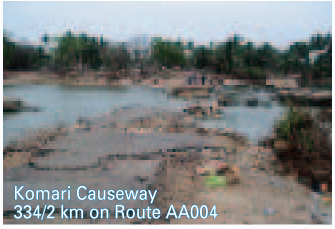
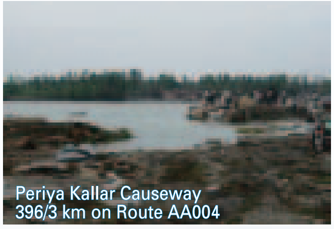
ROAD DEVELOPMENT AUTHORITY
MINISTRY OF HIGHWAYS
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

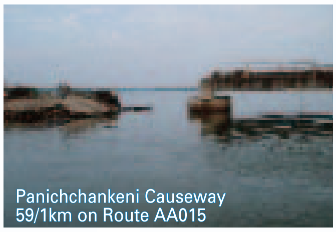
No.

JAPAN INTERNATIONAL
COOPERATION AGENCY(JICA)


Komari Causeway
334/2 km on Route AA004


Periya Kallar Causeway
396/3 km on Route AA004


Koddaia Kallar Causeway
398/1 km on Route AA004


Panichchankeni Causeway
59/1km on Route AA015

# RECOVERY, REHABILITATION AND DEVELOPMENT PROJECT FOR TSUNAMI AFFECTED TRUNK ROADS ON THE EAST COAST IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

## FINAL REPORT
## MAIN REPORT

**2 of 3**

**May 2006**


Route AA004 – AA015
AkkaraipattuA Trikkandimadu


Kallady Bridge
Batticaloa on Route AA004

**ORIENTAL CONSULTANTS CO., LTD.**

in association with

**NIPPON KOEI CO., LTD.**
**JAPAN ENGINEERING CONSULTANTS CO., LTD.**

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| JR |
| 06-048(2/3) |

The following foreign exchange rates are applied in the Project:

JPY 1.00 = 0.921 Rs. (as of April 2005) for Emergency Recovery Project

JPY 1.00 = 0.901 Rs. (as of August 2005) for Rehabilitation Project

# PREFACE

In response to the request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct the Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast and entrusted the Project to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Dr. Masaaki TATSUMI of Oriental Consultants Co., Ltd. and consist of Oriental Consultants Co., Ltd. in association with Nippon Koei Co., Ltd. and Japan Engineering Consultants Co., Ltd. to Sri Lanka, between March 2005 and February 2006.

The team held discussions with the officials concerned of the Government of Sri Lanka and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report in May 2006.

I hope that this report will contribute to the rehabilitation of Sri Lanka, and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Sri Lanka for their close cooperation extended to the Project.

May 2006

Kazuhisa MATSUOKA
Vice President
Japan International Cooperation Agency

# LETTER OF TRANSMITTAL

May 2006

Mr. Kazuhisa MATSUOKA,
Vice President
Japan International Cooperation Agency (JICA)
Tokyo, JAPAN

We are pleased to submit to you the Final Report of the Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast.

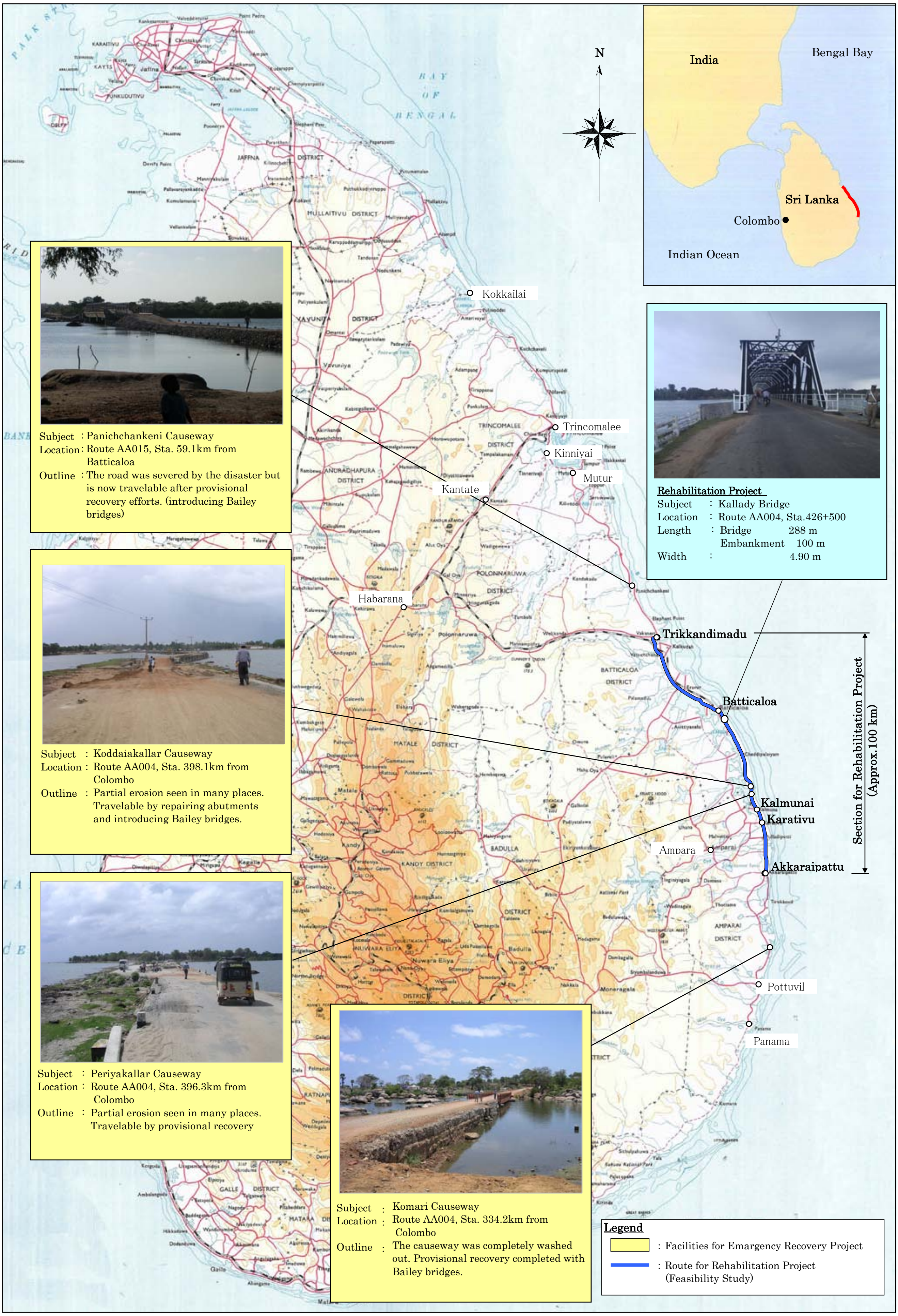
This Project was conducted by Oriental Consultants Co., Ltd. in association with Nippon Koei Co., Ltd. and Japan Engineering Consultants Co., Ltd. under a contract to JICA, during the period from March 2005 to May 2006. In conducting the Project, we have completed the Emergency Recovery Project and the Rehabilitation Project.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs of Japan, Japan International Cooperation Bank, Ministry of Highway of Sri Lanka, Road Development Authority, JICA Sri Lanka Office, JBIC Representative Office in Colombo and Embassy of Japan in Sri Lanka for their cooperation assistance throughout the Project.

Finally, we hope this report will contribute to further cooperation of Sri Lanka.

Very truly yours,

Masaaki TATSUMI
Team Leader,
Study Team of the Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast




**Location Map**

# PROJECT OUTLINE

| | |
|---|---|
| **1. COUNTRY** | Democratic Socialist Republic of Sri Lanka |
| **2. NAME OF STUDY** | Recovery, Rehabilitation and Development for Tsunami Affected Trunk Roads on the East Coast in the Democratic Socialist Republic of Sri Lanka |
| **3. COUNTERPART AGENCY** | Road Development Authority (RDA) of the Ministry of Highways |
| **4. OBJECTIVE OF STUDY** | ● To prepare draft tender documents and preliminary designs for the reconstruction of the four causeways damaged by the tsunami of 26th December 2004 as part of an Emergency Recovery Project.<br>● To carry out a feasibility study on trunk roads on the East Coast damaged by the tsunami as part of a Rehabilitation Project (including the New Kallady Bridge). |

**1. STUDY AREA** Project components for the Project road AA004 and AA015 are as follows:

- Four Causeways: Komari (Km 334/2 on AA004), Periya Kallar (Km 396/3 on AA004), Koddaia Kallar (Km 398/1 on AA004), Panichchaankeni (Km59/1 on A0015)
- The 100 km section of road on the East Coast from Akkaraipattu to Trikkandimadu on AA004 and AA015 (including the Kallady Bridge).

**2. SCOPE OF STUDY**

**<u>Emergency Recovery Project (Preliminary Design & Draft Tender Document Preparation for Four Causeways)</u>**

1) Execution of natural condition surveys
2) Preparation of preliminary designs
3) Preparation of construction plan & cost estimates
4) Preparation of draft tender documents
5) Preparation of community support program

**<u>Rehabilitation Project (FS & Preliminary Design of East Coast Road including the New Kallady Bridge)</u>**

1) Execution of natural condition surveys
2) Execution of traffic surveys
3) Execution of initial environmental examination (IEE)
4) Forecast of traffic demand
5) Establishment of appropriate design standards and criteria
6) Development of preliminary engineering design and cost estimation
7) Economic evaluation of the Project road and the New Kallady Bridge as a single undertaking
8) Development of community support program
9) Preparation of a road maintenance plan for rehabilitated road
10) Economic analysis and evaluation
11) Preparation of Project implementation plan

**3. EMERGENCY RECOVERY PROJECT** (Preliminary Design & Draft Tender Document Preparation for 4 Causeways)

The Emergency Recovery Project, together with executing the necessary natural condition surveys, prepared a preliminary design including a construction plan and cost estimate for the four causeways. Moreover, in the draft tender documents for this Project, employment opportunities for tsunami affected people are described.

**4. REHABILITATION PROJECT** (FS & Preliminary Design of East Coast Road including the New Kallady Bridge)

Regarding the Project road's preliminary design, geological, topographical, and high water level surveys were executed and reflected in the planning of the road and its drainage facilities. Project road alignment was then designed with the goal of keeping to the existing alignment as much as possible to minimize social impacts. Pavement structure, after in-depth discussions with RDA, was set with the assumption that road design life is 10 years. After considering cost effectiveness, it was proposed that urban areas receive an overlay only while widening and overlay work applying an aggregate base course be implemented for the other sections of the Project road. Regarding the New Kallady Bridge, its preliminary design was carried out and is to be constructed in parallel to the existing structure. A construction plan and cost estimate for Project road rehabilitation and the New Kallady Bridge's construction was then prepared.

Project evaluation was carried out based on forecasts of traffic demand using data from roadside OD surveys as well as other traffic surveys. The calculation of the EIRR for 10-, 15-, and 20-year periods resulted in values of 7.76%, 9.40%, and 10.10%. In terms of economic justification, an EIRR of at least 10% is desirable, which is obtained if a 20-year evaluation period is applied.

As for environmental impacts, it was deemed that these are minor via an IEE and that an EIA was unnecessary. In the case of social measures, it is recommended that community support be carried out via revitalization of Kalmunai Town and that jobs be provided to local people in the construction of the Project road (including the New Kallady Bridge).

Finally, the Project is to adopt a design-build method and is to start in April 2007 and continue for 30 months till September 2009.

**5. CONCLUSIONS & RECOMMENDATIONS:**

Recommendations are only for the Rehabilitation Project, as the Emergency Recovery Project is already in progress.

1) Detailed design should be based on the conceptual designs in this report. However, when the design of a particular piece of infrastructure is not clearly indicated, the Contractor should prepare his design based on sound engineering principles.
2) This report carried out a careful analysis to determine the most cost-effective pavement structure. Therefore, it is important that due attention is paid to the Project's design and materials in order to ensure costs are approx. in line with preliminary design estimates.
3) As part of the overall support system for tsunami affected people, the Contractor for the Project is to exert his efforts to provide income-earning opportunities for both skilled and unskilled workers.
4) The Project's road's design life is 10 years and it is therefore necessary that routine maintenance, together with functional and structural overlay work to be performed 10 and 20 years after Project completion, be diligently executed. For this reason, it is recommended that the Sri Lanka Road Fund be implemented as intended.

# Summary of Project

**Project Period:** March 2005 – May 2006

**Implementation Agency:** Road Development Authority of the Ministry of Highways

## 1 Project Background & Objectives

*The Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast* is an undertaking that will implement a preliminary design and prepare draft tender documents for the reconstruction of four causeways on AA004 and AA015 on the country's East Coast, as well as carry out a feasibility study on the rehabilitation of AA004 and AA015 between Akkaraipattu and Trikkandimadu (including the New Kallady Bridge).

## 2 Emergency Recovery Project

### 2.1 Outline of Emergency Recovery Project

The facilities considered by the Emergency Recovery Project consist of the following four causeways, which are at present under construction. The design conditions and outline of the preliminary design for the causeways are as shown in Table 2.1.1.

① Komari Causeway
② Periya Kallar Causeway
③ Koddaia Kallar Causeway
④ Panichchankeni Causeway

**Table 2.1.1. Causeway Design Conditions & Preliminary Design Outline**

| Item | | Komari | Periya Kallar | Koddaia Kallar | Panichchankeni |
|---|---|---|---|---|---|
| Road/Km | | A4, KM334/2 | A4, KM396/3 | A4, KM398/1 | A15, KM59/1 |
| Road Class | | A | A | A | A |
| Design Speed (km/hr) | | 70 | 70 | 70 | 70 |
| Effective Road Width (m) | | 10.0 | 13.6 | 13.6 | 10.0 |
| Estimated Present Traffic Volume (ADT: PCU/day) | | 500 | 7,070 | 7,070 | 500 |
| Pavement Type | Causeway Road | Concrete | Concrete | Concrete | Concrete |
| | Approach Road | Asphalt Concrete or DBST | Asphalt Concrete or DBST | Asphalt Concrete or DBST | Asphalt Concrete or DBST |
| Design Water Level (m) | | 1.6 | 1.8 | 1.8 | 1.9 |
| Opening for Canal | Required Structure | Bridge | Bridges/Culverts | Bridge/Culvert | Bridge |
| | Total Opening | 48m | 136m | 41m | 127m |
| Opening for Bridge (preliminary | Superstructure | Pre-cast Pre-tensioned Beam | Pre-cast RC Concrete Slab | Pre-cast RC Concrete Slab | Pre-cast Pre-tensioned Beam |

| | | | | | |
|---|---|---|---|---|---|
| design) | Substructure | Reversed T-shape & Wall Type | Reversed T-shape | Reversed T-shape | Pile Bent Type |
| | Foundation | Spread Foundation on Gneiss Rock Base | Spread Foundation on Sandstone | Spread Foundation on Sandstone | Cast-in-situ RC Concrete Pile Embedded in Coarse Sand |
| Causeway (preliminary design) | | Random Rubble Masonry Filling with Crushed Stone | Retaining Wall | Retaining Wall | Random Rubble Masonry Filling with Crushed Stone |
| Incidental Facilities | Sidewalk | Mounted up with Concrete Curb for all Causeways | | | |
| | Handrail | Typical Type of Pre-cast Concrete Handrails & Uprights for all Causeways | | | |
| | Duct for Utility cable | Two Ducts for Future Utilities to be Contained Inside Mounted up Sidewalks | | | |
| | End Pilasters | Both Ends of Handrails to Have Commemorative Plates | | | |
| | Guard Rail | Outside of Embankment Shoulders on Approach Roads | | | |
| | Road Marking | Center-line & Edge Lines | | | |
| | Reflective Road Studs | Center-line on Causeway Roads & Bridges | | | |
| | Relocation of Utility | No | Electric Line | Telephone Line Electric Line | No |

Note that the preliminary designs for the road and bridge sections of the causeways in the Emergency Recovery Project are for cost estimation purposes and would have to be re-examined when detailed design work is carried out.

## 2.2 Community Support Program & Social Environmental Considerations for Emergency Recovery Project

As for the community support program, the draft tender documents contain a mechanism to employ as many local residents as possible affected by the tsunami who have lost their means of earning a living. On the other hand, due to the urgent nature of the Project, a detailed environmental study was not executed. For this reason, the draft tender documents clearly indicate that causeway construction activities should be conducted carefully and all appropriate measures necessary taken in regards to protecting the ecosystem of seaside lagoons.

# 3 Rehabilitation Project

## 3.1 Outline of Rehabilitation Project

As for medium- and long-term rehabilitation programs for the trunk roads on the East Coast, the section of AA004 from Akkaraipattu to Batticaloa and AA015 from Batticaloa to Trikkandimadu, as well as the Kallady Bridge on AA004 to the south of Batticaloa, were selected. The vertical alignment on these sections is almost flat, and the horizontal alignment has few curves, meaning that it is possible to have a curvature radius with a design speed of 50 km/hr to 60 km/hr. Presently, the existing pavement structure is macadam, and the road surface is experiencing numerous types of damage such as cracking and pot holes at both the center and edge of the carriageway.

As for the New Kallady Bridge, on the other hand, its length and span arrangements will be the same as the existing Kallady Bridge and will be located 20m to the south.

### 3.2 Natural Condition Survey

According to a soil survey, the sub-base and base of the existing road, which are located underneath the surface layer, are about 40cm in thickness. In addition, the high water level for the Batticaloa Lagoon is 1.35m for a 50-year return period and for the Valachchenai Lagoon 3.30m for the same return period. These results are useful in determining the necessary elevation of the proposed road alignment and the placement of culverts.

### 3.3 Traffic Demand Forecast

As there was no existing traffic data for the Project area, the following traffic surveys were executed: 1) a roadside origin-destination survey (passenger & freight vehicles), 2) traffic volume survey, 3) bus passenger survey, 4) bus terminal survey, 5) road condition survey, 6) travel speed survey, 7) turning movement survey, and 7) rail terminal survey.

Based on the results of the above surveys, the area near Kalmunai has the largest daily traffic flow for a total of 8080 vehicles per day (vpd). Note that the average vpd for the Project road is about 4120, with about 16% of this traffic being heavy vehicles (i.e., large buses, medium trucks, and large trucks). In terms of passenger car units (pcu), the relatively busy Kalmunai area has a daily flow of 7070 pcu, with the average daily pcu flow for the Project road being about 3770, indicating that the there is a large number of small-sized vehicles such as motorcycles. In fact, 72% of existing traffic is has a pcu of 1.00 or smaller (i.e., passenger cars, 3 wheelers, and motorcycles).

The traffic evaluation criteria of daily vehicle-kilometers (Veh-km), vehicle-hours (Veh-hr), and average area speed are used to assess the impact of the rehabilitation of the Project road. In 2025, travel speeds without rehabilitation range from a low of 53 km/h to a high of about 56 km/h, while with rehabilitation speeds would be in the range of 64 km/h to 68 km/h, indicating that improvement of the Project road would have a significant impact on vehicle operation speeds in the Project area.

### 3.4 Environmental & Social Considerations

After a general examination, both the Project road and the New Kallady Bridge were determined to have impacts classified as "*Category B*", which indicate that these impacts on the environment and society are insignificant and normal mitigation measures can be designed readily.

Note that an initial environmental examination (IEE) has been conducted and it was deemed that there would be no significant impacts. Note the Sri Lankan Government does not require an IEE for this Project.

## 3.5 Preliminary Design for Rehabilitation of Eastern Trunk Road

The Project road shall basically keep to the existing alignment in order to minimize social and environmental impacts. However, for sections experiencing inundation during the rainy season, these sections shall be raised so as to be higher than inundation levels based on the guidelines of the RDA.

The standard ROW is basically 11.0m wide with a pavement width of 10.0m, while the minimum ROW will be 9.0m with a pavement width of 8.0m in the case of narrow sections bordered by structures. Note that the existing ROW in urban areas with a width greater than 11.0m shall be maintained in its current state. The composition of land use along the Project road is such that urban (ROW>11.0m), rural (ROW≧11.0m), paddy field and lagoon (ROW≧11.0m), and narrower urban sections (ROW=9.0m) account for 24%, 58%, 14% and 4% of the Project road length, respectively. The quantities to be compensated for are 773m of parapet wall, 77.1m of wire fence, and 510.88m$^2$ of land.

In regards to the most economical design for pavement, this was decided in discussions with RDA and it was deemed unnecessary to reconstruct the existing road and that overlay work would be sufficient. Moreover, it was determined that it would be economical only to carry out overlay work for urban areas and overlay work together with an aggregate base course (ABC) for other sections of the Project road.

## 3.6 Preliminary Design for Rehabilitation of New Kallady Bridge

The outline for the design of the New Kallady Bridge is as shown in the table below.

**Table 3.6.1. Design Outline of the New Kallady Bridge**

| Items | | | | Plan |
|---|---|---|---|---|
| Improvement Method | | | | The bridge will be constructed in parallel with the existing bridge |
| Bridge Design | Length | Bridge Length | | 289.5m |
| | | Span Arrangements | | 6 x 48.05m |
| | Type | Superstructure | | 6 Spans Continuous PC Box Girder (Extruded Construction) |
| | | Abutments | | RC Reversed-T Type |
| | | Piers | | RC Wall and Pile Cap (Oval Shape) |
| | | Foundation | Pier | Cast-in-Situ Protrusion RC Pile with Steel Tubular Pipe (dia. 1.2m) |
| | | | Abutment | Cast-in-Situ RC Pile (dia. 1.2m) |
| | | Pavement | Carriageway | Asphalt Concrete |
| | | | Cycle Lane | Cast-in-Situ Concrete |

| | | | | |
|---|---|---|---|---|
| | | | Sidewalk | Pre-cast Concrete Panel |
| | Accessory | Expansion Joint | | Steel Finger Type Joint on A1 and A2 Abutments |
| | | Bearing | | Elastic Rubber Type Bearings |
| Riverside Protection | | Bank Protection | | A1 Side : Soil Embankment<br>A2 Side : Grouted Riprap |
| | | Riverbed Protection | | Non |
| Approach Road | | Length | | Kalmunai Side : approx. 145m<br>Batticaloa Side : approx. 105m |
| | | Pavement | | Asphalt Concrete |
| | | Bank Protection | | A1 Side : Soil Embankment<br>A2 Side : Wet Masonry (grouted riprap) |
| | | Safety Barriers | | Steel Guard Rail for embankments higher than 2m |

## 3.7 Project Evaluation

Project costs and benefits (including the New Kallady Bridge) are first evaluated over the period of 2006 to 2020 using least cost analysis to confirm the cost-effectiveness of the selected road design, which is based on a design life of 10 years adopted after careful consideration and discussions with RDA. On the other hand, a 10-year period is too short to sufficiently consider benefits that will flow from the improvement of the Project road. Therefore, 15- and 20-year periods of time for economic evaluation are taken up.

Benefit cost analysis is next carried out for the three evaluation periods of 10, 15, and 20 years in order to check the economic viability of the Project road. Note that the longer the evaluation period the larger the economic internal rate of return (EIRR) becomes. In the case of a 10-year period, the EIRR is only 7.76%. On the other hand, the EIRR for the 15- and 20-year periods is 9.40% and 10.10%. In terms of economic justification an EIRR of at least 10% should be obtained, meaning that the Project satisfies the minimum if a longer evaluation period is applied.

## 3.8 Community Support Program for Rehabilitation Project

In the Rehabilitation Project community support takes two forms: ① the Kalmunai Township Redevelopment program and ② the provision of work directly to tsunami affected persons via the construction work of the Project road and bridge.

## 3.9 Plan for Maintenance of Rehabilitated Road Facilities

The minimal road maintenance that should be considered is pavement maintenance, shoulder maintenance, bridge maintenance, and traffic operation maintenance. Annual O&M costs (including the costs for functional and structural overlays) are as indicated in Table 3.9.1.

**Table 3.9.1. Road Maintenance Cost after Rehabilitation**

| Type of Work Content Classification | | Cost (Rs.) |
|---|---|---|
| Annual O&M | ① Maintenance | 9,000,000 |
| | ② Operation | 1,350,000 |
| | Total | ≑10,500,000 |
| Overlay | ③ Functional Overlay (after 10 years) | 618,000,000 |
| | ④ Structural Overlay (after 20 years) | 1,120,000,000 |

①: Based on actual Baseline Road maintenance expenditures; ②: 15% of ①; ③: Based on data from RDA's RMBEC; ④: Twice the value of ③.

Note, however, given the current lack of funding for maintenance, it is suggested that the Sri Lanka Government implement the planned Road Fund as quickly as possible.

## 3.10 Project Implementation Plan

Upon receiving a strong request from the Sri Lankan Government for the earliest possible commencement of the civil works, it has been decided that the period for pre-construction procedures be minimized. The Sri Lankan and Japanese sides have therefore planned to carry out in parallel the selection of the contractor, who will also be responsible for the detailed design work, and the supervising consultant. Thus, construction is scheduled to start in April 2007 and be completed 30 months later in September 2009.

## 3.11 Conclusions & Recommendations

The conclusions and recommendations for the Rehabilitation Project are as follows:

- Detailed design should be based on the conceptual designs in this report. However, when the design of a particular piece of infrastructure is not clearly indicated, the Contractor should prepare his design based on sound engineering principles.
- This report carried out a careful analysis to determine the most cost-effective pavement structure. Therefore, it is important that due attention is paid to the Project's design and materials in order to ensure costs are approx. in line with preliminary design estimates.
- As part of the overall support system for tsunami affected people, the Contractor for the Project is to exert his efforts to provide income-earning opportunities for both skilled and unskilled workers.
- The Project's road's design life is 10 years and it is therefore necessary that routine maintenance, together with functional and structural overlay work to be performed 10 and 20 years after Project completion, be diligently executed. For this reason, it is recommended that the Sri Lanka Road Fund be implemented as intended.

# Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast in The Democratic Socialist Republic of Sri Lanka

## Table of Contents

## ■3 OF 3: DRAWINGS

# Abbreviations

| | | |
|---|---|---|
| ABC | : | Aggregate Base Course |
| AC | : | Asphalt Concrete |
| ADB | : | Asian Development Bank |
| ADT | : | Average Daily Traffic |
| AFD | : | French Development Agency |
| ASTM | : | American Society for Testing and Materials |
| BC Analysis | : | Benefit Cost Analysis |
| BIQ | : | Basic Information Questionnaire |
| BM | : | Benchmark |
| BS | : | British Standard |
| CBO | : | Community Based Organization |
| CBR | : | California Bearing Ratio |
| CCD | : | Coast Conservation Department |
| CEA | : | Central Environmental Authority |
| CIF | : | Cost Insurance and Freight |
| CW | : | Causeway |
| DBST | : | Double Bituminous Surface Treatment |
| DCP | : | Dynamic Cone Penetration |
| DS | : | District Secretaries |
| DWL | : | Design Water Level |
| EC | : | European Community |
| EF | : | Equivalence Factor |
| EIA | : | Environmental Impact Assessment |
| EIRR | : | Economic Internal Rate of Return |
| ERD | : | Department of External Resources, Ministry of Finance and Planning (of Sri Lanka) |
| ESA | : | Equivalent Standard Axle |
| ESAL | : | Equivalent Standard Axle Load |
| FFPO | : | Fauna and Flora Protection Ordinance |
| FIDIC | : | International Federation of Consulting Engineers |
| GDP | : | Gross Domestic Product |
| GN | : | Grama Niladari |
| GOSL | : | Government of Sri Lanka |
| GPS | : | Global Positioning System |
| HDI | : | Human Development Index |
| HEC | : | Hydrological Engineering Center (US Army Corps of Engineers) |
| HSR | : | (Sri Lanka) Highway Schedule of Rates |
| HWL | : | High Water Level |
| ICTAD | : | Institution for Cooperation Training and Development |
| IDP | : | Internally Displaced Population |
| IEE | : | Initial Environmental Examination |
| INGO | : | International Non-Governmental Organization |
| IRI | : | International Roughness Index |
| JBIC | : | Japan bank for International Cooperation |
| JEC | : | Japan Engineering Consultants Company Limited |
| JICA | : | Japan International Cooperation Agency |
| JICS | : | Japan International Cooperation System |

| | | |
|---|---|---|
| JPY | : | Japanese Yen |
| KEL | : | Knife Edge Load |
| kmp | : | kilometer post |
| KTR | : | Kalmunai Township Redevelopment |
| LC Analysis | : | Least Cost Analysis |
| LTTE | : | Liberation Tigers of Tamil Eelam |
| MSL | : | Mean Sea Level |
| NEA | : | National Environmental Act |
| NFL | : | Normal Flood Level |
| NGO | : | Non-Governmental Organization |
| NK | : | Nippon Koei Company Limited |
| NPV | : | Net Present Value |
| OC | : | Oriental Consultants Company Limited |
| O&M | : | Operation & Maintenance |
| PC | : | Prestressed Concrete |
| pcu | : | passenger car unit |
| PI | : | Preliminary Information |
| RC | : | Reinforced Concrete |
| RCDC | : | Road Construction and Development Co. (Pvt) Ltd. (in Sri Lanka) |
| RDA | : | Road Development Authority |
| RDA-EPO | : | Road Development Authority - Eastern Provincial Office |
| RMBEC | : | Road Maintenance Budgeting and Expenditure Control |
| ROW | : | Right of Way |
| Rs. | : | (Sri Lankan) Rupees |
| SN | : | Structural Number |
| SPT | : | Standard Penetration Test |
| TAFOR | : | Task Force for Relief |
| TAFREN | : | Task Force for Rebuilding Nation |
| TRL | : | UK Transport Research Laboratory |
| UDL | : | Uniformly Distributed Load |
| UK | : | United Kingdom |
| UNDP | : | United Nations Development Programme |
| US$ | : | United States Dollars |
| USAID | : | United States Agency for International Development |
| VAT | : | Value Added Tax |
| Veh-hr | : | Vehicle-hour |
| Veh-km | : | Vehicle-kilometer |
| vpd | : | vehicles per day |
| WG | : | Working Group |

# *PART 1*
# *GENERAL*

# *CHAPTER 1*

## *Introduction*

# Chapter 1 Introduction

## 1.1 Background

### 1) Tsunami Damage to Sri Lanka & Its Roads

A devastating tsunami caused by an undersea earthquake off of Indonesia's Sumatra Island, on 26th December 2004 hit many coastal areas of countries across the Bay of Bengal and the Indian Ocean including Indonesia, Thailand, Sri Lanka, India, and some African countries, causing serious damage with about 300 thousand people killed or missing. In Sri Lanka, except for the 200km long western coastal area from Jaffna to Puttalam, 85% of the island's 2,825km coastline was affected by the tsunami and more than 30 thousand people killed and about 800 thousand people displaced. In addition, about 78 thousand houses were destroyed (41.4 thousand completely and 36.2 thousand partially) and public utilities, private property and infrastructure (including highways) were severely damaged.

The road network in Sri Lanka has a total length of about 100 thousand km including 4,339km of Class A inter-provincial trunk road and 7,670km of Class B intra-provincial arterial road, both under the RDA. Of the Class A and B roads, which total 5,243 km in the North, East, West and Southern Provinces, RDA reported that about 430km was damaged by the tsunami and became impassable. The most severely damaged were the highways from Colombo to Hambantota on the West and South Coasts, and from Pottuvil to Mullaitive and in and around Jaffna on the East and North Coasts.

### 2) Road Recovery & Rehabilitation Plan by GOSL

To immediately rehabilitate the road network in affected areas, the Ministry of Highways adopted a 3-stage program covering emergency, short- and medium-term repair/ rehabilitation/improvement as follows:

Stage 1: **Emergency repairs to a passable level of service to be carried out within the first 2-3 weeks from the date of the disaster**
All damaged road sections on the South, North and East Coasts have been already recovered and made passable.

Stage 2: **Reconstruction/rehabilitation of damaged roads/structures for short-term requirements within 3-4 months after completion of emergency repairs**
Temporary works have to be stabilized and reinforced with permanent bridges,

structural repairs, surface improvement and paving to ensure safety. The estimated total cost for Stages 1 and 2 is US$ 15.35 million.

Stage 3: **Rehabilitation/reconstruction/improvement of damaged roads for medium-term requirements to be carried out over 2-3 year period**

Taking into consideration public safety, many sections of rehabilitated road have to be realigned or shifted inland from the beach reservation, which is a 100m belt area on beaches designated by the Government of Sri Lanka after the tsunami disaster that prohibits any kind of construction work in order to minimize future tsunami risks. RDA has set up two options to implement projects in this Stage:

Option 1: To rehabilitate/reconstruct roads to their original normal condition without considering projected traffic and regional development needs (estimated total cost: US$ 153 million).

Option 2: To rehabilitate/reconstruct as well as widen roads to the required number of lanes based on projected traffic and regional development for the next 20 years (estimated total cost: US$ 490 million).

The trunk road network is one of the fundamental pieces of infrastructure that need to be urgently recovered or rehabilitated after such a severe disaster as the tsunami of 2004. Compared with other sectors, it is relatively neutral to the ethnic issues peculiar to Sri Lanka so that relatively early commencement of the recovery work for damaged trunk roads could be realized. Also, coordination among donors began soon after the disaster. As mentioned above, emergency repairs have been completed and the major component of the recovery work is shifting from temporary repairs to rehabilitation and construction of permanent structures and development beyond the original state before the disaster.

### 3) Coordination in Assistance among Donors

Assistance from donors other than the Japanese for the recovery and rehabilitation of trunk roads on the East Coast has been basically fixed and is as follows:

i) Bridge construction on the Kinniyai ferry section of AA015 by Saudi funding

ii) Rehabilitation of the road sections, excluding bridge sections, of AA015 between Trincomalee and Mutur by France

iii) Construction of three bridges (Mutur, Gangei, and Upparu) on AA015 between Trincomalee and Mutur by France

iv) Rehabilitation of the road section of AA015 between Mutur and Verugal (78 km to 110 km) by France

v) Rehabilitation of the road section of AA015 between Verugal and Trincomalee (37 km to 78 km, including three bridges) and construction of the Verugal and Kayankerny Bridges on AA015 by France

vi) Construction of a new Oddaimavadi Bridge on AA015 by Spain

vii) Rehabilitation of the road section of AA004 between Pottuvil and Akkaraipattu, excluding the Komari Causeway by EC/ADB

viii) Construction of the Arugam Bay Bridge on B374 by USAID

ix) Rehabilitation of the road section of B374 between Panama and Pottuvil by EC/ADB

### 4) Assistance by Japan

JICA dispatched a Preparatory Study Team to examine the possibility of recovery, rehabilitation, and development projects for tsunami affected areas in Sri Lanka from 13$^{th}$ to 31$^{st}$ March 2005, and conducted a field study and had discussions with the relevant officials of the Government of Sri Lanka. On 21$^{st}$ March 2005, the Scope of Work for three projects (i.e., the so-called "Northeastern," "Southern," and "Eastern Trunk Road" projects) was agreed upon and the Minutes of Meeting signed in Colombo between JICA and the relevant Ministries.

The basic policy regarding JICA's contribution is to implement recovery and rehabilitation works for trunk roads as urgently as possible via grant and loan assistance from the Government of Japan. The outline for Japanese assistance for these works as follows:

x) Rehabilitation of five bridges (Akurala, Seenigama, Magalle, Goiyapana & Weligama) on AA002 on the South Coast using Non-Project Grant Aid

xi) Rehabilitation of four causeways (Komari, Periya Kallar, Koddaia Kallar & Panichchankeni) on AA004 and AA015 on the East Coast using Non-Project Grant Aid

xii) Preparation of a rehabilitation plan (inclusive of a feasibility study) for the section of AA004 and AA015 between Akkaraipattu and Trikandimadu as a JICA Emergency Development Study, which would be implemented via a JBIC yen loan

xiii) Preparation of a construction plan (inclusive of a feasibility study) for a New Kallady Bridge on AA004 as a JICA Emergency Development Study, which would be implemented via a JBIC yen loan

**5) Formation of this Project**

As mentioned previously, the Scope of Work for the *Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast in the Democratic Socialist Republic of Sri Lanka* (hereinafter referred to as “the Project”) was signed on 21st March 2005 as one of three tsunami-related JICA projects, and is primarily concerned with the preliminary design and preparation of draft tender documents for the four causeways listed in Item xi) and the execution of a feasibility study for the 100km road from Akkaraipattu to Trikandimadu described in Item xii). Note that the feasibility study in Item xiii) was added to the scope of work during the course of the Project.

## 1.2 Scope

The Project consists of two major components: (i.e., the Emergency Recovery Project and Rehabilitation Project) as shown in Fig. 1.2.1. The Emergency Recovery Project is concerned with rehabilitating the four damaged causeways on the East Coast using permanent structures to replace the existing temporary ones and are as follows:

- Komari Causeway at 334/2 kmp on AA004
- Periya Kallar Causeway at 396/3 kmp on AA004
- Koddaia Kallar Causeway at 398/1 kmp on AA004
- Panichchankeni Causeway at 59/1 km on AA015

The work of the Emergency Recovery Project includes natural condition surveys on topography, geology and hydrology, preliminary design, construction planning, cost estimates, preparation of a community support program, drafting of tender documents for construction works, etc.

The Rehabilitation Project consists of a feasibility study on the rehabilitation/development of the trunk roads AA004 and AA015 on the East Coast for a total length of about 100km from Akkaraipattu to Trikkandimadu, as well as a feasibility study on the construction of a new Kallady Bridge on AA004 south of Batticaloa. The Project includes a review and analysis of present socioeconomic and environmental conditions, natural condition surveys on topography, geology and the environment, traffic surveys, an initial environmental examination based on JICA/JBIC guidelines, preliminary designs of the Project road and New Kallady Bridge, construction planning, cost estimates, project implementation plan, maintenance planning, economic analyses, etc.

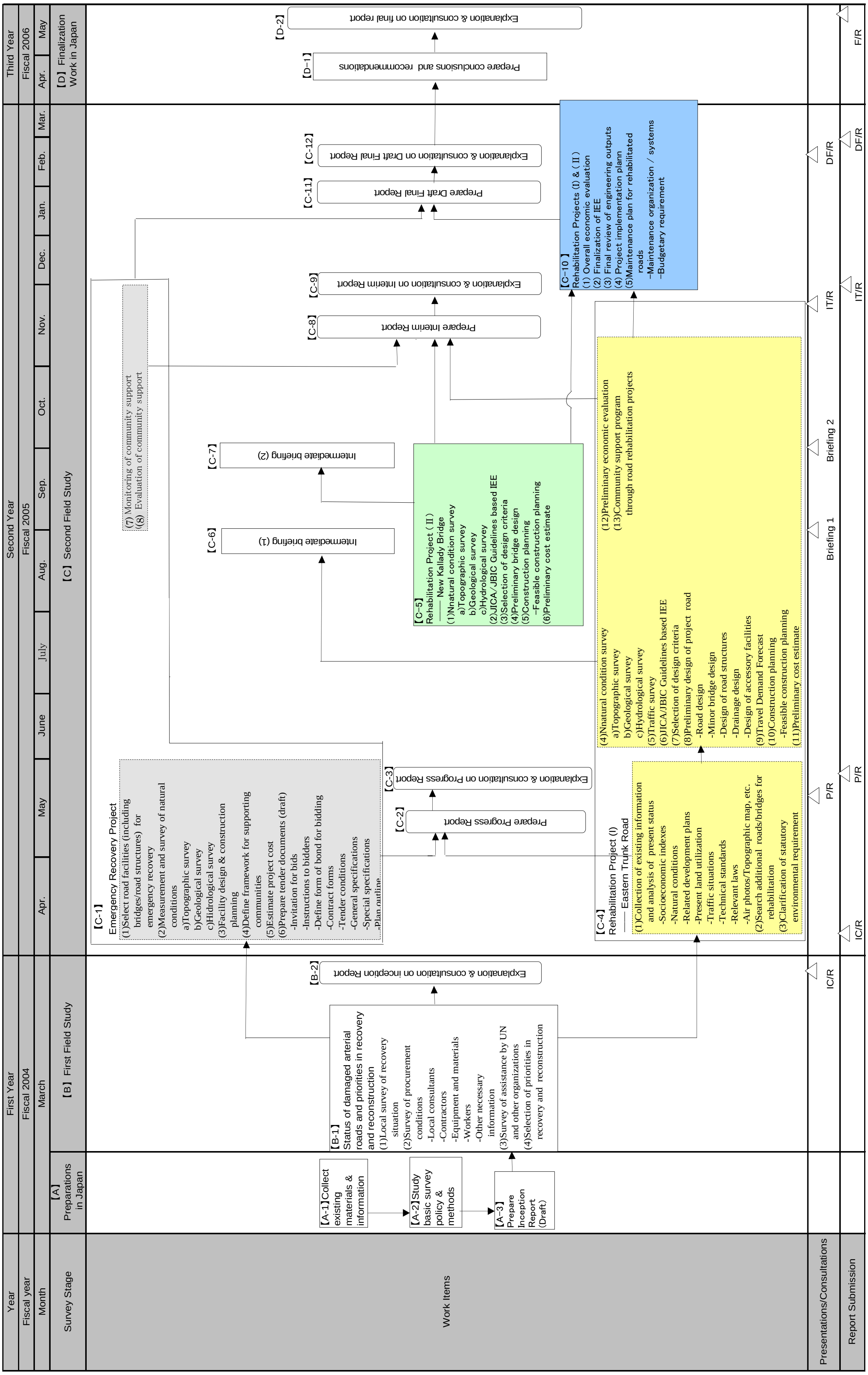



**Figure 1.2.1. Project Work Flow**

## 1.3 Components of Final Report

This Final Report contains the work undertaken by the Study Team in the period from March 2005 to May 2006, which concerns the Emergency Recovery Project for the four selected causeways and the Rehabilitation Project for the above-mentioned roads and New Kallady Bridge. Note that the drawings and IEE Report described in the Table of Contents are only submitted to JICA. In the case of the former, as there has been no change to the drawings of the Draft Final Report, RDA stated that it is unnecessary to re-submit them. As for the latter document, RDA noted that it is not a requirement of the Sri Lankan Government and therefore unnecessary.

Regarding the Emergency Recovery Project, after reviewing the present overall conditions of the Project area, the natural conditions of the four areas and facilities are examined. Then, the preliminary design[1] and construction plan of the facilities, as well as their cost estimate, are outlined. A description of the preparation of the draft tender documents and the tender implementation assistance follows this. Also, a community support program with monitoring and evaluation, together with social and environmental considerations for the Emergency Recovery Project, are reported.

As for the Rehabilitation Project, the statutory environmental requirements are first reviewed, followed by a description of the surveyed natural conditions of the coastal areas along the Project road (i.e., topography, geology, and hydrology). Next, present traffic flows in the area are surveyed and reported, and the outcomes of a traffic demand forecast subsequently disclosed. Then, the preliminary design and construction plan of the Project road between Akkaraipatu and Trikkandimadu and the New Kallady Bridge, as well as their cost estimates, are outlined. In addition, an economic analysis for the whole of the Rehabilitation Project is carried out. Moreover, a community support program for the Project is suggested, together with a maintenance plan for the rehabilitated roads and a Project implementation plan.

[1] Note that the preliminary designs for the road and bridge sections of the causeways in the Emergency Recovery Project are for cost estimation purposes and would have to be re-examined when detailed design work is carried out.

## 1.4 Project Organizational Setup

### 1.4.1 Project Implementation Organizations

The Project is implemented by organizations consisting of Japanese and Sri Lankan government entities and a Study Team of consultants as shown in Fig. 1.4.1 below.

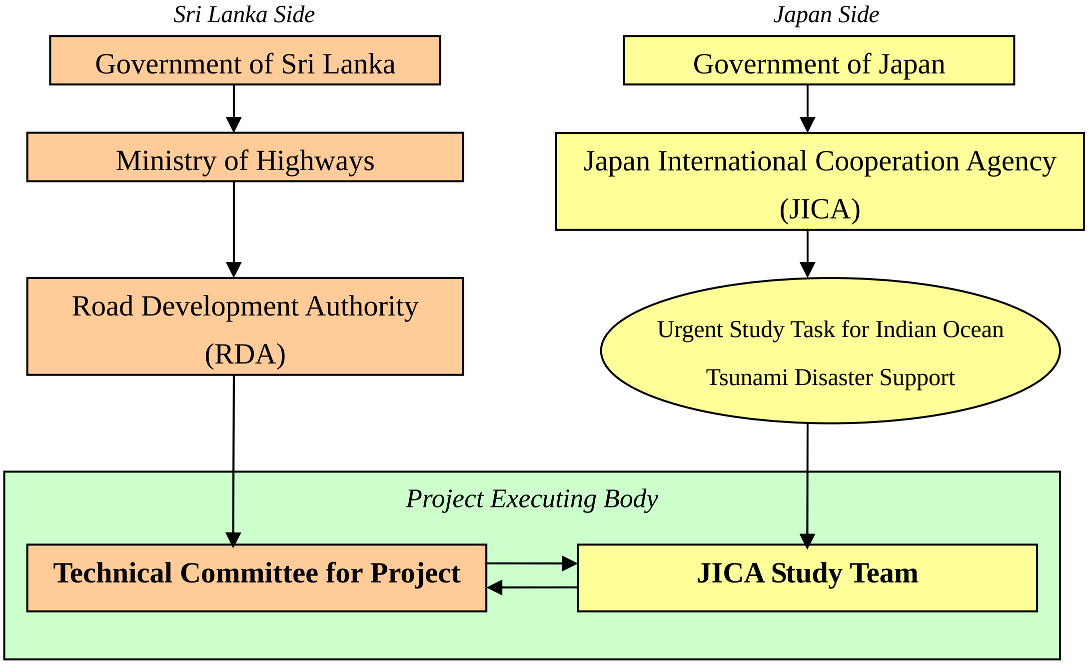



**Figure 1.4.1. Project Implementation Organizations**

### 1.4.2 Staffing

The members involved in this Project are listed as follows:

**1) Technical Committee for the Recovery, Rehabilitation and Development Project for Tsunami Affected Trunk Roads on the East Coast**

| No. | Name | Title |
|---|---|---|
| 1 | Dr. G. L. Asoka J. de Silva | Director, Engineering Services, RDA |
| 2 | Mr. R. M. Amarasekera | Director, Planning, RDA |
| 3 | Mr. M. G. E. Perera | Director, Highway Department, RDA |
| 4 | Mr. Mylvaganam Thuraisamy | Project Director, Japanese Aid Project, RDA |
| 5 | Mr. Rohita | Deputy Director, Engineering Services, RDA |
| 6 | Mr. Vasanthakumar | Design Engineer, Engineering Services, RDA |
| 7 | Dr. T. Takano | JICA Expert, RDA |

### 2) Members relevant to Urgent Task Force for Indian Ocean Tsunami Disaster Support of JICA

| No. | Position | Name | Title |
|---|---|---|---|
| 1 | Secretary General | Mr. M. Fuwa | Sr. Assistant, Social Development Dept. |
| 2 | Chief, Sri Lanka | Mr. Y. Kurashina | Team Director, Transportation 1, Group 3, Social Development Dept. |
| 3 | Member, Trunk Roads | Mr. N. Yamamura | Staff, Transportation 1, Group 3, Social Development Dept. |
| 4 | Support, Trunk Roads | Mr. S. Isogai | Staff, Transportation 1, Group 3, Social Development Dept. |
| 5 | Support, Trunk Roads | Mr. H. Matsumoto | Staff, Water Resources 2, Group 3, Global Environment Dept. |

### 3) JICA Study Team

| No. | Position | Name | Firm |
|---|---|---|---|
| 1 | Team Leader / Disaster Recovery Planning | Dr. Masaaki Tatsumi | OC |
| 2 | Deputy Team Leader / Disaster Mitigation | Mr. Yuichi Tsujimoto | NK |
| 3 | Community Support Planning | Dr. Rajamanoharan Kumarasuriyar | NK |
| 4 | Road Planning / Design 1 | Mr. Keigo Konno | OC |
| 5 | Road Planning / Design 2 | Mr. Hitoshi Okita | OC |
| 6 | Road Structure Design 1 | Mr. Hiroshi Fujisawa | NK |
| 7 | Road Structure Design 2 | Mr. Tetsuya Maeda | NK |
| 8 | Construction Planning / Cost Estimates 1 | Mr. Futoshi Hatanaka | OC |
| 9 | Construction Planning / Cost Estimates 2 | Mr. Nobuo Yoneda | JEC |
| 10 | Survey 1 | Mr. Hisashi Muto | JEC |
| 11 | Survey 2 / Natural Conditions | Mr. Satoshi Mizuno | JEC |
| 12 | Tender Documents 1 / Equipment Procurement Planning | Mr. Shinichi Matsumoto | NK |
| 13 | Tender Documents 2 | Mr. Hikohiro Nakamura | NK |
| 14 | Social Environment | Mr. Shigeru Sai | OC |
| 15 | Project Assessment | Dr. William Hayes | OC |
| 16 | Coordinator | Mr. Kouhei Shimomura | OC |

## 1.5 Project History

### 1.5.1 Brief Narrative

The Project has progressed as shown in the work flow of Figure 1.2.1, starting in March 2005 and ending in May 2006.

After the execution of field studies on the present condition of the Project areas, which were conducted in the starting stages, efforts have been made to complete the first major task —the preliminary design and construction planning of the four causeways for the Emergency Recovery Project — as quickly as possible. This was successfully accomplished within the target time of the end of May 2005. In parallel with the Emergency Recovery Project, work for the Rehabilitation Project for the 100km long section on the East Coast had also been initiated.

With the submission of the Progress Report at the end of May 2005, which described the work of the Emergency Recovery Project, assistance with the tender procedure for the civil works of this undertaking was conducted in June and July of 2005. Note that after the commencement of the construction works for the four causeways monitoring of the community support program continued periodically until the end of January 2006, with the assistance of a separate construction supervising team for the civil works.

During June and July of 2005, JICA decided that the construction of the New Kallady Bridge should also be included in the feasibility study of the Study Team for the Rehabilitation Project for the 100 km long section of trunk road between Akkaraipattu and Trikandimadu. In the Rehabilitation Project, the Study Team engaged in the preliminary design of roads, bridges, minor structures, drainage, and accessories. In parallel, an Initial Environmental Examination, traffic demand forecast, construction planning, cost estimation, and economic analysis were carried out. Also, a community support program and a maintenance plan for the rehabilitated road were summarized.

Note that intermediate briefings on Project output for the trunk roads and the New Kallady Bridge were held with JICA at the end of August and September, respectively, and the output incorporated into the Interim Report.

After submission of the Interim Report, emphasis was put on an overall evaluation of the Rehabilitation Project from the aspect of both recovering and developing the tsunami-affected Eastern Trunk Road, as well as making a final review of all engineering studies and community support programs. All of the Project outcomes were compiled in a Draft Final Report that was submitted at the end of February 2006.

The Draft Final Report was then reviewed by RDA and JICA till 20th March 2006, and comments submitted to the Study Team so the appropriate amendments could be made. That is, by incorporating the comments on the Draft Final Report a Final Report was prepared and submitted on 26th May 2006.

### 1.5.2 Project Milestones

The milestones of the Project are as follows:

| Date | Event |
|---|---|
| 13 to 23 March 2005 | Visit to Sri Lanka by JICA Preparatory Study Team, Negotiations with Government of Sri Lanka, and Field Trip to Project areas |
| 21 March 2005 | Signing of Scope of Work and Minutes of Meeting for Project between JICA and Sri Lankan Ministry of Highways |
| 11 April 2005 | Submission of Inception Report to RDA |
| 19 May 2005 | Transmittal of Draft Tender Documents for Emergency Recovery Project to JICS |
| 25 May 2005 | Briefing on Progress Report to RDA |
| 27 May 2005 | Briefing on Progress Report to JICA |
| 30 May 2005 | Submission of Progress Report to RDA and JICA |
| 8 July 2005 | Tenders Opened for Emergency Recovery Project by JICS |
| 19 July 2005 | Submission of Tender Evaluation Report for Emergency Recovery Project to JICA |
| 28 July to 9 August 2005 | Participation in Discussions with JBIC Fact-finding Mission |
| 3 August 2005 | Amendment of Contract for Project Consultancy Services due to Addition of New Kallady Bridge to Project Scope of Work |
| 1 September 2005 | Briefing on Intermediate Outcomes for the Rehabilitation Project to JICA |
| 5 September 2005 | Briefing to RDA on Intermediate Outcomes for the Rehabilitation Project, which resulted in agreement except for the cost estimation |

| | |
|---|---|
| 9 to 29 September 2005 | Intermittent Negotiations with RDA on Cost Estimate for Project Road, with an Agreement Reached after Adjustments to Pavement Design Policy |
| 28 September 2005 | Participation in Discussions with JICA and JBIC Fact-finding Mission |
| 10 October 2005 | Briefing on and Agreement with RDA on Intermediate Outcomes of the Rehabilitation Project for the New Kallady Bridge |
| 12 October 2005 | Briefing to JICA on Intermediate Outcomes of the Rehabilitation Project for the New Kallady Bridge |
| 1 November 2005 | Participation in Discussions with JICA and JBIC Appraisal Mission |
| 25 November 2005 | Briefing on Interim Report to RDA |
| 28 November 2005 | Briefing on Interim Report to JICA |
| 29 November 2005 | Submission of Interim Report to RDA and JICA |
| 22 February 2006 | Briefing on Draft Final Report to RDA |
| 24 February 2006 | Briefing on Draft Final Report to JICA |
| 27 February 2006 | Submission of Draft Final Report to RDA and JICA |
| 20 March 2006 | Deadline for Receiving Comments on Draft Final Report |
| 26 May 2006 | Submission of Final Report to RDA and JICA |

# *CHAPTER 2*

## *Overview of Project Area*

# Chapter 2 Overview of Project Area

## 2.1 Overall Socioeconomic Situations and Road Profile of Sri Lanka

### 2.1.1 Socioeconomic Profile of Sri Lanka

Since gaining independence in 1948 after 150 years of rule by the British monarchy, politics have been relatively democratic in character, and local, parliamentary and presidential elections have been held since independence that have resulted in smooth transitions of power. However, twenty-two years of ethnic war centered in the Northern and Eastern Provinces has imposed a large drain on the Government's financial resources, as a significant proportion of the annual national budget is consumed by military expenditures; thus, starving development-oriented economic, social and infrastructure sectors of very valuable resources.

#### 1) The Economy

Despite the two decades of ethnic conflict, Sri Lanka's economy has grown steadily since liberalization began in 1978, with the rate of growth reaching 5.3% in 2003 and an estimated 5.4% in 2004. For the first time in Sri Lanka's history, per capita income exceeded $1,000 in 2004. Many would argue that the benefits of this growth had not percolated widely enough to reach all segments of the population. With more than 70% of the population engaged in agriculture, growth appears to have been concentrated in urban areas, especially in the industrial and service sectors and therefore poverty still persists. About 20% - 25% of the population is considered to be living below the poverty line, and while much of this poverty is in rural areas, there is also severe urban poverty. Note that the annual inflation rate is about 12.3%, and unemployment, which is officially estimated at around 14%, may be as high as 35%-40% if underemployment is included.

#### 2) The Development Challenge

Sri Lanka has an ethnically diverse population of 19.2 million (identical in size to Australia's population and almost double that of the Tohoku region in Japan) residing in an area of about 65,600 sq.km (about the size of Tasmania in Australia or the Tohoku region of Japan). Population growth has averaged around a low 1.2% over the past few decades. However, due to the harsh climatic conditions and the low levels of development investment in the north, north-central and the eastern regions of the country, the population has tended to concentrate heavily towards the south, south central and south western regions.

Sri Lanka combines good human and natural resources with comparatively impressive social indicators. Life expectancy is high for a developing country, and about 87% of the population is literate. However, wide disparities exist in socioeconomic status and access to employment opportunities. One of the most serious social problems is extremely poor maternal and child nutrition, with stunting and wasting of children being more prevalent in the rural areas. The GOSL has placed a high priority on poverty alleviation. The country's natural resource base is rapidly being eroded, endangering health as well as livelihoods in agriculture, industry and tourism.

Sri Lanka ranks relatively high in terms of HDI (UNDP’s Human Development Index), especially among countries with similar levels of economies and could be considered a responsive, sustainable development partner. However, its track record as a high-level performer in development is relatively short, and while progress has been good, it is also fragile. Sustainability, particularly in the context of unresolved ethnic conflicts, will depend significantly on social and political stability, continued policy reform, environmental protection and conservation.

### 2.1.2 Road Profile of Sri Lanka

There exists about 99 thousand km of road in total in Sri Lanka. Of this, about 27,100 km is classified and is under the jurisdiction of RDA, the Provincial Councils, and the Local Authorities. The classified road network, which represents the country’s core network, is grouped into five classes and is described below.

A Class: Trunk roads that connect the national capital with district capitals, district capitals with one another, and other major roads that are paved and bitumen-surfaced with a carriageway width of over 7.32m and a crest width of over 11.0m.

B Class: Main roads that connect important towns to district capitals and provide links to A Class roads. B Class roads are paved and bitumen-surfaced and have a carriageway width between 3.66m to 7.32m.

C Class: Minor roads such as agricultural and local roads that usually have a single lane with a carriageway width of 3.66m and a crest width of 5.49 m and are generally paved and bitumen-surfaced.

D Class: Graveled roads having a 2.44m to 3.05m wide graveled surface and which are generally passable during dry weather only.

E Class: Unpaved paths generally not motorable except for jeeps.

RDA is in charge of maintaining and improving important national roads (or Class A and B roads) totaling about 12,000km as shown in Figure 2.1.1. The nine Provincial Councils, on the other hand, are responsible for Class C and D roads that total about 13,400km, while the Local Authorities supervise Class E roads (approx. 1,700km) that make up the remainder of the classified road network. In addition to the classified network there is the much larger unclassified road network, which totals about 72,000km The total length of each type of road and the responsible agency are summarized in Table 2.1.1.

**Table 2.1.1. Roads in Sri Lanka**

| Responsible Authority | Class | Total Length (km) | | Remarks |
|---|---|---|---|---|
| RDA | A | 4,339 | 12,009 | Classified road network totals 27,154km. |
| | B | 7,670 | | |
| Provincial Councils | C | 7,682 | 13,445 | |
| | D | 5,763 | | |
| Local Authorities | E | 1,700 | 1,700 | |
| Local & Other Authorities | | | 71,646 | Municipal/Urban Councils<br>Local Authorities<br>Mahaweli Authority,<br>Irrigation Department,<br>Dept. of Wild Life, and<br>Dept. of Land Development |
| Total | | | 98,800 | |

Sources: Economic and Social Statistics of Sri Lanka, Central Bank of Sri Lanka, 2003. UN Economic and Social Commission for Asia and the Pacific, Asian Highway Handbook, 2003

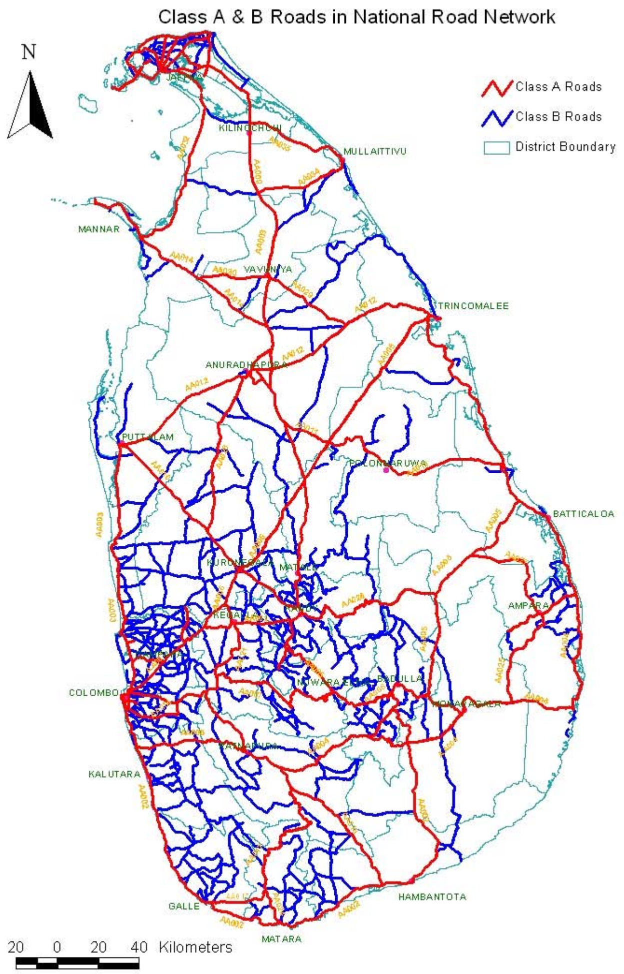



**Figure 2.1.1. Trunk Road Network in Sri Lanka**

## 2.2 Natural Conditions of Project Area

### 1) Definition of Project Area

In this report, the Project area is defined as the Batticaloa and Ampara Districts of Eastern Province. Natural conditions of the northeastern and eastern parts of the country covering the Project area, such as topography, geology, climate, ecology, and land use and settlement patterns, are briefly described below.

### 2) Topography

Extensive faulting and erosion over time have produced a wide range of topographic features, making Sri Lanka one of the most scenic places in the world. Three zones are distinguishable by elevation: the Central Highlands, the plains, and the coastal belt.

A coastal belt about 30 meters above sea level surrounds the island. Much of the coast consists of scenic sandy beaches indented by coastal lagoons. In the northeast and east where the Project area is located, as well as in the southwest, the coast cuts across a stratum of crystalline rock, creating rocky cliffs, bays, and offshore islands. These conditions have provided one of the world's best natural harbors at Trincomalee.

On the basis of elevation and landform, Sri Lanka can be roughly divided into six topographical regions as follows:

- Central Highlands
- Southwest country
- East and Southeast country
- Uplifted belt of lowland, upland and highland along the axis of maximum uplift
- Northern lowlands
- Coastal fringe consisting of lagoons, marshes sand bars, spits, peninsulas, dunes, islands and other associated features

The Project area belongs to the East and Southeast country in this classification. The East and Southeast country is a rolling or undulating plain dotted with isolated hills with somewhat flat tops (e.g., Monaragala and Kataragama).

Rivers in Sri Lanka, which are mostly short in length, originate in the Central Highlands and flow in a radial pattern towards the sea. The longest river is the Mahaweli Ganga (335 km) which passes through the plain and coastal belt of Eastern Province. Once they reach the plain, the rivers slow down and meander across flood plains and deltas. In the north, east, and southwest the rivers feed numerous artificial lakes and reservoirs that store water during the dry season. During the 1970s and 1980s, large-scale projects dammed the Mahaweli Ganga and neighboring streams to create large lakes.

### 3) Geology

More than 90 percent of Sri Lanka's surface lies on Precambrian strata, some of it dating back two billion years. The metamorphic rock surface was created by the transformation of ancient sediments under intense heat and pressure during mountain-building processes. Aside from recent deposits along river valleys, the island contains relatively limited strata of sedimentation surrounding its ancient hills. These general geological conditions seem to apply to the Project area and the East and Southeast country is classified as the Vijayan Complex, consisting of hornblende and biotite-bearing orthogneisses and granitoids with inclusions of metaquarrtzite and calc-silicate rocks (*Atlas of Sri Lanka, 1997*).

### 4) Climate

Sri Lanka's position between 5 and 10 north latitude endows it with a warm climate, moderated by ocean winds and considerable moisture. The average yearly temperature for the whole country ranges around 26˚ to 28˚C, but the mean temperature in Trincomalee is 29˚C, the highest of the country. The coolest month is January and the hottest is May.

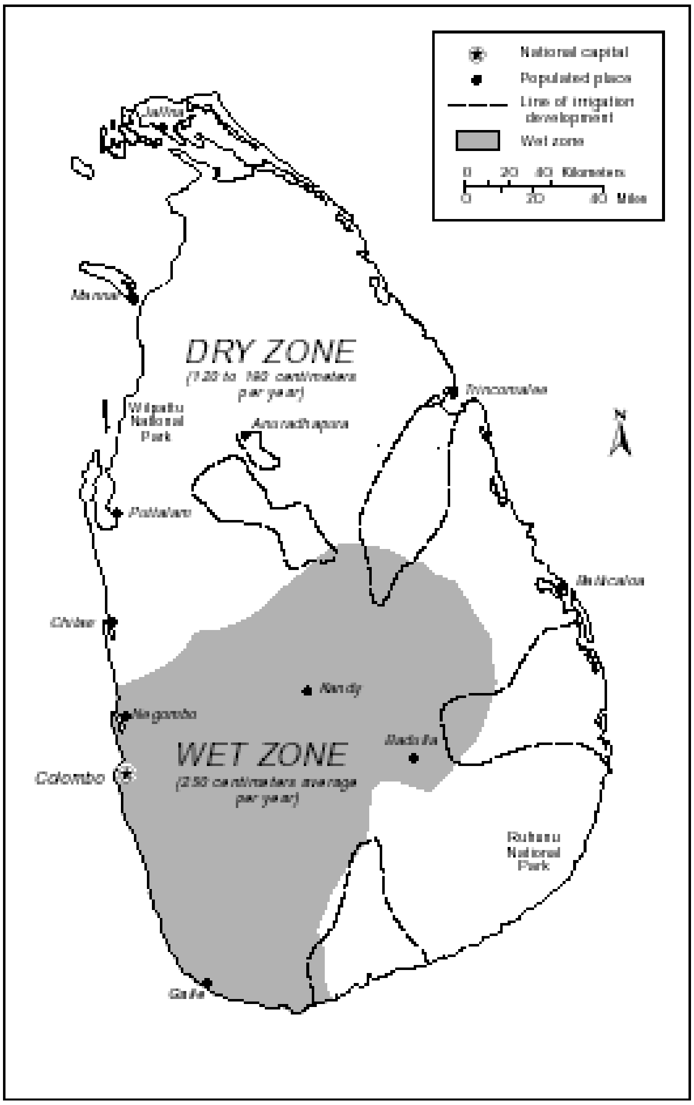
The rainfall pattern is influenced by the monsoon winds of the Indian Ocean and Bay of Bengal and is marked by four seasons. From mid-May to October, when winds come from the southwest bringing moisture from the Indian Ocean, the leeward slopes of the Central Highland in the east and northeast receive little rain. From December to March monsoon winds come from the northeast with moisture from the Bay of Bengal and the northeastern slopes of the mountains may be inundated with up to 1,250 mm of rain during these months. During the two inter-monsoonal periods, winds are light and variable, but periodic squalls, tropical cyclones, or evening thundershowers occur sometimes.

Humidity is typically lower in the northeast and east areas, though this is dependent on the seasonal patterns of rainfall.

### 5) Ecology

The pattern of life in Sri Lanka depends directly on the availability of rainwater. Most of the southeastern, eastern, and northern parts of the country comprise the "dry zone," which receives rain between 1,200 and 1,900 mm annually. (In the "wet zone," the mountains and the southwestern part of the country, the annual average rainfall is 2,500 mm.) Much of the rain in these areas falls from October to January, and during the rest of the year there is little precipitation and all living creatures must conserve precious moisture.

The natural vegetation of the dry zone is adapted to the annual changes from flooding to drought. The typical ground cover is scrub forest, interspersed with bushes and cactuses in the driest areas. Plants grow very fast from November to February when rainfall is heavy, but stop growing during the hot season from March to August. When water is absent, the plains of the dry zone are dominated by browns and grays. When water becomes available, either during the wet season or through proximity to rivers and lakes, the vegetation explodes into shades of green with a wide variety of beautiful flowers.




Source: US Library of Congress

**Figure 2.2.1. Precipitation and Irrigation of Sri Lanka**

## 6) Land Use & Settlement Patterns

In the 1970s and 1980s, the wet cultivation area was expanding rapidly, as the Government implemented large-scale irrigation projects to restore the dry zone to agricultural productivity. In the 1980s, the area drained by the Mahaweli Ganga changed from a sparsely inhabited region to a wet rice area similar to the southwest.

The coastal belt surrounding the island contains a settlement pattern that has evolved from older fishing villages. Separate fishing settlements expanded laterally along the coast, linked by a coastal highway and a railway. The mobility of the coastal population during colonial times and after independence led to an increase in the size and number of villages, as well as to the development of growing urban centers with outside contacts.

## 2.3 Environmental Characteristics of Project Area

At present the total forest area of the country is around 2.0 million ha. Out of this, in the Project related districts, some types of forests are found as Table 2.3.1.

**Table 2.3.1. Forest types in the Eastern Province (ha)**

| District | Moist monsoon | Dry monsoon | Riverine Dry | Mangrove | Sparse |
|---|---|---|---|---|---|
| Trincomalee | 4 | 110,491 | 1,826 | 1,491 | 17,629 |
| Batticaloa | 13,302 | 21,770 | - | 1,421 | 16,325 |
| Ampara | 45,190 | 69,265 | 10,160 | 292 | 41,760 |

Source: Atlas of Sri Lanka, 1997

Note that both of the moist monsoon forest and dry monsoon forest are distributed inland and only sparse and open forests are found along the Project route, which runs along a coastal area. The diversity of Sri Lanka's fauna is both rich and unique. Within the confines of this island of 65,525 sq.km are found 628 species of terrestrial vertebrates, while its inland and territorial waters have over 1,000 species of freshwater and marine fish. In the Eastern Province, there are several wild reserves as Shown in Table 2.3.2.

**Table 2.3.2. Wild Reserves in Eastern Province**

| District | Wild Reserve | Areas(ha) |
|---|---|---|
| Trincomalee | Kokilai Sanctuary | The whole lagoon |
| | Sober Islands Sanctuary | 71.0 |
| | Naval Headworks Sanctuary | 18,130.0 |
| | Seruwavila Sanctuary | 15,540.0 |
| Batticaloa | Somawathiya Chaitiya National Park | 37,762.2 |
| Ampara | Maduru Oya National Park | 58,849.8 |
| | Gal Oya National Park | 25,900.0 |

Source: Atlas of Sri Lanka, 1997
*: Gal Oya National Park is located approx. 20km west of the Project road (Rt.4).

## 2.4 Road Profile of Project Area

As mentioned above, the classified road network, which consists of roads categorized from Class A to E, is approximately 27,100 km in length. The Project area's Eastern Province, which has a land area of 9,361 $km^2$ (or 14.9 % of the national total) and a population of 1,518 thousand (or 7.9% of the national total), has a classified road network of 2,847 km, which is 10.5% of the national total (see Table 2.4.1 and Figure 2.4.1). These numbers seem to indicate no distinctive quantitative bias, but observations of the current status of the road network (e.g., road width, alignment, pavement, structures, drainage, etc.) suggest that the quality of roads in Eastern Province is relatively low.

**Table 2.4.1. Road Profile of Eastern Province**

| | Area in $km^2$ | Population in '000 | Road Length, in km | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | Total |
| National Total | 62,705 | 19,252 | 4,339 | 7,670 | 7,682 | 5,763 | 1,700 | 27,154 |
| Eastern Province | 9,361 | 1,518 | 620 | 527 | 556 | 1,003 | 141 | 2,847 |
| | 14.9% | 7.9% | 14.3% | 6.9% | 7.2% | 17.4% | 8.3% | 10.5% |

Sources: Central Bank of Sri Lanka 2003, UN Economic and Social Commission for Asia and the Pacific, Asian Highway Handbook, 2003

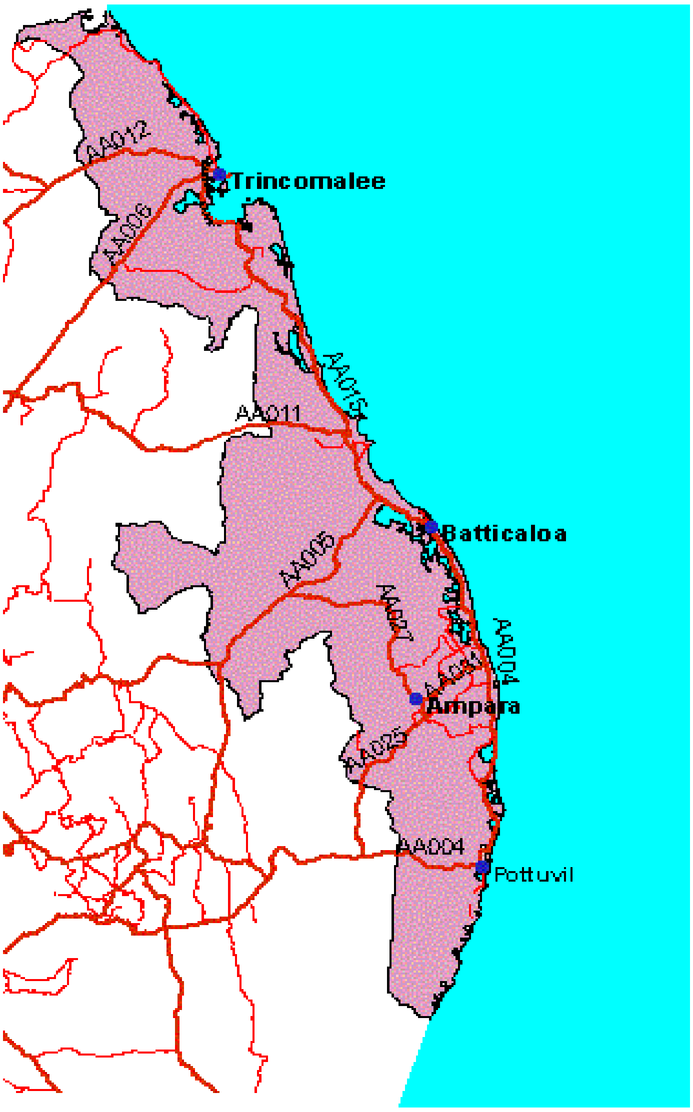



**Figure 2.4.1. Trunk Roads in Project Area**

Taking a look at the motor vehicle registration statistics shown in Table 2.4.2, the number of registered vehicles is obviously low for Eastern Province for all vehicle types except for land vehicles (agricultural and construction vehicles), given the relative size of the population or land area. The fact that the ownership of land vehicles is comparatively high in this region illustrates why this region and its road system are less developed.

**Table 2.4.2. Motor Vehicle Registration in Eastern Province**

| | National Total | Eastern Province | |
|---|---|---|---|
| | Vehicles | Vehicles | % of Nat. Total |
| Omnibuses | 14,633 | 431 | 2.9 % |
| Private Coaches | 17,556 | 468 | 2.7 % |
| Dual Purpose Vehicles | 137,144 | 1,967 | 1.7 % |
| Private Cars | 160,242 | 1,631 | 1.0 % |
| Land Vehicles | 58,974 | 5,929 | 10.0 % |
| Good Transport Vehicles | 127,585 | 2,549 | 2.0 % |
| Motor Cycles & Three Wheelers | 723,271 | 41,524 | 5.7 % |
| Others | 9,716 | 193 | 2.0 % |
| Total | 1,249,121 | 54,692 | 4.4 % |

As of 2003, Source: Central Bank of Sri Lanka

## 2.5 Pre-Tsunami Socioeconomic Conditions of Project Area

The Project area is situated in the districts of Ampara and Batticaloa. Unfortunately, the security situation at the time of the last National Census and Statistics Survey of 2001 prevented it from being conducted for the whole of Batticaloa District and some parts of Ampara District. Consequently, no data and information comparable to districts outside the North and East Provinces exist. However, a “Household Income and Expenditure Survey” was conducted in 2002/03 by the Department of Census and Statistics for these provinces. The data from this survey, together with results from some surveys conducted following the tsunami, has been used in developing the socioeconomic profile of the Project area.

Both Ampara and Batticaloa, two coastal districts in Eastern Province (Trincomalee is the other district of this province), have historically had low populations and low levels of development investment. From various surveys prior to the tsunami, Batticaloa District is known to have had a population of around 536,000 and Ampara District a population of about 605,000 (2003), which are approximately 3.0% and 3.2% of the total population of Sri Lanka. As for the ethnic breakdown of these two districts, this has been somewhat difficult to assess due to the 2001 census survey not being conducted. However, in 1981, Batticaloa District had an ethnic mix of 72% Tamils, 24% Muslims and 3% Sinhalese, while Ampara had an ethnic composition of 20% Tamils, 42% Muslims and 38% Sinhalese. Ampara’s composition seems to have slightly changed according to the partial results of the 2001 census, which indicates a breakdown of 19% Tamils, 42% Muslims and 39% Sinhalese. As mentioned before, no census was conducted in Batticaloa District in 2001.

Batticaloa has a total land area of 2,610 sq.km and 244 sq.km of inland water, while Ampara has 4,222 sq.km of land and 193 sq.km of water. This would suggest the population densities in these districts are relatively small (205 and 143 persons per sq.km respectively). However, spot densities, particularly in urban areas, are known to be extremely high. For instance, Kalmunai Township, an urban area located very close to the seacoast in Ampara District, is said to have a density of 23,000 persons per sq.km, which explains why this area experienced the biggest impact of the tsunami.

The dominant economic sectors of the Eastern Province are agriculture and fisheries, and, to a lesser but significant extent, services driven by tourism. The Eastern Province's contribution to national GDP has been around 5%, illustrating its underdeveloped state. Those engaged in agriculture mostly grow rice and vegetables, while coconut plantations and naturally growing palmyra and cashew are found along the coast. With a significant number of inland water bodies in the two districts, inland fishing is common, while those living along the coastal belt engage in off-shore fishing, which has been severely affected in the past few years by Government imposed restrictions due to LTTE naval activities.

The average household income per month for Eastern Province was Rs.7640 (the national average is Rs.12,803 and the average for Western Province is Rs.17,732). More than 50% of the population earns less than Rs.5500 per month, while the average amount spent by a household per month on food is Rs.6327 (the national average is Rs.13,147 and that for Western Province is Rs.18,600), illustrating the poverty level in this province in 2002.

## 2.6 Impact of the Tsunami on the Socioeconomic Conditions of the Project Area

Along the coastline in the Project area, persons and properties in 8 of the 13 DS divisions in Batticaloa and 11 of the 20 divisions in Ampara were severely affected by the tsunami. The overall impact on persons in Batticaloa and Ampara are illustrated in the table below:

**Table 2.6.1. Impact of Tsunami on Persons**

| District | Deaths | Injured | Missing | Displaced Families | Displaced Persons | No. of Refugee Camps |
|---|---|---|---|---|---|---|
| Batticaloa | 2,975 | 2,375 | 340 | 12,494 | 55,935 | 36 |
| Ampara | 10,436 | 6,711 | 161 | 38,002 | 103,949 | 70 |
| Total | 13,411 | 9,086 | 501 | 50,496 | 159,431 | 106 |

From the above table, it is evident that these two districts, particularly the DS divisions around Kalmunai in the Ampara District, which are densely populated, faced the brunt of the tsunami's brutal force. Nowhere else in Sri Lanka has the destruction to lives and property been as severe. Damage to property has had multiple effects. On the one hand, damages to houses, either wholly or partially, have made nearly 160,000 persons in the two districts homeless and asset-less. On the other hand, damage to important service providing institutions such as hospitals and schools has also been severe. The tables below show the extent of the property damage (both residential and non residential) in the two districts.

**Table 2.6.2. Impact of Tsunami on Property (Residential)**

| District | Number of Housing Units in Affected Areas | | | | |
|---|---|---|---|---|---|
| | Before Tsunami[1] | Completely Damaged | Partially Damaged & Unusable | Partially Damaged but Usable | Not Damaged |
| Batticaloa | 26,274 (100%) | 7,445 (28.33%) | 2,460 (9.36%) | 7500 (28.55%) | 8,869 (33.76%) |
| Ampara | 27,339 (100%) | 8,139 (29.77%) | 2,427 (8.89%) | 8,244 (30.15%) | 8,529 (31.20%) |
| Total | 53,613 (100%) | 15,584 (29.07%) | 4,887 (9.12%) | 15,744 (29.37%) | 17398 (32.45%) |

1: Total no. of houses in affected census blocks along coastal area only and NOT for the whole district.

**Table 2.6.3. Impact of Tsunami on Property (Non-Residential)**

| District | Number of Housing Units in Affected Areas | | | | |
|---|---|---|---|---|---|
| | Before Tsunami[1] | Completely Damaged | Partially Damaged & Unusable | Partially Damaged but Usable | Not Damaged |
| Batticaloa | 2,333 (100%) | 525 (22.50%) | 167 (7.12%) | 506 (21.69%) | 1,135 (48.65%) |
| Ampara | 3,200 (100%) | 1,173 (36.66%) | 243 (7.59%) | 683 (21.34%) | 1,101 (34.41%) |
| Total | 5,533 (100%) | 1,698 (30.69%) | 410 (7.41%) | 1,189 (21.49%) | 2,236 (40.41%) |

1: Total no. of buildings (non-residential) in affected census blocks along coastal area only and NOT for the whole district.

The above statistics while describing the total extent of the destruction in the Project area do not necessarily reflect the accurate state of damage at specific locations. For instance, even though the “completely damaged” housing in the affected areas of Batticaloa District amounts to 28.33% of that area’s housing stock, in the DS division of Koralai Pattu North almost 60% of that division’s housing stock was completely damaged and a further 12% was partially damaged and unusable. Similarly in Ampara, where the completely damaged housing accounted for 29.77%, the Kalmunai Muslim Division and the Kalmunai Tamil Division had, respectively, 32% and 44% of their housing completely damaged. The damage in Ampara District appears dispersed across a number of DS divisions, while in Batticaloa it is concentrated in a few.

As for non-residential buildings, the most significant damage was to schools, medical facilities and places of worship. With refugees being accommodated within the premises of schools and places of worship not damaged, these institutions are under great stress.

## 2.7 Tsunami Damage to Road Facilities & Recovery Status in Project Area

According to TAFOR and TAFREN, the tsunami damaged 1,615 km of road in Sri Lanka, including 135 km of RDA road, 300 km of provincial road, and 1,180 km of Local Authority road, as well as 22 bridges in total, including 2, 15 and 6 in the Northern, Eastern and Southern Provinces, respectively. Within two weeks after the disaster, all damaged roads had been temporarily repaired and made passable, and all damaged bridges bypassed with temporary Bailey bridges and made functional. In the Project area's Eastern Province, RDA counted 29 damaged sections/points on trunk roads, with a considerable number of road sections being washed out or damaged and some culverts and bridges being damaged or collapsed (see Table 2.7.1 and Figure 2.7.1). The total cost for emergency repairs and short-term rehabilitation (Stages 1 and 2) of these damaged roads and bridges was estimated at Rs. 434 million.

**Table 2.7.1. Damage to Trunk Roads in Eastern Province**

| No. | Road | Damage | Status | Cost for Stages 1 & 2 (Rs. Mil) |
|---|---|---|---|---|
| 9 | Trincomalee-Pulmoddai Road 22 km - Salappawaru Bridge | Approach (200m) washed off | Repaired | 2 |
| 10 | Beach Road, 1 km | Culvert damaged, Half the carriageway (75m) washed out | Repaired | 2 |
| 11 | A15, 116-121 km | Washed off | Repaired | 30 |
| 11 | A15, 126 km | Half the carriageway (100m) washed out | Repaired | 1 |
| 12 | Thampalakamam-Kinniyai Road, 8 km | Bailey bridge damaged | Repaired | 2 |
| 15 | A04, 334/1 km (Komari Bridge) | Collapsed | Repaired Reh. due | 50 |
| 14 | A04, 362-364 km | Washed out | Repaired | 18 |
| 14 | A04, 375 km | Washed out | Repaired | 6 |
| 14 | A04, 380 km | Washed out | Repaired | 6 |
| 13 | A04, 392 km | Washed out | Repaired | 6 |
| 13 | A04, 393 km | Washed out | Repaired | 6 |
| 13 | A04, 394 km | Damaged | Repaired | 2 |
| 13 | A04, 394/1 km Culvert | Washed out | Repaired | 1 |
| 13 | A04, 394/2 km | Washed out | Repaired | 1 |
| 13 | A04, 395/1 km | Washed out | Repaired | 1 |
| 13 | A04, 396/3 km (Periya Kallar Br/Cw) | Washed out | Repaired Reh. due | 3 |
| 13 | A04, 398/1 km (Koddaia Kallar Br/Cw) | Washed out | Repaired Reh. due | 5 |
| 13 | A04, 409/5 & 410/1 km (Culverts) | Washed out | Repaired | 5 |
| 13 | A04, 412 & 415 km | Carriageway partly damaged | Repaired | 6 |
| 17 | A15, 42/1 km Bridge | Bailey bridge damaged | Repaired | 50 |
| 17 | A15, 46-59 km | Damaged | Repaired | 6 |
| 18 | A15, 59/1 km (Panichchankeni Bridge) | Washed out | Repaired Reh. due | 2 |

| | | | | |
|---|---|---|---|---|
| 19 | A15, 60-78 km | Washed out | Repaired | 54 |
| 20 | Bar Road, 4/2 km Bridge | Washed out | Repaired | 20 |
| 21 | Ditto, 5/2 km Bridge | Damaged | Repaired | 20 |
| 21 | Ditto, 3-5 km | Damaged | Repaired | 9 |
| 22 | Pottuvil-Panama Road, 1-3 km | Washed out | Repaired | 50 |
| 23 | Ditto, Bridge No 3/4 (Arugam Bay) | Damaged | Repaired Reh. Due | 10 |
| 33 | Peradeniya-Badulla-Chenkaladi Road, 282/2 km Bridge | Damaged | Repaired Reh. Due | 60 |
| | Total | | | 434 |

Source: RDA

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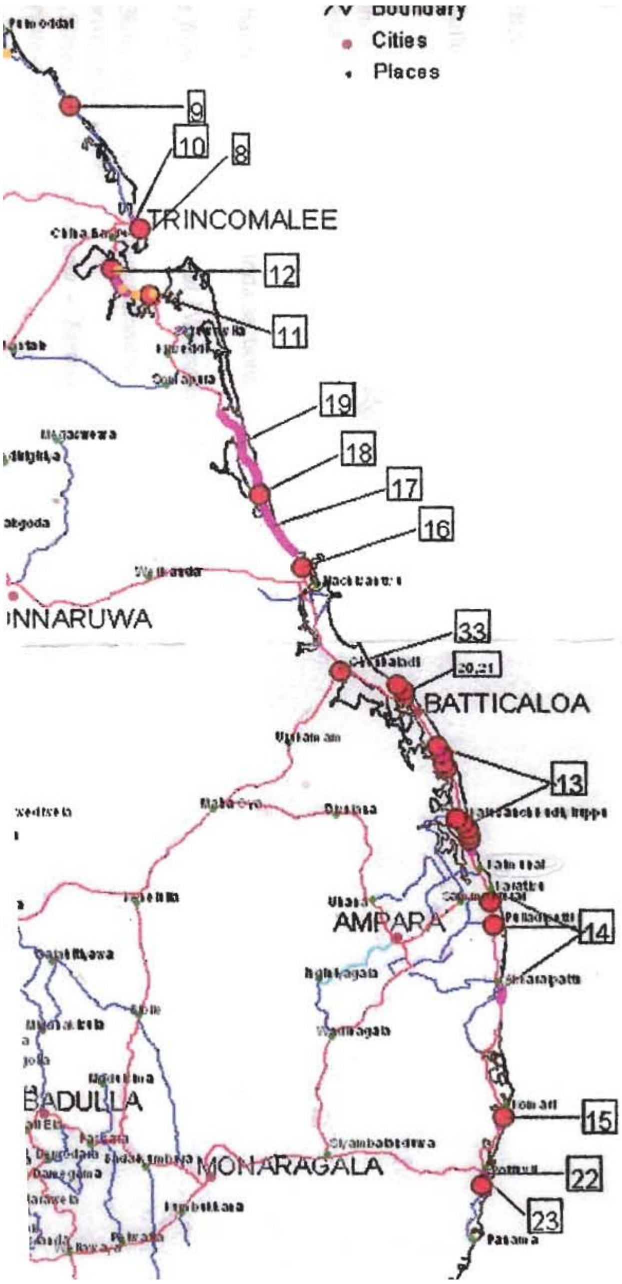



**Figure 2.7.1. Locations of Road Damage in Eastern Province**

# *PART 2*
# *EMERGENCY RECOVERY PROJECT*

# *CHAPTER 3*

## Overview of Emergency Recovery Project

# Chapter 3 Overview of Emergency Recovery Project

## 3.1 Selected Road Facilities for Emergency Recovery

### 3.1.1 Overview of Site Conditions for Emergency Recovery

The selected road facilities for the Emergency Recovery Project are the following four causeways on AA004 and AA015, which were heavily damaged by the last tsunami:

- Komari Causeway at Km 334/2 on AA004
- Periya Kallar Causeway at km 396/3 on AA004
- Koddaia Kallar Causeway at km398/1 on AA004
- Panichchankeni Causeway at km59/1 on AA015

The above causeways were either damaged or washed out by the tsunami and temporary Bailey bridges constructed as part of the emergency work. As the existing road width of causeways was around 5.4m, trucks and buses often waited in line in order to pass. In addition, pedestrians, bicycles, motorcycles and three wheelers worsened traffic congestion on the Periya Kallar and Koddaia Kallar Causeways, which are located near a town.

### 3.1.2 Present Conditions of Selected Roads for Emergency Recovery

#### 1) Topographic Conditions

The physical conditions of the causeways are as described Table 3.1.1.

**Table 3.1.1. Topographic Conditions for each Site**

| Causeway | Topography |
|---|---|
| Komari | • The lagoon is located on the landside of the causeway.<br>• The bridge and the causeway cross a narrow section of the lagoon, about 150m away from the sea.<br>• The opening of the bridge and the length of the causeway were 35m and 54m, respectively. |
| Periya Kallar | • The lagoon is located on the landside of the causeway and interconnected with the landside lagoon of Koddaia Kallar causeway.<br>• The bridge and the causeway are at a narrow section of the lagoon, about 400m and in width 1.5km away from the sand bar and lagoon mouth.<br>• The opening of the bridge/culverts and the length of the causeway are 104m and 630m, respectively. |
| Koddaia Kallar | • The lagoon is located on the landside of the causeway.<br>• The bridge and the causeway are at a narrow section of the lagoon, about 400m away from the sand bar at the seashore. |

| | |
|---|---|
| | • The opening of the bridge and the length of the causeway were 11.8m and 450m, respectively.<br>• The lagoons of Periya Kallar and of Koddaia Kallar are interconnected.<br>• The average sand bar height from high tide level is more than 2m and no flow discharge to sea. |
| Panichchankeni | • The bridge and the causeway are at a narrow section of the lagoon about 6km away from the lagoon mouth and divide the lagoon into two parts.<br>• The opening of the bridge is 32m in total length with 28 pipes of 1.5m in diameter, and the length of the causeway is 210m. |

## 2) Causeway Damage & Status of Emergency Repair Work

### a) Komari Causeway

The total length of this causeway was about 80m, which was completely washed away by the tsunami. The emergency repair work for this causeway consisted of constructing a 48.5m embankment section with a 4m wide gabion mat, together with a gabion mat for the substructure and a Bailey bridge for the superstructure of a 33m long bridge section, for a total length of 81.5m. This work secured the minimum requirements necessary for the safe passage of traffic.

### b) Periya Kallar Causeway

The total length of this causeway was about 700m, and of this approximately 630m included a retaining wall. A 120m section extending from the center of the structure to the north, which included an opening, was either washed away or badly damaged. In addition, parts of a 360m long area of the southern side were destroyed as well. Emergency repairs were carried out and consisted of providing a temporary embankment for the destroyed sections of the causeway that was consistent with its original width of 5.3m; thereby, securing a safe passageway for traffic.

### c) Kodaia Kallar Causeway

The total length of this causeway was about 490m and of this a 13m section with a retaining wall was completely washed away on the northern side. Moreover, 160m of the southern side having a retaining wall had its shoulder portion damaged. Emergency repair work consisted of using a 4.0m wide gabion mat for the substructure and a Bailey Bridge for the superstructure for the washed out section to secure a passageway for traffic. As for the southern side, the damaged portions of shoulder were repaired to ensure safety.

### d) Panichchankeni Causeway

The total length of this causeway is about 280m and of this there is a 66m long center bridge section with 6 spans, with the superstructure of 1 span on the southern side and the superstructure of 2 spans and a bridge pier on the northern side completely washed away. In addition, there is one bridge pier that was not washed away but that was tilted to the side, and as a result it is impossible to use the superstructure on that section. Emergency repair work consisted of using a gabion mat for the substructure and a Bailey Bridge for the superstructure in order to secure passage for traffic.

## 3.2 Natural Condition Survey for Emergency Recovery

### 3.2.1 Topographic Survey

### 1) Scope of Work

A topographic survey has been conducted to assess existing topographic conditions for the four tsunami affected causeways. The work items are as follows:

- Establishment of Benchmarks
- Plan survey
- Centerline survey
- Cross-section survey

### 2) Establishment of Benchmarks

The above surveys are not related to the Sri Lanka national grid or mean sea level datum. Due to the urgency of the work, survey measurements applied arbitrary co-ordinates for each site, and site co-ordinate values are independent of each other. Elevations also applied arbitrary datum whose assumed value was 50.000m. Benchmark coordinates based on this methodology are as shown in table 3.2.1.

**Table 3.2.1. Benchmark Coordinates for each Site**

| Causeway | Benchmark No. | North | East | Elevation |
|---|---|---|---|---|
| Komari | BM-1 | 1003.734 | 1983.022 | 50.000 |
| | BM-2 | 860.635 | 2025.369 | 49.566 |
| Periya Kallar | BM-1 | 2315.005 | 2965.503 | 50.000 |
| | BM-2 | 2241.886 | 2963.202 | 48.774 |
| | BM-3 | 1635.975 | 3044.659 | 49.508 |
| | BM-4 | 1608.495 | 3041.606 | 50.497 |
| Koddaia Kallar | BM-1 | 2180.826 | 2925.207 | 50.000 |
| | BM-1A | 2215.850 | 2895.358 | 51.052 |
| | BM-2 | 1613.965 | 3039.333 | 49.569 |
| | BM-2A | 1553.455 | 3048.258 | 50.236 |
| Panichchankeni | BM-1 | 1000.000 | 2000.000 | 50.000 |
| | BM-2 | 996.040 | 1641.619 | 49.525 |

### 3) Plan Survey

The plan survey has been conducted using the Total Station.

| Name of Causeway | Location | Length | Area of Survey |
|---|---|---|---|
| Komari | AA004 - 333km-P | App. 81m | 290m x 50m |
| Periya Kallar | AA004 - 397km-P | App. 700m | 900m x 50m |
| Koddaia Kallar | AA004 - 399km-P | App. 489m | 700m x 50m |
| Panichichankeni | AA015 - 56km-P | App. 277m | 280m x 50m |

### 4) Centerline Survey

This survey has been carried out in order to stake out pegs at about 20m interval stations, and principal points on the centerline are in accordance with benchmark coordinates in order to confirm the horizontal alignment of the existing centerline of causeways.

### 5) Cross-Section Survey

The measurement of cross-sections is done using the Total Station for either land or underwater based on the elevation of points at approximately 100m intervals for the existing road centerline. The measuring width is 20m from the centerline on either side (for a total of 40m).

## 3.2.2 Geological Survey

### 1) Scope of Work

A geological survey has been conducted to confirm the bearing layer (standard penetration test only) and performed in conformance with the latest international standards, such as the British Standard (BS), American Society for Testing and Materials (ASTM) and American Association of State Highway and Transportation Officials (AASHTO). Standard penetration test (SPT) equipment and procedures are in accordance with ASTM D 1586 and the drive hammer employed an automatic trip mechanism to ensure free fall. This survey was separated into the following two steps:

**a) 1st Geological Survey**

Field investigation consists of eleven boreholes at appropriate locations:

**Table 3.2.2. Number of Boreholes for 1st Survey**

| Bridge / Causeway | Trunk Road | No. of Borehole | Borehole Demarcation |
|---|---|---|---|
| Komari | AA004 | 2 | BH-1, BH-2 |
| Periya Kallar | AA004 | 4 | BH-1, BH2, BH-3, BH-4 |
| Koddaia Kallr | AA004 | 2 | BH-1, BH-2 |
| Panichchankeni | AA015 | 3 | BH-1, BH-2, BH-3 |

**b) 2nd Geological Survey**

The 2nd geological survey conducted boring at three underwater sites at the expected main bridge or culvert places for the Komari, Koddaia Kallar and Panichchankeni causeways.

**Table 3.2.3. Number of Boreholes for 2nd Survey**

| Causeway | Trunk Road | No. of Borehole | Borehole Demarcation |
|---|---|---|---|
| Komari | AA004 | 1 | BH – 03 |
| Koddaia Kallr | AA004 | 1 | BH – 03 |
| Panichchankeni | AA015 | 1 | BH – 04 |

## 2) Standard Penetration Test (SPT)

The SPT is the major determining factor for subsoil assessment via borehole investigation. In according with specifications, the SPT was conducted at each borehole at 1.0 m intervals.

## 3) Geological Conditions (on the basis of SPT only)

The summary of the geological survey on the basis of the SPT and core sampling is as follows:

**Table 3.2.4. Summary of Analysis for SPT**

| Causeway | Riverbed layer | Bearing layer | Test Boring |
|---|---|---|---|
| Komari | • Top 0~2m layer is silty sand<br>• 2nd layer is completely weathered rock (sand) layer; N-value is more than 50 | • 3rd layer is gneissic basement rock<br>- Depth: GL-3-5m~<br>- RQD: 23~86%<br>- Compressive strength:<br>Weathered rock at BH-3<br>Depth: 3.4-3.56m<br>$20N/mm^2$<br>Fresh rock at BH-3<br>Depth: 5.0-5.15m<br>$68N/mm^2$ | • BH-1 Onshore<br>• BH-2 Onshore<br>• BH-3 Offshore at existing Bridge |
| Periya Kallar | • Top layer is mostly sandy soil or sandstone layer | • Highly weathered rock in sand or silty sand layer | • BH-1 Onshore<br>• BH-2 Onshore |

| | | | |
|---|---|---|---|
| | - Depth: from GL-0-1.5m~<br>- Thickness: 3~4m<br>- RQD: 23~73% | - Area: GL-5~15m<br>- N-Value: 2~50<br>- Area: GL-15m~<br>- N-Value: More than 50 | • BH-3 Onshore<br>• BH-4 Onshore |
| Koddaia Kallar | • Top layer is mostly sandstone layer<br>- Depth: GL-0-5m~<br>- Thickness: 1.5~3m<br>- RQD: 18~100%<br>- Compressive strength: Sandstone at BH-1 Depth: 0.05-0.2m 25 MPa | • Highly weathered rock in sand or silty sand layer<br>- Area: GL-3~15m<br>- N-Value: 4~50<br>- Area: GL-15m~<br>- N-Value: More than 50 | • BH-1 Onshore<br>• BH-2 Onshore<br>• BH-3 Offshore at existing Bridge |
| Panichchankeni | • Top layer is sand layer<br>- N-value: 2~50<br>- Thickness of the layer is at 0~6m depth from the ground/riverbed level | • Highly weathered and decomposed rock<br>- Depth: GL-3-7m~<br>- N-Value: More than 50<br>• Basement rock layer was not encountered at maximum depth of boring 12m | • BH-1 Onshore<br>• BH-2 Onshore<br>• BH-3 Onshore<br>• BH-4 Offshore at existing Bridge |

### 3.2.3 Hydrological Survey

#### 1) Hydrological Field Survey

The Project area experiences heavy rainfall during the Northeast Monsoon Season from November to February. The monthly average rainfall distribution in Batticaloa for the last 30 years is as shown in Fig.3.2.1. Because of the excessive and intense rainfall, the water levels of lagoons rise rapidly during December, inundating surrounding areas and flooding the causeways that consequently obstructs vehicle flows. However, owing to the recent raising of causeway elevation, flooding occurs now only once every 3 to 4 years. Note that sandbars at the mouths of lagoons obstruct flow discharges to the sea and increase the extent of inundation.

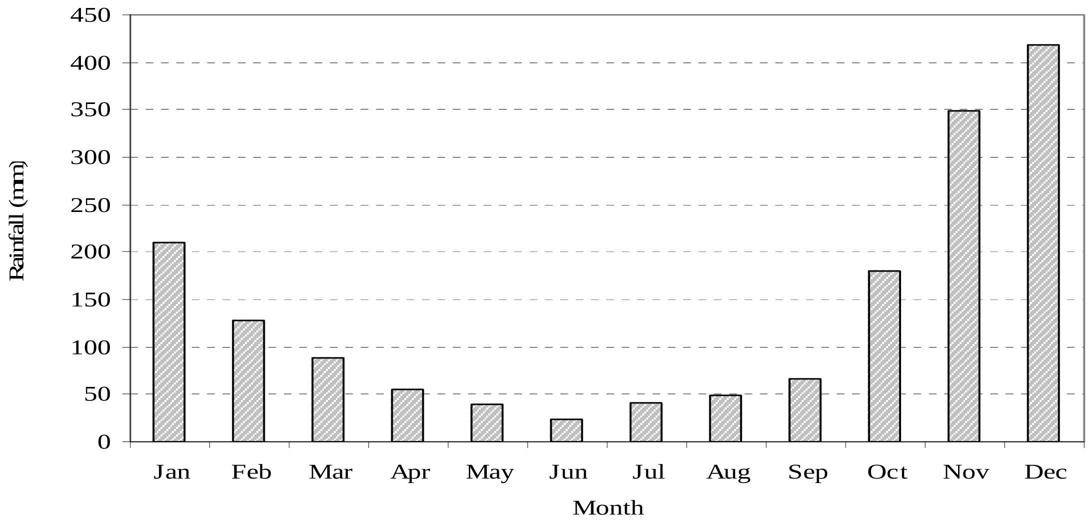



**Figure 3.2.1. Monthly Average Rainfall in Batticaloa for Last 30 years**

## 2) Hydrological/Hydraulic Analysis

The design discharge hydrographs of the sub-catchment areas for the 50-year return period were determined by applying the HEC-HMS hydrological model developed by the Hydrologic Engineering Center. A detailed hydraulic analysis was carried out to determine the water levels and the required bridge openings. Figure 3.2.2 illustrates water level variation over time under two conditions, for sandbar elevations 1m and 0.5m above the high tide water level.

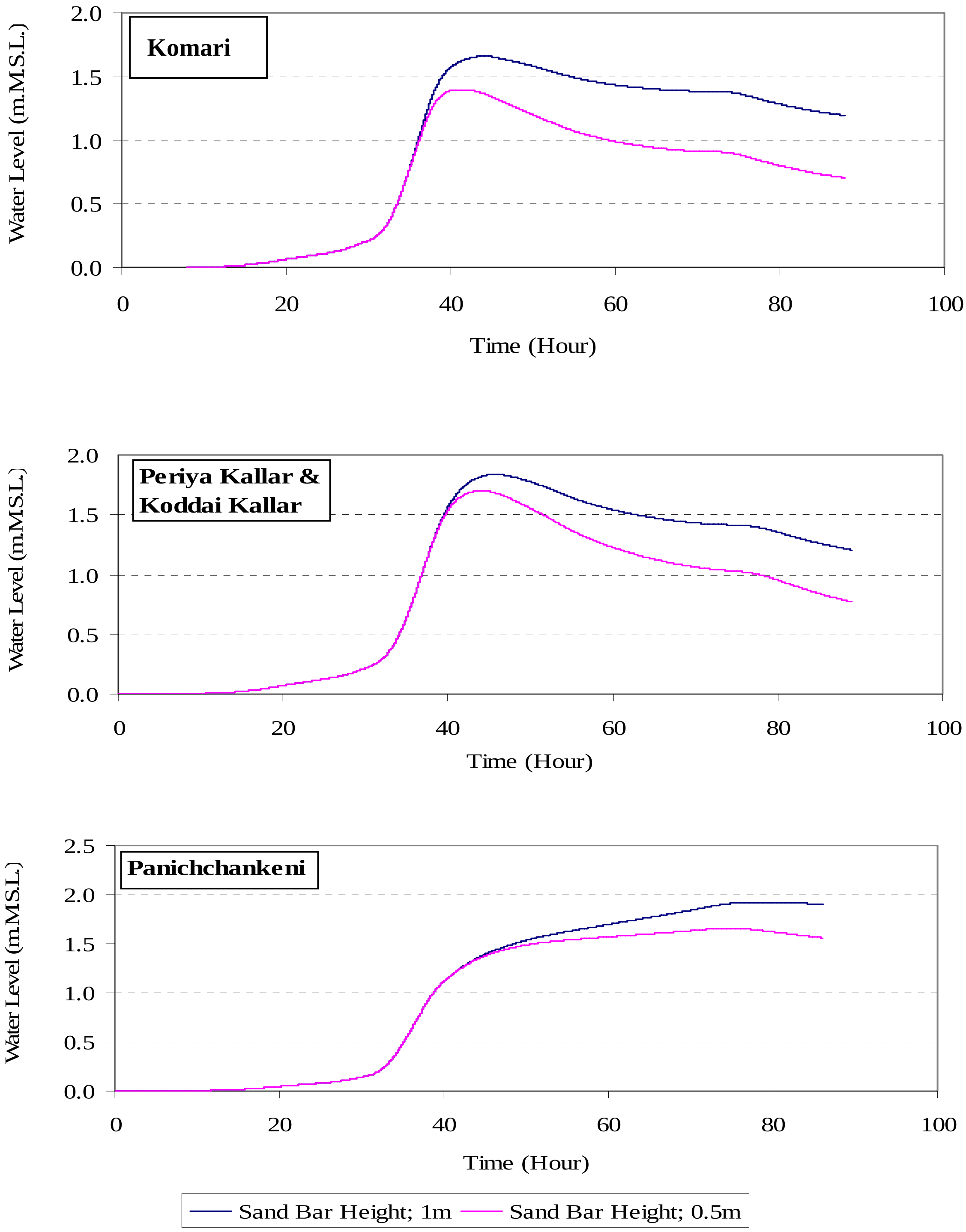



**Figure 3.2.2. Water Level Variation Over Time with New Openings**

In the case of a sandbar being 0.5m above the high tide water level, there is a sharp drop in the water level as compared with that of the 1m high sandbar. For design purposes, the dimensions determined under the 1m high sandbar are recommended, as they are representative of actual conditions. However, according to the results of the analysis, it is clear that if the sandbars are dredged before the rainy season, flooding levels can be reduced.

### 3) Design High Water Levels

After considering the hydrological and structural conditions, as well as taking into account pre-tsunami bridge/culvert lengths, the total opening lengths given in Table 3.2.5 are selected as appropriate design dimensions.

**Table 3.2.5. Design High Water Levels at Four Causeways**

| Description | Bridge / Causeway | | | |
|---|---|---|---|---|
| | Komari | Periya Kallar | Koddaia Kallar | Panichchankeni |
| Total Opening Length Required (m) | 48.0 | 136.0 | 41.0 | 127 |
| Design High Water Level (m, M.S.L.) | 1.6 | 1.8 | 1.8 | 1.9 |
| Mean Sea Level (m) | 47.2 | 47.3 | 47.3 | 48.5 |
| Design High Water Level (m) | 48.8 | 49.1 | 49.1 | 50.4 |

## 3.3 Principles for Project Implementation

As the target for the Project is the emergency recovery of the four tsunami affected causeways, the Project is required to start and be completed as early as possible. Generally, a design-build contract, in which the detailed design is conducted by the contractor as one component of the contract, is supposed to be able to commence the civil works earlier than a conventional type contract, mainly because mobilization and preparatory works can be initiated at the same time as the start of the detailed design. For this reason, the Ministry of Highways of Sri Lanka suggested a design-build contract as the procurement procedure. In discussions between the Government of Sri Lanka and JICA regarding this matter, a consensus that the Project would be implemented by the design-build method has been reached. The characteristics of the design-build method for the Project are as follows:

- The period from the distribution of the tender documents to the signing of the contract with the contractor will be estimated as less than 1.5 months. This procurement period is half a month shorter than the normal procurement.

- After conclusion of the contact between the owner and the contactor, the detailed design will be carried out so as to optimize the implementation of the construction plan.
- The detailed design and actual civil works are combined harmoniously so that the total Project period can be considerably shortened (see Chapter 5 for details).

# *CHAPTER 4*

## *Facility Designs for Emergency Recovery*

# Chapter 4 Facility Designs for Emergency Recovery

## 4.1 Design Standards & Criteria to be Adopted

### 4.1.1 Design Standards

Bridges and other structures shall be designed by basically applying RDA Standards and the British Standard (BS). However, reference will also be made to Japanese bridge/structural design standards and other manuals when appropriate. Due consideration should be given to local conditions such as live loads, temperature, earthquake, and clearance. Design standards for this Project are listed below.

Main Standards from RDA:

- Geometric Design Standards of Roads (1998)
- A Guide of the Structural Design of Flexible Pavements under Sri Lankan Conditions (1998)
- Bridge Design Manual (1997)
- Road Notes No.29 (1970) A Guide to the Structural Design of Pavements for New Roads (1970) used for design of Concrete Pavements
- Standard Specifications for Construction and Bridges (1989)
- Bridge Construction Manual (1997)
- Manual on Traffic Control Devices, National Road Safety Secretariat (2003)

Reference Standards:

- British Standard BS 5400 (1978 - 2000)
- Specification of Highway Bridges (Japan Road Association, 1996)

Underpass Structures:

- Design Manual for Roads and Bridges (British Highway Agency, 1989)

The items to be designed are as follows:

- Bridges and culverts
- Retaining walls and other structures on causeway roads and approach roads
- Concrete pavements and flexible pavements
- Temporary structures (if any)

### 4.1.2 Geometric Criteria

#### 1) Road Classification

The bridges under this Project are categorized according to the road classification given in the "Geometric Design Standards of Roads". However, the design live loads are categorized differently as shown in the table below.

**Table 4.1.1. Road Classification**

| | Road Classification | Design Live Load |
|---|---|---|
| All causeways | A - Class road | HA and HB live load |

#### 2) Design Criteria for Roads

The design criteria for causeways and approach roads based on the Geometric Design Standard of Roads in 1998 RDA are summarized in Table 4.1.2.

**Table 4.1.2. Summary of Geometric Design Criteria**

| Items | | | Unit | Specified Values | |
|---|---|---|---|---|---|
| Road Class | | | - | A (R3) | |
| Classification of Road Location | | | - | Rural | |
| Location | | | | Open | |
| Design Speed | | | km/h | 70 | |
| Width | | | | Komari & Panichchankeni | Periya Kallar & Koddaia Kallar |
| | Causeway Section | Carriageway | m | 2 x 3.5 = 7.0 | 2 x 3.5 = 7.0 |
| | | Cycle Lane | m | - | 2 x 1.5 = 3.0 |
| | | Sidewalk | m | 2 x 1.5 = 3.0 | 0, 2 x 1.8 = 3.6 |
| | | Minimum ROW | m | 10.0 | 13.6 |
| | Approach Road Section | Carriageway* | m | 2 x 3.5 = 7.0 | 2 x 3.5 = 7.0 |
| | | Cycle Lane | m | - | 2 x 1.5 = 3.0 |
| | | Shoulder | m | 2 x 1.5 = 3.0 | 0, 2 x 2.0 = 4.0 |
| | | Drain | m | if needed | if needed |
| | | Minimum ROW (w/o Drain) | m | 10.0 | 14.0 |
| Cross Fall | | Concrete Pavement | % | 2.0 | |
| | | Asphalt Concrete Pavement | % | 2.5 | |
| | | Surface Dressing | % | 3.0 | |
| | | Shoulder (Gravel) | % | 4.0 | |
| Maximum Superelevation (Desired Maximum) | | | % | 6.0 (4.0) | |
| Minimum Radius | | | m | 185 | |
| Minimum Radius with Adverse Cross Fall | | Open (Adopted) | m | 1105 | |
| | | Built-up | m | 810 | |

| | | | | |
|---|---|---|---|---|
| Pavement Widening and Different Superelevation | Radius | | Widening Width | Different Superelevation |
| | R = 225m | m | Not required | 2.5% |
| | R = 215m | m | Not required | 3% |
| | R = 205m | m | Not required | 4% |
| | R = 195m | m | Not required | 5% |
| | R = 185m | m | Not required | 6% |
| Minimum Length of Spiral Curve (Desired Maximum) | | m | 40 | |
| Maximum Grade Change without Vertical Curve | | % | 0.7 | |
| Maximum Gradient | | % | 4.0 (2.0) | |
| Critical Length of Gradient | i = 3.0% | m | 480 | |
| | i = 4.0% | m | 330 | |
| Minimum Vertical Curve Length | | m | 60 | |
| Minimum Vertical Curve | Crest | m | 3,000 | |
| | Sag | m | 1,300 | |

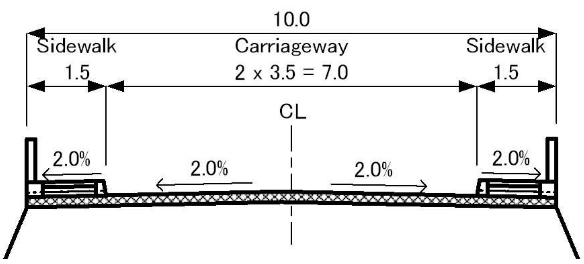
## 3) Effective Road Width

The effective road widths on the causeways and approach roads are as listed Table 4.1.3.

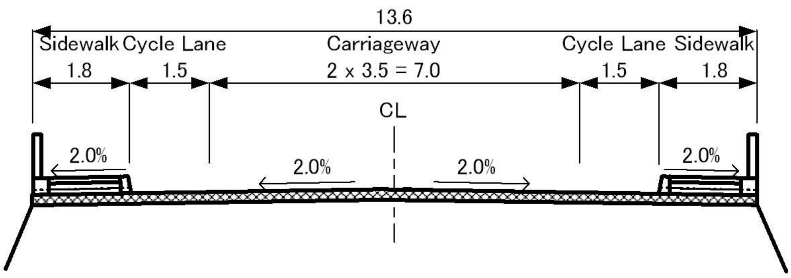
**Table 4.1.3. Effective Road Widths of Causeways and Approach Roads**

| Causeway | Causeway Section (m) | Approach Road Section (m) |
|---|---|---|
| Komari | 1.50+2 x 3.5+1.5=10.00 | 1.5+2 x 3.5+1.5=10.0 |
| Periya Kallar | 1.8+1.5+2 x 3.5+1.5+1.8=13.6 | 2.0+1.5+2 x 3.50+1.5+2.0=14.0 |
| Koddaia Kallar | 1.8+1.5+2 x 3.5+1.5+1.8=13.6 | 2.0+1.5+2 x 3.50+1.5+2.0=14.0 |
| Panichchankeni | 1.5+2 x 3.5+1.5=10.0 | 1.5+2 x 3.5+1.5=10.0 |

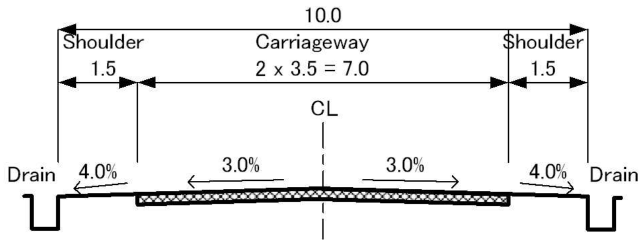
Typical cross sections of causeways and approach road sections are shown in Figure 4.1.1.



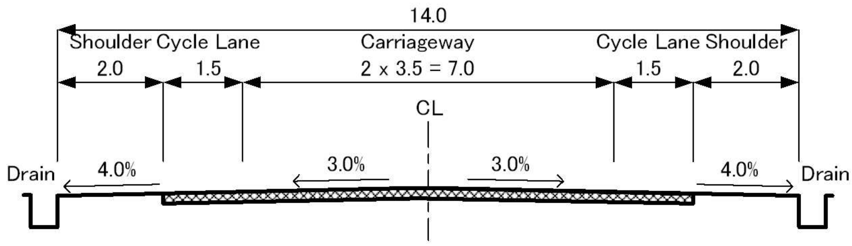

Komari & Panichchankeni Causeways




Periya Kallar & Koddaia Kallar Causeways




Komari & Panichchankeni Approach Roads




Periya Kallar & Koddaia Kallar Approach Roads

**Figure 4.1.1. Cross Sections of Causeways & Approach Roads**

## 4) Bridge/Culvert Height & Openings for Lagoons

Each causeway crosses a lagoon dividing it into two parts: a landside and seaside part. The ground elevation of the lagoons is mostly below mean sea level with mild slopes. The discharge of catchments does not tend to flow through the bridges/culverts at a high velocity, since the lagoon itself retains a substantial quantity of water, resulting in the rise of the water level being due to the topographical characteristics of the lagoons. Note that sandbar formation obstructs flow discharges to the sea.

The required total length of openings for a bridge and causeway should be determined by hydrological and hydraulic analyses to handle the temporal variations in water level for a lagoon. Note that because of the low discharge the length of a bridge span can be adjusted, provided that the total length of openings is maintained. Based on hydraulic analysis, the required total opening lengths for bridges/culverts are given in Table 4.1.4. In these cases, the depths of flow through the structures are calculated from the existing riverbed level. Therefore, it is recommended to design the bottom level of the inner area of the culverts either at the existing riverbed level or below that. The approach and exits of culverts should be well prepared/dredged so that flows will not be obstructed. The bed slope of culverts should be 0.002.

**Table 4.1.4. Required Design Height & Opening for Structures**

| Description | Bridge/Culvert | | | |
|---|---|---|---|---|
| | Komari | Periya Kallar | Koddaia Kallar | Panichchankeni |
| Design Water Level (m) (From MSL) | 1.6 | 1.8 | 1.8 | 1.9 |
| Required Total Opening Length (m) | 48 | 136 | 41 | 127 |

## 5) Clearance under Bridge Girders for Lagoons

The flow through a bridge or culvert in a lagoon is significantly smaller than than of a flow through a bridge in a river. Therefore, a minimum 0.3m clearance under the girder or top slab of culvert from the design water level (with a 50-year return period) in lagoons is considered to be sufficient.

## 6) Level of Causeway Road & Approach Road Surface

The concrete slab level of a causeway road and aggregate base level of an approach road should be above the design water level.

## 7) Level of Footing of Bridge Foundation

Local scouring of bridge foundations should be estimated to identify the magnitude of possible erosion and thereby to decide the depth and type of foundations and to design the necessary countermeasures, if any. The modified versions of Loursen’s live bed scour equation recommended by the Hydrologic Engineering Center, US Army Corps of Engineers was applied. As velocities close to the bed are not very high in lagoons, rubble masonry gabion mats can be applied to prevent riverbed erosion at bridge locations where it is necessary.

## 8) Results of Hydrological/Hydraulic Design for Bridges/Causeways

The design discharge hydrographs of the sub-catchment areas for a 50-year return period were determined by applying the HEC-HMS hydrological model developed by the Hydrologic Engineering Center. A detailed hydraulic analysis was carried out to determine the water levels and the required bridge openings.

**Table 4.1.5. Hydrological Design Conditions of Structures**

| Description | | Units | Bridge / Causeway | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | Komari | Periya Kallar | Koddaia Kallar | Panichchankeni | |
| | | | | | | | |
| **Catchement Characteristics** | | | | | | | |
| Catchement Area | | $km^2$ | 173 | 402 | | 381 | Periya Kallar & Koddai Kallar lagoons are interconnected |
| Lagoon Area (Land Side) | | $km^2$ | 4.4 | 30.8 | | 28.5 | |
| Lagoon Area (Sea Side) | | $km^2$ | 0.0125 | 0.975 | | 2.38 | |
| Ave. Sand Bar Height at Sea outfall | | m | 0.9 | 1 | | - | Above High tide level; 0.6m |
| Old Bridge Opening | | m | 32 | 103.6 | 11.8 | 35+28 nos 1.5m Dia. | According to measured data (approximate) |
| Observed Flood Level (By Hearing) | From MSL | m | 1.5 | 1.7 | 1.7 | 1.7 | Under present condition |
| | | | | | | | |
| **Design Conditions** | | | | | | | |
| Design Return Period | | yr | 50 | 50 | 50 | 50 | |
| Design High Water Level (From MSL) | HWL | m | 1.6 | 1.8 | 1.8 | 1.9 | 50 yr return period; 1m high sand bar |
| Minimum Free Board | | m | 0.3 | 0.3 | 0.3 | 0.3 | |
| Required Bridge/Culverts Opening | | m | 48 | 136 | 41 | 127 | |
| Max. Velocity through Opening | | m/s | 1 | 1.7 | 1.5 | 2 | Max. velocity during the peak of flood |
| Local Scouring for Foundation | (estimated) | m | 0.95 | 1.14 | 1.23 | 1.62 | Loursen's live bed scour equation |

### 4.1.3 Structure Design Criteria

Structure design shall follow both the Bridge Design Manual, RDA (1997) and BS 5400 Part 2 (1978). The above-mentioned standards are supplemented by the following items as further detailed in the subsequent sub-clauses.

- Design Loads
- Properties of Materials
- Stability Analysis of Pile Foundation
- Culvert

### 1) Design Loads

Bridges shall be able to resist the effects of the loads as listed below.

- Dead loads and superimposed dead loads
- Live loads
- Braking and traction of vehicle load
- Earth pressure
- Water current
- Temperature
- Shrinkage and creep
- Buoyancy

The following loads shall be considered according to site conditions or structure type and the designer’s judgment.

- Wind Loads
- Floating Debris and Log Impact

There is no record of earthquakes in Sri Lanka; therefore, it is not necessary to consider its effect in the design.

**a) Dead Loads & Superimposed Dead Loads**

The dead load including self weight, curb, handrails, and the superimposed dead load are calculated in Table 4.1.6.

**Table 4.1.6. Dead Load Intensity**

| Category | Item | Unit | Value | Remarks |
|---|---|---|---|---|
| Dead load | Reinforced concrete | $kN/m^3$ | 25.0 | |
| | Pre-stressed concrete | $kN/m^3$ | 25.0 | |
| | Plane concrete | $kN/m^3$ | 23.5 | |
| | Asphalt pavement (if any) | $kN/m^3$ | 23.0 | |
| | Steel | $kN/m^3$ | 78.5 | |
| | Compact sand | $kN/m^3$ | 19.0 | |
| | Loose sand | $kN/m^3$ | 16.0 | |
| Super-imposed Dead load | Public utilities (telephone line) | | Proper weight | Sea side of Koddaia Kallar |

**b) Live Loads**

HA loadings are applied in the design of all bridges and HB loadings for roads of Class A and B are combined with HA loadings.

**i) HA Load**

Three kinds of HA loads are considered in the design:

- Nominal uniformly distributed load (UDL)
- Nominal knife edge load (KEL)
- Single nominal wheel load alternative to UDL and KEL

**ii) HB Load**

Only one HB loading is required to be considered on any superstructure or on any substructure supporting two or more superstructures. According to the Bridge Design Manual, RDA, 30 units of HB loading should be applied in a design.

**iii) HB and HA Loading combined**

HB and HA loadings are combined and applied as specified in BS 5400 Part 2. However, the HB loading is always to straddle two (2) notional lanes in accordance with the Bridge Design Manual of RDA.

**iv) Footway and Cycle Track Live Load**

HB and/or HA loadings shall be applied in the design of footways and cycle track lanes on bridges, as specified in BS 5400 Part 2.

**c) Braking and Traction of Vehicle Load**

**i) Longitudinal Force**

The longitudinal load resulting from traction or braking of vehicles shall be taken as the more severe of nominal loads of HA or HB type, applied to the road surface and parallel to it in one notional lane only.

**ii) Skidding Load**

Horizontal load of 250 kN due to skidding shall be taken in the design with HA load.

**d) Earth Pressure**

Only active earth pressure acting on abutments shall be considered, without taking into account the resistance by passive earth pressure.

**e) Water Current**

The horizontal force generated by water current shall be calculated according to the Bridge Design Manual of RDA.

**f) Temperature**

**i) Effective Bridge Temperature**

Effective bridge temperature shall be considered in accordance with the Bridge Design Manual of RDA for continuous bridges in the calculation of temperature stress.

**ii) Frictional Bearing Resistance Force from Temperature Change**

Ten percent of the superstructure dead load shall be considered in the design of substructures (longitudinal direction), which is the minimum friction coefficient for gum type sliding bearings (Japanese design standards).

**g) Shrinkage & Creep**

Loss of pressure by shrinkage and creep shall be considered in the calculation of pre-stressing force, bending moment and deflection of girders.

**h) Buoyancy**

Appropriate water level shall be taken into account in computing the effect of buoyancy.

**i) Differential Settlement**

Potential differences in settlement between a structure having a pile foundation and a structure/approach road having a non-pile foundation shall be taken into consideration in designing.

## 2) Design of Structures

### a) Design Class for Prestressed Concrete Structures

The bridges of this Project are located in a coastal area and are significantly affected by sea water. Hence, the bridges are to be designed as Class 1.

### b) Properties of Materials

### i) Concrete

**Table 4.1.7. Concrete Strength**

| Classification | Characteristic Strength (N/mm$^2$) | | Young's Modulus (kN/mm$^2$) | |
|---|---|---|---|---|
| | At transfer | Serviceability | At transfer | Serviceability |
| Precast PC Beam | 36 | 50 | 29.8 | 34.0 |
| Crossbeam | 24 | 35 | 25.1 | 29.5 |
| RC Slab | - | 35 | - | 29.5 |
| Concrete Pavement | - | 35 | - | 29.5 |
| Abutment, Pier | - | 30 | - | 28.0 |
| Cast-in-situ RC Pile | - | 40 | - | 30.0 |
| RC Driven Pile | - | 30 | - | 28.0 |
| Box Culvert | - | 30 | - | 28.0 |

Poisson's Ratio: 0.20
Temperature Coefficient: 12 * $10^{-6}$
Stress-Strain Curve for Design: BS 5400 Part 4, Figure 1

### ii) Steel

**Table 4.1.8. Steel Strength**

| Classification | Characteristic Strength (N/mm$^2$) | | Young's Modulus (kN/mm$^2$) | |
|---|---|---|---|---|
| | At transfer | Serviceability | At transfer | Serviceability |
| G460 | - | 460 | 200 | 200 |
| 12S15.2B<br>12S12.7B<br>7S12.7B | - | 1,850 | 200 | 200 |
| 1S28.6<br>1S21.8 | - | 1,800 | 200 | 200 |

Poisson's Ratio: 0.30
Temperature Coefficient: 12 * $10^{-6}$
Stress-Strain Curve for Design: BS 5400 Part 4, Figure 2 (Reinforcement), Figure 3 (PC Strand)

### iii) Constants of Backfill Soil

Internal friction of angle : $\varphi$ = 30 degree
Unit weight : $\gamma$ = 19 kN/m$^3$
Cohesion : c = 0 kN/m$^2$

### c) Stability Analysis of Pile Foundation

The method of stability analysis for pile foundations is not specified in BS 5400 and BS 8004. Hence, the displacement method, which is commonly used in Japan, is adopted, to calculate the pile reaction and amount of displacement. Stability of piles is examined to ascertain the following 3 conditions:

- The axial compressive force on the pile does not exceed the allowable axial compressive bearing capacity of the pile.
- The axial pull-out force on the pile does not exceed the allowable pull-out capacity of the pile.
- The horizontal displacement of the pile does not exceed 15 mm to avoid plasticity of ground.

**i) Allowable Bearing Capacity of Piles**

The allowable bearing capacity of a pile is to be calculated in accordance with the equation set up in BS 8004 as follows:

Ultimate Bearing Capacity of a Pile:

$R_u = f * A_s + A_b * q$

Where,

$R_u$ : ultimate bearing capacity (kN)

$A_s$ : surface of pile shaft ($m^2$)

$A_b$ : area of pile tip ($m^2$)

f : average skin friction or adhesion per unit area of shaft in the condition of full mobilization of frictional resistance (kN)

q : ultimate value of resistance per unit area of pile tip due to shearing stress of soil ($kN/m^2$)

$f * A_s = \Sigma f_i * U * l_i$

Where,

$f_i$ : skin friction ($kN/m^2$)

Sand $f_i = 5 * N$ ($f_i <= 200$)

Clay $f_i = 10 * N$ ($f_i <= 150$)

Skin friction of soft soil (N<=2) is to be neglected.

N : blow count of SPT

Allowable Bearing Capacity of a Pile:

$R_a = 1/n * (R_u - W_s) + W_s - W$

Where,

$R_a$ : allowable bearing capacity of a pile (kN)

n : safety factor (=2.5)

Safety factor 2.5 is normally used for verification of foundation in case of standard condition, therefore n = 2.5 is used for this design (Pile Design and Construction Practice, M.J. Tomlinson)

$W_s$ : effective weight of soil to be replaced with a pile

W : effective weight of a pile in the ground

Allowable Uplift Capacity of a Pile:

$P_a = 1/n * P_u$

Where,

$P_a$ : allowable uplift capacity of a pile (kN)

n : safety factor (=6)

Safety factor 6 is normally used for verification of foundation in case of standard condition, therefore n = 6 is used for this design (Pile Design and Construction Practice, M.J. Tomlinson)

$P_u$ : ultimate uplift resistance of a pile

$P_u = f * A_s$

**ii) Allowable Horizontal Displacement**

Horizontal displacement at the top of a pile shall be checked to avoid adverse effects on the superstructure and to avoid plasticity of the ground in front of the pile. Allowable horizontal displacement shall generally be less than 1 % of pile diameter or 15mm, whichever is bigger in order to assure safety against lateral force.

### 4.1.4 Design of Culverts

### 1) Inner Dimensions

Inner dimensions of culverts shall be decided properly in consideration of the following:

- Direction of the water course and location
- Topographical conditions of the lagoon area
- D.W.L.
- Minimum span length of the culvert is equal or wider than the existing bridge/culvert structures.
- Minimum clearance under the upper slab of the culvert is 0.3m from the applied Design Water Level (D.W.L.)
- Internal level of the lower slab of the culvert is lower than the existing concrete

### 2) Foundation

Spread foundations shall be adopted when settlement impacts on the inner dimensions are not considered. For most culverts sites, countermeasures for soft ground shall be taken for embankments prior to culvert construction. In general, a culvert's weight is lighter than embankment soil, and culvert stability is ensured by adopting a spread foundation. "Replacement of soft soil with sand material" and "replacement plus preloading method" are mainly applied for embankments in soft soil areas and the same method shall be adopted for both the culvert and embankment sections. Culverts planned for preloaded sections must be installed after the soil is consolidated. Surcharge fills are excavated before culverts are installed.

## 4.2 Outlines of Facility Designs for Emergency Recovery

### 4.2.1 Existing Condition of Each Causeway

In order to carry out a reasonable design, it is necessary to assess the damaged parts and existing condition of the objective four causeways (see Table 4.2.1).

**Table 4.2.1. Existing Condition of Damaged Parts**

| | Damaged Part | Existing Condition | Remarks |
|---|---|---|---|
| Komari | **Causeway Bridge Section**<br>South side of bridge (approx. 29m) completely washed out. Remaining north side of old bridge approx. 9m.<br><br>**Causeway Road Section**<br>Both northern (approx. 50m in length) & southern (approx. 5m long) causeways completely damaged. | **Causeway Bridge Section**<br>Temporary bridge (bailey bridge) built (approx. 33m long, 4.2m width). Abutment & pier substructures built with gabion.<br>**Causeway Road Section**<br>Temporary gabion wall (deep section) & embankment (shallow section) constructed. | Gabion of Bailey bridge base is slightly sinking.<br>Insufficient causeway width |
| Periya Kallar | **Causeway Bridge Section**<br>No significant damage.<br><br>**Causeway Road Section**<br>Central section of causeway road completely washed out & retaining walls on north side causeway road collapsed. | **Causeway Bridge Section**<br>Existing short bridge still usable.<br>**Causeway Road Section**<br>Detour constructed for washed out section & retaining wall section under reconstruction. | Insufficient causeway width |
| Koddaia Kallar | **Causeway Bridge Section**<br>No significant damage.<br><br>**Causeway Road Section**<br>Causeway of Ondachchimadam | **Causeway Bridge Section**<br>Existing causeway bridge still usable.<br>**Causeway Road Section**<br>Temporary bridge (approx. | Telephone line and electric line were collapsed.<br>Insufficient causeway width |

| | | | |
|---|---|---|---|
| | side completely washed out & embankment on south side of causeway collapsed. | 30m) built at Ondachchimadam. Lagoon side of embankment under construction. | |
| Panichchankeni | **<u>Causeway Bridge Section</u>**<br>Behind both abutments area washed out & pier caisson foundation tilted from scouring.<br>**<u>Causeway Road Section</u>**<br>Some pipe culverts (1.5m diameter) & masonry wall washed out & damaged. | **<u>Causeway Bridge Section</u>**<br>Temporary bridge (bailey bridge) set (approx. 37m) on existing superstructure.<br>**<u>Causeway Road Section</u>**<br>Temporarily repaired. | Insufficient causeway width |

### 4.2.2 Design Policy for Each Causeway

According to Table 4.2.1, some parts of the causeways were either washed out or damaged by the tsunami. Furthermore, the width of the objective causeways is insufficient for a two-lane road. The design policy for the causeways and the approach roads are as described as below.

- Causeway facilities shall be planned economically, meaning that local materials and manufactured goods shall be used whenever possible.
- Causeways shall be planned with the proper elements and cross-section width and alignment to satisfy Class A road standards and present traffic conditions.
- The road elevation for all causeway bridge and road sections (including approach roads) shall be higher than the high water level of the lagoons. This means that vehicles and pedestrians will be able to use the causeways throughout the year.
- Openings for causeways connecting the seaside and landside of lagoons shall be sufficient in terms of hydrologic engineering requirements.
- The alignment and width of approach roads shall be planned without extra land acquisition on the basis of present land use conditions.
- Mounted up sidewalks, handrails, road markings and reflective road studs shall be used to ensure pedestrian and vehicle safety.

### 4.2.3 Preliminary Design of Causeway Facilities

### 1) Komari Causeway:

- The new causeway centerline is same as that of the existing causeway, as the new causeway road will use the existing embankment and riverbed.
- The bridge length is to be 53m, which has been determined on the basis of a required

opening width of 48m.

- The causeway road is to use random rubble masonry casted on riverbed sediment of sand and filled with crushed stone.

## 2) Periya Kallar Causeway

- The same centerline is applied for the new causeway.
- Bridge length has been determined to be 160m on the basis of a required opening width of 136m, consisting of 12 span and 28 span slab bridges each 4m in length.
- The causeway road is to use concrete retaining walls casted on a riverbed sandstone layer.

## 3) Koddaia Kallar Causeway

- The same centerline including some improvement to the curve radius is applied for the new causeway.
- Bridge length has been determined to be 56m on the basis of a required opening width of 41m, consisting of 14 span slab bridges 4m in length.
- The causeway road is to use concrete retaining walls casted on a riverbed sandstone layer.

## 4) Panichchankeni Causeway

- The new causeway centerline is the same as the existing one.
- The bridge length has been determined to be 142m on the basis of a required opening width of 127m.
- Five of the seven new pile bent type piers will be installed between the abutments and piers of the existing bridge, with a span length of 17.5m. Therefore, the existing caisson foundations don’t become the obstacles for the new structure foundations.
- The causeway road is to use random rubble masonry with crushed stone filling and casted on riverbed sediment of sand.

### 4.2.4 Preliminary Plan for Bridges & Causeway Roads

### 1) Bridge Type

#### a) Superstructure

The type of bridge structure for the openings on the Komari and Panichchankeni causeways is determined via the depth of the base layer and existing conditions. Bridge lengths will be more than 50m for the Komari and 140m for the Panichchankeni causeways, respectively, and bridge spans will be more than 10m. The following alternative plans for the superstructure are taken into consideration as shown in Table 4.2.2.

#### i) Reversed T-Shaped Pre-Tensioned PC Beam

In the construction of a pre-tensioned PC bridge, beams are produced in a factory in Colombo and transported to site by trailer. Typical PC beams from 9.5m to 19m in length are designed by RDA and available for use for causeway opening structures. The low height of a beam is to minimize the elevation of a causeway road. Note that the construction period using pre-tensioned beams is shorter than that for post-tensioned girders, as the latter can be built during the rainy season in a factory, which also minimizes site work.

#### ii) T-Shaped Post-Tensioned PC Girder

The economical span length of a post-tensioned PC girder is more than 25m. Generally, post-tensioned PC girders are fabricated on site in a wide opening/flat area, and many facilities are required such as truck cranes or launching girders. As the erection of a post-tensioned girder requires a longer time than a pre-tensioned beam, there must be a sufficient number of girders for the operation to be economical. For this Project, on-site manufacturing is not practical.

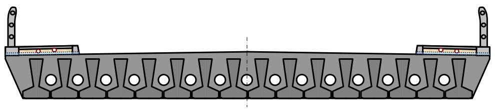
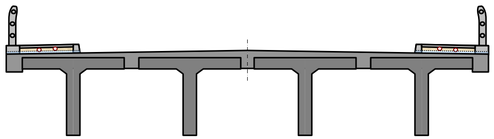
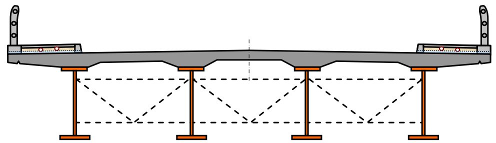
#### iii) I-Shaped Steel Girder

Steel I-girders are not manufactured in Sri Lanka and have to be transported here. As fabrication and transportation costs are high, this plan is also not appropriate.

#### iv) Overall Evaluation

In conclusion, the reversed T-shaped pre-tensioned PC beam is the most reasonable for the Project.

# Table 4.2.2. Comparative Study for bridge Superstructures

| Description | **Alternative-A**<br>**Pre-tensioned PC Beam** | **Alternative-B**<br>**Post-tensioned PC Girder** | **Alternative-C**<br>**I-shaped Steel Girder with RC Slab** |
|---|---|---|---|
| Plan<br><br>View of Cross Section |  |  |  |
| Construction Condition | - Precast PC beams are fabricated in a factory and transported to the site, then erected by track crane.<br>- There are some precast fabrication factory for maximum length of 17.5m or 19m long of beam as typical type.<br>Some fabrication factories are constantly operating and<br>- has own trailer for transporting of beams to the site. | - Post-tension PC girder is applied for the span of 25~40m<br>- Post-tension PC girder is fabricated and stressed in the construction site and then erected by track cranes. | - Steel girders are procured from the third countries, so the transport cost is relatively high. |
| Construction Period | - PC beams are minimized the fabrication period and effectively fabricate in the west coast side in dry season while the site are rainy season. ◎ | - Fabrication of PC girder are required the construction yard at the site and shall be fabricated in the dray season. ○ | - Steel girder is fabricated in third countries in rainy season and transport at the site through Colombo port. ○ |
| Procurement of Material and Erection | - One or two track carne of 40~50ton lifting capacity is required for erection. ◎ | - Procurement of high strength concrete for girder at the temporary site plant is difficult.<br>Two track cranes of around 100ton lifting capacity are required for erection and difficult to lent. ○ | - Two track cranes of around 30ton lifting capacity is required for erection. |
| Maintenance | - Maintenance of bridge is not necessary exception of cleaning of drain, expansion joint, bearing and incidentals. ○ | - Maintenance of bridge is not necessary exception of cleaning of drain, expansion joint, bearing and incidentals. ○ | - it is required to inspect and maintenance periodically for the painting. △ |
| Economical Aspects | - It is economical because typical type of beams are used usually in Sri Lanka. ◎ | - To fabricate a few numbers of girders at not maintained site is costly. ○ | - Steel material and fabrication cost of steel girder is extremely high compared with concrete girder mainly consists of local product material △ |
| Overall Evaluation | - Some fabrication factory are constantly operating and has trailer for transport of beams △ | Due to installation of cofferdam, cost up and construction period is extended. ○ | The steel girder use is not reasonable for high cost and main material imported from third countries. △ |

◎ : Very Good ○ : Good △: Poor

**b) Substructure/Foundation**

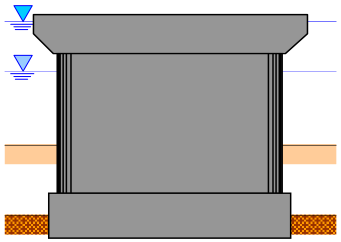
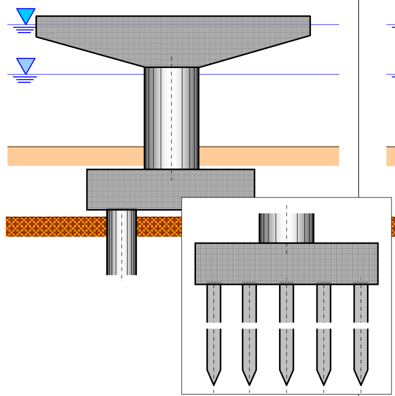
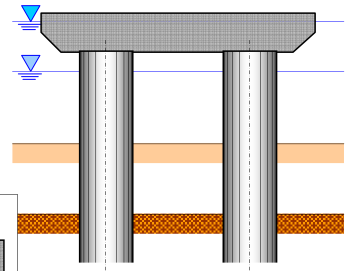
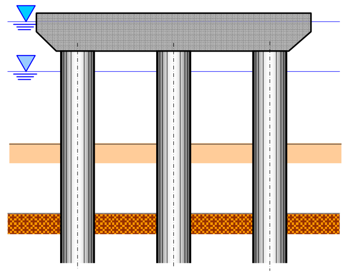
**i) Komari**

A spread foundation on a gneiss rock base is used for the bridge abutment and piers as a foundation type.

**ii) Panichchankeni**

A cast-in-situ RC concrete pile of the bent type is selected for the bridge pier taking into consideration construction cost and time as shown in Table 4.2.3. For the pile bent type, horizontal displacement at the bearing in the direction of the bridge axis and in the transverse direction tends to be large because the top structure is heavy. To address this problem, the number of pile bents at each pier will be three and their diameter will be 1200mm in order to give bridge piers high strength.

### Table 4.2.3. Comparative Study for Bridge Substructure/Foundation in Panichchankeni Causeway

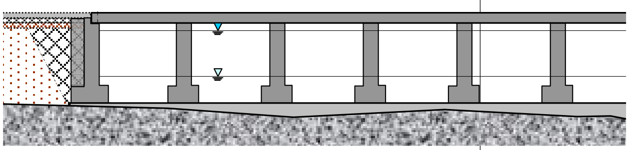
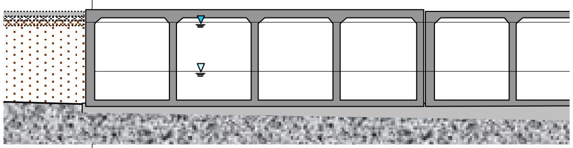
| Description | Alternative-A<br>Wall with Spread Foundation | Alternative-B<br>Column with Cast-in-situ Pile<br>/Pre-fabricated Concrete Pile | Alternative-C<br>Beam with Caisson | Alternative-D<br>Pile Bent |
|---|---|---|---|---|
| Ground Condition | - Depth of water level is high (3.8m depth to riverbed in dry season)<br>- Riverbed layer is sediment sand<br>- Basement layer is more than 50 of N-value of coastal sand and depth from riverbed is more than 3m Rock layer is not encountered | | | |
| Plan<br><br>View of Cross Section |  |  |  |  |
| Hydrology Characteristics | - Minimize the affected structure area in the water course ◎ | - Opening width is reduced due to a bold column in the water course △ | - Opening width is reduced due to bold columns of caisson in the water course △ | - Minimize the affected structure area in the water course ○ |
| Construction Ability | - Spread footing is located below water level, cofferdam is necessary to install in the lagoon so the construction period is extended. △ | - Pile cap with more than 4 cast-in-place piles and that will be unstable short length pile,<br>- or more than 6 pre-fabricated concrete piles.<br>- Pile cap is located below water level, sheet pile cofferdam is necessary to install so the construction period is extended. △ | - Traditional method of circular caisson of dia. 2~2.5m in Sri Lanka<br>- Construction of caisson is necessary to build sand bank higher level than the water level.<br>- Depth of caisson in the coarse sand layer must be deep due to avoid settling ○ | - It is necessary to build a sand bank higher level than the water level.<br>- Piling work is faster than any other foundation ◎ |
| Maintenance | - Maintenance of riverbed scoured around footing is necessary periodically. △ | - Maintenance of riverbed scoured around column and pile cap is necessary periodically △ | - Maintenance of riverbed scoured around caissons is necessary periodically △ | - Maintenance of riverbed scoured around piles is necessary periodically. △ |
| Economical Aspects | - Construction costs are showing a tendency to rise due to installation of deep cofferdam of sheet piles. △ | - Construction costs are showing a tendency to rise due to installation of cofferdam. △ | - Construction costs are showing a tendency to rise due to long construction period ○ | - It is possible to cost down in case that a drilling machine is procured from Colombo ◎ |
| Overall Evaluation | - Due to installation of cofferdam, cost up and construction period is extended. △ | Due to installation of cofferdam, cost up and construction period is extended. △ | Due to installation for casted concrete step by step, construction period is extended. ○ | It is a suitable pier type aiming at cost down and shorten the construction period. ◎ |

◎ : Very Good ○ : Good △: Poor

## 2) Short Bridge Type

Periya Kallar and Koddaia Kallar causeways are located at the same lagoon, and their topographical/geological conditions are similar. The opening structure of the causeway sections shall be economically designed on a sandstone layer of the riverbed as short-span bridges or box culverts. A comparison between the bridge and culvert alternatives is shown in Table 4.2.4. Note that a slab bridge is better in terms of construction cost and time.

**Table 4.2.4. Comparative Study for Short Bridge on the Rock Laye**

| Description | **Alternative-A**<br>**Slab Bridge** | **Alternative-B**<br>**Box Culvert** |
|---|---|---|
| Ground Condition | - in the case of stone layer riverbed | |
| Plan<br><br>View of Cross Section |  |  |
| Structure | - Concrete wall type pier and cast-in-situ RC concrete slab<br>- Same as existing bridge in Periya Kallar causeway | - 3 or 4 continuous span of culvert box |
| Construction Period | - Piers and slabs are possible to construct individually ◎ | - Construction period is long due to continuous culvert with re-bar is casted step by step ○ |
| Fanction as Road | - Every span of slab appears construction or expansion joint ○ | - Surface of road is smooth with continuous top slab ◎ |
| Maintenance and Repair | - ◎ | - Maintenance is difficult due to continuous structure with re-bar ○ |
| Economical Aspects | - 100% ◎ | - 120% of slab bridge ○ |
| Overall Evaluation | - It is a suitable structure aiming at cost down and shorten the construction period. ◎ | ○ |

◎ : Very Good ○ : Good △: Poor

## 3) Causeway Road Type

Either an embankment or wall type for the causeway road section shall be selected for the causeways of Komari, Periya Kallar, Koddaia Kallar and Panichchankeni, depending upon the geological condition of the riverbed and the traffic volume of the road (see Table 4.2.5).

**a) Periya Kallar & Koddaia Kallar Causeways**

As the existing retaining concrete wall, which is set on a sandstone layer, is stable, a new and higher concrete retaining wall on the same location is appropriate for the expected higher traffic volumes to ensure durability and reliability.

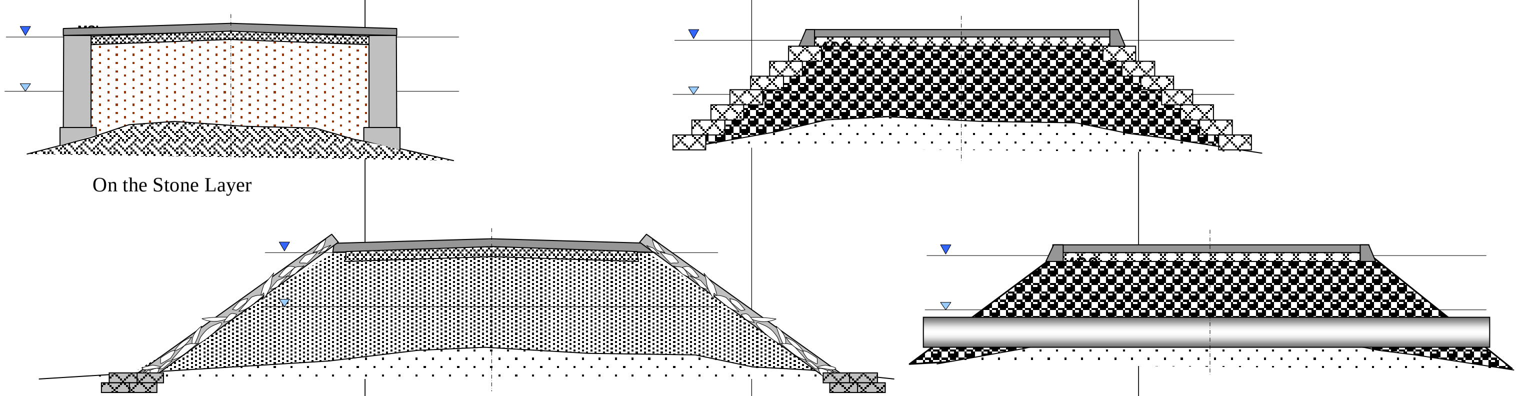
**b) Komari and Panichchankeni Causeways**

These causeways are located on sand sediment and there is a medium amount of traffic. Random rubble masonry on an embedded gabion base placed in the riverbed is appropriate for the causeway roads in terms of construction cost. Note that all causeway road sections shall be paved with concrete slabs for a longer life period in view of the difficulty of reconstruction in a lagoon area.

## 4) Length of Approach Roads

The elevation of an approach road shall be higher than the design water level for lagoon causeways. The length of an approach road is therefore adjusted to satisfy this elevation and to smoothly interface with the existing road.

## Table 4.2.5. Comparative Study for Causeway Road

| Description | Alternative-A<br>**Retaining Wall** | Alternative-B<br>**Rundom Rubble Masonry Protection** | Alternative-C<br>**Gabion Wall with Amour Rock** | Alternative-D<br>**Amour Rock with Pipe Culverts** |
|---|---|---|---|---|
| Plan<br><br>View of Cross Section |  | | | |
| Concept | - Ridged and stable gravity concrete wall and filling with soil or sand.<br>- Most of existing Periya Kallar and Koddaia Kallar causeways are built as same method. | - Random rubble masonry placed on gabions in the sand layer of riverbed. Filling with suitable material and compaction. | - Protected gentle slopes by gabion walls and filling with amour rock | - Amour rock bank with pipe culverts Existing Panichchankeni causeway was constructed with riprap and pipe culverts. |
| Construction | - All the work shall be done in dry bricked up with cofferdam of sand mat.<br>Then remove sediment sand and weathered stone and cast leveling concrete and gravity retaining wall.<br>Filling up borrow pit soil or sand between the both side of walls. | - All the work shall be done in dry bricked up with cofferdam of sand mat.<br>- Then remove sediment sand and excavate and place gabion in the riverbed.<br>- Build up grouted rip rap with filling up suitable material gradually with proper compaction. | - All the work shall be done in dry bricked up with cofferdam of sand<br>- mat.<br>Then remove sediment sand and place gabion wall with geotextail.<br>- Build up gabion with filling up amour rock with crushed rock gradually. | - All the work shall be done in dry bricked up with cofferdam of sand<br>- mat.<br>Then remove sediment sand and place amour rock with pipe culverts gradually. |
| Stability | - To build up durable gravity concrete wall on the rock layer is stable in the heavy traffic volume road. | - Use at low traffic volume road | - Use at low traffic volume road | - Use at low traffic volume road |
| Overall Evaluation | - Suitable to use at Periya Kallar and Koddaia Kallar causeways build on the stone layer ◎ | - Economical to use at Komari and Panichchankeni causeways build on the sand layer ○ | - Acceptable to use at Komari and Panichchankeni causeways build on the sand layer ○ | - Limited to use for temporary structure △ |

◎ : Very Good ○ : Good △: Poor

Note that this result is for cost estimation purposes and would have to be re-examined when detailed design work is carried out.

# *CHAPTER 5*

## *Construction Planning and Cost Estimate for Emergency Recovery*

# Chapter 5 Construction Planning & Cost Estimate for Emergency Recovery

## 5.1 Construction Planning

### 5.1.1 General

Construction planning mainly consists of establishing a construction method and preparing a construction time schedule. The results of this work are utilized in estimating construction costs and establishing the Project implementation schedule.

### 5.1.2 Construction Area

The Project area is located on the East Coast of Sri Lanka and requires a full day's travel (approximately 10 to 12 hrs) to reach from Colombo via either the AA004 or A011 road. The surface conditions of these roads are not good in some of the urban areas and in most parts of the Eastern Province. Hence, the haulage of construction materials and equipment to the Project area is somewhat difficult.

The climatic condition of the Project area can be divided into two seasons as follows:

Rainy Season: From mid October to mid January
Dry Season : From mid January to mid October

Water levels at causeways exceed normal water levels during the rainy season by 1.0m to 1.5m, and rise to about 30cm above the road surface during the period of mid-December to mid-January every year. Therefore, construction work on causeways should be planned so no major work is carried out during times of flooding.

The elevation of the foundation for structures shall be determined based on geological conditions. It is a distinct feature of each site that a medium to hard rock surface exists at the ground level and at shallow depths under the riverbed.

It should be noted that a limited number of boring/geological surveys were conducted during the pre-tender stage. It is the sole responsibility of the contractor to carry out additional investigations to determine the foundation depth/types for the four causeways.

### 5.1.3 Major Work Item

Major construction works based on the results of this preliminary design of each causeway are as shown Table 5.1.1.

**Table 5.1.1. Major Construction Works for Each Causeway**

| Komari | Periya Kallar | Koddaia Kallar | Panichchankeni |
|---|---|---|---|
| **Temporary Work**<br>• Diversion Road<br>• Filling Cofferdam<br>**Removal Work**<br>• Removal of Bailey Bridge<br>• Removal of Existing Structure<br>**Structure Work CW**<br>• PC Girder Bridge<br>• Riprap Retaining Wall<br>**Road Surfacing Work CW**<br>• Concrete Pavement<br>• RDA type Handrail<br>• Road Studs<br>**Approach Rad**<br>• DBST<br>• Side Ditch<br>• Road<br>• Marking<br>• Road Sign<br>• Guard Railing<br>• Embankment Grassing | **Temporary Wrk**<br>• Diversion Road<br>• Filling Cofferdam<br>**Removal Work**<br>• Removal of Existing Structure<br>**Structure Work CW**<br>• Slab Bridge/Box Culvert<br>• Concrete Retaining Wall<br>**Road Surfacing Work CW**<br>• Concrete Pavement<br>• RDA Type Handrail<br>• Road Studs<br>**Approach Road**<br>• DBST<br>• Side Ditch<br>• Road Marking<br>• Road Sign<br>• Guard Railing<br>• Grouted Riprap | **Temporary Work**<br>• Diversion Road<br>• Filling Cofferdam<br>**Removal work**<br>• Removal of Bailey Bridge<br>• Removal of Existing Structure<br>**Structure Work CW**<br>• Slab Bridge/Box Culvert<br>• Concrete Retaining Wall<br>**Road Surfacing Work CW**<br>• Concrete Pavement<br>• RDA Type Handrail<br>• Road Studs<br>**Approach Road**<br>• DBST<br>• Side Ditch<br>• Road Marking<br>• Road Sign<br>• Grouted Riprap | **Temporary Work**<br>• Diversion Road<br>• Filling Cofferdam<br>**Removal Work**<br>• Removal of Bailey Bridge<br>• Removal of Existing Structure<br>**Structure Work CW**<br>• PC Girder Bridge (pile foundation)<br>• Riprap Retaining Wall<br>**Road Surfacing Work CW**<br>• Concrete Pavement<br>• RDA Type Handrail<br>• Road Studs<br>**Approach Road**<br>• DBST<br>• Side Ditch<br>• Road Marking<br>• Road Sign<br>• Grouted Riprap |

### 5.1.4 Construction Method

### 1) Diversion Road & Temporary Cofferdam Plan

During construction any hindrance to public traffic should be avoided, and it is therefore necessary to build diversion routes. There is also the intention of building cofferdams in order to construct the retaining walls and bridge substructures of the causeways. Taking into consideration existing road width and the required width of the new structures, the diversion roads and temporary cofferdams planned are as follows:

**a) Periya Kallar & Koddaia Kallar**

The road section of the Periya Kallar and Koddaia Kallar causeways shall be built via staged construction. That is, each half of a causeway's road section shall be constructed in two separate stages as shown below, and diversion roads are to be provided at locations where work on a structure is taking place:

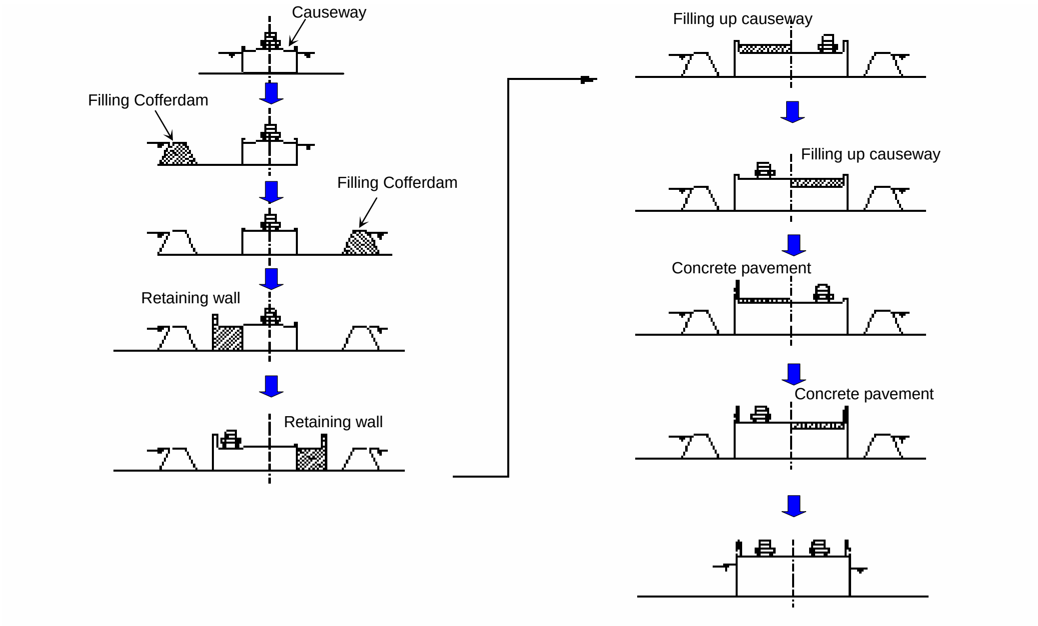



**Figure 5.1.1. Staged Construction for Periya Kallar & Koddaia Kallar**

**b) Komari & Panichchankeni**

Due to the existing width of the causeways and the pilling work involved in the Panichchankeni Causeway, diversion roads have to be provided for the entire length of these two causeways as shown below, with these diversion roads also serving as cofferdams.

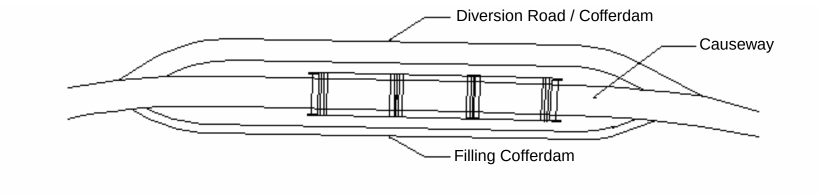



**Figure 5.1.2. Diversion & Cofferdam Plan for Komari/Panichchankeni**

### 2) PC Girder Bridge Construction Plan

For bridges to be constructed with PC girders, the girders will be transported to site by an approved supplier and stocked in accordance with specifications. The pre-tensioned type of PC girder is produced only in the Colombo area. The main PC supplier in Colombo (State Development & Construction Corporation (Semi-governmental Corporation)) has experience in transporting PC girders of this type and is doing so for some of the ongoing construction on the East Coast. The weight of the girders to be used in the Project is approximately 7 tons and will be erected using about a 35 ton class mobile crane.

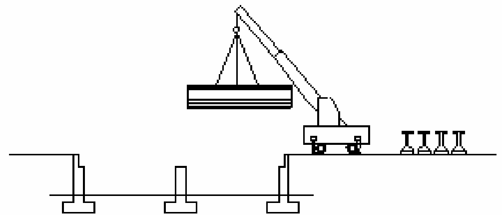


**Figure 5.1.3. Erection of PC I-girder by Mobile Crane**

### 3) Slab Bridge/Box Culvert Construction Plan

For cast-in-situ slabs, the superstructure is constructed over a working platform as long and wide as the superstructure shown in Figure 5.1.4. This platform is supported by a scaffolding system placed underneath and anchored at ground level. The scaffolding system shall consist of a coated plywood deck over a series of wooden/steel beams.

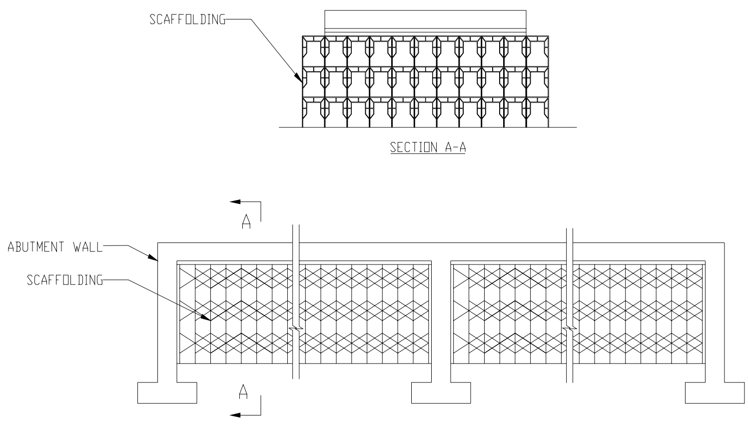



**Figure 5.1.4. All Stage Scaffolding System for Slab Bridge Construction**

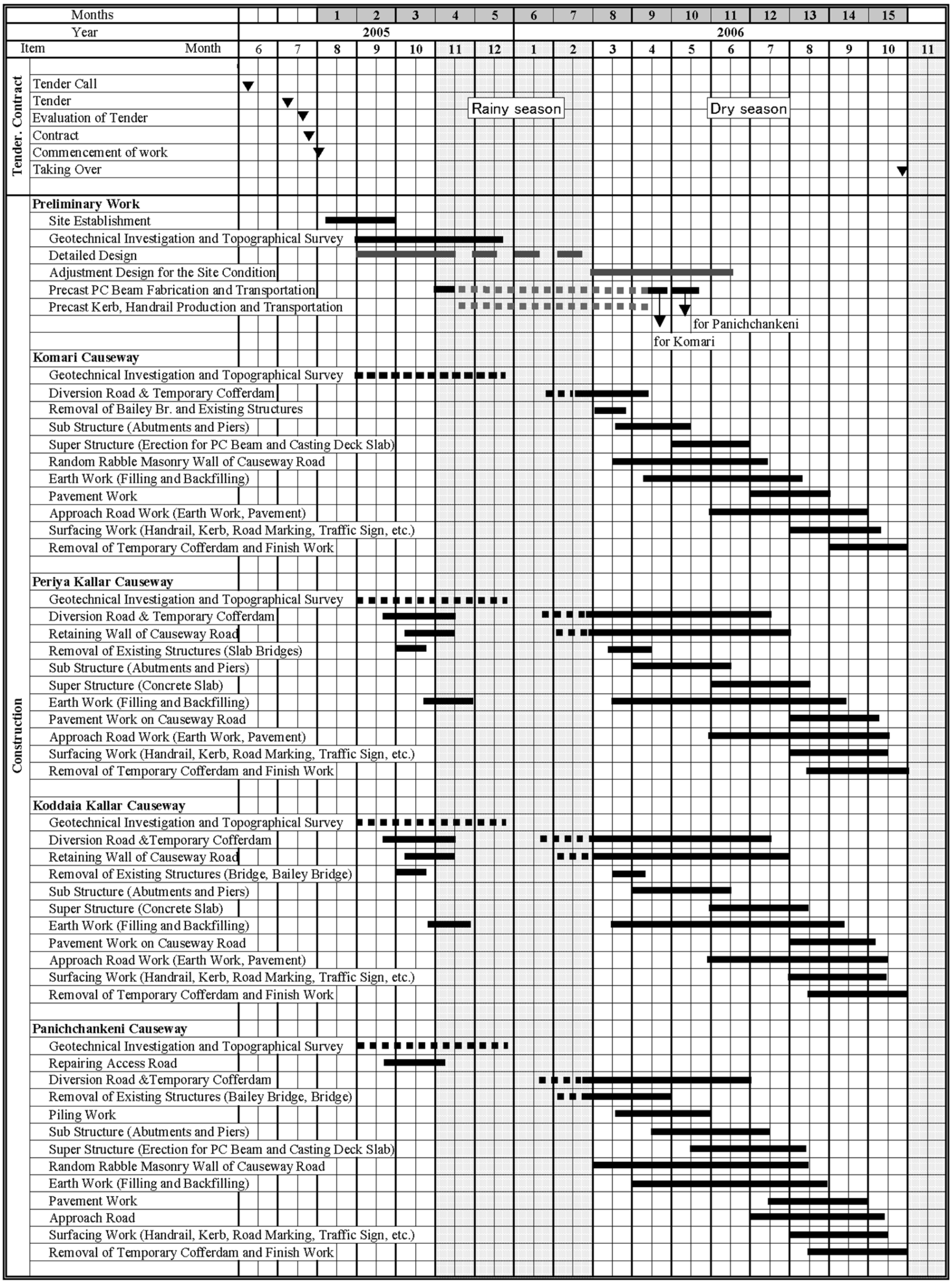
#### 4) Piling

Bored piling foundations are to be used for the PC girder bridge of the Panichchankeni Causeway. According to geological data gathered from investigations, it is intended to adopt an all casing method for piling works. Note that the piling machine has to be carried from Colombo, and an earth platform has to be constructed prior to the commencement of the piling work in order to set-up the piling apparatus.

### 5.1.5 Construction Schedule

Taking into account the weather, water levels at causeways, and the urgency of rehabilitation, the construction period was set at 15 months for the Project as shown in Table 5.1.2. As this table indicates, detailed design will require a net period of about four months and at least one month for the procurement of the design consultant, unless a design-build contract is adopted. Without a design-build system, there would be a delay of at least five months in the start of the tender process (from tender call to commencement of work） for contractors. Accordingly, in order for preparatory works such as diversion roads, temporary cofferdams, removal of existing structures, earthworks, etc. to be carried out as quickly as possible, a design-build system is necessary.

## Table 5.1.2. Construction Time Schedule



## 5.2 Cost Estimate

### 5.2.1 General

Project cost is estimated for the Emergency Recovery Project based on the results of the preliminary design and construction implementation plan for the four causeways. To arrive at total Project cost, unit rate components were prepared applying the Sri Lanka Highway Schedule of Rates (HSR) and the Japanese Cost Estimation Standard. When these two were not applicable, consultations were held with relevant contractors to obtain unit-cost information. In addition, costs were compared with those for recent major road construction projects funded by international donor agencies in Sri Lanka to confirm their reliability. Note that the total construction cost includes costs for the relocation of public utilities on the causeways (electricity and telephone lines) as the provisional sums item. The basic assumptions and methods for estimating Project costs are as follows:

- Private contractor(s) carry out all construction work.
- The unit cost of each cost component is estimated by applying the HSR for fiscal year 2003, the Japanese Civil Work Estimate Standard of 2004, the Japanese Bridge Erection Cost Estimates of 2003, and information collected from interviews with relevant contractors.
- When the HSR and Japanese standards are inadequate for providing the unit cost for a particular item, then interviews are h eld with local contractors to gather the necessary data to determine the appropriate cost.
- Currency exchange rate: JPY 1 = Rs. 0.921 (average for April 2005)
- Taxation: 15% VAT

### 5.2.2 Procurement

#### 1) Labor Force

Local contractors carry out most of the general road work in Sri Lanka and hence there is an ample labor pool with skills in civil works, except when special skills are required for work such as post-tension type of pre-stressed concrete. Note that the bridges in this Project are a pre-tension type of pre-stressed concrete and there are local construction firms capable of undertaking this work.

## 2) Supply of Machinery

As it is difficult to procure special/heavy construction machinery or large numbers of regular machinery on the East Coast, machinery will be carried from the Colombo area to ensure the smooth implementation of the Project.

## 3) Supply of Construction Materials

The major materials required for the Project and their availability in Sri Lanka are as shown in Table 5.2.1.

**Table 5.2.1. Availability of Material in Sri Lanka**

| Material | Production & Supply in Sri Lanka | Market Availability | Price for Cost Estimation |
|---|---|---|---|
| Cement | Sufficient | Available | Market price |
| Reinforcement | Diameter (D≦32mm) | Available | Market price |
| Shape steel | Not Produced | Only small size available | Market price |
| Bridge bearing | Not Produced | Not available | Imported price |
| Expansion joint | Not Produced | Not available | Imported price |

**a) Borrow Material**

The earthwork volumes necessary for the construction of the causeways could be obtained from the borrow pits shown in Table 5.2.2. The borrow pits are located at distances between 1km and 20km from the relevant sites. Details on existing borrow pits are as shown in Table 5.2.2.

**Table 5.2.2. Borrow Pits**

| No. | Borrow Pit 1 (for Komari) | Borrow Pit 2 (for Periya & Koddaia) | Borrow Pit 3 (for Panichchankeni) |
|---|---|---|---|
| Name | AA004 Road Sta. 334km | Owner's name : Mr. Thirucheheivam | Navalady, Korale Pattu |
| Location | Near Komari causeway | Virachenai, Palugumun, Periyaporathivu | A11 Sta.129+500 |
| Contact Tel. No. | Mr. Mijwad<br>Office : 067-2278793<br>Mob. : 077-6060180 | Mr. Mathivannan<br>Mob. : 077-6990426 | RDA Operation borrow pit<br>RDA Batticaloa<br>Office : 065-2224455 |
| Distance from each causeway | 1 km | 20 km | 23 km |
| Type of Site | Operation pit | Operation pit | Operation pit |
| Quantity (approx.) | 100,000m$^3$ | 1,000,000m$^3$ | 2,000,000m$^3$ |
| Previous Project (used this site) | RDA road project<br>World Vision road project | RDA road project | RDA road project |
| Type of Material | Lateritic soil | Tropical red soil | Gravelly soil |

**b) Quarry Material**

There are several operating quarry sites from which the required quarry material could be obtained, which are located at distances between 125km and 30km from the construction sites. Details on these quarry sites are given in Table 5.2.3.

## Table 5.2.3. Quarry Sites

| No. | | Quarry site 1 (for Komari) | Quarry site 2 (for Komari) | Quarry site 3 (for Komari) | Quarry site 4 (for Periya Kallar & Koddaia Kallar) | Quarry site 5 (for Periya Kallar & Koddaia Kallar) (for Panichchankeni) | Quarry site 6 (for Periya Kallar & Koddaia Kallar) (for Panichchankeni) |
|---|---|---|---|---|---|---|---|
| Name and Location | | Valanda Metal Crusher<br>Weliyaya, Obbegoda, Monaragala | Pavillian Metal Crusher<br>Monaragala | Nithe Crusher Plant<br>5 mile post, Nithe | T. Pahnitharan<br>Ammankulam, Wellavli, Mandur | Priyantha Enterprises<br>Kalahagala, Pollonnaruwa, 15km from A11 Sta.69 | Kapila Metal Crusher<br>Lakshauyana, Pollonnaruwa, 5km from A11 Sta.68 |
| Contact Tel.No. | | Mr. W.T Daynanda (055-2276552, 072-2585091) | Mr. H.R. Wickremasinghe (055-2276127) | Mr. Mijwad (Office 067-2278793, Mob 077-6060180) | Mr. K.Madhivannan (Mob 077-6990426) | (Office 078-8752127, Mob 077-7771785) | (Office 027-2225981, Mob 077-223020) |
| Distance from each causeway (approx.) | | 80 km | 80 km | 35 km | 30 km | 135 km (for Periya & Koddaia)<br>100 km (for Panichchankeni) | 125 km (for Periya & Koddaia)<br>90km (for Panichchankeni) |
| Type of Site | | Operation pit | Operation pit | Operation pit | Operation pit | Operation pit | Operation pit |
| Capacity | | 300m3/month | 53 m3/month | 1400 m3/month | 1100 m3/month | 1200 m3/month | 2800 m3/month |
| Quantity (approx.) | | 60,000m3 | 38,000m3 | 250,000m3 | 100,000m3 | 200,000m3 | 180,000m3 |
| Type of Material | | Granite Gneiss | Granite Gneiss | Granite Gneiss | Granite Gneiss | Granite Gneiss | Granite Gneiss |
| Previous Project (used this site) | | RDA road project | - | RDA road projects | RDA road project | RDA road project | RDA road project, UDA project, ADB project |
| Available size | 250mm-500mm | - | - | Available | Available | - | Available |
| | 150mm-225mm | - | - | Available | Available | - | Available |
| | 100mm | - | - | Available | - | - | Available |
| | 50mm | - | - | Available | - | - | Available |
| | 37.5mm | | - | - | - | Available | Available |
| | 19mm | Available | - | - | - | Available | Available |
| | 12.5mm | Available | - | - | - | Available | Available |
| | 6.3mm.DOWN WARDS | Available | - | - | - | Available | Available |
| | Graded : 37.5mm | Available | Available | - | - | - | Available |
| | Graded : 19mm | - | - | - | - | - | Available |
| | Graded : 12.5mm | - | - | - | - | - | Available |

#### c) River Sand

There are several river sand pits from which river sand could be obtained and they are located at distances between 70km and 15km from the construction sites (see Table 5.2.4 for details).

**Table 5.2.4. River Sand Pits**

| No. | River Sand Pit 1<br>(for Komari) | River Sand Pit 2<br>(for Periya & Koddaia) | River Sand Pit 3<br>(for Panichchankeni) |
|---|---|---|---|
| Location | Supeweva, Pottuvil<br>(from Pottuvil police station 4.5km) | Wellavali, Manuor | Devala Junction,<br>Manampitiya A11 Sta.83 |
| Contact<br>Tel. No. | Mr. Mijwad<br>Office : 067-2278793<br>Mob. : 077-6060180 | Mr. K.Madhivannan<br>Mob. : 077-6990426 | Mr. W.P.Premuda<br>071-2540306 |
| Distance from each causeway | 15 km | 25 km | 70 km |
| Type of Site | Operation pit | Operation pit | Operation pit |
| Previous Project (used this site) | RDA road project | RDA road project | RDA road project, Mahaveli project |

### 5.2.3 Unit Cost

### 1) Labor

Table 5.2.5 shows the labor unit rates on the East Coast (data from RDA) used in estimating the construction cost, which are based on an eight-hour workday.

**Table 5.2.5. Unit Rates for Labor**

| Classification | Unit rate (Rs.) |
|---|---|
| Engineer (10 years experience) | 60,000/month |
| Skilled Labor (technician) | 650/day |
| Semi-Skilled Labor | 550/day |
| Unskilled Labor | 475/day |

### 2) Materials

Table 5.2.6 indicates the unit costs for major construction materials on the East Coast. The costs for imported materials are estimated using the CIF for Colombo, including port handling and clearance charges. The costs for local materials are based on market prices in the East Coast area.

**Table 5.2.6. Unit Rates for Major Materials**

| Item | Unit | Unit Rate (Rs.) |
|---|---|---|
| Portland Cement | 50kg | 550 |
| Reinforcement Steel Bar | Ton | 80,000 |
| Bitumen 80/100 | Liter | 30 |
| Petrol | Liter | 70 |
| Diesel | Liter | 48 |

### 5.2.4 Total Project Cost

After the completion of the preliminary design, construction plan, and cost estimate, total project cost and its breakdown has been estimated and is as shown in Table 5.2.7.

**Table 5.2.7. Total Project Cost (JPY million)**

| Item | Cost |
|---|---|
| Earth work and Removal Existing Structures | 40.1 |
| Pavement and Base | 80.7 |
| Structures (including temporary work) | 489.2 |
| Incidentals (Road furniture and Drainage) | 52.0 |
| Preliminaries and Provisional sums | 150.0 |
| Construction Cost Total (JPY million) | 812.0 |

# *CHAPTER 6*

## *Preparation of Draft Tender Documents for Emergency Recovery Project*

# Chapter 6 Preparation of Draft Tender Documents for Emergency Recovery Project

## 6.1 General

In accordance with the Scope of Work agreed upon between RDA and JICA on 21st March 2005, the preparation of draft tender documents for the emergency recovery of four tsunami-damaged causeways as outlined in Chapter 3 is one of the major components to be addressed by the Study Team in its work.

In view of the urgency, nature, and scale of the Emergency Recovery Project, the Study Team proposed to apply a simple tendering procedure based mainly on JICA's guidelines for procurement. Several discussions were held between the Project's implementing agencies, who are RDA and JICA, and the Study Team to confirm the implementation system and the basic tendering conditions in order to prepare the appropriate draft tender documents. As a result, the principles for the preparation of these documents were established and are described in the following section of this chapter.

## 6.2 Principles for Preparation of Draft Tender Documents

### 1) Implementation System

The Project is to be implemented as a design-build system, which will enable the contractor to proceed in parallel with preparations for construction while carrying out the necessary detailed design work and thereby expedite the emergency recovery process.

### 2) Tender Forms, Conditions of Contract & Specifications

- The Instructions to Tenderers, Tender Forms and Contract Forms provided in JICA's sample tender documents will be used.
- The Conditions of Contract will be mainly based on the FIDIC Short Form of Contract (Green Book) - Edition 1999, which is applicable for small-scale and design-build projects, with additions or modifications based on JICA's guidelines for procurement in order to satisfy the Project's requirements.
- Specifications will essentially refer to the Standard Specifications for Road and Bridge Works published by RDA - Edition 2003, as the general or base specifications, and will be supplemented by other specifications as needed by the Study Team in order to satisfy the Project's requirements.

## 6.3 Composition of Draft Tender Documents

A set of draft tender documents prepared on the basis of the above-mentioned principles consists of the following documents and were compiled into a single volume:

Part 1: Invitation for Tenders

Section 1: Instructions to Tenderers

Section 2: Tender Forms

- Form T1: Form of Tender and Appendix to Tender
- Form T2: General Information on Tenderer
- Form T3: Financial Statement
- Form T4: General Experience
- Form T5: Particular Experience
- Form T6: List of Proposed Major Construction Plant and Equipment
- Form T7: Detailed Explanations on Design of Major Structures
- Form T8: Construction Method Statement
- Form T9: Construction Schedule
- Form T10: Organization Chart and Manning Schedule
- Form T11: Quality Control Plan
- Form T12: Safety Plan
- Form T13: Environment Control Plan

Section 3: Contract Forms

- Form C1: Contract Agreement
- Form C2: Performance Security
- Form C3: Advance Payment Security

Part 2: Conditions of Contract

Part 3: Bill of Quantities

Part 4: Design Criteria

Part 5: Specifications

Part 6: Drawings

# *CHAPTER 7*

## *Community Support Program and Social Environmental Considerations for Emergency Recovery*

# Chapter 7 Community Support Program & Social Environmental Considerations for Emergency Recovery

## 7.1 Rationale for Incorporating Community Support to the Tsunami Victims in the Emergency Recovery Project

The overall impact of the Indian Ocean tsunami of December 26, 2004 was undoubtedly very severe on most coastal areas in Sri Lanka. In terms of lives lost and properties destroyed, the East Coast appears to have been hit the hardest with nearly 150,000 persons having been displaced due to the complete or partial destruction of their houses. Many households lost their principal income earner while others lost their means of income generation, particularly in the fishing industry. The response to this tragedy from the international donor community has been prompt and substantial. However, a significant majority of those affected still continue to live in refugee camps until permanent shelters are provided. The donor community, mostly international NGOs and bilateral and multi-lateral aid agencies, has on the other hand poured in substantial amounts of material goods and food rations. It is unclear although as to how these unfortunate households will sustain their livelihoods in the future. It is in this context that the Community Support Program has been conceived for the Eastern Trunk Roads Project.

It should be noted that in the original proposal developed for the Eastern Trunk Roads Recovery, Rehabilitation and Development, the community support component considered constituted the following two elements:

- The Study Team will devise a mechanism to employ as many local residents as possible who were affected by the tsunami and who lost their means of earning a living as workers for the emergency recovery works (second stage), which is to be contained in statement of prioritized employment in the draft tender documents.
- The Study Team will develop a mechanism to revitalize communities via the implementation of the “Michinoeki” concept in the third stage.

However, following two field visits and Study Team deliberations, it was decided that the element concerning “Michinoeki” was not within the scope of the Project and impractical to be implemented. Thus, the Project has pursued only the element concerning the employment of tsunami-affected local residents for the emergency recovery works.

## 7.2 Objectives of Support Program of the Emergency Recovery Project

The support program conceived for this Project has the following objectives:

- Giving those eligible and willing tsunami victims in the vicinity of the four causeway Project sites in need of immediate income support an opportunity to earn such income by having them provide skilled or unskilled labor.
- Providing an opportunity for members of the community to make an investment through labor (skilled/unskilled) in the development of the physical infrastructure of the community.
- Injecting of financial resources into the local economy that has been seriously affected by the tsunami.

In order to achieve the above objectives, an appropriate implementation mechanism has been devised taking into consideration local conditions prevalent at the moment. It must be noted that although the target communities experienced severe losses and hardships following the tsunami, since then an unprecedented level of support and goodwill through material and non-material assistance from the international and national donor communities has poured in. Consequently, the need for livelihood assistance within the target communities may have decreased to some extent.

It also must be noted that, unlike the direct assistance provided to individuals and households by most other projects and programs involved in the tsunami relief activities, this particular project (Eastern Trunk Roads) is mainly focused on recovering and rehabilitating tsunami-damaged infrastructure, which is to be implemented through one or more contractual agreements with the private sector. As such, the proposed assistance to the target communities would be channeled through the contractors undertaking the construction projects.

## 7.3 Method of Recruiting Tsunami Victims in Emergency Recovery Works

With due consideration for the objectives and local conditions outlined above, an appropriate method has been formulated for the recruitment of able and willing tsunami victims in the emergency recovery works.

Step 1 - Assessment of Labor Availability:

Efficient and effective announcements intimating the need for casual labor in the proposed construction works would be made in all refugee camps in close proximity to the construction sites and interested individuals would be invited to register at a nominated office. The nominated office for this purpose could be that of a "Facilitator" (e.g. Sevalanka or any other active CBO in the region) invited to participate in this project. JICA's Planning Coordination Officer for tsunami affected areas in the North and East, Ms Isa IMAZATO, should be drawn into this process. [Let us assume the number registering to be X.]

Step 2 - Assessment of Labor Requirements:

The contractor/sub-contractor would endeavor to estimate its requirements for skilled and unskilled labor at each of the four construction sites on a daily/weekly basis. [Let us assume this number to be Y.]

Step 3 - Assessment of Labor Suitability:

With the use of a "checklist of criteria" specifically developed for this purpose (see below), the "Facilitator" in conjunction with the contractor's representative would assess the suitability of those who have registered to work for the Emergency Recovery Project. [Let us assume the number suitable to be Z.]

*Checklist of Criteria for Assessing Suitability*

To be eligible for work in the Emergency Recovery Project a person needs to be:

- Registered with the relevant Gramasevaka Niladhari (GN) as a tsunami victim
- An employable adult (students and the aged are not eligible)
- In good health (those with physical disabilities and/or other illnesses would be ineligible)
- In a position to his/her dedicate full-time to emergency recovery work (i.e., be free of any other obligations that would constrain working full-time)

Step 4 - Recruitment of Labor for Emergency Recovery Works:

The contractor would be required to recruit a certain number of registered persons from amongst the tsunami victims found suitable using the following simple formula, which should/could be used every time recruiting is initiated - whether, daily, weekly or on a longer basis.

If **Y** (no. of jobs) > **X** (no. of registered applicants) > **Z** (no. of suitable applicants), **then 100% of Z should be recruited.** (That is, when the required number of jobs is MORE than the number of registered applicants and the number of suitable persons is LESS than the number of persons required, ALL suitable persons should be employed)

If, **Y** (no. of jobs) < **X** (no. of registered applicants) **and Y** (no. of jobs) > **Z** (no. of suitable applicants) **then 100% of Z should be recruited.** (That is, when the required number of jobs is LESS than the number of registered applicants but MORE than the number of suitable applicants, then ALL suitable persons should be employed)

If, **Y** (no. of jobs) < **X** (no. of registered applicants) **and Y** (no. of jobs) < **Z** (no. of suitable applicants) **then 100% of Y should be recruited.** (That is, when the number of registered applicants AND the number of suitable applicants is MORE than the required number of jobs, then ALL required labor should be employed from among the tsunami victims community.)

## 7.4 Potential Risks & Risk Management

As highlighted earlier, for the humanitarian aspects of the Project to succeed, a few highly fragile and risky conditions need to be recognized and overcome. These include:

*Pricing of Labor*

Some INGOs currently operating in the region have already implemented "cash-for-work" projects involving tsunami-affected communities. These INGOs may have already established a basic daily wage for casual unskilled labor. If this wage is higher than what contractors would be offering in the emergency recovery works, there would either be no significant response from the community or a feeling of vulnerable communities being exploited would prevail. Such a situation could have a negative social impact on the overall Project.

To ensure that the above does not occur, contractors bidding for the emergency recovery works should be appropriately directed in the draft tender documents to give due consideration to the above and price labor accordingly. Some guidelines on existing conditions may be provided as appropriate.

*External Influence while Engaging Labor*

As is a common practice in Sri Lanka, there is likely to be undue pressure brought upon the contractor by special interest groups for particular individuals or segments of the community to be given preferential treatment when selecting required labor. Such practices, if not prevented, is likely to cause unnecessary animosity within the community towards the Project.

This situation could be prevented by engaging the services of an appropriate Facilitator well respected within the community to mediate and negotiate on behalf of the community.

## 7.5 Intended Community Support in the Emergency Recovery Project

The Emergency Recovery Project focus is almost entirely on the reconstruction and recovery of four tsunami ravaged causeways – Komari, Periya Kallar, Koddaia Kallar and Panichchankerni. However, the devastating effect of the tsunami, particularly on the Eastern Coast, was such that, in addition to the loss of several thousand lives and extensive property destruction, there has been a significant loss of livelihood for those who were fortunate enough to survive the tsunami. The international and national response towards this has been overwhelming, yet has fallen short of what was required to put all affected families on the path to rebuilding their lives. This Project too has explored ways and means of developing a component within the Project intended to contribute towards the community rebuilding process.

A vast majority of those affected belonged to the fishing community who had been living in the coastal belt when the tsunami hit. Most had lost their means to livelihood with the destruction of fishing boats, gear, associated implements and facilities. The international and national donor communities active in the region have been slowly but steadily providing material assistance to get several households to recommence their economic activities. However, there are those who either do not belong to the fishing community or those whose traumatic experience had been such that the sea poses more a threat than a hope and, consequently, have been seeking alternative employment. It is those households that this Project has targeted in the community support component of the Project.

The approach adopted in this Project is to provide for those willing and able amongst the tsunami-affected, opportunities in the construction sector. This is perceived as not only providing livelihood opportunities in the short-term, but also the acquisition of relevant skills used in the construction industry.

## 7.6 Instruction on Community Support in Draft Tender Documents

In order to ensure that maximum exposure is given to these opportunities, appropriate clauses had been included in the draft tender documents for the construction of the four causeways. The clauses included as "Instructions to the Tenderers" in the draft tender documents stipulates thus:

> "The Contractor will be required in particular to use local labor from among tsunami victims, and products and services that meet the requirements and stipulations of the Tender Documents, to the maximum extent possible in the execution of the Works."

Further, in providing a safeguard against exploitation of the tsunami victims in these construction projects, the draft tender documents stipulate that:

> "To encourage local tsunami victims to participate in the Project construction works as much as possible, the wage rates to be paid to them shall be equal to or higher than those being applied by international relief organizations and agencies in the sites concerned."

## 7.7 Monitoring of Community Support

In order to ensure that the community support component of the Project is implemented as intended, appropriate monitoring and evaluation mechanisms have been incorporated in the Project. Monitoring is expected to be an ongoing activity focusing on the extent to which the contractor is able to adopt the community support policies as highlighted in the draft tender documents.

For monitoring purposes, the contractor provided the Study Team through the employer the following information:

1. Actions taken or to be taken for maximizing the involvement of tsunami victims in the construction works:
   - An offer of priority to tsunami victims declared at the beginning of a recruitment interview

- Recruitment of common labor at construction sites
- Announcement of labor vacancies around refugee camps
- Advertisement of available labor vacancies in newspapers
- Priority to relatives of employed tsunami victim workers under consideration
- Monitoring of employment status

2. The contractor's statement about the responses received so far (how successful was the contractor) with respect to the above is as follows:

   "Major works have not started yet due to a two-month delay caused by social, contractual and technical problems, and so the recruitment of labor has not progressed as expected. The contractor also reported that the average wage level demanded by tsunami victims for work was almost double that of non-victims, and recruitment negotiations have till now been mostly unsuccessful. In addition, most tsunami victims with a certain skill level required by the contractor are already employed in other projects. In conclusion, the effort to employ large numbers of tsunami victims is proceeding poorly."

3. The number and percentage of tsunami victims employed by contractor is given below, with actual and planned employment shown in Tables 7.7.1. and 7.7.2, respectively.

**Table 7.7.1. Actual Employment of Labor (As of 20 January 2006)**

| Employer | | Hazama | Subcontractor A | Subcontractor B | Total |
|---|---|---|---|---|---|
| Skilled | Total | 0 | 12 | 12 | 24 |
| | Tsunami Victims | 0 | 0 | 0 | 0 |
| | | 0% | 0% | 0% | 0% |
| Semiskilled | Total | 0 | 12 | 6 | 18 |
| | Tsunami Victims | 0 | 3 | 0 | 3 |
| | | 0% | 25% | 0% | 17% |
| Unskilled | Total | 0 | 0 | 3 | 3 |
| | Tsunami Victims | 0 | 0 | 3 | 3 |
| | | 0% | 0% | 100% | 100% |
| Total | Total | 0 | 24 | 21 | 45 |
| | Tsunami Victims | 0 | 3 | 3 | 6 |
| | | 0% | 13% | 14% | 13% |

**Table 7.7.2. Planned Employment of Labor at Peak Time**

| Employer | | Hazama | Subcontractor A | Subcontractor B | Total |
|---|---|---|---|---|---|
| Skilled | Total | 0 | 60 | 12 | 72 |
| | Tsunami Victims | 0 | 10 | 3 | 13 |
| | | 0% | 17% | 25% | 18% |
| Semiskilled | Total | 0 | 60 | 6 | 66 |
| | Tsunami Victims | 0 | 20 | 3 | 23 |
| | | 0% | 33% | 0% | 35% |
| Unskilled | Total | 10 | 30 | 3 | 43 |
| | Tsunami Victims | 7 | 20 | 3 | 30 |
| | | 70% | 67% | 100% | 70% |
| Total | Total | 10 | 100 | 21 | 181 |
| | Tsunami Victims | 7 | 50 | 9 | 66 |
| | | 70% | 33% | 43% | 36% |

4. Wage rates paid or to be paid for each of the above categories:

- Skilled Labor — Rs.600 per day as planned, actually Rs.490 to Rs.750
- Semiskilled Labor — Rs.400 per day as planned, actually Rs.480
- Unskilled labor — Rs.300 per day as planned, actually Rs.300

The contractor is reported to expect to employ around 150 persons at any one time during the construction. The selection of this labor force would follow the policy mentioned below as agreed between the contractor and the sub-contractor.

- Every month the contractor would confirm the proportion of tsunami victims among the available labor pool.
- The assertion of one being a tsunami victim would be made on the basis of self-declaration by the applicant during the recruiting process.
- The application process would give priority to tsunami victims.
- However, skills to meet specific labor demands would be given the highest priority.

The contractor stated that he would hold to the standpoint that because of the emergency nature of the Project, no extra effort would be taken to identify tsunami victims if that would delay the process of recruitment and, consequently, the construction work. Rather, the responsibility to ensure a reasonable level of participation of tsunami victims is with the sub-contractor while the contractor would only be monitoring the situation and, if necessary, recommend to the sub-contractor strategies to improve the situation. The contractor also emphasized that although there is an intention to recruit labor in and around the Project site, no under-qualified persons would be employed whether or not that person is a tsunami victim. The Japanese Embassy is said to have concurred with this position

## 7.8 Evaluation of Community Support

While monitoring would be an on-going activity, a Project-life evaluation has been designed to be conducted to assess if the intended objectives are achieved and whether there are any unintended impacts arising out of the Project. In order to facilitate the monitoring and evaluation, a set of indicators to be assessed at the end of the Project have been suggested. These indicators are grouped under the following five categories — Economic, Social, Operating or Organizational, Technical and Environmental.

***Economic Indicators*** will assess the increased level of earnings of the tsunami victims engaged in the Emergency Recovery Project and estimate to what extent this income has impacted on their lifestyles. The spin-off effect on the local economy would also be monitored and estimated. Most importantly, this indicator would assess whether those employed in the Project are receiving wages and concessions in keeping with GOSL's labor policies/laws/regulations.

***Social Indicators*** will inform if the program is being implemented without any bias towards or against any particular groups (ethnic, gender, religious or any other local classification). It would also indicate if any segment(s) of the local population have been marginalized due to Emergency Recovery Project activities. Information on hardships experienced by families owing to a family member being engaged in the Project would also be collected.

***Operating & Organizational Indicators*** are required to monitor if the engagement of tsunami victims in Project are according to the recruitment guidelines outlined above and are consistently applied across all four Project sites at all times. It would also provide an insight into the working arrangements offered to those engaged on the Project and maintained during construction activities. This indicator would also be relevant and useful in negotiations between the community "facilitator" and contractor.

***Technical Indicators*** will be useful in assessing work progress; especially, with respect to the quantity and quality of work provided by the tsunami victims engaged. The impact of working conditions on the progress of the overall Project would determine if the conditions under which the original recruitment was made would have to be renegotiated.

***Environmental Indicators*** will be required to monitor what health and psycho-social impacts the Project has on tsunami victims employed on the Project as well as their families. On the other hand, any impact on the environment brought about by the work ethics and practices of the tsunami victims on the Project would also be monitored. While the Project does have a major component on social-environmental consideration, which is dealt with in the next section, the environmental indicators referred to in this section deal with only those aspects that relate to the community support element of the Project.

## 7.9 Social Environmental Consideration for Emergency Recovery

### 7.9.1 General

An environmental study for the Project has not been carried out in detail due to the urgency of the Project. However, given the vulnerability of the ecosystem of seaside lagoons through which the causeways pass, construction activities should be conducted carefully with appropriate mitigation measures for anticipated negative impacts. From the viewpoint of social impacts, involuntary resettlement can be avoided via sufficient consideration in the design stage of the approach roads. Therefore, in this section, social environmental considerations for the Project will highlight the items that need to be addressed during the construction stage.

### 7.9.2 Anticipated Negative Impacts and Mitigation Measures

#### 1) Degradation of aquatic fauna

The construction activities have the potential to degrade aquatic fauna in the lagoon due to a deterioration in water quality and to the disturbance or destruction of the habitat. The mitigation measures proposed are as follows:

- Avoid sedimentation caused by earthworks as much as possible
- Site construction camps should be at least 50 m far away from water bodies
- Discharge of waste into waterways is prohibited
- Keep oil, grease and fuel oil in closed containers with sufficient volume

of secondary containment.

### 2) Interference of local transportation

The rehabilitation of the causeways includes the replacement of bridges. As a result, construction activities might interfere with local traffic flows. The mitigation measures proposed are as follows:

- Provide a temporary bypass or allow passage through the construction area
- Provide enough edge space for one-way traffic flow

### 3) Air Quality

Transportation, loading and unloading of material generates dust particles and emission from vehicles and heavy equipment. The following mitigation measures are proposed:

- Regular maintenance of vehicle and equipment to minimize emission of pollutants
- Cover put on top of truck loads

### 4) Noise

As site preparation and the transportation of construction materials generate noise, the following mitigation measures are proposed:

- Speed limit to be applied to all trucks
- Regular maintenance of vehicles and equipment to minimize noise generation