
CHAPTER 10 BRIDGE OPERATION AND MAINTENANCE

10.1 Current Situation of RDA

10.1.1 Organization

(1) Whole Organization (Division and Their Duty)

RDA was established in 1986 by RDA ACT No.73 in 1981 as road administrative organization affiliated with MOH as a succeeding organization of Department of Highway which was internal bureau of Ministry of Highway (hereinafter "MOH"). Since then, it has a responsibility on maintenance and improvement of Class -A and Class -B road. By executing of new construction of Class -A and Class -B roads, construction of the highway expanding the existing roads network, plan, design and construction of the bridges made the total road network 12,020km in length and number of bridges is 4456 (Span, more than 3m) according to the statistic of the year 2010. Management of RDA is performed by the board of directors (Board of Management) appointed by Minister of MOPH. The maintenance policy of the national road network is formulated by the board of directors under the Minister of MOPH responsibility in accordance with government policy. The board of directors is composed of a Director General (Chief Executive Officer), 5 numbers of Additional Director General and 16 Directors. In addition, 11 persons of Project Directors are deployed at PMU affiliated with MOPH. Organization chart of RDA is given in Figure 10.1-1.

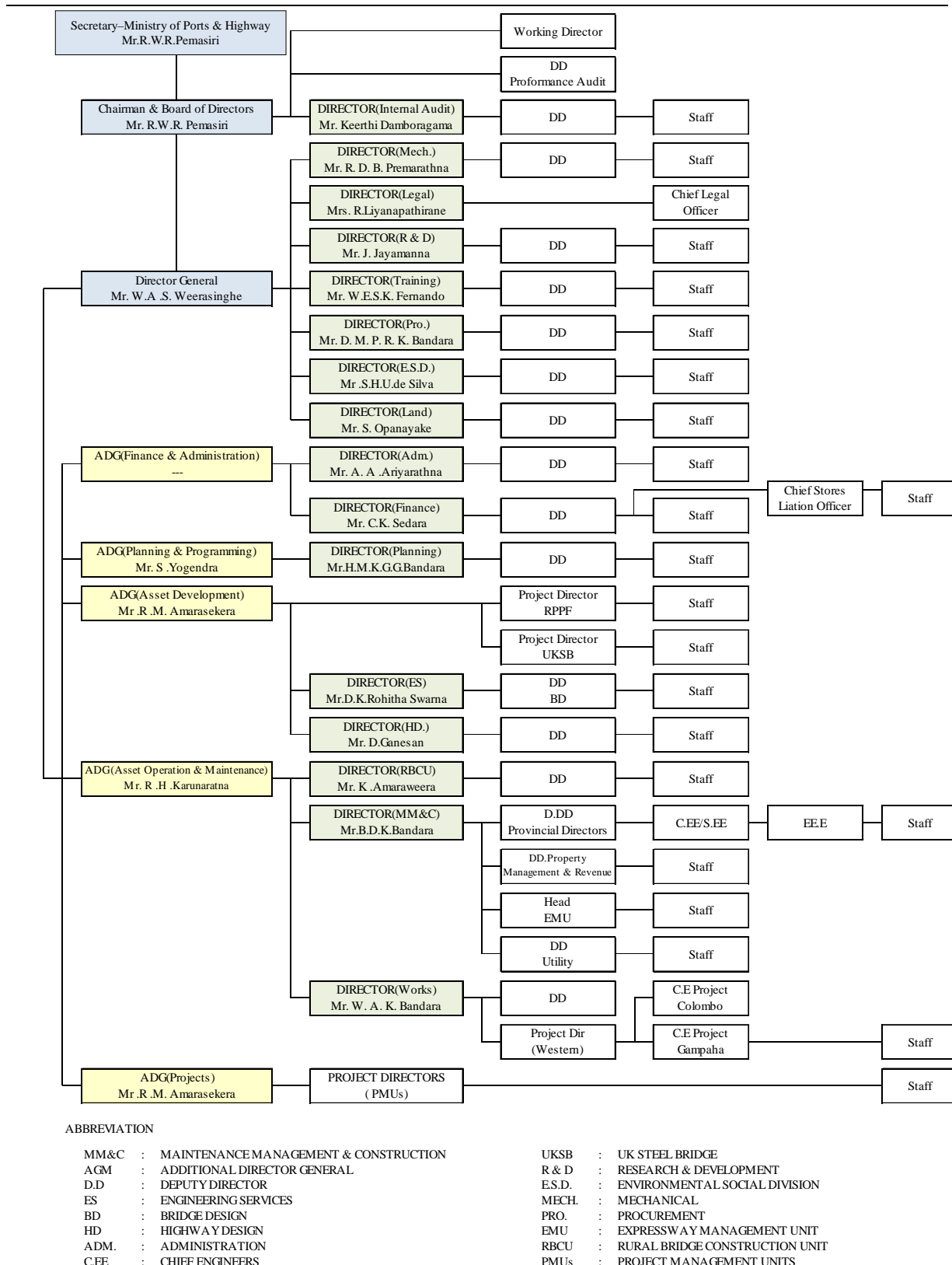


Figure 10.1-1 RDA Organization Chart

(2) Role of Each Division

Main roles for each division are summarized in Table 10.1-1.

Table 10.1-1 Role of Each Division

Division	Roles and Functions
1.Internal Audit	Assisting the top management that whether policies of RDA are efficiently applied throughout RDA and organization is efficiently fulfilling its objects.
2.Mechanical	Providing vehicles, construction machinery and equipment, production plant, ferry services and related services.
3.Legal	Carry out all legal activities relating to RDA and the projects, such as drafting & piling complaints, answers, objections, and various type of pleading in behalf of RDA.
4.Research & Development	Mainly responsible for monitoring of quality control of work. Providing investigation of foundation, embankments etc, and training of technical personal in road construction, rehabilitation & maintenance techniques.
5.Training	Carry out training function of RDA. Provide training facilities of all categories of employees in RDA to enhance their knowledge, upgrade their skills, and develop appropriate attitudes in order to improve their effectiveness.
6.Procurement	Handling procurement activities of road and bridge improvements under GOSL funding and bulk purchase of stationary and goods for RDA.
7.Environmental Social	Review and improve any environment social safeguard documents prepared by external agencies& in behalf of RDA and monitoring the level of safeguards compliances.
8.Land	Expediting land acquisition works with respect to all road development projects under the land acquisition act.
9.Administration	Overall human resource management and administration function of RDA such as staff recruitment, placement, capacity development, staff promotion, disciplinary procedures, grievances handling etc.
10.Finance	Overall financial management of RDA ,collect all revenues of such as hoarding and testing charges, control expenditure on capital works, prepare overhead budget for the year & control it within these limits.
11.Planning	Responsible for planning short term, medium term, long term program me for implementation. The overall function of this division divided into four areas such as, Planning formulation programming progress monitoring and GIS unit, Data collection and evaluation unit, Traffic management and safety unit, Management information system unit.
12.Engineering Services	Design of bridges and approach roads for bridge improvements and rehabilitation projects.
13.Highway Design	Preparation of geometric design of roads, intersections, and reviewing the designs submitted by consultants.
14.Rural Bridge Construction Unit	Undertake urgent and emergency repairs to bridges and provide low-cost bridges in rural areas.
15.Maintenance Management & Construction	Handling all kinds of road and bridge maintenance work such as routine, recurrent, periodic maintenance, structure improvements, light signal etc.
16.Works	Handling all road widening and improvement works on national highways. Also involving pre construction and construction phases.
17.Project Management Units (UKSB)	Handling regional bridge projects by using U.K fund. Contract was scheduled to complete 05 flyovers & 150 bridges.
18.Expressway Management Unit	Study operation, maintenance and management of expressways especially Southern expressway in Sri Lanka with the assistance of JICA.
19.Property management & Revenue Division	Generate income for RDA out of it own resources, by levying rentals from Hoardings/ Bill board/Gantries/Cantilevers/Telephone booths etc.

Source) RDA

(3) Staff

Total number of RDA staff is summarized in Table 10.1-2, and number of each department and site office staff are given in Table 10.1-3.

Table 10.1-2 The Total Number of RDA Staff

Classification	Accepted Number of The Staff (Person)
Executive (Engineering and professional)	923
Semi executive /Officer (Administration, Finance, Developing program/Duty concerning Implementation)	142
Assistant for administration member (Office work and other service business)	1,161
Assistant for administration member (Technology)	384
Technology workers	1,198
Semi technology workers	690
Workers	4,691
Total	9,189

Source) RDA Annual Report 2010

Table 10.1-3 Number of Staff at Each Division and Site Office

Division	Directors		Staffs		Total
	Engineering	Administration /Finance	Technical	Clerical	
1.Internal Audit	---	1	9	6	16
2.Mechanical	1	---	20	8	29
3.Legal	---	1	---	5	6
4.Research & Development	2	---	6	6	14
5.Training	1	---	1	5	7
6.Procurement	1	---	2	5	8
7.Environmental Social	2	---	2	2	6
8.Land	1	---	2	13	16
9.Administration	---	1	---	22	23
10.Finance	---	1	---	38	39
11.Planning	4	---	29	43	76
12.Engineering Services	2	---	18	2	22
13.Highway Design	2	---	25	4	31
14.Rural Bridge Construction Unit	1	---	3	5	9
15.Maintenance Management & Construction	3	---	8	12	23
16.Works	3	---	11	11	25
17.Project Management Units	20	---	155	275	450
18.Local offices	10	---	400	391	801

Source) RDA

(4) Outline of Bridge Operation and Maintenance Organization

Relating to bridge maintenance there are three divisions, Planning Div., Engineering Service Div. and Maintenance Management & Construction Div.

Following 3 types of site offices are existed under Maintenance Management & Construction Div. for inspection, operation and maintenance work.

- PD (Provincial Director) Office: They control the operation and maintenance of road and bridge in a province (9 provinces in the whole country).

- CE (Chief Engineer) Office: They control over the operation and maintenance of a road and bridge within the District (25 Districts in the whole country).

- EE (Executive Engineer) Office: They control over the operation and maintenance of the road and bridge of segment (100-200 km) (52 routes in the whole country).

The number of staff with years of experience for 3 divisions related to Bridge operation and maintenance are given in Tables 10.1.4, 10.1.5, and 10.1.6.

Table 10.1-4 Number of Staff by Years of Experience at Planning Div.

Year of Experience	0~5years	5~10years	10~25years	Total
Director	---	---	1	1
Deputy Director	1	2	1	4
Chief Engineer/Senior Engineer	2	2	---	4
Engineers	9	1	1	11
Technical Officer	---	1	1	2
GIS analyst	2	---	---	2
Planning / Management Assistant	6	6	1	12
Other	---	---	---	43
Total				79

Source) RDA

Table 10.1-5 Number of Staff by Years of Experience at Engineering Service Div.

Year of Experience	0~5years	5~10years	10~25years	Total
Director	---	---	1	1
Deputy Director	---	---	1	1
Chief Engineer/Senior Engineer	---	---	2	2
Engineers	13	4	---	17
Drafts man	12	2	2	16
Other	---	---	---	5
Total			---	42

Source) RDA

Table 10.1-6 Number of Staff by Years of Experience
at Maintenance Management & Construction Div.

Year of Experience	0 - 5years	5 - 10years	10 - 25years	Total
Director's Office				33
Director	---	---	1	1
Deputy Director	---	---	2	2
Chief Engineer/Senior Engineer	---	---	1	1
Engineers	---	1	3	4
Technical Officer	---	---	2	2
Other	---	---	---	23
PD's Office				361
Provincial Director	---	---	10	10
Projects-CE	---	---	4	4
Bridge & Highway Design -CE	---	---	1	1
Engineer				31
Technical Officer	---	---	1	1
Other				314
CE's Office				497
Chief Engineer	---	---	24	24
Engineer				68
Technical Officer				51
Other				354
EE's Office				1113
Executive Engineer				53
Engineer				104
Technical Officer				159
Other				797
Baseline Unit under EE Colombo				6
Engineer	---	---	1	1
Technical Officer				1
Other				4
Total				2010

Source) RDA

(5) Plan of New Organization for Bridge Operation and Maintenance.

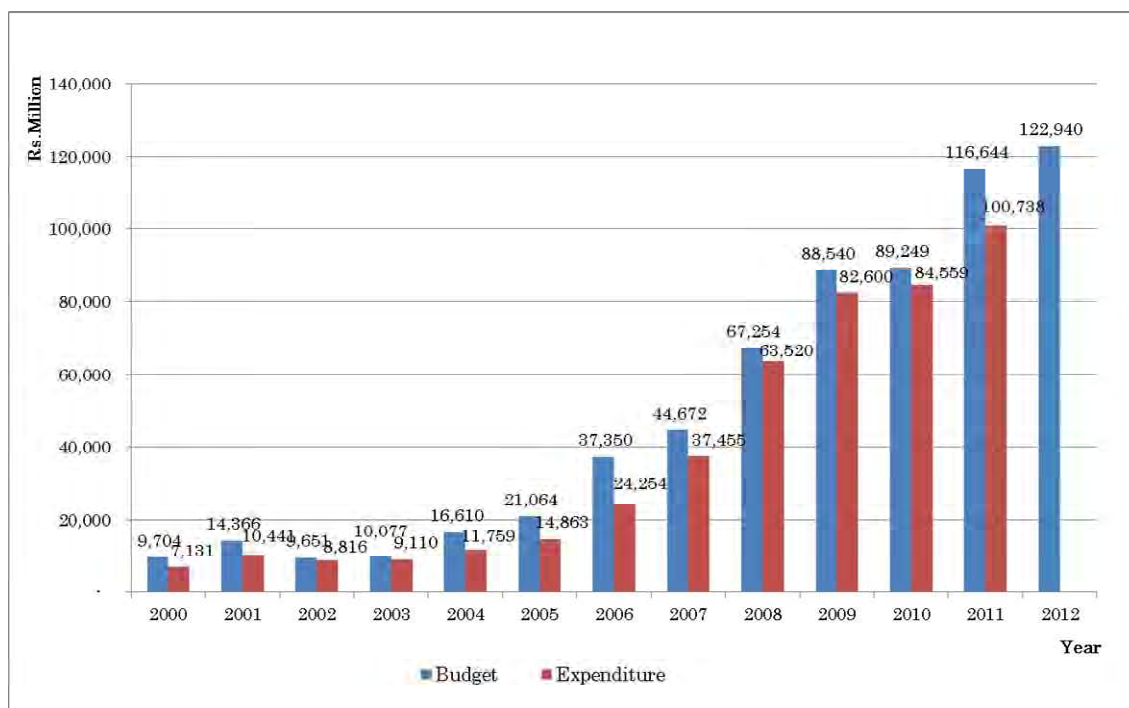
Currently, new division specialized in bridge operation and maintenance (Bridge Assessment Unit) is planned in RDA.

This Bridge Assessment Unit is explained in detail “10.6.5 Counter Part (Proposal)”

10.1.2 Budget for Bridge Operation and Maintenance

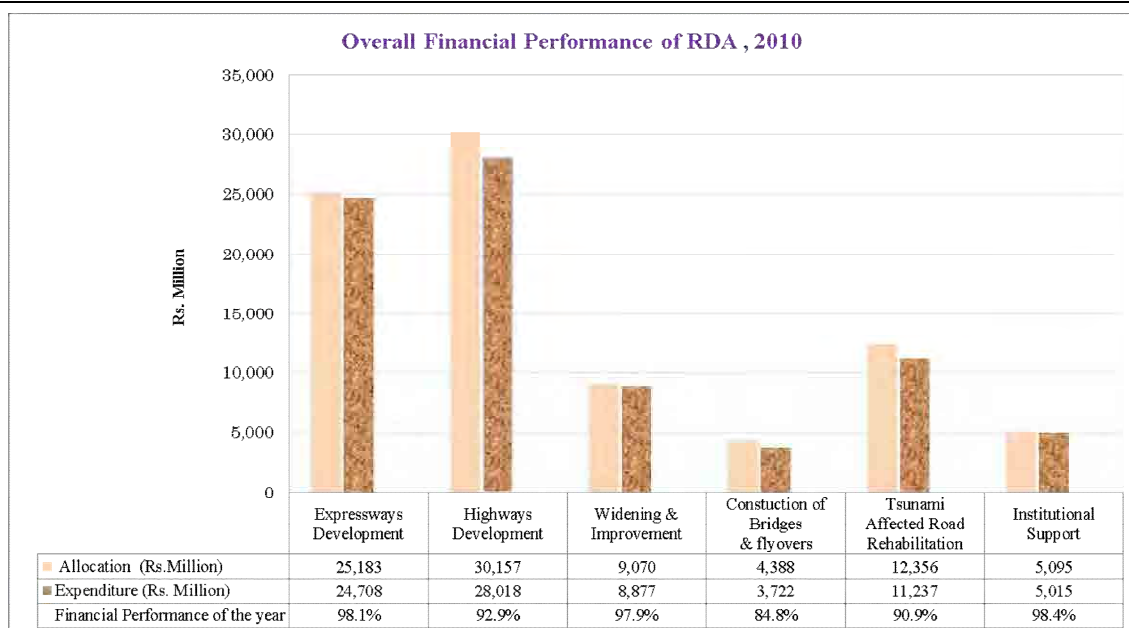
(1) RDA Total Budget

Total budget transition between 2000 and 2012 in RDA is given in Figure 10.1-2. It indicates that the budget is increasing rapidly in recent years. And the amount of total budget for RDA in 2010 is shown in Figure 10.1-3 and Table 10.1-7. The amount of budget distributed to RDA was 86,249 million Rs. including donor support, and the amount disbursed was 81,577 million Rs.



Source) RDA

Figure 10.1-2 RDA Total Budget (2000 to 2012)



Source) RDA Annual Report 2010

Figure 10.1-3 RDA Total Budget (2010)

Table 10.1-7 RDA Total Budget (2010)

Items	Distribution Amount (million Rs.)	Expenditure Amount (million Rs.)	Ratio of Budget Execution
Highway maintenance cost	25,183	24,708	98.1%
National road maintenance cost	30,157	28,018	92.9%
Extension, Improvement cost	9,070	8,877	97.9%
Bridge, Viaduct construction cost	4,388	3,722	84.8%
Tsunami damage road rehabilitation cost	12,356	11,237	90.9%
Organization operation expenses	5,095	5,015	98.4%
Total	86,249	81,577	94.6%

Source) RDA Annual Report 2010

(2) Budget for Road and Bridge Operation and Maintenance

The amount of budget and the amount disbursed (for the past 2 years) of each province for operation and maintenance of road and bridge is shown in Table 10.1-8. In addition, although the amount of distribution for each province is unknown, the amount of total budget in 2012 is 5,500 million Rs., operation and maintenance budget as well as the amount of whole RDA budget is increasing.

Table 10.1-8 Budget for Road and Bridge Operation and Maintenance for Each Province

Amount unit: million Rs.

	2010		2011	
	Budget Amount	Disbursement	Budget Amount	Disbursement
Western	821.50	807.92	500.50	499.02
Central	606.50	596.00	851.50	849.99
Southern	600.00	595.70	601.50	600.21
Uva	225.00	217.12	518.50	516.47
Sabaragamuwa	229.00	222.48	465.00	463.61
North Central	294.50	260.11	619.00	617.60
North Western	288.00	245.93	512.00	511.00
Northern	873.00	867.98	521.50	519.43
Eastern	249.00	200.87	613.50	610.48
TOTAL	4,186.50	4,014.11	5,203.00	5,187.81

Source) RDA

(3) Amount of Disbursement for Replacement of Dilapidated Bridges and Operation/Maintenance

The amount disbursed for each province for replacement of bridges and operation/ maintenance (the last 3 years) is shown in Table 10.1-9.

Replacement means reconstruction of aging bridges, Operation/Maintenance means daily and periodical inspection and structure repair means replacement and repair works for parts of bridge structure.

In the disbursement at year 2010, total amount of disbursement for roads and bridges is 4,014 million Rs. for replacement of bridges is 399 million Rs.(8%) and for operation and maintenance of bridge is 84 millions Rs (2%) as shown in Table 10.1-8. It indicates that very few budget was assigned to the bridge.

Table 10.1-9 Amount Disbursed for the Past Three Years of Each Province on Structure Repair

Amount unit: million Rs.

	Replacement			Operation/Maintenance		Structure Repair
	2009	2010	2011	2009	2010	2011
Western	102.0	122.0	77.5	1.8	9.4	39.2
Central	32.8	14.5	3.7	1.4	0.5	44.0
Southern	19.5	46.0	4.5	2.6	3.3	48.6
Uva	43.0	43.0	66.7	1.8	10.4	36.4
Sabaragamuwa	47.0	59.5	77.0	4.4	3.3	50.0
North Central	31.3	3.0	2.8	1.8	0.0	23.5
North Western	46.2	47.5	65.4	7.1	46.9	25.5
Northern	0.2	-	-	0.5	1.8	1.0
Eastern	3.9	3.5	50.8	1.3	8.7	37.8
Total	325.9	339.0	348.4	22.7	84.3	306.0

Source) RDA

(4) Source of Fund

Source of fund of RDA budget is shown in Table 10.1-10. It indicates that most of sources are donor's support.

Table 10.1-10 The Budget According to Separated Revenue Source of RDA

A source of Revenue	Allocation (million Rs.)	Amount Disbursed (million Rs.)	
Domestic Funds (DF)	23,534.90	22,943.02	(28%)
Foreign Aid Loan (FAL)	44,201.10	41,203.95	(51%)
Foreign Aid Grant (FAG)	4,005.50	3,550.75	(4%)
Reimbursable Foreign Aid-Loan(RFAL)	752.00	615.55	(1%)
Reimbursable Foreign Aid-Grant(RFAG)	200.00	44.71	(1%)
Foreign Aid related Domestic Funds(FARDF)	13,555.60	13,219.32	(16%)
Total	86,249.10	81,577.30	(100%)

Source) RDA Annual Report 2010

10.1.3 Donor's Assistance for Road Sector

(1) Bridge Projects Assisted by Donors.

Donor support in road sector is focusing on the road maintenance and improvement at district area. The main projects are shown in Table 10.1-11. There are no bridge operation and maintenance project, and the steel bridge construction project (Photograph 10.1-1) supported by UK fund is the largest scale.

Table 10.1-11 Main Road Projects Assisted by Donor

Project	Donor	Outline
Southern Expressway	ADB, JBIC, NDF, SIDA, GOSL	Expressway between Kottawa and Pinnaduwa (95.3km), opened Nov, 2011. Extension section Pinnaduwa to Matara (35.8km) is under construction by China companies.
Colombo - Katunayake Expressway	China	26km highway which connects Katunayake airport to Colombo. It is under construction by Chinese companies. Opening of traffic in 2012 is aimed
Outer Circular Highway Project	JICA China	The beltway of 28 km of extension (expressway standard) Phase-1 : Kottawa~Kaduwela (11km) under construction Phase-2 : Kaduwela~Kadawatha (8.9km) under construction Phase-3 : Kadawatha~Kerawelapitiya (9.2km) In land acquisition
Colombo Kandy Alternate Highway (North East Expressway)	F/S (SIDA)	Total length 98 km (Rs 90 bil) expressway, F/S is completed, and topographical survey, geological survey, hydrological survey, social environment investigation and detail design are ongoing at 38 km extension section.

Project	Donor	Outline
Japan Aided Projects	JICA	Implementing the following projects i) Eastern poverty measures infrastructure project, ii) Baseline road extension project (Phase III), iii) Eastern 5 Bridges reconstruction project.
Miscellaneous Foreign Aided Project (MFAP)	EDCF Kuwait Fund Saudi Fund etc.	Implementing following projects by several finances, i) Road improvement project Ratnapura - Banlangoda, ii) Road improvement projects Banlangoda - Bandarawela, iii) 32 bridges bypass reconstruction project, iv) Kinniya bridge construction, road improvements projects Thambalamuwa - Kinniya and etc.
World Bank Funded Road Sector Assistant Project	World Bank (WB)	Implementing the road sector support project (13 sections), the main section of business, i) Ingiriya - Ratnapura section, ii) Nittanbuwa - Kandy section, iii) Haliela - Bandarawela section and etc.
National Highway Sector Project	Asian Development Bank (ADB)	Improvement of national expressways, operation and maintenance projects, main section in the business, i) A005 Nuwara - Badulla (54.9km), ii) A006 Habarana - Kantale (43.6km), iii) A012 Puttalam - Anuradhapura (70km) and etc.
Asian Development Bank Funded Projects	Asian Development Bank (ADB)	The following projects are carried out about district road maintenance and improvement. i) Reconstruction project in conflict areas, ii) Tsunami damage reconstruction project, iii) Trincomalee road project, iv) Steel bridge project, v) Northern part road reconstruction project.
Northern Road Connectivity Project (NRCP)	Asian Development Bank (ADB) the Sri Lankan government	Planning to following projects, i) Northern road linking project, ii) Urgent project in conflict areas, iii) Road project preparation and etc.
UK Steel Bridge Project	UK	At the whole country district roads of RDA and other than RDA roads, design, provision of steel members for 118 steel bridges and technical assistance for construction. UK Steel bridge Under the Project, 33 bridges were complete in 2011, within this length longer 30m are 8 nos. and structure type is bailey.

Source) RDA Annual Report 2010

Note) SIDA: Swedish Development Agency EDCF: Economic Development Corporation Fund

* Other donor's projects are covering many small and middle span bridges. Comparatively long bridges are mostly truss bridges.



Source) RDA

Photograph 10.1-1 UK Steel Bridge Project

(2) Inhouse Consultant

There are no in house consultant supported by donor, and only RDA staff.

10.2 Current Condition of Bridge Managed by RDA

10.2.1 Current Condition of Bridges

(1) Number and Classification of All Bridges Managed by RDA.

Currently, the bridges with 3m or greater span are managed by RDA, are 4,456 bridges. The breakdown by bridge length and types are shown in Table 10.2-1 (the number of bridges for each breakdown is changed with defects of database). The number of bridges length more than 30m are 365 and 8.3 % of the total and less than 10m are about 70 % of the total.

Moreover, when bridges are classified by the types of structure, 80% of 4,292 bridges in the whole are concrete type (RC, PC), and 20% are steel bridge.

RC bridges are constructed after the 1950s and PC Bridges are after the 1970s, post tensioned beams are used for about L=30 length bridges, and pretension beams (standard of main beam width 1000(500) mm) are used for less than L=25(19)m length bridges. For the steel bridge (truss and plate girder bridge), the standard beam up to about L=40m is manufactured by Government Factory (factory of Ministry of Public Works) since prewar days.

Table 10.2-1 Number of Bridge by Length/Type

Length (m)	Number of Bridge	Ratio (%)		Bridge Type	Number of Bridge	Ratio (%)
30 < L	365	8.3		RC	2,381	55.5
10 < L ≤ 30	1,029	23.4		PC	800	18.6
5 < L ≤ 10	1,800	41.0		Steel bridge	915	21.3
L ≤ 5	1,202	27.3		Others	196	4.6
Total	4,396	100.0		Total	4,292	100.0

(2) Elapsed Years and Degree of Bridges Managed by RDA.

The number of bridges by the construction year is summarized in Table 10.2-2, and Figure 10.2-1, records of 2,204 bridges are existing. It turns out that there are many bridges built in the 1970s to 1980s from these records.

Moreover, the numbers of bridges which are more than 50 years in service and 100 years in service respectively, show in Table 10.2-3. According to this table, the bridges that passed more than 50 years after construction is 42% as of year 2010 and passed more than 100 years is 2%. Naturally the ratio becomes increased, and it is necessary to produce a bridge replacement plan and operation and maintenance plan. There are some bridges which operation and maintenance are appropriately carried out and are utilized satisfactorily more than 100years, on the other hand among recent built bridges, there are salt damaged concrete bridges and steel bridges which corrosion are progressing. It is important to make improvement of construction technology and operation and maintenance capability for the bridges.

Table 10.2-2 Number of Bridges
by Construction Year (1)

Construction year	Number of bridges
1900	43
1910	7
1920	68
1930	141
1940	227
1950	139
1960	292
1970	400
1980	410
1990	230
2000	135
2010	112
Total	2204

Source) RDA

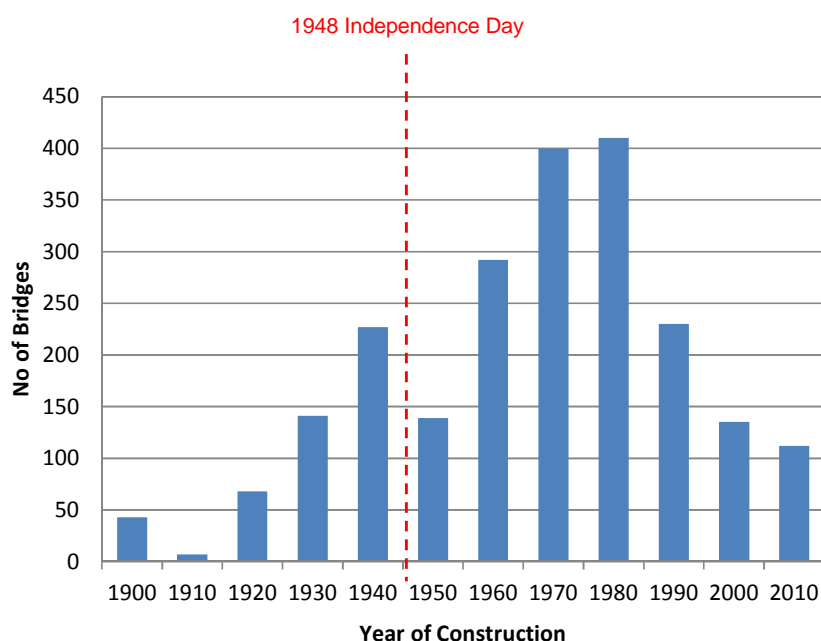


Figure 10.2-1 The Number of Bridges by Construction Year (2)

Table 10.2-3 Number of Bridges after 50 Years and 100 Years in Service.

Year	More than 50 Years		More than 100 Years	
	The Number of Bridge	Ratio	The Number of Bridge	Ratio
2000	625	28%	43	2%
2010	917	42%	50	2%
2020	1317	60%	118	5%
2030	1727	78%	259	12%
2040	1957	89%	486	22%
2050	2092	95%	625	28%

Source) RDA

(3) Comparison with Situation in Japan in Recent Years

Currently, the aging of bridge has become a problem in Japan, they are required for replacement, emergency repair and reinforcement. Bridge construction in Japan has been carried out in the high economic growth period (1960s - 1990's) intensively. Therefore, it is concerned that renovation of the groups of bridges that have been constructed in this period will be carried out at same term intensively in near future.

The bridge construction has been intensively in 1960s to 1990s in Sri Lanka as well, and it is speculated that the similar problem will occur. In addition to the above, the rate that the number of bridges constructed before 1960 occupies to the whole in Sri Lanka is larger than in Japan, and the urgency of the bridge degradation problem is speculated to be more serious than Japan.

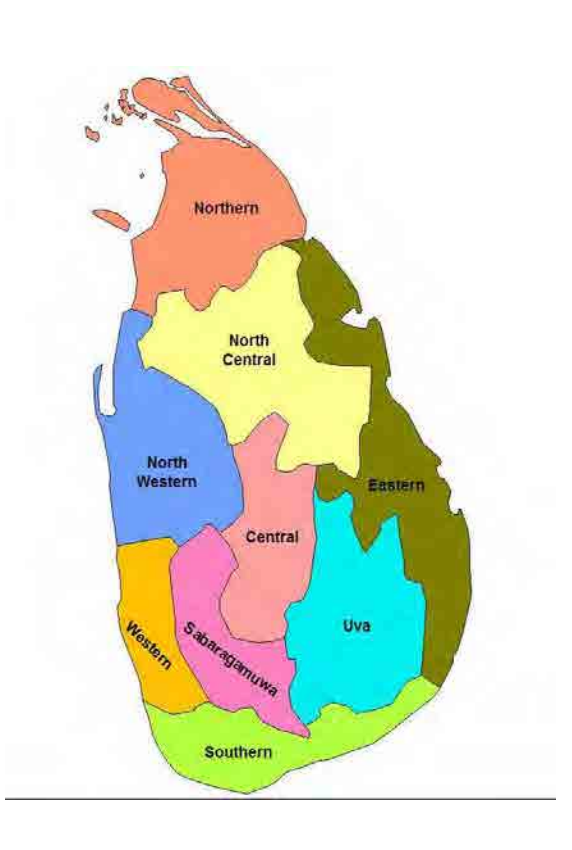
10.2.2 Number of Bridges Managed by The Local Organization of RDA

(1) Number of Bridge Managed by Each Province.

The number of bridges managed by each province is shown in Table 10.2-4. Western province and Sabaragamuwa province have the largest number of bridges. North Central, Central, and Sabaragamuwa which are located in the central part of Sri Lanka are mountains range and there are many dangerous area of slope mudslide in the mountain road. It is necessary to care the bridges for the damage caused by slope collapse. Southern part of the island, North Western, Eastern belong to tropical rain forests, since it is a pluvial humid area, it is necessary to mind about the corrosion of steel bridge and also the measure to damage from salt water at coastal area.

Table 10.2-4 Number of Bridges of PD Office Management of Each Province (Total 4247 Bridge)

Province	The Number of Bridge	Component Ratio (%)
Northern	276	6.2
North Central	361	8.1
North Western	463	10.4
Eastern	334	7.5
Central	626	14.0
Western	788	17.7
Sabaragamuwa	698	15.7
Uva	437	9.8
Southern	473	10.6
Total	4456	100.0



Source) RDA

10.2.3 Damaged Condition of Bridges

(1) Damaged Condition of Bridges

The number of damaged points at each part and by degree of damage according to the inspection records for 58 bridges received from EE office of Kalutara is shown in Table 10.2-5. In addition, the judgment RDA criteria of degree of damage are as follows.

- Degree 1 : Component is in good condition with little or no deterioration.
- Degree 2 : Component shows deterioration of a minor nature with primary structural material which is first signs of being affected.
- Degree 3 : There is significant damage and a detailed survey to be carried out to establish whether repair work is to be carried out or not.
- Degree 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.

From the analysis of this result, there are many bridges which have many parts applicable to the degree 3 or 4 damage, and to be repaired urgently. Moreover, since there are no particular parts which have especially high or low degree of damage, it is considered that damage is advancing to the whole of bridge.

Table 10.2-5 Totalization for Degree of Damage

	Element	Degree 1 Damage	Degree 2 Damage	Degree 3 Damage	Degree 4 Damage	Total
Bridge surface	Pavement	21 (36%)	14 (24%)	22 (38%)	1 (2%)	58
	Curb	22 (71%)	7 (23%)	2 (6%)	0 (0%)	31
	Handrail	28 (54%)	9 (17%)	15 (29%)	0 (0%)	52
Superstructure	Floor Slab	25 (56%)	8 (18%)	8 (18%)	4 (9%)	45
	Main Girder	15 (42%)	8 (22%)	8 (22%)	5 (14%)	36
	Secondary Member	7 (41%)	8 (47%)	1 (6%)	1 (6%)	17
	Painting	34 (63%)	17 (31%)	2 (4%)	1 (2%)	54
Accessory	Joint	0 (0%)	4 (27%)	9 (60%)	2 (13%)	15
	Bearing	3 (43%)	0 (0%)	3 (43%)	1 (14%)	7
	Drainage	6 (25%)	8 (33%)	10 (42%)	0 (0%)	24
Substructure	Subtraction	27 (47%)	26 (45%)	4 (7%)	1 (2%)	58
	Pier	4 (33%)	5 (42%)	3 (25%)	0 (0%)	12
	Foundation	2 (20%)	5 (50%)	3 (30%)	0 (0%)	10
	Wing	15 (38%)	20 (50%)	4 (10%)	1 (3%)	40
	Embankment	9 (56%)	5 (31%)	2 (13%)	0 (0%)	16

Source) RDA

Japan Bridge & Structure Institute, Inc., Dainichi Consultant Inc.
and Landtec Japan, Inc.

(2) Classification of Damage Condition of Bridges

It is shown in Photograph 10.2-1 about highly damaged existing bridge which received from EE office of Kalutara and it's also taken by this inspection.

1) Damage to the concrete beam



Rebar exposure and corrosion of the concrete girder
Kalutara(AA002- 31/3)



Collapse of lining concrete
Kalutara(B224-11/5)

2) Damage to the steel beam



Corrosion of steel main truss and cross beam
Kalutara(AA002-20/1)



Corrosion and cross sectional deficit of steel main girder
Kalutara(B157-23/1)

3) Damage to the pavement and the floor slab



Consumption of pavement
Colombo



Collapse of floor slab
Kalutara(B157-27/8)

4) Damage to the abutment



Collapse of abutment
Kalutara(AA002- 7/1)



Crack of abutment
Colombo(AA001-6/1)

5) Damage of Attachments



Damage of expansion device
Colombo(B388- 2/5)



Damage of handrail
Matara(B607-10/1)

Source) RDA, Study Team

Photograph 10.2-1 Damage Condition of Bridge

(3) Causes of Damage

Though causes of damage to bridge structures are assumed to be such severe environment as chloride damage along the coastal area, heavy loading and poor workmanship during construction, it is difficult to identify the specific causes for each project bridge during this Study. However, it is considered that such damage can be prevented if appropriate inspection/ repair works for earlier detection and proper repair works are conducted.

(4) Typical Repair Method

1) Crack Injection

Cracks in a concrete structure will degrade its durability, functional performance capability and safety due to the ingress of water and oxygen, consequent corrosion in reinforcement steels and repetitive loading by heavy vehicles.

Injection, routing and patching, and surface coating methods are generally used for crack repair. Appropriate method is selected based on given conditions such as extent of crack width movement, crack depth, with or without leakage water, and crack growth rate.

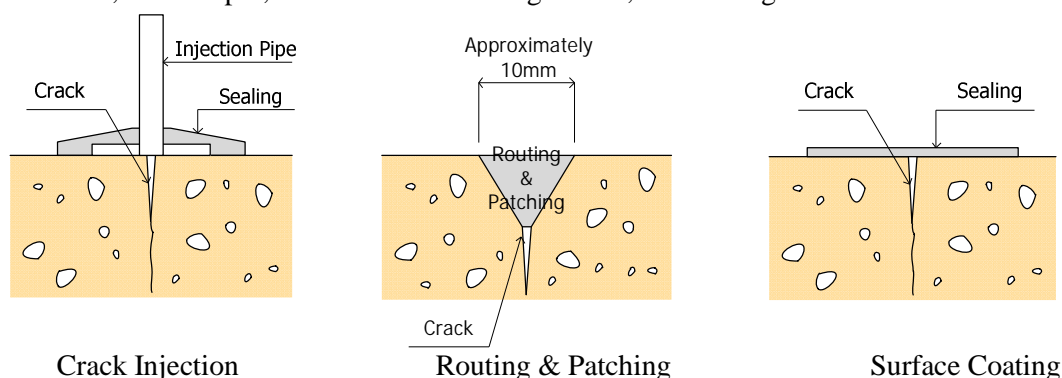


Figure 10.2-1 Crack Repair Method

2) Restoration of Damaged Member

Restoration works are widely used where fragile of concrete, corrosion of reinforcing bar, scaling and/or spalling of concrete and exposed reinforcing bar are observed. Defects caused by poor construction such as honeycomb or cold joints are also repaired with restoration works.

Appropriate restoration method shall be selected with full understanding of causes of defects/damage, extent of deterioration, features of defect, environmental and other external given conditions in advance after careful investigation.

It shall be ensured sufficient resistance to external forces is provided even with the lack of member during restoration works.

a) Member with Small Extent of Damage

After cleaning the concrete substrate surface, removing the rust and applying corrosion inhibitors on exposed reinforcement steels, plaster work is given to inject repair materials into defect directly by trowels, spatulas or hands with gloves. In order to prevent materials from spalling, the following measures are to be taken:

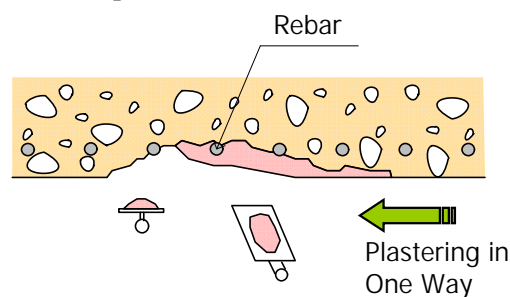


Figure 10.2-2 Plaster Finish

- Depth of one application should be small.
- Non-shrinkage material should be used.
- Bonding agent should be applied on substrate surface.
- Sufficient curing time should be provided.

b) Member with Large Extent of Damage

Injection method is used to inject repair materials into defect with forms.

Forms shall have sufficient resistance to injection or swelling pressure, and shall be completely filled with joints between sheathings by sealing materials. Attention shall be paid on complete removal of air from the form with appropriate arrangement of injection and exit ports. Injection ports shall be provided to lower places with exit ports to higher places.

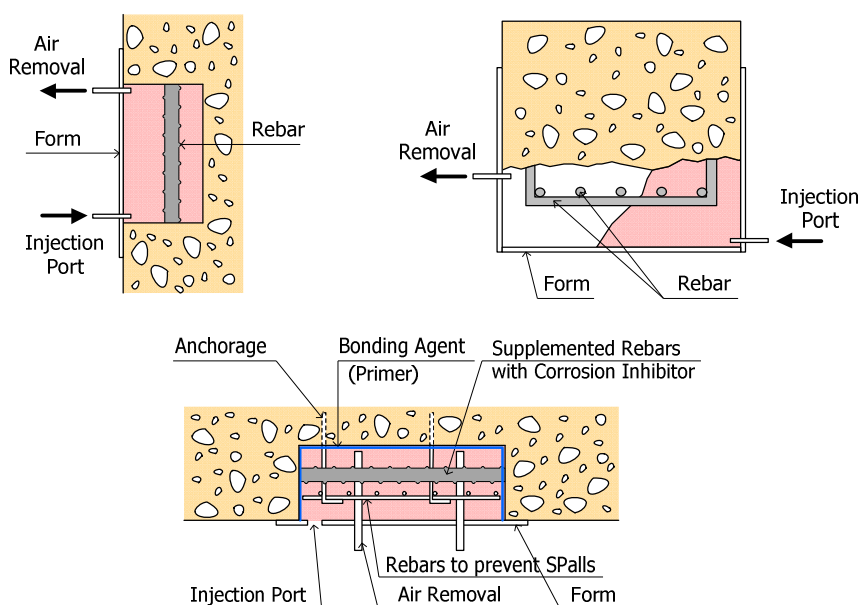


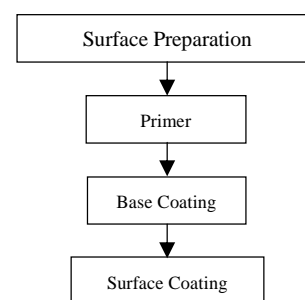
Figure 10.2-3 Pre Packed Concrete

3) Repainting Steel Bridge

Steel structures are initially deteriorated in surface coating. When the corrosion is progressed into steel members with the loss of member section, it will degrade the loading capacity of a structure remarkably.

Repainting will initially be carried out with the removal of existing surface coatings by blasting method (surface preparation), followed by application of surface coating. With the assumption of 20 years residual life, Ra-III paint system will be used.

Painting is conducted with three (3) layers: primer, base coating and surface coating.



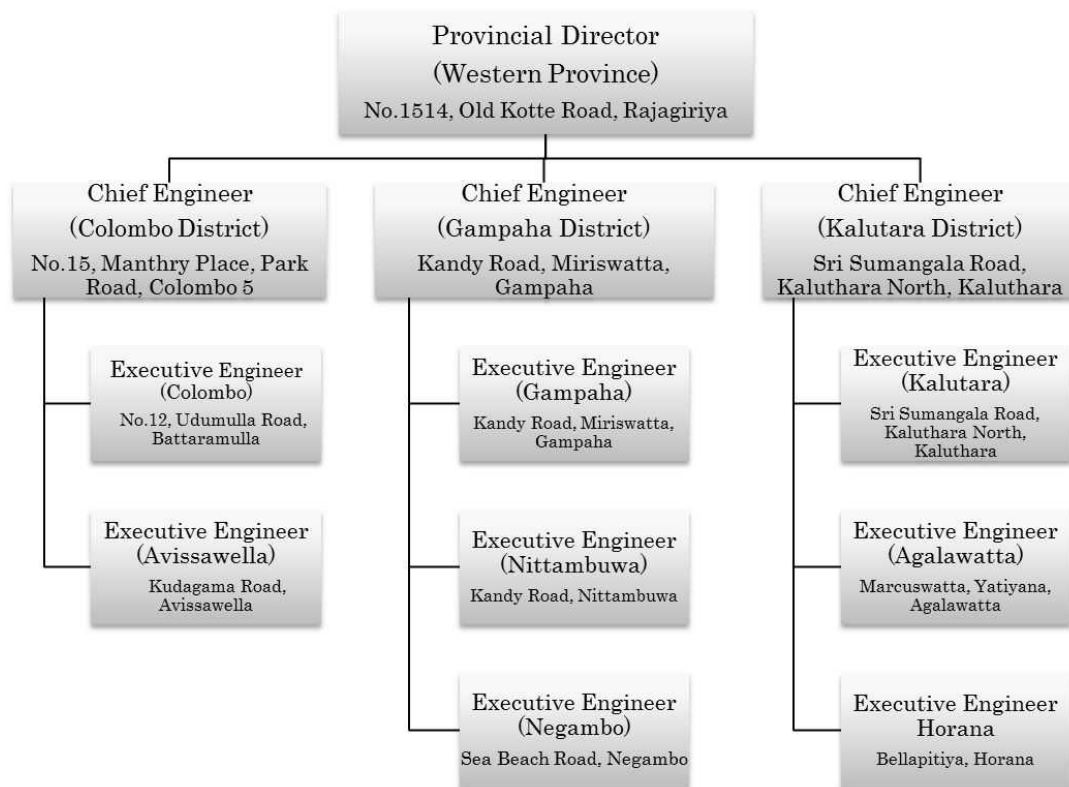
10.3 Operation and Maintenance System for RDA Bridges

10.3.1 Current Situation of Operation and Maintenance Organization

(1) Organization Scale and Role of PD (Province), CE (District) and EE.

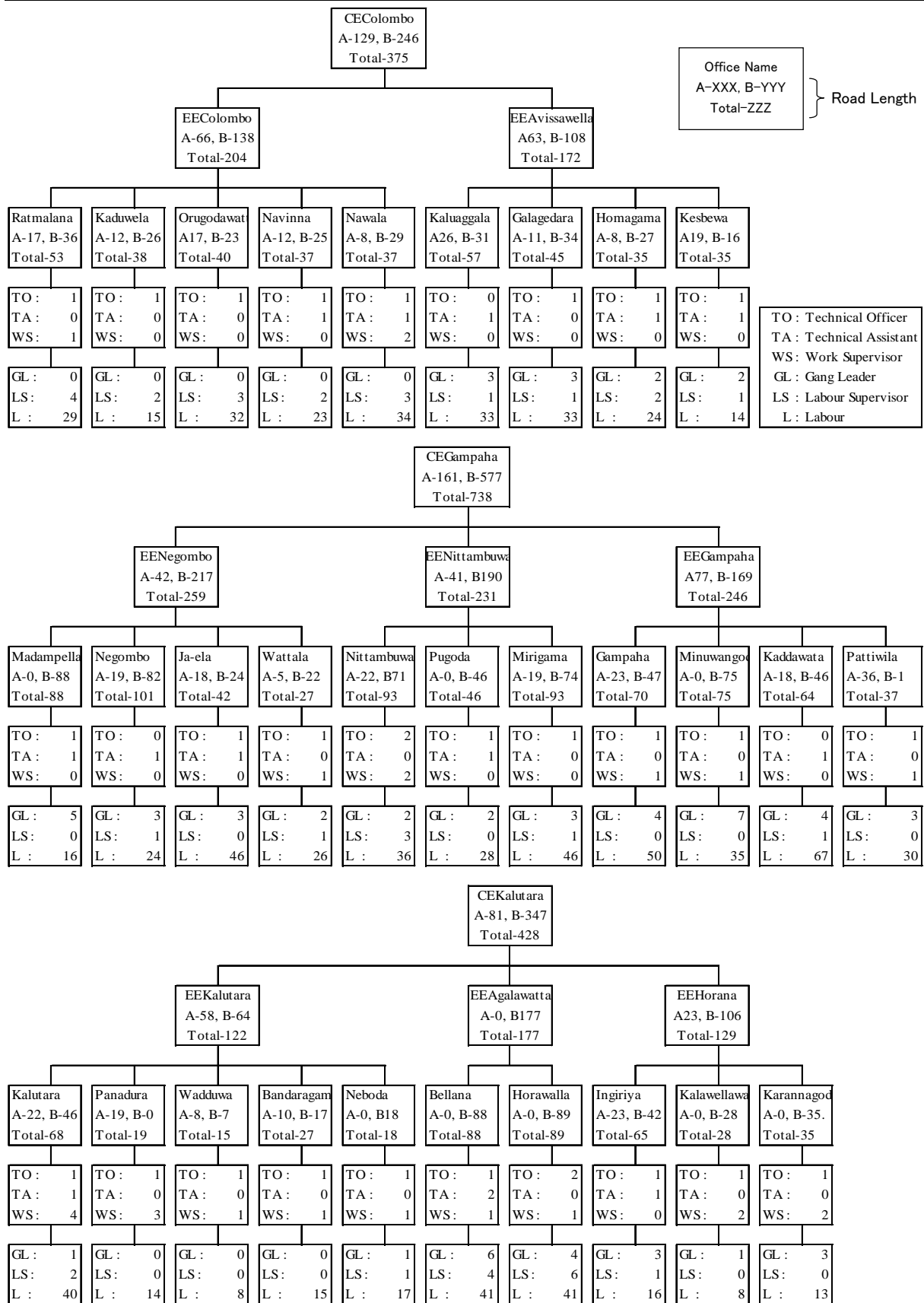
Western Province organization chart is shown in Figure 10.3-1 and their personal distribution chart is in Figure 10.3-2 as a representative of whole 9 Provinces. The number is shown in Figure 10.3-2 is number of staff and managed road length of route A and B.

In the local organization of the Province of Western, 3 Chief Engineers (CE) are arranged under 1 Provincial Director (PD), and also 8 Executive Engineers (EE) are arranged under CE. In addition, 2 to 5 numbers of groups are organized in EE office. The Road managed by Western province is total 1540km length (Class A 370km and Class B 1170km), and have about 600 numbers of bridges. The local office list in the whole country is shown in Table 10.3-1.



Source) RDA

Figure 10.3-1 Organization Chart of Western State



Source) RDA

Figure 10.3-2 Figure of Staff Placement

Table 10.3-1 List of Local Office

(PD)Western	(PD)Northern
(CE)Colombo	(CE)Jaffna
(EE)Colombo	(EE)Pallai
(EE)Avisawella	(CE)Vavunia
(CE)Gampaha	(EE)Vavunia
(EE)Gampaha	(EE)Mannar
(EE)Nittambuwa	(CE)Mulative
(EE)Negambo	(EE)Mulative
(CE)Kalutara	(EE)Kilinochchi
(EE)Kalutara	(EE)Point Pedro
(EE)Agalawatta	(PD)North Western
(PD)Southern	(CE)Kurunegala
(CE)Galle	(EE)Kurunegala
(EE)Galle	(EE)Kuliyapitiya
(EE)Hiniduma	(EE)Maho
(CE)Matara	(CE)Chilaw
(EE)Matara	(EE)Chilaw
(EE)Deniyaya	(EE)Puttalam
(CE)Hambantota	(PD)North Central
(EE)Tangalle	(CE)Anuradhapura
(EE)Kandasurindugama	(EE)Anuradhapura
(PD)Central	(EE)Medawachchiya
(CE)Kandy	(EE)Maradankadawela
(EE)Kandy	(CE)Polonnaruwa
(EE)Kundasale	(EE)Polonnaruwa
(EE)Kadugannawa	(EE)Habarana
(CE)Nuwara Eliya	(PD)Eastern
(EE)Nuwara Eliya	(CE)Bataloa
(EE)Norwood	(EE)Bataloa
(EE)Haguranketha	(CE)Trincomalee
(CE)Matale	(EE)Trincomalee
(EE)Matale	(CE)Akkaraipattu
(EE)Nalanda	(EE)Akkaraipattu
(PD)Sabaragamuwa	(CE)Ampara
(CE)Ratnapura	(EE)Ampara
(EE)Ratnapura	(EE)Kalmunai
(EE)Pelmadulla	(PD)Uva
(CE)Kegalle	(CE)Bandarawela
(EE)Kegalle	(EE)Badulla
(EE)Ruwanwella	(EE)Bandarawela
(EE)Embilipitiya	(EE)Mahiyangana
	(CE)Monaragala
	(EE)Monaragala
	(EE)Bibile

Source) RDA

(2) Specific Works of PD (Province), CE (District) and EE.

The specific works which each office carries out is as follows.

	Specific Work Contents
PD Office	<ul style="list-style-type: none"> • Inspection of Road/Bridge improvements and maintenance works. • Procurement of medium budget works. • Recruitment of direct labor force.
CE Office	<ul style="list-style-type: none"> • Inspection of Road/Bridge improvements and maintenance works. • Procurement of small budget works(less than 5 Million Rs.) • Payments of direct labor force.
EE Office	<ul style="list-style-type: none"> • Bridge inspection works. • Preparing inspection reports. • Supervision of Road/Bridge maintenance works.

Source) RDA

10.3.2 Flow of Operation and Maintenance System

Bridge operation and maintenance work was classified into the following three categories. Furthermore, RDA divisions operating each works category are summarized in Table 10.3-2.

- Bridge inspection work (inspection - data compile - data evaluation)
- Bridge operation and maintenance plan preparation (plan preparation - budget preparation)
- Bridge operation and maintenance work (work plan - work management - completed confirmation - updating of completed record)

Table 10.3-2 The Flow and the Department in Charge of Bridge Operation and Maintenance Work.

Category	Stage	Organization in Charge
Bridge Inspection	Implementation of bridge inspection	EE office
	Sort of inspection result	EE office Planning department
	Evaluation of inspection result	EE office
Bridge Operation and Maintenance Plan	Work plan preparation	Planning department Engineering department
	Budget preparation	EE→CE→PD office Planning department Operation and maintenance department
Bridge Operation and Maintenance Work	Work plan	Engineering department
	Work management	PD,CE,EE office Operation and maintenance department
	Completed confirmation	PD,CE,EE office Operation and maintenance department
	Updating of completed record	Planning department Operation and maintenance department

Source) Study Team

10.3.3 Actual Situation of Inspection works

(1) Implementation of Bridge Inspection

EE office has done inspection work for all managed bridges within a year. Inspection methods are visual and photography, and crack width measurement has not been performed. Inspection works are not performed independently, they are performed as a part of the road inspection, and it is hard to say that sufficient time for bridge inspection is secured. The visual inspection is performed under the bridge mainly from neighborhood, and a ladder, a boat and etc are used occasionally. RDA has had a 200kg loading inspection vehicle (photograph 10.3-1) since the early 1980s, it is kept in the repair shop of Ratmalana and have not been used for bridge inspection. In the hearing from local offices, the most of offices do not know the presence of this inspection vehicle.



Source) Study Team

Photograph 10.3-1 Bridge Inspection Vehicle

Bridge inspection results are arranged in inspection ledger shown in Figure 10.3-3. The degree of damage for each part is determined by inspectors based on a qualitative evaluation criteria which is given in the ledger, and it is concerned that the degree of damage varies depending on evaluators.

RDA - P / Form / TS / 1 (b) - 2008

Bridge Inspection Form (Concrete and Other Type Bridges)

Province:

Bridge No.in kmin Miles	Route No:	Name of Road:
GPS COORD	X:	Y:	No of spans	Crossing/Bridge Name
	Component	Type	Condition	Rating
Bridge Surface	Pavement	A/C, DBST, SBST, Tar, Gravel, other	Good, Waving, Rutting, Crack, Pot hole, Others	
	Curb		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces, Others	
	Railing	Concrete, Steel, Other	Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces, Others	
Super-Structure	Deck slab	RCS/Arch(Concrete/Brick/Dressed stone), Stone slabs, Timber	Good, scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Rust, corrosion, Deformation of plates, Free lime water leakage, Others	
	Main beam/ Main structure	RCB/PSC-PRE/PSC/POS, Other	Good, scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Excessive deflection of members, Others	
	Diaphragm	RCB/PSC-PRE/PSC/POS, Other	Good, scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Excessive deflection of members, Others	
	Painting			
Accessory	Expansion Joint		Invisible, Existed, Good, Abnormal sound, Clogged, Deformation, Gap, Others	
	Bearing		Sliding, Invisible, Existed, Good, broken, Anchor bolt, Abnormal displacement	
	Drainage		Clogged, Broken, Water leakage, Support Broken, Pipe broken Others	
Sub-Structure	Abutment1	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken (Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	
	Abutment2	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	
	Pier/s	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	
	Pier/s	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	
	Foundation	PILE/Cylinder/Spread(DAW stone, RRM, Concrete)	Settlement, Leaning, Moving, Crack, Scouring, Others	
	Wing wall	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces	
	Embankment	River bank(Upstream & downStream) Side bank(Left & right)		
Others	1st approach			
	2nd Approach			
Others (eg: Traffic signs)	(Specify)			
Rating	1. Component is in good condition with little or no deterioration			
	2. Component shows deterioration of a minor nature with primary structural material which is first signs of being affected.			
	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			
	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.			
Name of the Inspector			Designation	Date
Remarks /Sketches				

Source) RDA

RDA - P / Form / TS / 1 (c) - 2008

Bridge Inspection Form (Steel Bridges)

Province:

Bridge No.in kmin Miles		Route No:		Name of Road:	
GPS COORD	X:	Y:	No of spans	Crossing/Bridge Name	
	Component	Type	Condition		Rating
Bridge Surface	Pavement	A/C, DBST, SBST, Tar, Gravel, other	Good, Waving, Rutting, Crack, Pot hole, Others		
	Curb		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces, Others		
	Railing	Concrete, Steel, Other	Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces, Others		
Super-Structure	Deck slab	RCS/Channel plates / Corrugated plates/ Deck plates/ Buckle plates, Timber/Other	Good, scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Rust, corrosion, Deformation of plates, Free lime water leakage, Others		
	Main beam/ Main structure	RSJ/Truss (Through/ Halfthrough/ Deck) /Steel plate girder	Good, Rust, Corrosion, Buckling, Excessive deformation, Rivet off, Others		
	Diaphragm, Sway bracing, Lateral bracing	RSJ/Truss (Through/ Halfthrough/ Deck) /Steel plate girder	Good, Rust, Corrosion, Buckling, Excessive deformation, Rivet off, Others		
	Painting				
Accessory	Expansion Joint		Invisible, Existed, Good, Abnormal sound, Clogged, Deformation, Gap, Others		
	Bearing		Sliding, Function of rotation, Invisible, Existed, Good, broken, Anchor bolt, Abnormal displacement		
	Drainage		Clogged, Broken, Water leakage, Support Broken, Pipe broken Others		
Sub-Structure	Abutment1	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken (Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Abutment2	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Pier/s	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Pier/s	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others		
	Foundation	Pile/Cylinder/Spread(D/W stone, RRM, Concrete)	Settlement, Leaning, Moving, Crack, Scouring, Others		
	Wing wall	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces		
	Embankment	River bank(Upstream & downStream) Side bank(Left & right)			
Approachs	1st approach				
	2nd Approach				
Others (eg: Traffic signs)	(Specify)				
Rating	1. Component is in good condition with little or no deterioration				
	2. Component shows deterioration of a minor nature with primary structural material which is first signs of being affected.				
	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.				
Name of the Inspector			Designation	Date	

Source) RDA

Figure 10.3-3 Bridge Inspection Ledger

(2) Compile of Inspection Result

The inspection ledger is reported annually to the headquarter Planning Department, CE, and PD office from EE office with a bridge ledger, and aggregated to the Excel data by the Planning Department staff.

These Excel data were received from the headquarter Planning Department. Contents were checked in this study, there are many blanks in a list of a bridge ledger, and the inspection ledger had hardly been aggregated. The report from an office is by data or paper medium, and since the staff are counted by hand for every bridge, in order to create the database of 4000 or more bridges improvement of the data sort system is required.

(3) Evaluation of Inspection Results

As data evaluation for the bridge inspection results, the degree of damage mentioned in the inspection ledger is all, tasks such as determining the repair priority by the degree of damage is not performed at all.

10.3.4 Actual Situation of Operation and Maintenance Plan (Data Evaluation – Preparation of Plan – Preparation of Budget)

(1) Preparation of Management Plan

When serious damage is found, only treatment works may be done, and proper repair working plan will not to be prepared under the present circumstances.

(2) Budget Preparation

PD office summarizes the budget request from CE offices and request the budget to headquarter. However, the amount actually distributed is as low as about 20% of the amount requested, and the amount of a budget assigned to the bridge is about 5-10% of the whole, and the remainder is assigned to the road. Insufficient budget is one of the factors for poor bridge operation and maintenance.

10.3.5 Actual Situation of Operation and Maintenance Works

(1) Work Plan

PD office prepares a plan of operation and maintenance work and indicates it to each office. However, if serious damage is found by inspection, it to be reported to the headquarter Engineering Department and the Engineering Department makes plan for repair works.

The organizations which carry out works is different according to the scale of the works. The works which cost is less than 1 million Rs. is carried out by EE office, and more than 5 million Rs. is carried out by headquarter, and the middle cost works which cost is between 1 and 5 million Rs. will be carried out mainly by CE and PD office.

(2) Work Management, Confirmation of Completion

General work management and confirmation of completion is carried out by EE office, but CE office performs confirmation sometimes depending on construction scale.

(3) Updating of Completed Record

There is an inspection item of "Record of Repair /Rehab." in a bridge ledger and the bridge which have repair and maintenance works, this item to be filled in, However no bridge ledger which item is filled, in the 60 bridges received ledger of Kalutara this time.

10.3.6 Technical Manual is for Operation and Maintenance Works

The present RDA manuals related to bridge operation and management is sorted in Table 10.3-3.

Table 10.3-3 RDA Technical Manuals for Operation and Maintenance Work

	Name	Year, Form	Contents
1	Bridge Maintenance Manual	1997, A4 variation 21 pages	Describes Cautions of bridge inspection (superstructure, substructure). This is classified into four sections, the whole situation, periodic inspection in every 3 months, condition inspection if needed, and detail inspection.
2	Road Maintenance Manual	1989 A5, 99 pages	The outline of operation and maintenance and inspection of road bridge/ culvert are explained in 2 pages, and other measures are described.
3	Visual Road Condition Surveys Guidelines	2008 A4, 43pages	Explanation of Inventory and inspection Form of culvert and bridge. Inspection Foam: Inventory 1page, concrete bridge 2 pages, steel bridge 2 pages, repair record(concrete bridge 1 page, steel bridge 1 page), sample of repair record form is not indicated.

Source) RDA

10.3.7 Trial of Performance Based Road Operation and Maintenance Contract

(1) Outline

Performance Based Maintenance Contracting (hereinafter, "PBMC") for Route A4 (37 km) of Sabragamuwa province and Route A7 (42 km) has been completed in September 2011 with the support of ADB. Contractor was a local contractor CML-MTD only, and a contract amount was 170 million Rs. Local contractors have registration rank of ICTAD. This is classified into 10 ranks from C1 (received order contract amount is more than 600 millions Rs.), and C2 (contract amount is more than 300million) to C10 (contract amount is more than 1million). CML-MTD is registered as C1 rank.

(2) Contents of Implementation

Business contents are general works for ensuring the standard and operation level of road satisfactory. Namely, keeping good condition of the whole road facilities including pavement, traffic safety facility, planting, bridge structure, light fixtures, weeding and cleaning.

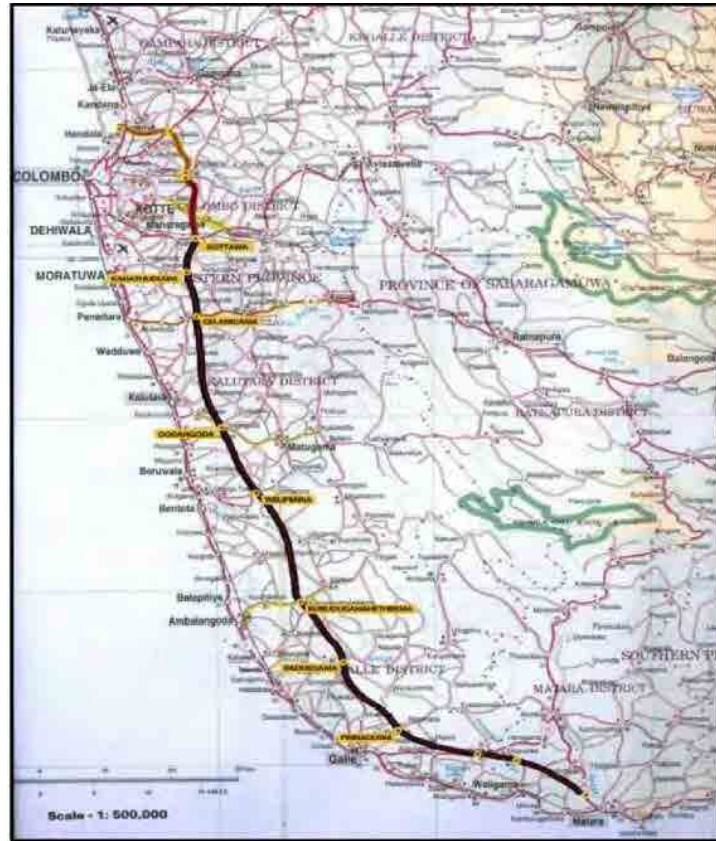
As a management system of RDA, works are managed and performed by EE office, and work results are checked by headquarter.

(3) Future prospect

In RDA, five PBMC projects are planned over the next five years. However, since PBMC contents are specialized to the road, it is not optimal as the operation and maintenance of the bridge. Moreover, it is difficult to apply for seriously damaged existing route because of the PBMC characteristic. Therefore, it is necessary to establish another operation and maintenance system for Sri Lanka which has many damaged bridges.

10.3.8 Current Situation of Asset Management Introduction

Asset management system has been introduced for Southern expressway which was opened in November 2011 (Figure 10.3-4) by ADB support.



Source) RDA

Figure 10.3-4 Southern Part Highway Position Figure

(1) Route Outline

- Road extension: 95.2Km (Kottawa-Pinnaduwa)
- Number of lanes: one side 2 lanes, total 4 lanes (the land already acquired six lanes minute)
- Speed Limit: 100km/h
- Number of bridge: 19 river crossing bridges, 4 interchange bridges, 27 overpass bridges

(2) Inspection Work

3 types of inspections, namely, daily visual inspection, periodic annual inspection by special inspectors and emergency inspection during abnormal weather are carried out (Photograph 10.3-2).



Source) RDA

Photograph 10.3-2 Inspection Work

(3) Operation and Maintenance Work

The following 9 items are carried out as operation and maintenance work (Photograph 10.3-3).

i.cleaning, ii.vegetation management, iii.Traffic safety facilities management, iv.Corresponding of the accident, v.Damage prediction, vi.Pavement maintenance, vii. Structure maintenance, viii.Drainage facilities maintenance, ix.Embankment and slope maintenance.



Source) RDA

Photograph 10.3-3 Operation and Maintenance Work

(4) Database Operation

4 items of database system, i.Bridge, ii.Slope, iii.Pavement, iv.Road facilities and drainage have been established. Information of structure parameters and inspection results are inputted on internet, and total management is possible.

Among these, Input screen of " i.Bridge " is shown in Figure 10.3-5



Source) RDA

Figure 10.3-5 Bridge Information System Input Screen

10.4 Extraction of The Issues in Bridge Operation and Maintenance Works of RDA

10.4.1 The Organizational Issues

Current condition and issues in RDA organization related to bridge operation and maintenance are shown in Table 10.4-1.

Table 10.4-1 Current Condition and Issues in RDA Organization Related to Bridge Operation and Maintenance

Category	No.	Issues	Current condition
Operation and Maintenance Plan	1-1	Insufficient budget for bridge operation and maintenance	<ul style="list-style-type: none"> ■ Budget for bridge operation and maintenance is allocated as leveled every year. ■ Most of budget is allocated for the road operation and maintenance, less for the bridges. ■ Only routine works are possible within the budget.
	1-2	The leadership of RDA and the staff's incentive are missing about bridge operation and maintenance	<ul style="list-style-type: none"> ■ RDA staff have not strong mind for repairing bridges, because bridges will be close only after having big damage.
Operation and Maintenance Work	1-3	Shortage of maintenance staff	<ul style="list-style-type: none"> ■ Local office staff is responsible for the maintenance of roads and bridges, but most of their duty is for the road operation and maintenance ■ There is no engineer who concentrates on bridge maintenance on site.
	1-4	Accumulation of knowledge and experience is not enough.	<ul style="list-style-type: none"> ■ There is no organization which specialized in bridge operation and maintenance in both headquarter and local office, and there is no full time engineer, either. ■ It is impossible to accumulate knowledge and experience in this organization. ■ The most of bridge operation and maintenance are simple routinely works, such as the clearing, and there are few duties of bridge repair. ■ Almost no accumulation of technology for bridge operation and maintenance.
	1-5	Engineers have less site experience	<ul style="list-style-type: none"> ■ Engineers have mainly office works such as budget preparation, procurement and administrative procedures. ■ Practical operation on site has become the works of Technical Officer ■ Engineers have no knowledge about experience on site. ■ Site operation by Technical Officer who has less technical knowledge is not reliable.

Source) Study Team

10.4.2 The Operation and Maintenance Works Issues

Current condition and issues of bridge operation and maintenance are summarized by category as shown in Table 10.4-2.

Table 10.4-2 Current conditions and problems of bridge operation and maintenance work

Category	No	Problems	Current condition
Bridge Inspection	2-1	Inspection has not been done regularly	<ul style="list-style-type: none"> ■Each bridge has been inspected annually by local office, furthermore, the frequency of inspections are increasing for damaged bridges. ■Specific inspection for the bridge has not been done, inspections are carried out at the same time as the road inspections.
	2-2	Inspection methods have not been clearly defined.	<ul style="list-style-type: none"> ■Only two maintenance manuals have been established “Bridge Maintenance Manuals (1997)” and “Visual Road Condition Survey Guidelines (2008)”. ■The content of manual is not including the entire bridge maintenance. In addition, description contents lack of concreteness and the manual is insufficient for the site use.
	2-3	There is no inspection equipments.	<ul style="list-style-type: none"> ■Currently inspections are carried out by visual. ■It is difficult to go to the bridge undersurface at the bridges crossing river., so there are not many undersurface inspection for such bridges. ■One vehicle for inspection of undersurface of the bridge was introduced in the 1980s, but is no longer used in most decrepit.
	2-4	Ledger of the bridges is not established.	<ul style="list-style-type: none"> ■The current inspection results are prepared by each EE in accordance with “Visual Road Condition Survey Guidelines (2008)”, and data sent to the planning department of headquarter directly for manage. ■Not all of the inspection results from each EE are reported, therefore the data of planning department of headquarter is incomplete.
Operation and Maintenance Work	2-5	Own design criteria considering the proper bridge maintenance is not established.	<ul style="list-style-type: none"> ■Proper establishment of design criteria for bridge consultant is essential for the effective bridge maintenance. ■The current bridge design standards define the basic matters only, and for details have been applied to the BS “British Standard”. ■It is important to have their own bridge design standard considering the maintenance after the construction of bridges.

Source) Study Team

10.4.3 Problems in The Actual Condition of Bridges

Current conditions and problems in the bridges managed by RDA are shown in Table 10.4-3.

Table 10.4-3 Current Condition and Problems in the Bridge

Category	No	Problems	Current condition
Operation and Maintenance Plan	3-1	Bridges are neglected without repair.	<ul style="list-style-type: none"> ■A budget specialized in bridge maintenance is almost not allocated (Budget sufficiently rate is about 20% of the budget request). ■Therefore, local bridge maintenance is daily management only.
	3-2	Recognition that the bridges can be life longer by “LCC” early repair is lacking.	<ul style="list-style-type: none"> ■When damage apparent after progressed gradually, the function of the bridge is already impaired. As a result, it would restore the function only by the replacing. ■It is important to find damage at an early stage and to take quick repair for the bridge life longer and for the economy, RDA engineer have to recognize this subjects.
Operation and Maintenance Work	3-3	No knowledge about the appropriate method for damage repair.	<ul style="list-style-type: none"> ■There is little experience for repair works of the bridges until now. ■Therefore there are no accumulation of the bridge repair technology and also no technical improvements

Source) Study Team

10.5 Course of Action and Prioritization of The Issues to Be Solved

In Chapter 10.4, the organizational issues of RDA, bridge operation and maintenance works issue and also the problems in the actual condition of bridges were extracted by the category. The priorities for dealing with the technical cooperation project by JICA and basic policies towards the solution of these issues were sorted out in Table 10.5-1.

Table 10.5-1 Basic Policies and Prioritization of Problems to Be Solved about Bridge Operation and Maintenance

Note: prioritization ◎ "high", ○ "normal", △ "low"

Category	Issues		Policies	Priority
Bridge Inspection	2-1	Inspection is not made periodically	Improvement of bridge inspection manual, then technical guidance based on it.	◎
	2-2	Inspection method is not defined clearly	Improvement of bridge inspection manual.	◎
	2-3	There is no inspection equipment	Procurement of bridge inspection vehicles	◎
	2-4	The bridge ledger is not sorted out completely.	Improvement of bridge inspection manual.	◎
Operation and Maintenance Plan	1-1	Maintenance management budgets, especially bridge maintenance management budgets are insufficient.	Ensure budget which specialized in bridge operation and maintenance budget.	△
	1-2	The leadership and staff incentive are missing for bridge operation and maintenance.	Recognition of the importance of bridge operation and maintenance.	○
	3-1	Bridge has been left without repairing.	Improvement of bridge operation and maintenance manual, and guidance based on it.	○
	3-2	the recognition of bridge life longer by "LCC" repairing at an early stage is lacking.	Recognition of the importance of bridge operation and maintenance.	△
Operation and Maintenance Work	1-3	Not enough staff for operation and maintenance is insufficient.	Establishment of the exclusive organization of bridge operation and maintenance.	◎
	1-4	Accumulation of knowledge and experience for operation and maintenance are not enough.	Improvement of the bridge inspection and operation and maintenance manual, and guidance based on them.	○
	1-5	Engineers have less experience on site	Improvement of the bridge inspection and operation and maintenance manual, and guidance based on them.	○
	2-5	The own design criteria suitable bridge operation and maintenance are not developed.	Development of bridge design criteria.	△
	3-3	There is no knowledge about the suitable repair method for damage.	Improvement of bridge operation and maintenance manual and guidance based on it.	○

Source) Study Team

10.6 The Technical Cooperation Project for RDA (Proposal)

10.6.1 Aim of The Project

It becomes a main issue in the bridge operation and maintenance of RDA, within the present limited staff, budget, and technological accumulation how the business is carried out efficiently and suitably in order to solve many problems which is sorted out in Chapter 10.4 and Chapter 10.5. Then, the aim of the technical cooperation project by JICA is "Improvement and strengthening of the technical capacity of each organization through the technical assistance to the bridge operation and maintenance work of RDA".

10.6.2 Consideration Items of The Contents

The content of technical project is considered based on the above project and also considered how to carry out bridge operation and maintenance by RDA as a "road governmental agency". Sorted out in Table 10.6-1, what is the assistance about the bridge operation and maintenance required for RDA as a "Road governmental agency", and the capability which engineers of RDA should learn.

Table 10.6-1 Consideration Matters about Examination of Assist Content

Items	Contents
What is the assistance about bridge operation and maintenance required for RDA?	
Bridge operation and maintenance work to be performed as the road governmental agency	<ul style="list-style-type: none"> ■ Production of bridge operation and maintenance planning ■ Create short term and medium long term plan based on formulation plan ■ A budget document creation and a budgetary request, based on short term plan ■ Bid preparation, consultant selection and contractor selection ■ Implementation of construction (work), construction supervision, a completion inspection
Short term and medium long term plan about Bridge operation and maintenance	<ul style="list-style-type: none"> ■ Medium long term plan <ul style="list-style-type: none"> - Understanding the condition of bridge and the calculation of the medium long term maintenance costs - Creation of the vision about Bridge operation and maintenance, and creation of a long term plan and Milestone ■ Short term plan (fiscal year) <ul style="list-style-type: none"> - From evaluation of the condition of each bridge to repair prioritization - Create a bridge operation and maintenance list, and a operation and maintenance plan and budgetary request of the following fiscal year based on prioritization
What is the capability which RDA engineer should learn?	
New operation and maintenance organization for performing suitable bridge operation and maintenance, methods of operation in the limited staffs and budget	<ul style="list-style-type: none"> ■ New operation and maintenance system <ul style="list-style-type: none"> - A fund scale is expanded about the road operation and maintenance trust fund founded in 2008, so that bridge operation and maintenance fully be performed - Built a system to manage by own country technical to improve the state of the art in bridge operation and maintenance of local contractor ■ A new implementation method <ul style="list-style-type: none"> - The performance based type operation and maintenance which introduced experimentally is evaluated and if a good result is obtained, a range of application is expanded and it strives for enforcement of efficient operation and maintenance work. - Operation status of the road operation and maintenance system which introduced experimentally is recognized, and it is similarly referred as bridge operation and maintenance system introduction.

Source) Study Team

Japan Bridge & Structure Institute, Inc., Dainichi Consultant Inc.
and Landtec Japan, Inc.

10.6.3 Issues and The Contents

The contents and detail, in each operating category corresponding to the project aim based on the correspondence policy and its priority to the issue examined in Chapter 10.5 are sorted out in Table.10.6-2.

Table 10.6-2 The Contents and Detail in Each Operating Category

Category	Project Aim	Detail	Contents	Remarks
Bridge Inspection	Bridge inspection and technology transfer related to selection of a repair construction method based on the result.	Implementation of bridge inspection	Implementation of daily/periodic inspection using visual observation or simple equipments	
		Collection and arrangement of inspection data	Arrangement of inspection data, preparation of a bridge ledger and bridge condition data	
		Analysis and evaluation of inspection data	Arrangement of damage data, evaluation of a damage condition	
		Repair construction method selection based on analysis and evaluation	Repair construction method selection as measures based on damage evaluation	The knowledge of a repair construction method is insufficient
Operation and Maintenance Plan	Technology transfer about the operation and maintenance plan creation based on the selected repair construction method	Maintenance repair plan preparation by the selected repair construction method	Repair plan preparation of individual bridge, and repair, operation and maintenance work plan preparation of nationwide bridge	Recognition of repair in early stages of damage is low
		Preparation of bridge operation and maintenance master plan	Repair of damaged bridge, prioritization of operation and maintenance work (implementation plan, organization, schedule, budget, etc.)	There is no concept of LCC (life cycle cost).
		Preparation of bridge operation and maintenance plan which is based on budget planning and budgetary requests	Preparation of short term (fiscal year) and medium long term operation and maintenance	
Operation and Maintenance Work	Technology transfer about operation and maintenance work by suitable quality control	Bridge maintenance work and operation method plan of repair work	Design of bridge repair work, implementation plan preparation of repair work	
		Maintenance work, construction supervision under repair construction	Quality control method of bridge operation and maintenance work and bridge repair work	Recognition of bridge life is prolonged by thoroughly quality control is low.

Japan Bridge & Structure Institute, Inc., Dainichi Consultant Inc. and Landtec Japan, Inc.

Category	Project Aim	Detail	Contents	Remarks
Operation and Maintenance Work	Technology transfer about operation and maintenance work by suitable quality control	Bridge maintenance work, completion inspection of repair work	Implementation method of completion inspection	
		Bridge ledger data update accompanying the completion work	Inspection - preparation of operation and maintenance plan - operation and maintenance work completion - establishment of series of operation and maintenance cycle of data update	

Source) Study Team

10.6.4 Technical Cooperation Project (Proposal)

(1) Implementation Scheme

The implementation scheme of technical cooperation project is suggested in Table 10.6-3 in order to realize the contents in each work category.

Table 10.6-3 Implementation Scheme of Technical Corporation Project (Proposal)

Items	Contents	Remarks
Main scheme		
Dispatch of experts	<ul style="list-style-type: none"> ■ Dispatch of a long term specialist: Bridge operation and maintenance policy adviser ■ Dispatch of a short term specialist: i) Bridge operation and maintenance plan (team leader), ii) Bridge Inspection 	
Equipment supply	<ul style="list-style-type: none"> ■ Bridge inspection vehicles, other bridge inspection equipment 	Refer to Appendix-1
	<ul style="list-style-type: none"> ■ Bridge inspection result data system software 	
Auxiliary scheme		
This country training	<ul style="list-style-type: none"> ■ Bridge inspection, training about asset management 	
This country studying abroad	<ul style="list-style-type: none"> ■ Research on an asset management system 	

Source) Study Team

(2) The contents of Implementation and Implementation Period

Technical cooperation project show in Table 10.6-4 is suggested to carry out in single phase.

In this period mainly focusing improvement of maintenance manual and inspection work. Counterpart organization of RDA side is confirmed maintenance work including repair, asset management will be focusing in next phase.

Table 10.6-4 Implementation Term and Contents of Technical Corporation Project

Items	Contents	Remarks
(2.0years) Single phase		
Draft creation of a bridge maintenance management manual	<ul style="list-style-type: none"> ■ In RDA, there is bridge operation and maintenance manual which is created in 1997 although, renewal of the contents and addition, etc have not been made until now. ■ Then, new manual preparation based on the present manual is performed. 	
Implementation of OJT and trial employment by the created manual	<ul style="list-style-type: none"> ■ Let Western province be a place of pilot work. ■ As a case study of pilot work, bridge inspection and bridge operation and maintenance work are carried out. 	
Support of finalization of a bridge operation and maintenance manual, and institutionalization	<ul style="list-style-type: none"> ■ The result of OJT and trial employment is arranged and support of finalization of a bridge operation and maintenance manual, and institutionalization is offered based on the result. 	
Nationwide deployment of manual	<ul style="list-style-type: none"> ■ National deployment of finalized bridge operation and maintenance manual, and spread activities are performed. ■ OJT and trial employment are performed in each state. 	

Source) Study Team

(3) Implementation Scale

The schedule of each scheme and specialist's layout plan (Proposal) based on the above-mentioned proposal is shown in Figure 10.6-1.

	1st Year												2nd Year												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Implementation Schedule																									
Phase 1 (2.0 years)																									
Preparation of Manuals	■	■	■	■	■																				
OJT						■	■	■	■																
Pilot Project (Advance Training in Japan)									■	■	■	■	■	■	■	■									
Human resource development															■	■	■	■							
Finalization of Manuals																			■	■	■	■	■		
Support to Standardize Manuals																					■	■	■	■	
Task Name:Despatch Specialists																									
Long Term Expert																									
A-1 Road/Bridge Maintenance Policy Adviser	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24	
Short Term Expert																									0
A-2 Bridge Maintenance Plan (Team Leader)	1	1	1		1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1	21	
A-3 Bridge Inspection	1	1			1	1	1	1		1							1	1				1	1	1	12
Subtotal	3	3	2	1	3	3	3	3	1	2	3	2	2	2	2	1	3	3	2	2	3	3	3	57	
Total of work	29												28												57

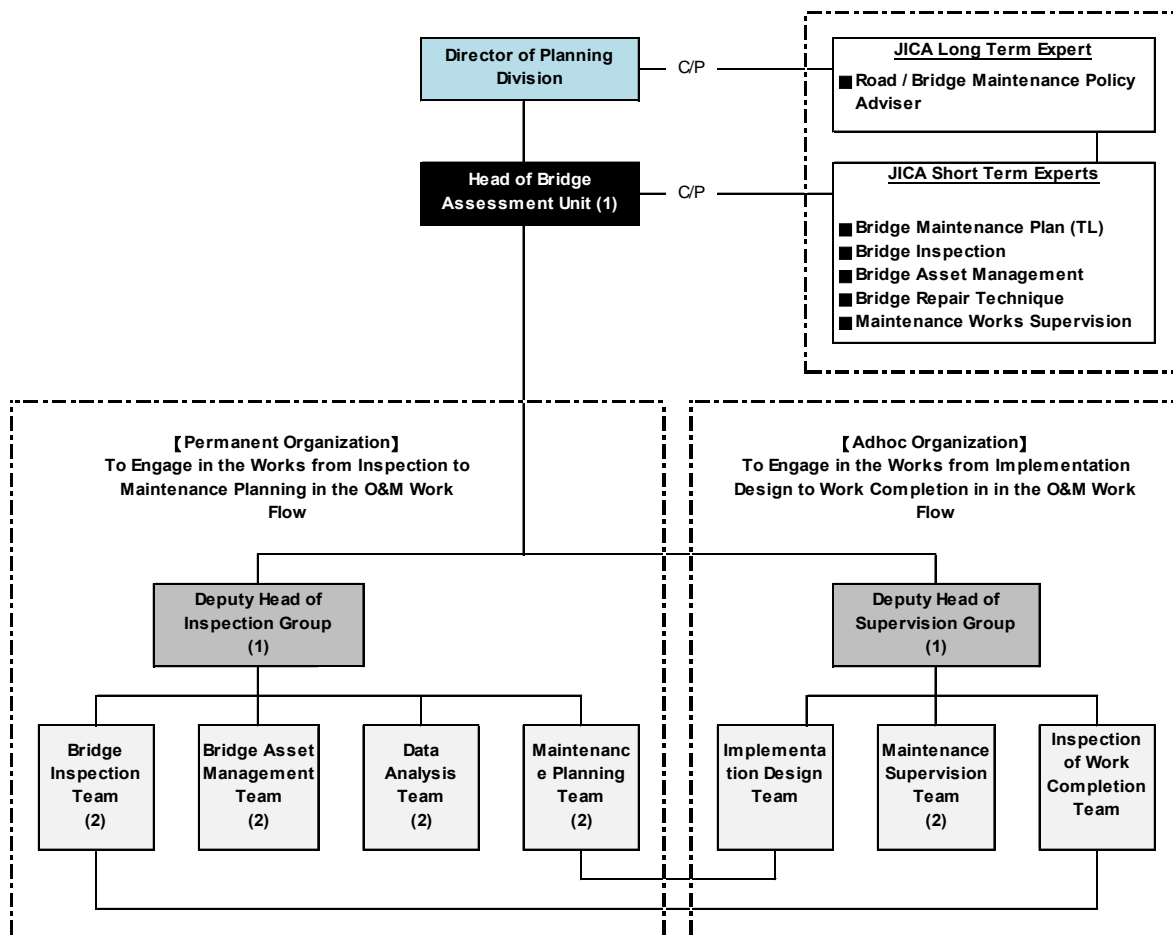
Source) Study Team

Figure 10.6-1 The Schedule for a Technical Cooperation Project
and a Specialist's Layout Plan (Proposal)

10.6.5 The Counterpart (Proposal)

(1) Outline of newly established organization "Bridge Assessment Unit"

RDA is planning to establish "Bridge Assessment Unit" as the special units for bridge operation and maintenance in the Planning Department. As requested by RDA the consultants propose the organization and role of "Bridge Assessment Unit" as in Figure 10.6-2 and 10.6-3.



Source) Study Team

Figure 10.6-2 Organization Chart of [Bridge Assessment Unit] (Proposal)

The proposed organization outline is as follows.

- Among the organizations which proposed, left hand side "Inspection Group" serves as core group of "Bridge Assessment Unit", and continue after the end of the technical cooperation project.
- Among the organizations which proposed, right hand side "Supervision Group" is a provisional organization for this technical cooperation project, after end of this project it will be dispersed, the results of the technical cooperation project is taken over by the related structure in RDA.
- The proposed organizational chart in () expresses the number of staff of the organization, and place 13 technical engineer staffs by whole "Bridge Assessment Unit". As for these items, 4 persons are elected from RDA headquarters, and remaining 9 persons are elected from each state local office.
- The member of "Maintenance Planning Team" and "Bridge Inspection Team" in "Inspection Group" holds the additional post in "Implementation Design Team" and "Inspection of Work Completion Team" in "Supervision Group".
- All the members in this unit have a works rotation at a constant frequency during this project, and at the end of this project will have experience for all the works in this unit.

Work Categories		Tasks in the JICA Technical Cooperation Project			Bridge Assessment Unit.	Provincial Director (PD)	Chief Engineer (CE)	Executive Engineer (EE)	Planning Div.	Engineering Service Div.	Maintenance Management & Construction (MMC) Div.
Works from Inspection to Maintenance Planning	1	1-1	Execution of bridge inspection (routine/ periodic)	●	○	○	○				○
		1-2	Collection of inspection results (preparation of bridge inventory, bridge condition database)	●	○	○	○				○
	2	2-1	Analysis and evaluation of inspection results	●						○	○
		2-2	Selection of repair methods	●						○	○
		2-3	Prioritization of repair and maintenance works of damaged bridges	●						○	○
3	3-1	Preparation of bridge maintenance master plan (execution plan, organization, schedule, budget etc.)	○					●		○	
Works from Implementation Design to Work Completion	4	4-1	Implementation methods of bridge repair and maintenance work	○	●	●	●				●
	5	5-1	Supervision of bridge repair and maintenance work	○	●	●	●				●
		5-2	Inspection of work completion for quality control	○	●	●	●				●
	6	6-1	Updating inventory data by repair and maintenance work records	●					○	○	

Source) Study team

Note: ●Main role, ○auxiliary role

Figure 10.6-3 Role of Bridge Assessment Unit (Proposal)

RDA is proceeding towards the establishment of the "Bridge Assessment Unit" as refer to the proposal of the consultant. "Bridge Assessment Unit" establishment is planned to be proposed and deliberated in RDA board of directors in December, 2012. In deliberations held on Nov.21 2012 with the consultant, The vice minister of port and road announced that "Bridge Assessment Unit" will be established 3 months before the technical cooperation project commencement, so that it can respond to implementation of the technical cooperation project.

(2) The Counterpart Corresponding to Each Activity of The Technical Cooperation Project

The bridge operation and maintenance of RDA is realized by the cooperation of each department now. In the technical cooperation project, between all related departments to be connected across boundaries, and "Bridge Assessment Unit" newly established institution plays the role as the point of contact for the relevant departments. Moreover, PD office of 9 states across the country serves as a base of on-site activity of the technical cooperation project. In the technical cooperation project, the pilot office which can be expected big result during the implementation will be selected. It is probably selected from Western province PD office, the assist contents of the technical cooperation project passing to the whole RDA organization, and the counter part for each specific support is assumed in Table 10.6-5.

Table 10.6-5 The Counterpart in Project (Proposal)

Category	Assist Items	Counter Part	
		Main	Support
Bridge Inspection	Implementation of bridge inspection	Bridge Assessment Unit Provincial Director (PD) District Chief Engineer (CE) Executive Engineer (EE)	Maintenance Management & Construction (MMC) Div.
	Collection and arrangement of inspection data		
	Analysis and evaluation of inspection data	Bridge Assessment Unit	Engineering Service Div. MMC Div.
Operation and Maintenance Plan	Repair method selection based on analysis and evaluation		
	Maintenance repair plan preparation by the selected repair construction method	Bridge Assessment Unit	Engineering Service Div. MMC Div.
	Preparation of a bridge operation and maintenance master plan	Planning Div.	Bridge Assessment Unit. MMC Div.
Operation and Maintenance Work	Preparation of the bridge maintenance and operation plan which is based on of budget planning and a budgetary request.		
	Bridge maintenance work, Implementation method planning of repair work.	MMC Div. Provincial Director (PD) District Chief Engineer (CE) Executive Engineer (EE)	Bridge Assessment Unit
	Maintenance work, construction supervision under repair/ repair construction		
	Bridge maintenance work, completed inspection of repair work		
Data updates of the bridge ledger accompanying the completion of work	Bridge Assessment Unit	Planning Div. Engineering Service Div.	

Source) Study Team

10.6.6 The Expected Achievement by This Project

By implementing the technical cooperation project, the assumed results are as in Table 10.6-6.

Table 10.6-6 The Result Expected by the Project

Items	Contents
The operating competency of the bridge operation and maintenance related post of RDA improves, and bridge operation and maintenance work can become independent and carry out smoothly.	<ul style="list-style-type: none"> ■ Preparation of bridge operation and maintenance manual ■ Establishment of bridge inspection system ■ Implementation of the suitable construction supervision in bridge operation and maintenance work
RDA capability is improved continuously for the independent short term (fiscal year) plan and medium long term plan which should be performed as a road governmental agency.	<ul style="list-style-type: none"> ■ Maintenance of accurate bridge ledger ■ Maintenance of accurate bridge condition data ■ Preparation of a bridge operation and maintenance master plan

Source) Study Team

10.6.7 RDA Attitude for the Technical Cooperation Project (Proposal)

The consultant creates the technical cooperation project (Proposal) which arranged above mentioned proposal, It explained to the bridge maintenance management related division of RDA executive (November 16, 2012), the President of RDA (November 19, 2012), and a port road vice minister (November 21, 2012), and performed the exchange of idea about the contents, the support way, etc. Then, the idea from RDA is as follows.

(1) The Whole Technical Cooperation Project

It agrees to the contents and the method basically. The early start is expected from the present condition of the bridges operation and maintenance of RDA.

(2) Contents of Individual Category

1) Inspection Vehicles

Although there is a bridge inspection vehicle purchased by the OECF loan in the 1980s, it has passed more than 20 years already and practical utilization has not been made. The investigation from the bridge undersurface is indispensable, but actually investigation is hardly carried out. In order to understand the actual condition it is necessary to survey from the bridge undersurface by bridge inspection vehicle in the future.

2) Inspection Equipments

In bridge inspection, basically non destructive test is mainly used. Therefore, introduction of advanced inspection technology in Japan is expected. (ex.: Reinforcing bar investigation in concrete, salinity concentration measurement of concrete, etc.)

3) Inspection Results Database System

Currently bridge inspection results are accumulating database by hand typing of the person in charge of the planning division. The data management in soft data is required for more efficient data accumulation, and introduction of the database system is urgently required. RDA opinion is to build a similar system when the consultant introduced the case of Japanese bridge data system. In the technical cooperation project, the database system introduction which suits the situation of Sri Lanka needs consideration.

(3) Assistance for Preparation of Request (Proposal)

Based on the result of the above mentioned discussion, we assisted for preparation of request of the technical cooperation project which the Sri Lanka government draws up and it submits to the Japanese government. Assistance for preparation of request (Proposal) is shown in Appendix-2. Moreover, PDM (Proposal) which used as a springboard for determination of assist content in the future is shown in Appendix-3.

10.6.8 The Points of Concern on The Technical Cooperation Project Implementation

The matter which should mind in implementation of this technical cooperation project is sorted out in Table 10.6-7.

Table 10.6-7 The Points of Concern on The technical Cooperation Project Implementation

Items	Contents
Establishment of C/P organization	<ul style="list-style-type: none"> ■ The counterpart of the technical cooperation project is considered to become MMC division in the organization of present RDA. ■ RDA is advancing new establishment of "Bridge Assessment Unit" which takes charge of bridge operation and maintenance. Therefore, it is considered that the counterpart of this technical cooperation project becomes "Bridge Assessment Unit". ■ Therefore, it is necessary to determine the organization content of "Bridge Assessment Unit" at early stage. (Number of staff, organizational functions, the technical level of the staff)
Application of the existing bridge database system	<ul style="list-style-type: none"> ■ The bridge operation and maintenance manual prepared in the technical cooperation project is prepared according to the existing manual. ■ Then, utilized section, review section and newly additional section in the existing bridge maintenance and operation are clarified. ■ Similarly, utilizable section about the existing bridge database system is clarified, and it also enables to build efficiently the bridge database system by the technical cooperation project. ■ Moreover, the idea of "Bridge Management System" which RDA has as a concept is also taken into consideration, and builds the system of the whole bridge operation and maintenance.

Source) Study Team

CHAPTER 11 LOCAL SUBCONTRACT OF SURVEYS

11.1 Geological Investigation Survey

1) Purpose of the Survey and outline of the work

Soil tests including borehole excavation were carried out near the expected bridge construction points and collecting data for future bridge planning.

2) Selection of Survey points

Locations of expected bridge construction are spreading whole of the island. (North, North Central, Southern, and Western provinces). Among these areas, the soil structure to classify the area to determine from the existing soil information etc. and 17 locations representing the each area were selected and carried out geological Survey.

After that, some bridges in Eastern and Northern provinces were excluded from the list of the bridges to be reconstructed. As a result 11 bridge locations near bridge construction sites were remaining.

3) Result of Survey

As geological Survey, Borehole Excavation, Standard Penetration Test, Sampling of surface and bed rock layer, and Strength test were carried out.

Results of the Survey were compiled to Bore hole charts, laboratory test, CR (Core recovery), / RQD (Rock Quality Designation) and so on.

Further Survey is necessary to clarify exact bearing layer, however in this Survey rough depth of bearing layer were confirmed. Depth from ground surface to N=50 layer is as follows.

Northern Province :	3.5m~9.0m
North Central Province :	5.8m~8.5m
Southern Province :	4.5m~9.0m
Western province :	7.0m~13.0m

As a bearing layer of bridge foundation, weathered rock or hard rock are applied. Rock as bearing layer has compression strength more than 20N/mm².

As a type of foundation for future bridge construction in Sri Lanka, spread foundation is applicable at shallower than 5m and pile foundation is applicable at deeper than 5m. (The depth of foundation is varied with surrounding soil and construction conditions.)

4) Further issue

As a detailed study for new construction of bridge, the locations of substructures are fixed and detailed geological Survey will be carried out for each foundation. As a bearing layer based on RDA standard, apply hard rock or apply weathered rock strong enough to bear the bridge load based on Japanese Standard will be examined.

11.2 Social and Environmental Survey

1) Purpose of the Survey and outline of the work

Investigation for relevant law in Sri Lanka, site Survey of target bridges and surrounding areas, hearing Survey of near the bridge site, site Survey for RAP program, understand the actual condition of surrounding bridge site and Survey for aggregate source which are Necessary information for planning of bridge and approach road were carried out.

2) Selection of Survey point

Firstly screening the number of houses near bridge sites by using satellite photograph, and carried out 20 locations site Survey.

3) Result of Survey

Results of the simple and quick hearing from the people living around the bridges.

Survey for identification of quarries: Basic Survey for location of quarries. Approve of quarries and access roads and so on will be confirmed in detailed Survey.

4) Further issue

RDA has strong intension to minimize the number of affected houses due to the difficulty of relocation of affected houses.

Further detailed RAP study will be carried out based on JICA guideline after fixing the alignment carefully, having public consultation. In this study stage simple and quick Survey was carried out, detailed Survey will be carried out as a further requirements.

11.3 Hydrological Survey

1) Purpose and outline of the Survey

Confirmation of river condition around the bridge sites, analysis of high water level and comparison of historical high water level collected from the people living around the sites.

2) Selection of Survey points

Preparation of hydrological Survey was carried out at the same time of selection of target bridges. Additional Survey was carried out after changing the locations of target bridges and finally site Survey was carried out at 40 bridge locations. These locations are covering whole target bridge locations.

3) Result of Survey

Simple level topographical Survey was carried out at the bridge center line cross over the river and prepared profile showing assuming high water level. Some existing bridges are not satisfied the high water level, however it is possible to shift the location of abutment and raise up the elevation of bridges at the time of newly construction. The elevation of the bridge is confirmed based on detailed further study.

4) Further Issue

Detailed Survey will be carried out after confirmation of alignment of bridge locations including the effect from the approach roads.

11.4 Traffic Count

1) Purpose and outline of the Survey

Traffic count which is the basic information for bridge planning was carried out on the National road. RDA has already covered at major cities on National highway but not covering exact location of target bridge sites. Then to determine priority of newly construction in this study, traffic count Survey was carried out.

2) Selection of Survey points

Focusing the 37 bridges requiring urgent reconstruction and screened on the same route and closed locations, carried out Survey at 29 bridge locations.

3) Result of Survey

At each bridge sites on National highway, from 6 AM to 8 PM, on 2days at weekday and 1day at weekend, classification of vehicles are carried out at the same time.

4) Further Survey of traffic volume

Further detailed traffic count Survey including pedestrian traffic will be carried out for newly construction of the bridges. Results of this study to be comparison with RDA traffic data and will use for yearly movement for future.

**DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
ROAD DEVELOPMENT AUTHORITY**

**DATA COLLECTION SURVEY
ON PRIMARY BRIDGES
ON NATIONAL ROADS
AND MAINTENANCE SYSTEM
OF BRIDGES**

FINAL REPORT (APPENDIX)

FEBRUARY 2013

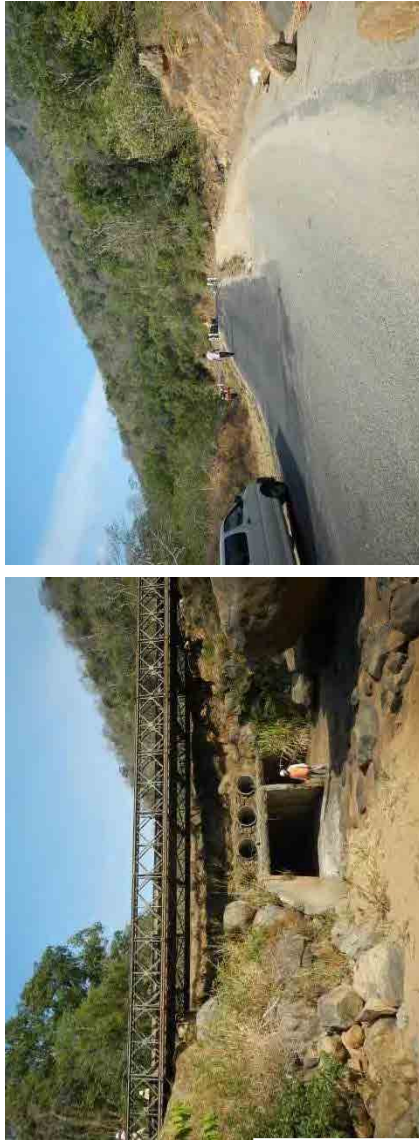
Japan International Cooperation Agency (JICA)

**JAPAN BRIDGE & STRUCTURE INSTITUTE, INC. (JBSI)
DAINICHI CONSULTANT, INC.
LANDTEC JAPAN, INC.**

CHAPTER 3 IDENTIFICATION OF THE BRIDGE FOR REHABILITATION AMONG THE RDA PROPOSED BRIDGES

3.1 Selected 79 nos Bridges to Studied Reconstruction as Result of Investigation

Bridge Inventory No.	Road No.	Road Name				Province	District	AA DT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	B492	Kandehandiya - Adikarigama - Randenigala - Loggal Oya				Central	Nuwara Eliya	1,900	2			Forest Reserve
2	Bridge No.	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		No. of Span	Comple-tion Year	Bridge Soundness		Flood Records
	35/10	33.72	Overall	Curb-to-Curb		Super-structure	Abutment			Pier	Super-structure	
			5.20	4.90	1	Bailey Bridge	RC Capping Beam	-	Good	Good	Sufficient	none



< PRESENT CONDITIONS >

[BRIDGE]

A 1-lane temporary bridge over the damaged embankment/ pipes and box culverts

[SOUNDNESS]**

- Superstructure Good RATE 1

- Substructure Good RATE 1

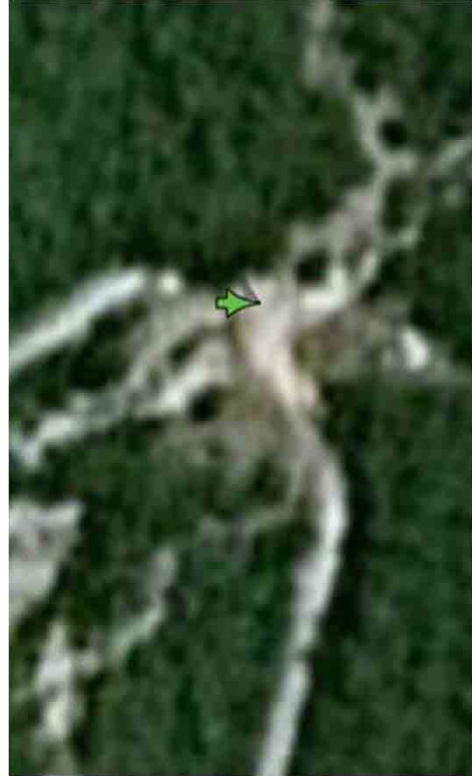
- Others

[SURROUNDING AREA]

< PROPOSAL >

Reconstruction is not recommended.

Bridge Length: Approach Length:
 Superstructure:
 Substructure:
 Foundation:
 Resettlement:



** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name		Province	District	AAADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition		
	AA005	Peradeniya - Badulla - Chenkaladi (PBC)		Eastern	Ampara	1,900	2			ok		
15	Bridge No.	Bridge Name	Bridge Length (m)	No. of Lane	Bridge Type		Completion Year	Super-structure	Sub-structure	Bridge Soundness	Loading Capacity	Flood Records
	241/1	Mahapalama	155.75	1	Super-structure RC I Girder/ Precast Columns	Abutment						



< PRESENT CONDITIONS >

[BRIDGE]

Curb-to-Curb of 4.20m wide is insufficient for 2-lane traffic of Class A Road. A1 Abutment and P6 to P8 Piers were damaged seriously.

[SOUNDNESS]**

- Superstructure Good RATE 1

- Substructure Critical RATE 4

Piles of piers have been exposed and damaged seriously.

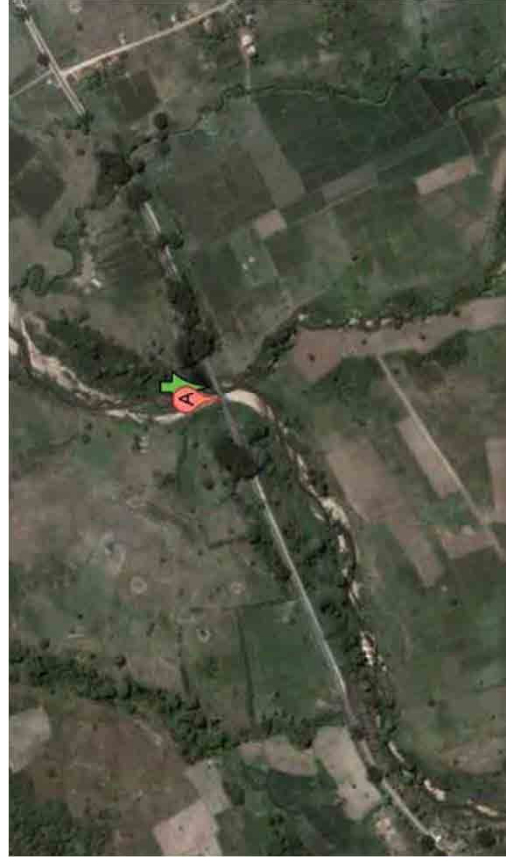
- Pile Caps that widths are exactly same as the diameter of Piles have been damaged seriously.
Abandoned old substructures remain under the existing bridge.

[SURROUNDING AREA]

< PROPOSAL >

(Reconstruction at L-Side of the existing bridge)
Eliminated by LOT size

Bridge Length: Approach Length:
Superstructure:
Substructure:
Foundation:
Resettlement:



** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name				Province	District	AADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	AB039	Muativu - Kokilai - Pulmoodai Road				Eastern	Trincomalee		2	Improvement of road in progress		Coastal / New Bridge
16	Bridge No.	Bridge Name	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		No. of Span	Bridge Soundness		Flood Records
	New	Kokilai	1,000	Overall	Curb-to-Curb		Super-structure	Abutment		Pier	Super-structure	



< PRESENT CONDITIONS >

[BRIDGE]

[SOUNDNESS]**

- Superstructure RATE

- Substructure RATE

- Others

[SURROUNDING AREA]



< PROPOSAL >

Reconstruction is not recommended because of Environmental problem.

Bridge Length: Approach Length:

Superstructure:

Substructure:

Foundation:

Resettlement:

** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name				Province	District	AAADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	AA006	Ambepussa - Kurunegala - Trincomalee (AKT)				Eastern	Trincomalee	5,700	4	Improvement of road by foreign fund is in progress		ok
17	Bridge No.	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		No. of Span	Bridge Soundness		Flood Records	
	184/1	36.95	Overall	Curb-to-Curb		Super-structure	Abutment		Pier	Super-structure		Sub-structure
			6.60	6.35	2	Steel Lattice Truss	RC Wall Type	3	Poor	Fair	Insufficient	none



< PRESENT CONDITIONS >

[BRIDGE]

Curb-to-Curb of 6.60m wide is sufficient for the time being for 2-lane traffic.

[SOUNDNESS]**

- Superstructure RATE 3
- Steel members corroded
- Re-bar of RC Slab rusted
- Substructure RATE 2
- Fair
- Others

[SURROUNDING AREA]



< PROPOSAL >

(Reconstruction of 2-lane bridge on the existing alignment)
Eliminated by LOT size

- Bridge Length: Approach Length:
- Superstructure:
- Substructure:
- Foundation:
- Resettlement:

** SOUNDNESS RATE

- RATE 1: Good condition
- RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.
- RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.
- RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name		Province	District	AAADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	B483	Sammanthurai - Malkampiddi - Deegawapiya		Eastern	Ampara		2			ok
18	Bridge No.	Bridge Name	Bridge Length (m)	No. of Lane	Bridge Type		Completion Year	Super-structure	Bridge Soundness	Flood Records
	3/2	Pallaaru	23.15	1	Super-structure	Pier				
		Overall	Curb-to-Curb		RC Girder	Brick covered by mortar/ RC		Good	Critical	
		Bridge Width (m)				No. of Span				
		4.90	4.17			3				



< PRESENT CONDITIONS >

[BRIDGE]

Curb-to-Curb of 4.17m wide is insufficient for 2-lane traffic of Class B Road.

[SOUNDNESS]**

- Superstructure Good RATE 1

- Substructure Critical RATE 4

- Others A Pile Bent type Pier was constructed in front of damaged A 2 Abutment.

B483 consists of an alternative route of AA031 during floods and is used as a main road to transport harvest, bricks and sand.

[SURROUNDING AREA]

The right bank of the river at L-side of A1 Abutment was scoured seriously because of insufficient bridge opening for floods..

< PROPOSAL >

(Reconstruction at R-side of the existing bridge)
Eliminated by LOT size

Bridge Length: Approach Length:

Superstructure:

Substructure:

Foundation:

Resettlement:

** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.



Bridge Inventory No.	Road No.	Road Name				Province	District	AADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	AA031	Karaithivu - Ampara				Eastern	Ampara	9,100	2			ok
21	Bridge No.	Bridge Name	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		Completion Year	Bridge Soundness		Flood Records
				Overall	Curb-to-Curb		Superstructure	Abutment		Substructure	Loading Capacity	
	2/1		59.20	5.90	5.30	2	Precast RC T Girder	RC Wall Type		Good	Insufficient	Bridge submerged during floods



< PRESENT CONDITIONS >

[BRIDGE]
 Curb-to-Curb of 5.30m wide is insufficient for 2-lane traffic of Class A Road.
 Skewed bridge of 60 degree
 Insufficient bridge elevation and opening for floods
 [SOUNDNESS]**
 - Superstructure Good RATE 1
 - Substructure Good RATE 1

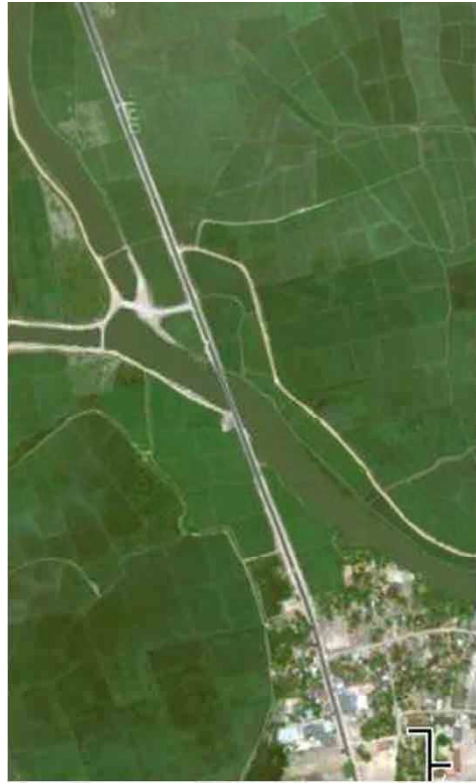
[SURROUNDING AREA]
 Water pipe bridge at L-side of the existing bridge

< PROPOSAL >
 (Reconstruction at L-side of the existing bridge)
 Eliminated by LOT size

Bridge Length: Approach Length:
 Superstructure:
 Substructure:
 Foundation:
 Resettlement:

** SOUNDNESS RATE

- RATE 1: Good condition
- RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.
- RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.
- RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.



Bridge Inventory No.	Road No.	Road Name		Province	District	AADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	AA031	Karaithivu - Ampara		Eastern	Ampara	9,100	2			ok
22	Bridge No.	Bridge Name	Bridge Length (m)	No. of Lane	Bridge Type		Completion Year	Super-structure	Bridge Soundness	Flood Records
	1/2		63.05	1	Super-structure	Pier				
			Overall		RC Wall Type					
			Curb-to-Curb		RC Wall Type					
			5.10	4.20	RC Girder	RC Wall Type	1939	Good	Good	none
								Insufficient		



< PRESENT CONDITIONS >

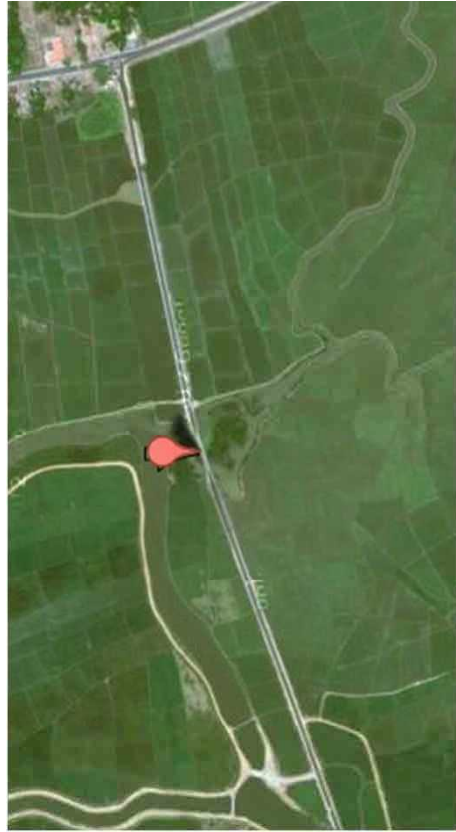
[BRIDGE]
 Curb-to-Curb of 4.20m wide is insufficient for 2-lane traffic of Class A Road.
 Insufficient bridge elevation and opening for floods

[SOUNDNESS]**
 - Superstructure Good RATE 1
 - Substructure Good RATE 1

[SURROUNDING AREA]
 Water pipe bridge at L-side of the existing bridge

< PROPOSAL >
 (Reconstruction at L-side of the existing bridge)
 Eliminated by LOT size

Bridge Length: Approach Length:
 Superstructure:
 Substructure:
 Foundation:
 Resettlement:



** SOUNDNESS RATE

- RATE 1: Good condition
- RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.
- RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.
- RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No. 23	Road No.	Road Name				Province		District		AADT (No./Day)	Construction Plan of Road to/ from Bridge		Environmental Condition
	AA028	Anuradhapura - Padeniya				North Central		Anuradhapura			Road improvement by Korean fund		Forest Reserve
	Bridge No.	Bridge Length (m)	Bridge Width (m)		No. of Lane	Super-structure	Bridge Type	Pier	No. of Span	Comple-tion Year	Bridge Soundness	Flood Records	
30/1	156.60	Overall	Curb-to-Curb	2	PC I Girder	RC Wall Type		5	Approx. 30 years ago	-	Sufficient	Flood water level is 1.5m above the causeway.	



< PRESENT CONDITIONS >

[BRIDGE]

Curb-to-Curb of 7.40m wide is sufficient for 2-lane traffic of Class A Road.

[SOUNDNESS]**

- Superstructure
Good

RATE 1

- Substructure
Good

RATE 1

- Others

[SURROUNDING AREA]



< PROPOSAL >

Reconstruction is not recommended because of Environmental problem.

Bridge Length:
Superstructure:
Substructure:
Foundation:

Approach Length:

Resettlement:

** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name				Province	District	AAADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge		Environmental Condition
	AA011	Maradankadawela - Habarana - Tirikkondiamadu				Central	Polonnaruwa	2,200	2			Floodplains National Park
26	Bridge No.	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		No. of Span	Comple-tion Year	Bridge Soundness		Flood Records
	78/1	34.80	Overall	Curb-to-Curb		Super-structure	Abutment			Pier	Super-structure	
			6.70	5.42	2	Reversed Trapezoidal Steel Girder	RC Wall Type	RC Wall Type	Fair	Good	Sufficient	Bridge submerged during floods



< PRESENT CONDITIONS >

[BRIDGE]

Curb-to-Curb of 5.42m wide is insufficient for 2-lane traffic of Class A Road.

Insufficient bridge elevation and opening for floods

[SOUNDNESS]**

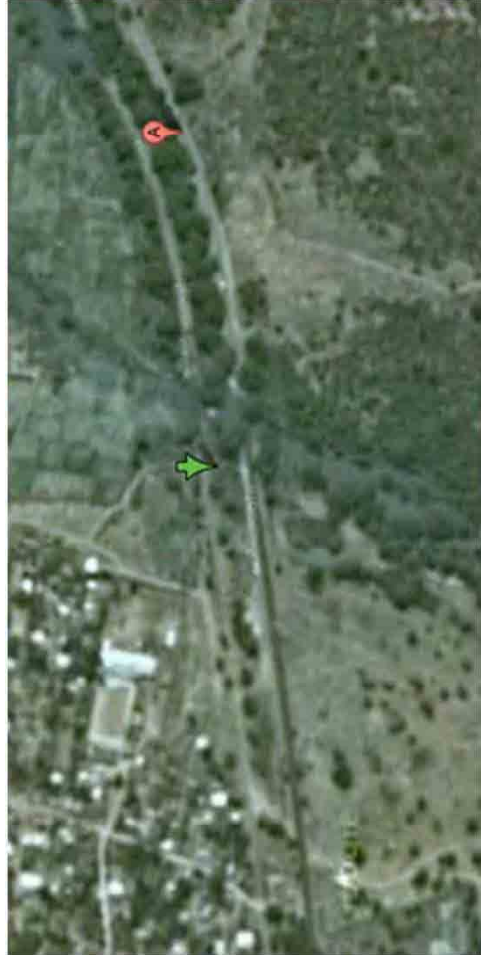
- Superstructure RATE 2
- Fair
- Main girders rusted
- Substructure RATE 1
- Good
- Others

[SURROUNDING AREA]

< PROPOSAL >

Reconstruction is not recommended.

- Bridge Length: Approach Length:
- Superstructure:
- Substructure:
- Foundation:
- Resettlement:



** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name				Province	District	AADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge	Environmental Condition	
	AA011	Maradankadawela - Habarana - Tirikkondiamadu				Central	Polonnaruwa	6,600	2		Forest Reserve	
27	Bridge No.	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		No. of Span	Completion Year	Bridge Soundness		Flood Records
	82/3	500 Feet Bridge	60.40	Overall		Curb-to-Curb	Superstructure			Abutment	Pier	
			6.80	5.15	2	Reversed Trapezoidal Steel Girder	RC Wall Type	RC Wall Type	Fair	Good	Sufficient	Bridge submerged during floods



< PRESENT CONDITIONS >

[BRIDGE]

Curb-to-Curb of 5.15m wide is insufficient for 2-lane traffic of Class A Road.
Insufficient bridge elevation and opening for floods

[SOUNDNESS]**

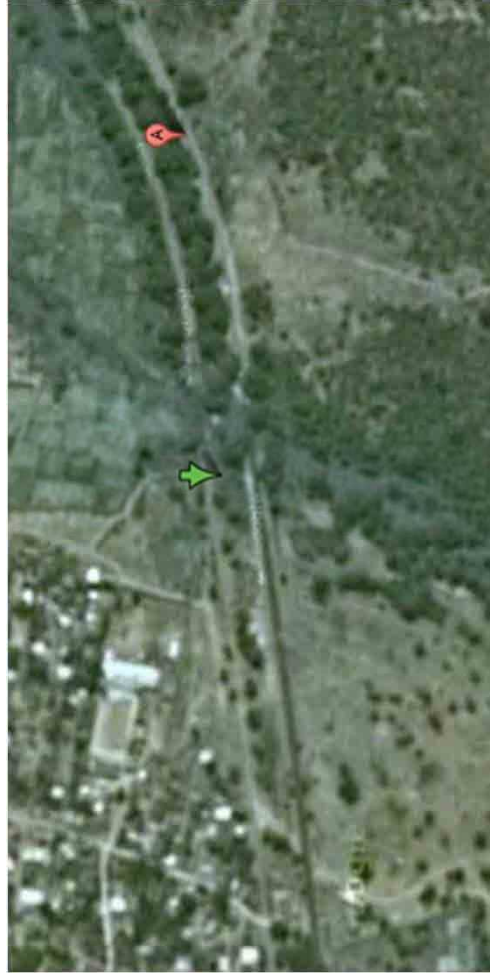
- Superstructure RATE 2
- Fair
- Main girders rusted
- Substructure RATE 1
- Good
- Others

[SURROUNDING AREA]

< PROPOSAL >

Reconstruction is not recommended because of Environmental problem.

- Bridge Length:
- Superstructure: Approach Length:
- Substructure:
- Foundation:
- Resettlement:



** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

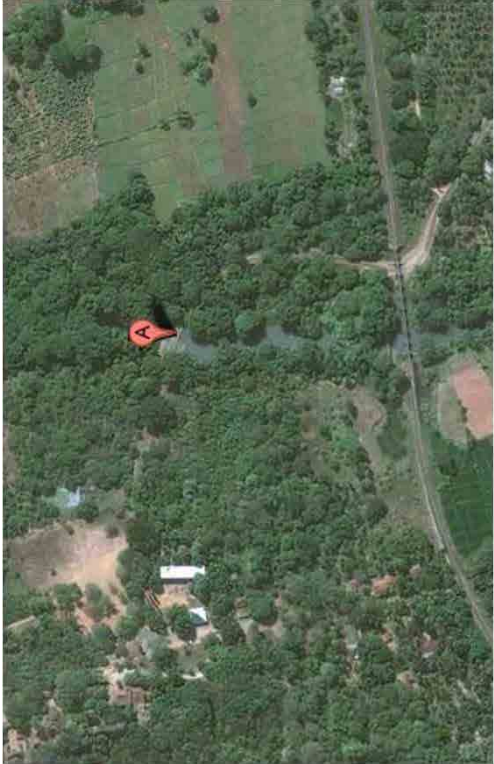
RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name				Province	District	AA DT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge			Environmental Condition
	B182	Kalawewa - Avukana		North Central	Anuradhapura	700	2	Bridge			ok		
30	Bridge No.	Bridge Name	Bridge Length (m)	Bridge Width (m)	Bridge Type		No. of Span	Comple-tion Year	Super-structure	Sub-structure	Loading Capacity	Flood Records	
	4/2	Kalaoya Causeway	43.00	Overall Curb-to-Curb	No. of Lane	Multiple Pipe Culvert							Pier
				5.00	2	-	1		Fair	-	Insufficient		



< PRESENT CONDITIONS >

[BRIDGE]
 Narrow for 2-lane traffic
 Insufficient causeway elevation for floods
 [SOUNDNESS]**
 - Superstructure Fair RATE 2
 - Substructure RATE
 - Others
 [SURROUNDING AREA]



< PROPOSAL >
Reconstruction is not recommended.
 Bridge Length:
 Superstructure:
 Substructure:
 Foundation:
 Resettlement:
 Approach Length:

** SOUNDNESS RATE
 RATE 1: Good condition
 RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.
 RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.
 RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

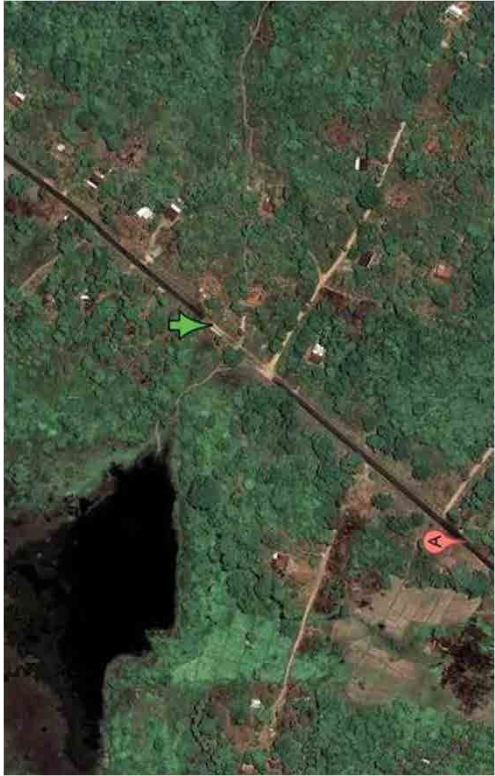
Bridge Inventory No.	Road No.	Road Name				Province	District	AADT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge			Environmental Condition
	B060	Bogahawewa - Pulmuddai				North Central	Anuradhapura	1,100	2				ok
38	Bridge No.	Bridge Name	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		Comple-tion Year	Bridge Soundness		Flood Records	
	3/1	Alth halmillama	81.00	Overall	Curb-to-Curb		Super-structure	Abutment		Pier	Super-structure		Sub-structure
				5.70	5.70	2	-	-	-	-	-	Flood water level is 1m above the causeway.	



< PRESENT CONDITIONS >

[BRIDGE]
 Narrow for 2-lane traffic
 Insufficient causeway elevation for floods
 [SOUNDNESS]**
 - Superstructure RATE
 - Substructure RATE
 - Others

[SURROUNDING AREA]



< PROPOSAL >
New bridge more than 30m long is not recommended.

Bridge Length: Approach Length:
 Superstructure:
 Substructure:
 Foundation:
 Resettlement:

** SOUNDNESS RATE

- RATE 1: Good condition
- RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.
- RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.
- RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

Bridge Inventory No.	Road No.	Road Name				Province	District	AA DT (No./Day)	No. of Lanes of Road Proposed by RDA	Construction Plan of Road to/ from Bridge			Environmental Condition
	B564	Otappuwa Ihalaawewa				North Central	Anuradhapura		2	Causeway improvement by RDA			ok
39	Bridge No.	Bridge Name	Bridge Length (m)	Bridge Width (m)		No. of Lane	Bridge Type		Comple-tion Year	Bridge Soundness		Flood Records	
	10/2	Karabaya Causeway	45.00	Overall	Curb-to-Curb		Super-structure	Abutment		Pier	Super-structure		Loading Capacity
			7.60	12.00	2	-	-	-	-	-	Insufficient		



< PRESENT CONDITIONS >

[BRIDGE]

Carriageway of 7.60m wide is sufficient for 2-lane.
Closed for 3 months during floods

[SOUNDNESS]**

- Superstructure Poor RATE

- Substructure RATE

- Others

[SURROUNDING AREA]

< PROPOSAL >

(New bridge on the existing alignment)
Eliminated by LOT size

Bridge Length: Approach Length:

Superstructure:

Substructure:

Foundation:

Resettlement:

** SOUNDNESS RATE

RATE 1: Good condition

RATE 2: Fair condition with minor natures: Periodical maintenance is required. No urgent repair is needed.

RATE 3: Significant damages: Damaged portion(s) are to be repaired immediately.

RATE 4: Critical damages: Urgent improvement, reconstruction or restriction of heavy vehicles is required.

