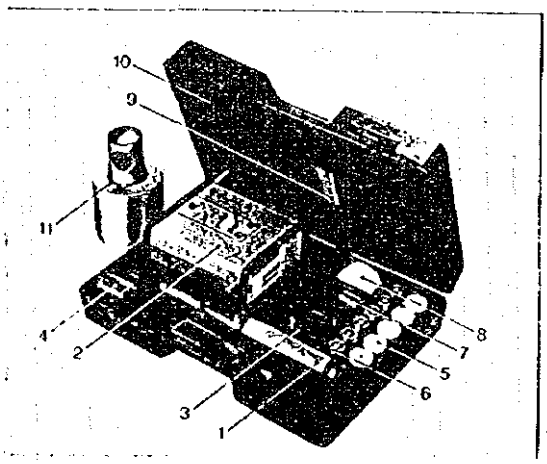
The compressive strength of concrete can be estimated without breaking with a Schmidt hammer. This method was introduced by Mr. Schmidt in 1948 and are used now in worldwide. However the test result depends on shape and dimension of structures, point to be tested, wet/dry condition of structure surface and smoothness of surface. Therefore results show reference only not exact figure.

1. Hammer
2. Cable
3. Indicator unit
4. Display
5. Cable plug
6. On/off switch
7. Switch for menu open/finish
8. Start switch
9. Selection of menu
16. Record paper
18. Battery box
20. Adapter plug



[Standard Set]

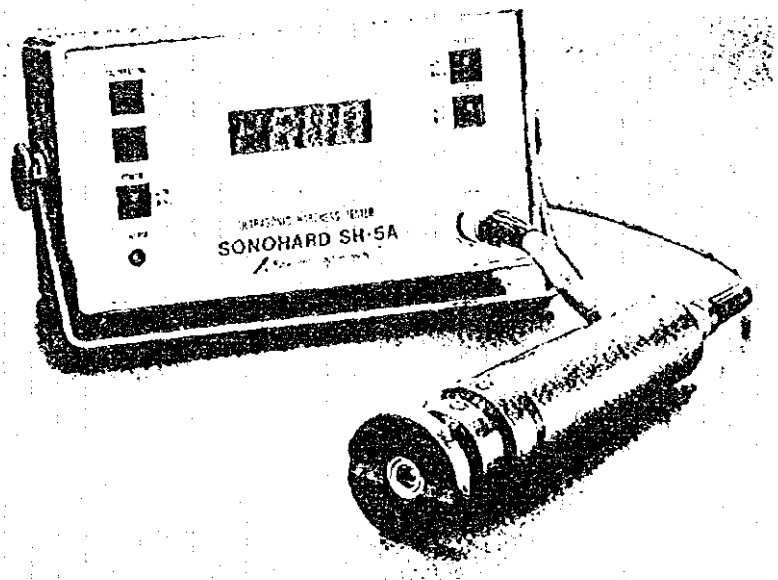
1. Hammer
2. Indicator unit
3. Belt to carry
4. Paper winding
5. Paper
6. Battery
7. Anti dust ring
8. Carbo random stone
11. Test anvil



(2) Ultrasonic Hardness Meter

This meter is used to measure rapidly to pick hardness or Rockwell hardness with ultrasonic vibration.

SONOHARD® SH-5A



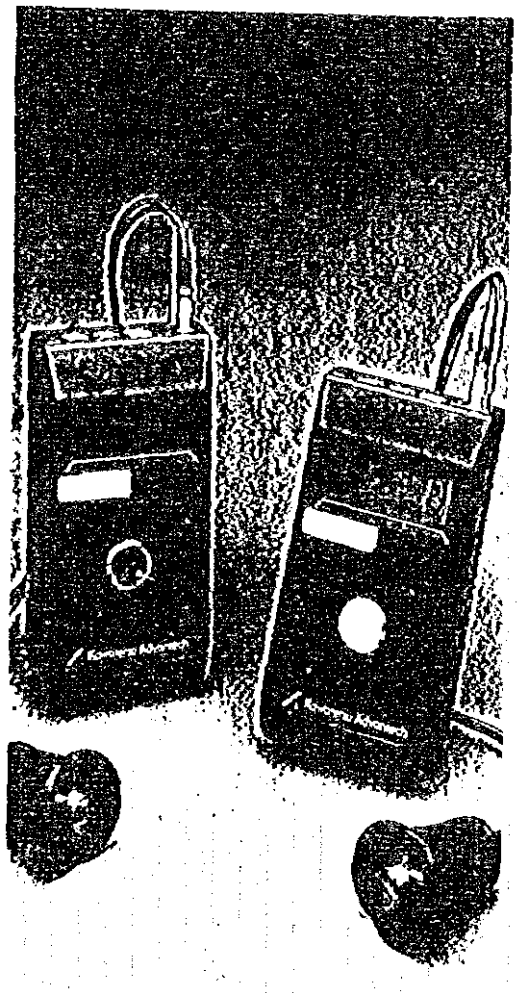
(3) Ultrasonic Thickness Meter

This meter is used to measure the thickness of steel tank, steel pipe and structures. It will be used also to measure degree of collosion.

Materials to be tested: steel, cast steel, aluminum, copper, titan, grass, ceramic, plastic, etc.

Range of thickness 0.8 mm to 80 mm

Unit of measure 0.1 mm



(4) Concrete Neutralization Tester (CONKIT)

Concrete during casting contains strong alkali. However when time passes, concrete touches carbon dioxide (CO_2) in the air and alkali of concrete will decrease.

The pH of concrete is below 9, then reinforcement steel has a environment to start rust.

Procedure of test

1) Spray test liquid to the point of concrete

2) Red color- to alkali
   No change-to Neutral

3) In order to test the depth of neutralization, chip concrete with electric hammer drill then spray test liquid.

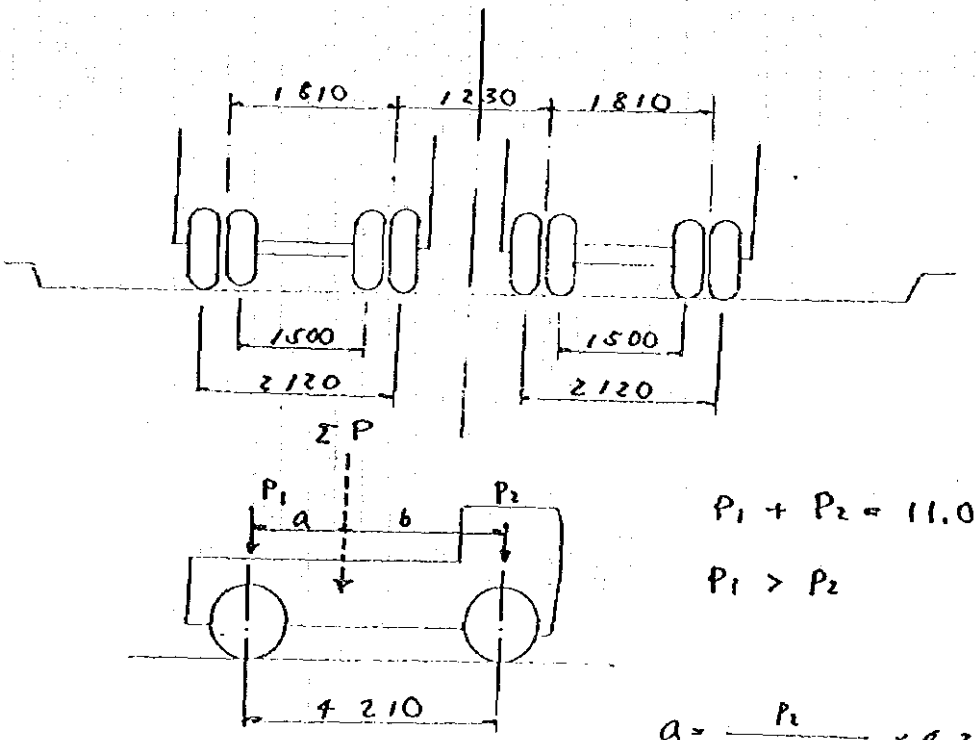
Full Scale Loading Test

To obtain the actual carrying capacity of dominant type of bridges in Sri Lanka and determine the appropriate design load on rehabilitation planning and design. Full scale loading test was carried out on some bridges.

Prior to the loading test all dimensions were surveyed in order to obtain calculated deflection to be compared with surveyed actual deflection.

As to test method and result, please see relevant chapter of main text.

Loading on BR. Ser. No. 212



$P_1 + P_2 = 11.0\ tf$

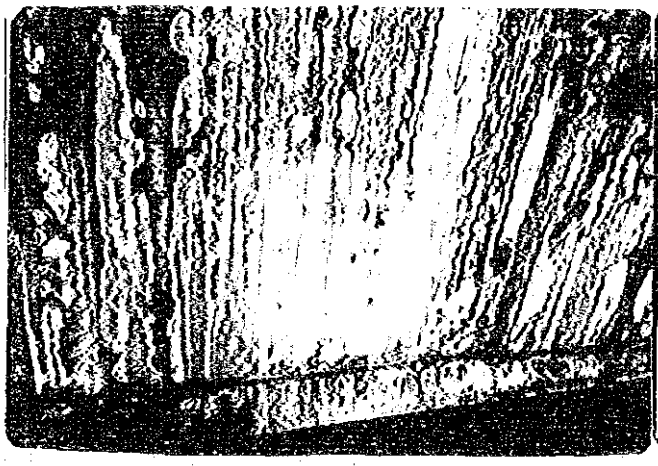
$P_1 > P_2$

$$a = \frac{P_2}{P_1 + P_2} \times 4.210$$

$b = 4.21 - a$

Schmidt Hammer Test

Ser. No. 212 AA002 138/1 km

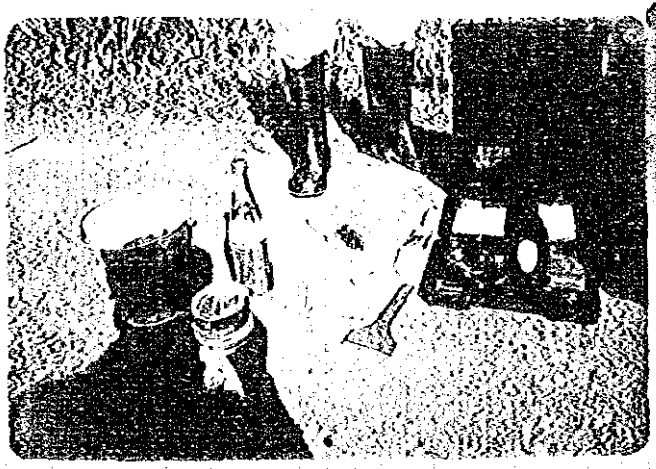


A1 - P1 Curb end

Schmidt hammer test

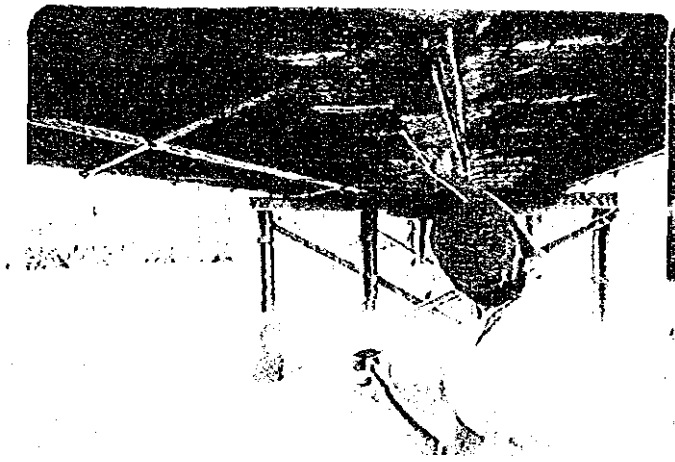
Steel Beam Thickness Measurement

Ser No. 59 B157 43/4 km



Thickness measuring tools, a whole set

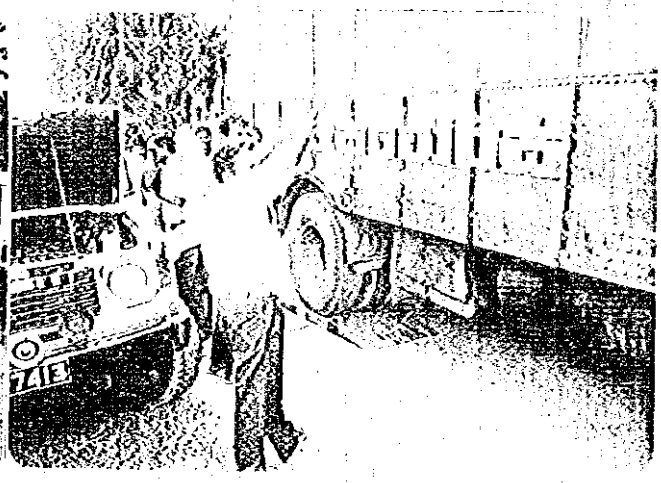
Thickness measurement



P4 - A2 RSJ girder and bearing

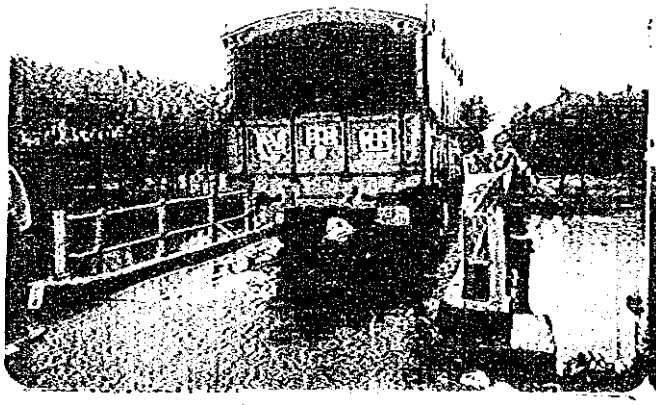
A2 abutment

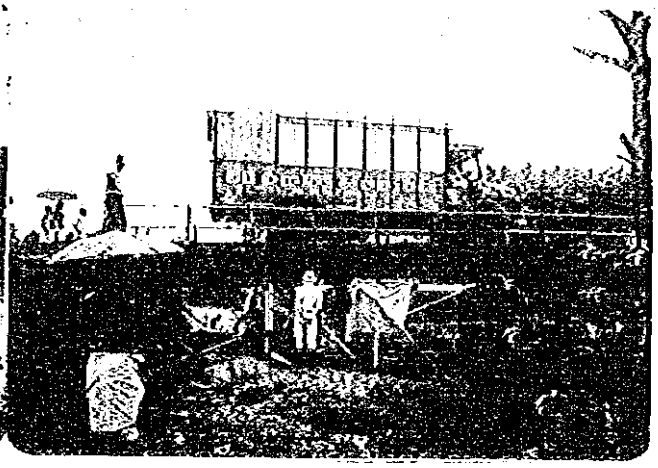
Loading Test



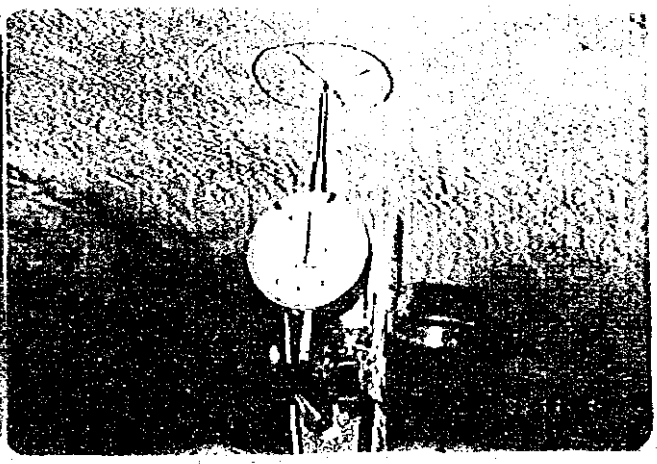
Axle Load Test

Same as Left





Ser No. 59



Ser No. 212

3.4 Inspection Machineries and Access Facilities

3.4.1 Bridge inspection vehicle

The use of a bridge inspection vehicle, rapid to install and superior in safety, will prove convenienceto the inspection.

The Sri Lanka RDA obtains one German-made sky lift, which however can not be set to existing single-lane bridge, as its outrigger is larger than the bridge width and thus not used in the bridge inspection.

For the bridge maintenance and management in Sri Lanka from now on, it is recommended to purchase and utilize a midium bridge inspection vehicle as shown in page 3-19.

Cautions for inspection with a bridge inspection vehicle are as follows:

(1) A trained operator must operate the bucket/platform and keep contact with an inspector on the bucket/platform.

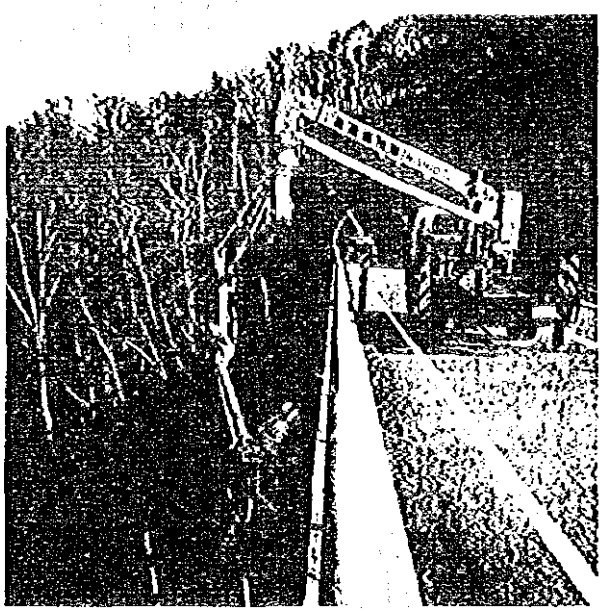
(2) Bridges in Sri Lanka are mostly of a single-lane and the use of the bridge inspection vehicle may cause closing of the road to traffic. Accordingly it is necessary to submit the work plan beforehand to a local police authority for approval.

3.4.2 Access facilities

The problem during inspection of bridges is how to make access to check particularly the damaged slabs, main girders and piers.

For bridges with narrow under clearance, scaffolding is a general practice to take for inspection. A bridge inspection vehicle is used when the bridge piers are tall or for an arch bridge crossing over a valley.

The safety as well as the cost and required time must be taken into account when selecting which means to take scaffolding or a bridge inspection vehicle.



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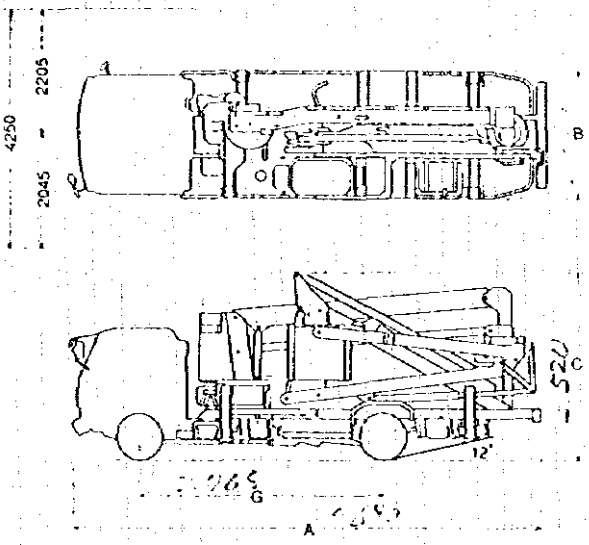
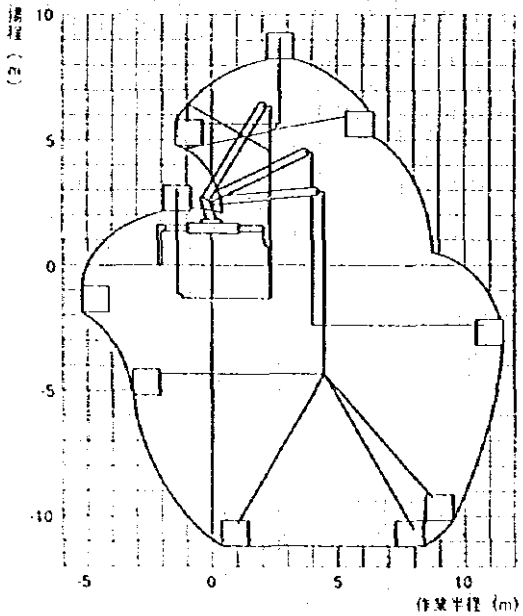
■主要寸法図 (KU-070)

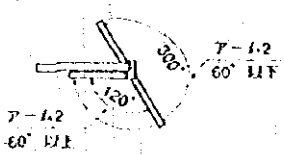


■作業範囲図 (KU-070)

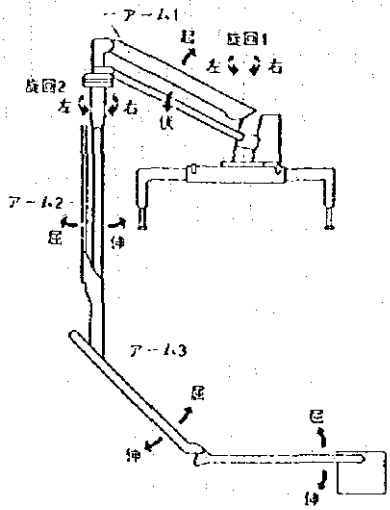


●旋回1 旋回角度

●旋回2 旋回角度



(1) 作業範囲図は、アウトリガーを堅土上に水平に設置したときのものであり、ブームのたわみを含んでいません。
(2) 作業高さ3mまでの側壁越え可能。



- Deck/platform

Weight	250 kg
Depth	5.8 m
Height	6.4 m
Working radius	5.4 m

- Boom

Angle	-15° ~ 60°
Length	3.06 m ~ 5.11 m

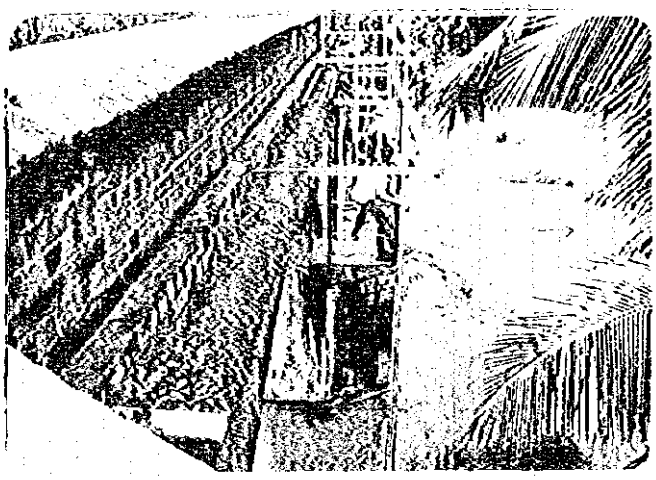
- Post

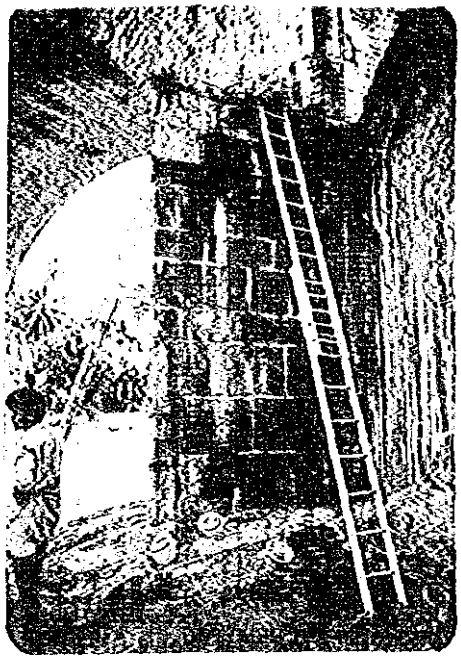
Length	2.94 m ~ 9.44 m

- Outrigger

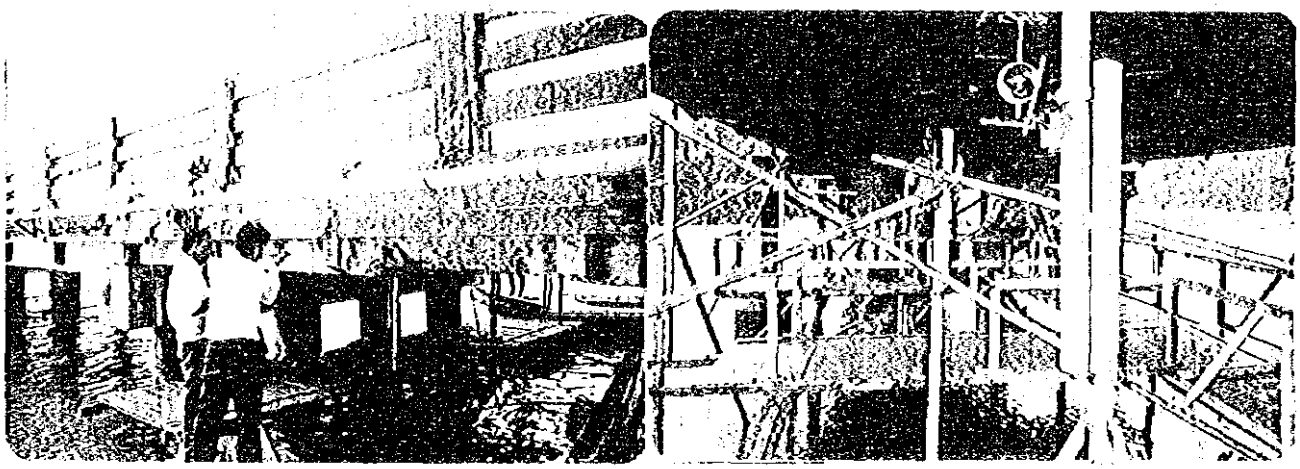
Front	3.35 m
Rear	3.17 m

Scaffolding for Investigation





Ser No. 85 AA001 91/2 km



Ser No. 7 B425 20/4 km

Scaffolding for loading test
Ser No. 59

3.5 Inspection Forms

A set of forms listed below was agreed to use from now on by RDA in the course of bridge maintenance and management, as shown in pages 3-22 to 3-28.

* Bridge inventory form
* Bridge inspection form (steel bridge)
* Bridge inspection form (concrete bridge)
* Bridge inspection form 2
* Photographs
* Bridge rehabilitation record form (steel bridge)
* Bridge rehabilitation record form (concrete bridge)

Bridge Inventory

SER No.

NAME OF BRIDGE	CLASS OF ROAD	CROSSING: NAME OF RIVER OR ROAD	COMPLETED	MAINTENANCE BY

Design Information	Yes	No	Manufacture		Date of Preparation		Prepared by		
Type of Bridge	Superstructure			Design Loading			Load Limitation	No Yes	t
	Substructure	Abutment		Design Standard	BS				
		Pier		Skew of Bridge	Square	Skew	R L	deg. R=	
Length of Bridge		m	Span	Condition of Crossing	Road	Width m	Clearance m	Skew deg.	
Width of Bridge	Overall width	m	Carriageway m	Pedestrianway m	River	Width of River m	Depth m	Free Board m	Design Quantity m3/sec
Affixed articles									
Traffic Volume		(year)	Ratio of Heavy Vehicle %	(year)	Others	Repair etc.			
Final Record of Repair	Pavement	Deck Slab	Main Beam	Painting	Expansion Joint	Bearing	Drainage	Railing	Curb	Affixed articles
	Others				Substructure					

Plan

Cross Section

Elevation

Result of Visual Inspection				Date of Inspection	
Pavement		Bearing		Abutment	
Curb		Expansion Joint		Pier	
Railing		Drainage		Wing Wall	
Deck Slab		Affixed Articles		River Bank	
Main Beam				Approaches	
Painting					
Others		Others		Others	
Superstructure		Bridge Accessary		Substructure	
Overall Rating					

Surrounding condition

Rating

1. No damage detected on the basis of the inspection results.
2. Damage has been detected and a follow-up survey is required.
3. There is significant damage and a detailed survey needs to be carried out to establish whether repair work is to be carried out or not.
4. There is substantial damage and urgent repair is required or the bridge has to be closed to traffic or restriction on vehicle weight have to be imposed.

Comment

Photographs

NAME OF BRIDGE	SER No.	Date of Inspection	
Front			
Photo album No. -		Photo album No. -	
Elevation			
Photo album No. -			

Bridge Inspection Form (Steel Bridge)

SER No.

NAME OF BRIDGE	CLASS OF ROAD	CROSSING: NAME OF RIVER OR ROAD	COMPLETED	DATE OF INSPECTION	MAINTENANCE BY

	Component	Condition of Damage	Rating	Sketch and comments on major damage
Bridge surface	Pavement	Type / Condition Good, Waving, Rutting, Crack, Pot hole, Others		
	Curb	Type / Condition Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces		
	Railing	Type / Condition Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces		
Superstructure	Deck slab	Type / Condition Good / 1 direction / 2 direction / Flaking / Rebar exposed / Others 1.Minor 2.Intermediate 3.Major		
	Main beam Main structure	Type / Condition Good, Rust, Corrosion, Buckling, Excessive deformation, Rivet off, Others		
	Diaphragm, Sway bracing, Lateral bracing	Type / Condition Good, Rust, Corrosion, Buckling, Excessive deformation, Rivet off, Others		
	Painting	Condition		
Accessory	Expansion Joint	Type / Condition Invisible, Existed, Good, Abnormal sound, Clogged, Deformation, Gap, Others		
	Bearing	Type / Condition : Sliding, Function of rotation Invisible, Existed, Good, broken, Anchor bolt , Abnormal displacement		Comments on rehabilitation method
	Drainage	Condition Clogged, Broken, Water leakage, Support Broken, Pipe broken Others		
Substructure	Abutment	Type / Condition : Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Abutment	Type / Condition : Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Pier	Type / Condition : Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Pier	Type / Condition : Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Foundation	Type / Condition Settlement, Leaning, Moving, Crack, Scouring, Others		
	Wing wall	Type / Condition Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces		
	Embankment	River bank / Side bank Back filling / Others		
Others	Affixed article			
	Traffic sign			
	Approaches			
	Others			

Components of photographs taken

0 Black board(Name of Bridge	5 Main beam	10 Abutment	15 Main damage	20
1 Front	6 Sway bracing	11 Abutment	16 Main damage	21
2 Road surface	7 Drainage	12 Pier	17 Main damage	22
3 Expansion joint	8 Bearing	13 Pier	18	23
4 Deck slab(Underface)	9 Elevation	14 Pier	19	24

Rating

1. No damage detected on the basis of the inspection results.
2. Damage has been detected and a follow-up survey is required.
3. There is significant damage and a detailed survey needs to be carried out to establish whether repair work is to be carried out or not.
4. There is substantial damage and urgent repair is required or the bridge has to be closed to traffic or restriction on vehicle weight to be imposed

Note : Further inspection shall be carried out on the "major damage" detected in this inspection.

Bridge Inspection Form (Concrete Bridge)

SER No.

NAME OF BRIDGE	CLASS OF ROAD	CROSSING: NAME OF RIVER OR ROAD	COMPLETED	DATE OF INSPECTION	MAINTENANCE BY

	Component	Condition of Damage	Rating	Sketch and comments on major damage
Bridge surface	Pavement	Type / Condition		
		Good, Waving, Rutting, Crack, Pot hole, Others		
	Curb	Type / Condition		
		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces		
	Railing	Type / Condition		
		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces		
Superstructure	Deck slab	Type / Condition / 1.Minor		
		Good / 1 direction / 2 direction / Flaking / Rebar exposed / Others / 2.Intermediate / 3.Major		
	Main beam	Type / Condition		
		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, excessive deflection of members, Wear of surface, Sheath exposed, PC cable damaged, Anchorage broken, Others		
	Diaphragm,	Type / Condition		
		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, excessive deflection of members, Wear of surface, Sheath exposed, PC cable damaged, Anchorage broken, Others		
Accessory	Expansion Joint	Type / Condition		
		Invisible, Existed, Good, Abnormal sound, Clogged, Deformation, Gap, Others		
	Bearing	Type / Condition : Sliding, Function of rotation		
		Invisible, Existed, Good, broken, Anchor bolt , Abnormal displacement		Comments on rehabilitation method
	Drainage	Condition		
		Clogged, Broken, Water leakage, Support Broken, Pipe broken Others		
Substructure	Abutment	Type / Condition : Leaning, Settlement, Sliding,		
		Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Abutment	Type / Condition : Leaning, Settlement, Sliding,		
		Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Pier	Type / Condition : Leaning, Settlement, Sliding,		
		Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Pier	Type / Condition : Leaning, Settlement, Sliding,		
		Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Foundation	Type / Condition		
		Settlement, Leaning, Moving, Crack, Scouring, Others		
	Wing wall	Type / Condition		
		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces		
	Embankment	River bank / Side bank		
		Back filling / Others		
Others	Affixed article			
	Traffic sign			
	Approaches			
	Others			

Components of photographs taken

0 Black board(Name of Bridge	5 Main beam	10 Abutment	15 Main damage	20
1 Front	6 Diaphragm	11 Abutment	16 Main damage	21
2 Road surface	7 Drainage	12 Pier	17 Main damage	22
3 Expansion joint	8 Bearing	13 Pier	18	23
4 Deck slab(Underface)	9 Elevation	14 Pier	19	24

Rating

1. No damage detected on the basis of the inspection results.
2. Damage has been detected and a follow-up survey is required.
3. There is significant damage and a detailed survey needs to be carried out to establish whether repair work is to be carried out or not.
4. There is substantial damage and urgent repair is required or the bridge has to be closed to traffic or restriction on vehicle weight to be imposed

Note : Further inspection shall be carried out on the "major damage" detected in this inspection.

Bridge Inspection Form 2

NAME OF BRIDGE	SER No.	Date of Inspection

LOCATION	CONDITION	Sketch
Photo album No. -		
		Comment

LOCATION	CONDITION	Sketch
Photo album No. -		
		Comment

Bridge Rehabilitation Record Form (Steel Bridge)

NAME OF BRIDGE		CLASS OF ROAD				CROSSING UNDER THE BRIDGE					COMPLETED				MAINTENANCED BY		
Component		Class	Date of Inspection	Rating	Date of Rehabilitation	Rehabilitation Method	Class	Date of Inspection	Rating	Date of Rehabilitation	Rehabilitation Method	Class	Date of Inspection	Rating	Date of Rehabilitation	Rehabilitation Method	
Bridge surface	Pavement																
	Railing																
	Curb																
	Deck slab																
	Main beam/structure																
	Diaphragm																
	Sway/Lateral Bracing																
	Painting																
Accessory	Expantion joint																
	Bearing																
	Drainage																
Substructure	Abutment A1																
	Pier P1																
	P2																
	P3																
	P4																
	P5																
	Abutment A2																
	Foundation																
	Embakment A1 Left wing																
	Right wing																
	Left side																
	Right side																
	Backfilling																
	Embakment A2 Left wing																
	Right wing																
	Left side																
	Right side																
	Backfilling																
Others	Affixed articles																
	Traffic sign																
	Approaches																
	Others																
Signature																	

Bridge Rehabilitation Record Form (Concrete Bridge)

NAME OF BRIDGE		CLASS OF ROAD				CROSSING UNDER THE BRIDGE					COMPLETED					MAINTENANCED BY	
Component		Class	Date of Inspection	Rating	Date of Rehabilitation	Rehabilitation Method	Class	Date of Inspection	Rating	Date of Rehabilitation	Rehabilitation Method	Class	Date of Inspection	Rating	Date of Rehabilitation	Rehabilitation Method	
Bridge surface	Pavement																
	Railing																
	Curb																
Super structure	Deck slab																
	Main beam/structure																
	Diaphragm																
Accessory	Expantion joint																
	Bearing																
	Drainage																
Substructure	Abutment A1																
	Pier P1																
	P2																
	P3																
	P4																
	P5																
	Abutment A2																
	Foundation																
	Embakment A1 Left wing																
	Right wing																
	Left side																
	Right side																
	Backfilling																
	Embakment A2 Left wing																
	Right wing																
	Left side																
	Right side																
	Backfilling																
Others	Affixed articles																
	Traffic sign																
	Approaches																
	Others																
Signature																	

3.6 Bridge Visual Inspection (Preliminary Bridge Inspection)

Bridge visual inspection carried out in May, 1995 was shown in photos of subsequent pages.

As the number of bridges to be inspected was as large as 100 and they are located widely scattered all over the country, three teams were formed. Each team includes three to four members, including one or two Study Team members and two released engineers of RDA. These teams covered the following areas respectively:

Team 1: Area around Colombo and western province, with Colombo as a base point
Team 2: Southern province, with Galle as a base point
Team 3: Central province, with Kandy as a base point

Each team carried following investigation tools:

- Measuring equipment: Convex tape (3m, 5m), folding measure, 50 m tape, clinometer, crack scale, plumb bob, slide calipers, test hammer, etc.
- Recording tools: Camera, white board, marker pen, ribbon rod, flashlight, chalk, drawing board, etc.
- Access equipment: Ladder, rope, binoculars, etc.
- Safety tools: Color cones, leather gloves, working gloves, boots, etc.

The inspection schedule is shown in Table 3.5.

A total of 39 days were necessary to inspect all of 104 bridges, which means that one team carried out the inspection of 3.7 bridges a day in the average. The number of bridges inspected per day was small because the bridges are scattered all over the country, taking a time for traveling.

Table 3.5 Schedule of Preliminary Bridge Inspection

		COLOMBO TEAM (KASUGA, KATAOKA)		KANDY TEAM (NAMBA, HARIYA)		GALLE TEAM (FURUKAWA)	
		SER. NO (TYPE)	HOTEL	SER. NO (TYPE)	HOTEL	SER. NO (TYPE)	HOTEL
MAY. 8	MON	7(PSC/PRE.RCB)	COLOMBO	Same as Colombo Team		Same as Colombo Team	
9	TUE	66(STTR/T) 195(RSJ/COR) 197(STTR/T) 201(ARCH/CO)	ditto	Same as Colombo Team		Same as Colombo Team	
10	WED	79(STTR/T) 17(RSJ/BUC) 32(RSJ/COR)	ditto	Same as Colombo Team		Same as Colombo Team	
11	THU	39(RSJ/COR)	Anuradapura	68(RSJ/BUC.PSC/PRE)	Anuradapula	75(STTR/T), 76(STTR/T)	Bentota
12	FRI	193(collapse) 61(BAILEY) 144(RSJ/RCS) 103(RCS)	ditto	65(RSJ/RCS) 63(CAUSEWAY) 73(RCS) 62(CAUSEWAY)	Kandy	33(STTR/T) 67(RSJ/RCS) 19(STTR/T)	ditto
13	SAT	122(STTR/T) 71(PSC/PRE)rec. 80(STTR/T)	COLOMBO	139(CAUSEWAY) 119(ARCH/BR) 26(STTR/T)	ditto	173(RSJ/BUC) 138(RSJ/BUC) 21(STTR/T.RSJ/BUC) 202(BAILEY)	ditto
14	SUN		ditto		ditto	40(RSJ/BUC) 21(STTR/T.RSJ/BUC) 59(RSJ/BUC) 58(RSJ/RCS)	Ahungalla
15	MON	2(RSJ/BUC) 123(PSC/PRE)	ditto	106(RSJ/RCS) 128(STTR/T)	Badulla	31(RSJ/RCS) 18(RSJ/RCS) 30(RSJ/COR)	ditto
16	TUE	136(RSJ/COR) 147(RSJ/BUC) 148(RSJ/BUC)	ditto	43(ARCH/BR) 45(ARCH/CO) 44(RSJ/BUC) 178(STTR/D)	Bandarawela		ditto
17	WED	77(STTR/T, RSJ/RCS) 120(RSJ/COR), Red. RCS	ditto	91(RC/BOX) 89(RSJ/COR)	COLOMBO	35(RSJ/RCS) 25(RSJ/RCS) 41(RCS) 24(RSJ/T) 72(STTR/T)	ditto
18	THU	129(ARCH/BR) 130(STTR/T) 131(RSJ/COR)	ditto	69(STTR/T) 133(RSJ/BUC)	ditto	52(RSJ/COR) 27(ARCH/ST) 74(RSJ/BUC)	Galle
19	FRI	53(STTR/T) 151(RSJ/BUC) 154(RSJ/BUC)	ditto	127(RSJ/COR) 55(RSJ/BUC) 56(RSJ/BUC)	ditto		COLOMBO
20	SAT		ditto		ditto		ditto
21	SUN		ditto		ditto		ditto
22	MON	20(RSJ/COR) 34(STTR/T)	Kandy	47(ARCH/ST) 46(ARCH/ST) 135(RSJ/BUC)	Nuwara Eliya		Ahungalla
23	TUE	102(RSJ/CCR) 36(RSJ/COR) 60(CAUSEWAY	ditto	22(BAILEY) 93(STTR/T) 208(BAILEY) 57(RSJ/BUC)	Kandy		Galle
24	WED	78(RSJ/BUC) 150(RSJ/COR) 108(RSJ/BUC)	COLOMBO	99(STTR/D) 84(ARCH/S) 85(ARCH/BR)	COLOMBO	1(RCB)	Hambantota
25	THU	38(RSJ/T)	ditto	175(RSJ/COR) 70(RSJ/RCS)	ditto	87(PSC/PRE) 42(STTR/T) 86(PSC/PRE)	Colombo
26	FRI	209(ARCH/BR)Wdn.(RSJ/RCS) 210(RSJ/RCS) 211(RSJ/RCS)	ditto	209(ARCH/BR)Wdn.(RSJ/RCS) 210(RSJ/RCS) 211(RSJ/RCS)	ditto		ditto
27	SAT						ditto
28	SUN						ditto
29	MON						ditto
30	TUE					212(PSC/PRE)	ditto
31	WED						