



JAPAN INTERNATIONAL  
COOPERATION AGENCY



Republic of the Philippines  
DEPARTMENT OF  
PUBLIC WORKS AND HIGHWAYS

THE STUDY  
ON  
THE IMPROVEMENT OF EXISTING BRIDGES  
ALONG PASIG RIVER AND MARIKINA RIVER  
IN  
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT  
MAIN TEXT (2/3)

JULY 2004



KATAHIRA & ENGINEERS INTERNATIONAL



CTI ENGINEERING INTERNATIONAL CO. LTD.

## **PREFACE**

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Study on the Improvement of Existing Bridges along Pasig River and Marikina River in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched a study team headed by Mr. Tsuneo Bekki of Katahira & Engineers International, and consisting of Katahira & Engineers International CTI Engineering International Co. LTD., to the Republic of the Philippines, five times between October 2002 and June 2004.

The team held discussions with the officials concerned in the Government of the Republic of the Philippines, and conducted field surveys on eighteen bridges (seventeen bridges : existing bridges, one bridge : a new bridge) . Upon returning to Japan, the team prepared this report.

I hope that this report will contribute to the improvement of the bridges in the Republic of the Philippines and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials of the Government and those concerned in the Republic of the Philippines for the close cooperation they extended to the study.

July 2004

Kazuhisa Matsuoka  
Vice President  
Japan International Cooperation Agency

Mr. Kazuhisa Matsuoka  
Vice President  
Japan International Cooperation Agency  
Tokyo, Japan

July 2004

Dear Mr. Matsuoka,

**Letter of Transmittal**

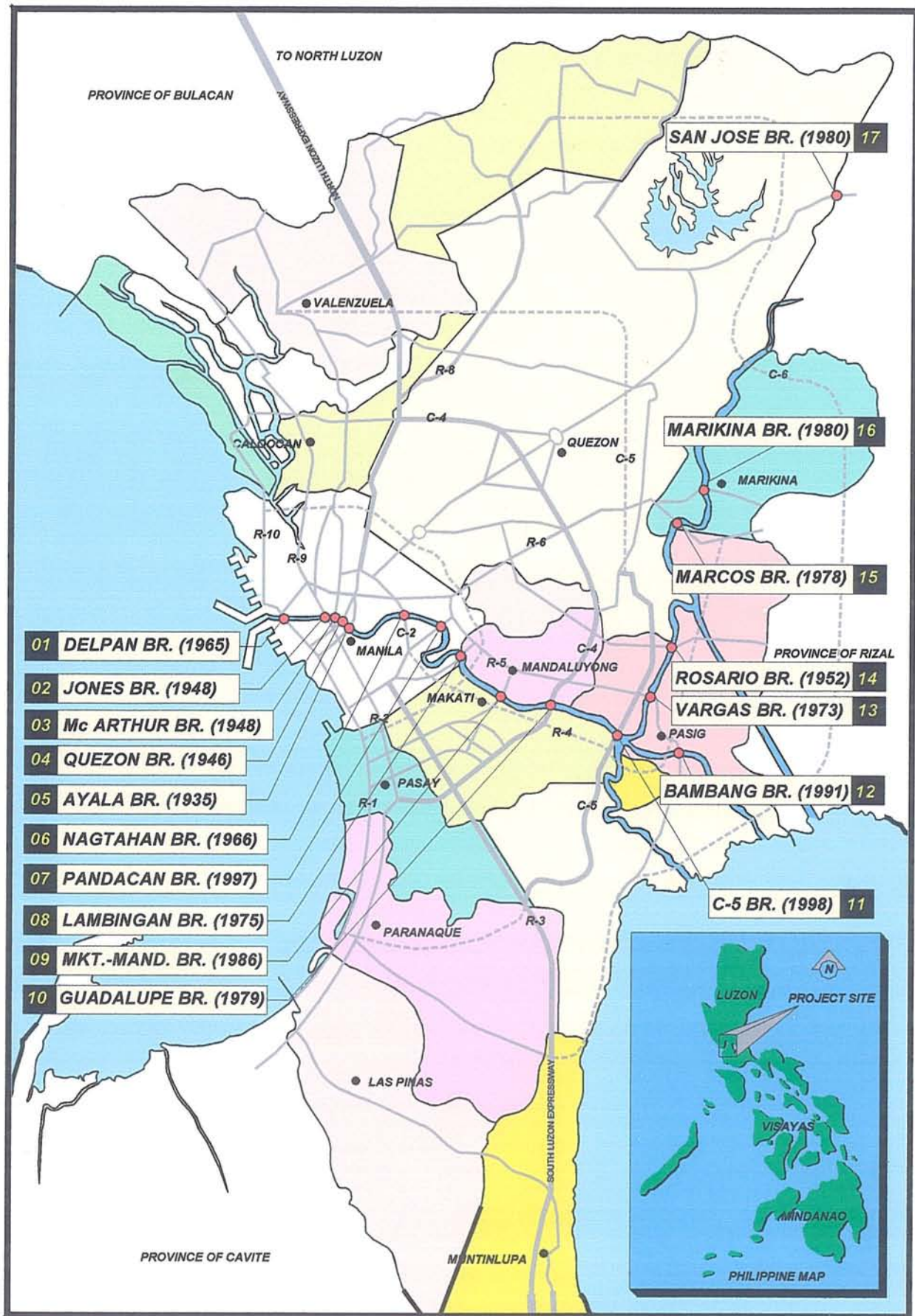
We are pleased to submit to you the report of “The Study on the Improvement of Existing Bridges along Pasig River and Marikina River in the Republic of the Philippines”. The report includes the advises and suggestions of the authorities concerned of the Government of Japan and your agency as well as the comments made by the Department of Public Works and Highways and other authorities concerned in the Republic of the Philippines.

This report studies and analyses the condition of seriously and heavily damaged and deteriorated existing seventeen (17) bridges along Pasig River and Marikina River and presents the improvement works of these bridges. The report also studies the construction of new bridge in line with improvement of traffic function of Ayala Bridge. Moreover, this report proposed the urgent improvement works of seven (7) bridges (existing six (6) bridges and new construction of one (1) bridge) to be implemented in the period 2004 – 2010. The Study concludes that these projects are technically, economically, financially and environmentally viable and will contribute the socio-economic development in Metro Manila. In view of the urgency of improving bridges in Metro Manila, we recommend the Government of the Philippines to implement the projects with top priority.

We wish to take this opportunity to express our sincere gratitude to your agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure and Transport. We also wish to express our deep gratitude to the Governmental Agencies concerned in the Republic of the Philippines for the close cooperation and assistance extended to us during the Study. We hope this report will contribute to the development of Metro Manila.

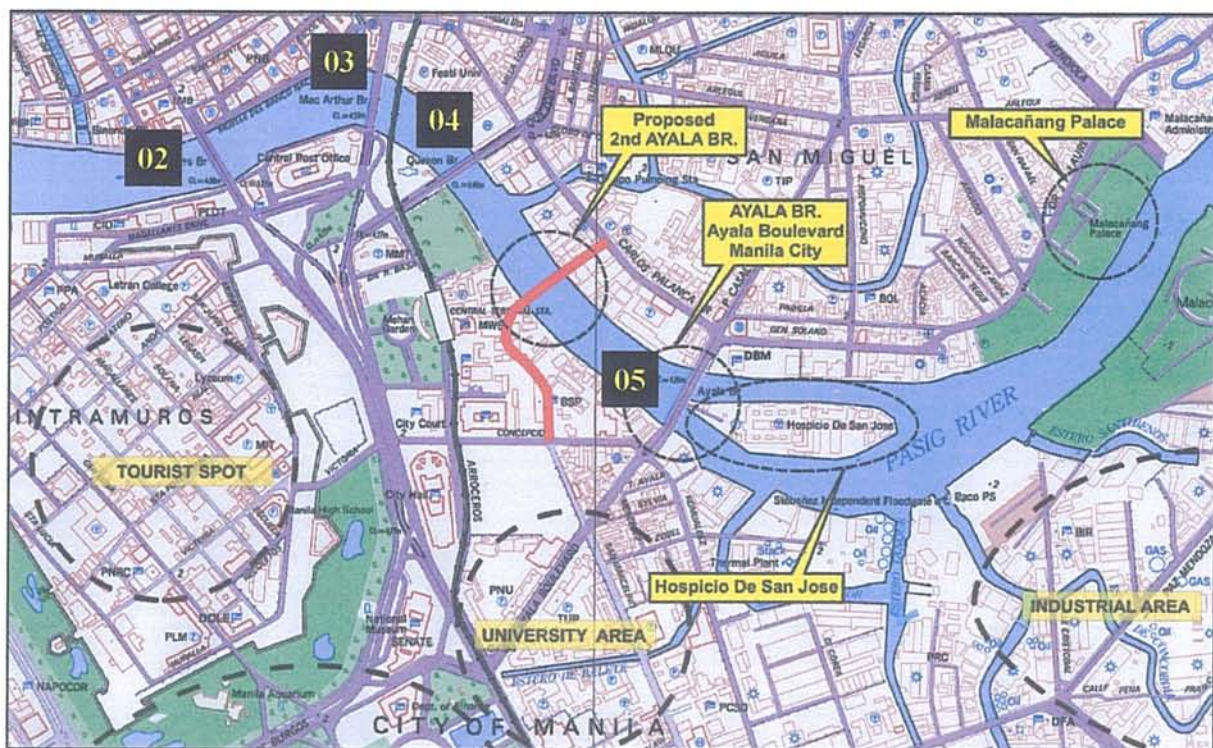
Very truly yours,

Mr. Tsuneo BEKKI  
Team Leader  
of the Study on the Improvement of Existing Bridges  
along Pasig River and Marikina River  
in the Republic of the Philippines



LOCATION MAP OF THE PROJECT

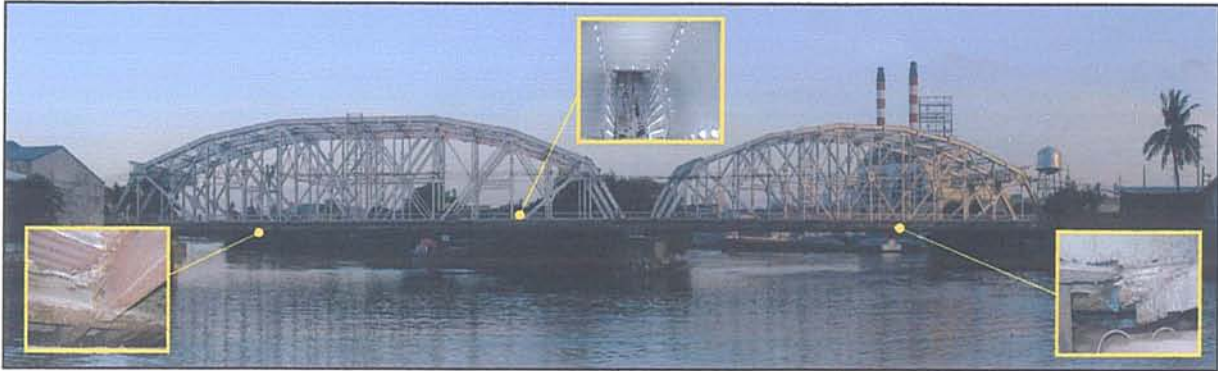




**VICINITY OF PROPOSED SECOND AYALA BRIDGE**

- 02 – JONES BRIDGE (1948)
- 03 – Mc ARTHUR BRIDGE (1948)
- 04 – QUEZON BRIDGE (1946)
- 05 – AYALA BRIDGE (1935)

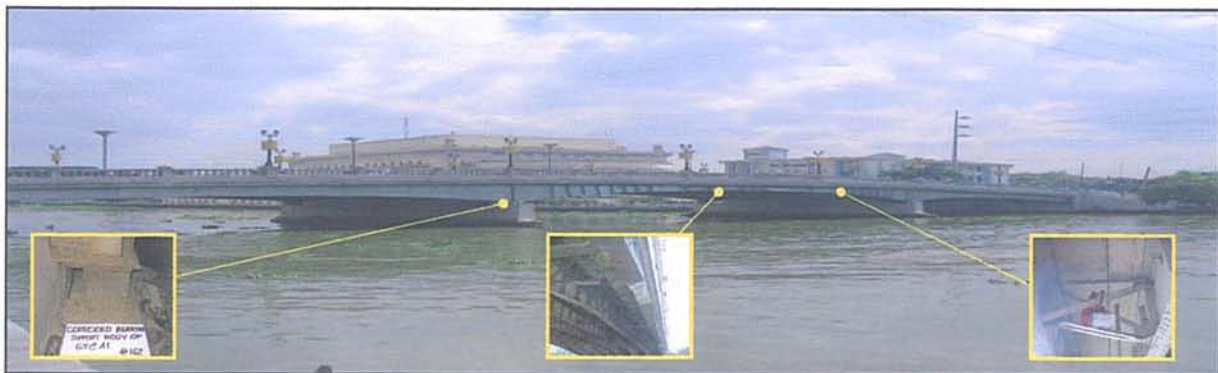
## PHOTOGRAPH OF MAIN BRIDGES



**Ayala Bridge**



**Proposed Second Ayala Bridge**



**Jones Bridge**





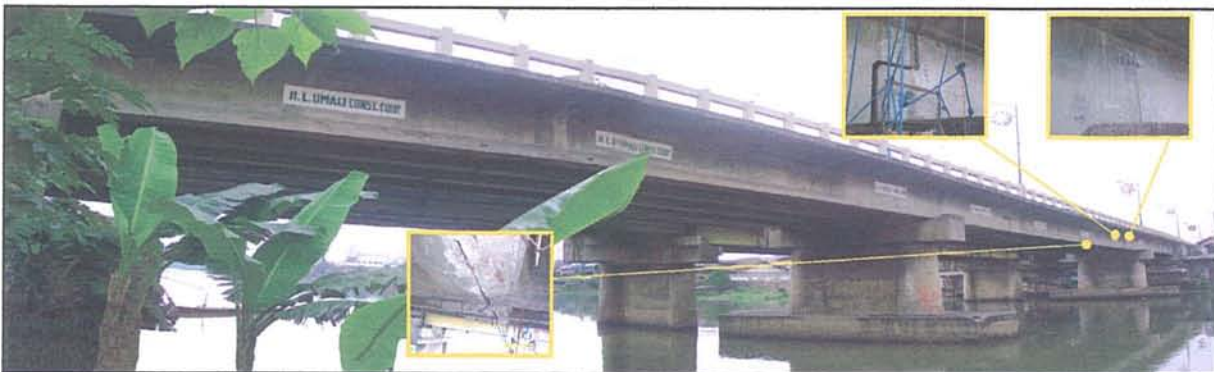
**Quezon Bridge**



**Lambingan Bridge**



**Guadalupe Quezon**



**Vargas Bridge**

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## ABBREVIATIONS

<b>AADT</b>	: Average Annual Daily Traffic
<b>AASHTO</b>	: American Association of State Highway and Transportation Officials
<b>ADB</b>	: Asian Development Bank
<b>ADT</b>	: Average Daily Traffic
<b>AIP</b>	: Annual Infrastructure Program
<b>AMSL</b>	: Above Mean Sea Level
<b>APL</b>	: Adaptable Program Loan
<b>AS</b>	: Allowable Stress
<b>ASD</b>	: Allowable Stress Design
<b>BCA</b>	: Benefit / Cost Analysis
<b>BCGS</b>	: Bureau of Coast and Geodetic Survey
<b>BMS</b>	: Bridge Management System
<b>BOC</b>	: Bureau of Construction
<b>BOD</b>	: Bureau of Design
<b>BOE</b>	: Bureau of Equipment
<b>BOM</b>	: Bureau of Maintenance
<b>BORS</b>	: Bureau of Research and Standards
<b>BOT</b>	: Built, Operation and Transfer
<b>BPH</b>	: Bureau of Public Highways
<b>BRP</b>	: Bridge Retrofit Project
<b>BRS</b>	: Bureau of Research and Standard
<b>BSP</b>	: Boy Scout of the Philippines
<b>BSWM</b>	: Bureau of Soils and Water Management
<b>CGS</b>	: Coast Guard Station
<b>COD</b>	: Chemical Oxygen Demand
<b>COE</b>	: Certificate of Exemption
<b>CLUP</b>	: Comprehensive Lands Use Plan
<b>CPDO</b>	: City Planning and Development Office
<b>Danida</b>	: Danish International Development Assistance

<b>DAO</b>	: Department Administrative Order
<b>DBM</b>	: Department of Budget and Management
<b>DENR</b>	: Department of Environment and Natural Resources
<b>DEO</b>	: District Engineering Office
<b>DIA</b>	: Direct Impact Area
<b>DO</b>	: Department Order
<b>DO</b>	: Dissolved Oxygen
<b>DOTC</b>	: Department of Transportation and Communications
<b>DPH</b>	: Department of Public Highways
<b>DPWH</b>	: Department of Public Works and Highways
<b>DPWTC</b>	: Department of Public Works, Transportation and Communications
<b>ECA</b>	: Environmental Critical Area
<b>ECC</b>	: Environmental Compliance Certificate
<b>EIA</b>	: Environmental Impact Assessment
<b>EIAPO</b>	: Environmental Impact Assessment Project Office
<b>EIRR</b>	: Economic Internal Rate of Return
<b>EIS</b>	: Environmental Impact Statement
<b>EMB</b>	: Environmental Management Bureau
<b>EMK</b>	: Equivalent Maintenance Kilometer
<b>EO</b>	: Executive Order
<b>EUAC</b>	: Equivalent Uniform Annual Cost
<b>EVF</b>	: East Valley Fault
<b>FCA</b>	: First Cost Analysis
<b>FTI</b>	: Flood Terminal Incorporated
<b>FYBCR</b>	: First Year Benefit Cost Ratio
<b>GAA</b>	: General Appropriate Act
<b>GMA</b>	: Greater Manila Area
<b>GNP</b>	: Gross National Product
<b>GOJ</b>	: Government of Japan
<b>GOP</b>	: Government of the Philippines



<b>GRDP</b>	: Gross Regional Domestic Product
<b>HDSJ</b>	: Hospicio de San Jose
<b>HPD</b>	: Historical and Preservation Division
<b>HTL</b>	: Highest Tide Level
<b>IBRD</b>	: International Bank for Reconstruction And Department
<b>ICC</b>	: Investment Coordinating Committee
<b>ID</b>	: Inspectorate Division
<b>IEE</b>	: Initial Environmental Examination
<b>IIA</b>	: Indirect Impact Area
<b>IRR</b>	: Implementing Rules and Regulations
<b>ISD</b>	: Inventory Statistics Division
<b>JBIC</b>	: Japan Bank for International Corporation
<b>JICA</b>	: Japan International Cooperation Agency
<b>JRA</b>	: Japan Road Association
<b>LBCR</b>	: Laguna de Bay Coastal Road
<b>LCA</b>	: Lifecycle Analysis
<b>LF</b>	: Load Factor
<b>LFD</b>	: Load Factor Design
<b>LGUs</b>	: Local Government Units
<b>LOS</b>	: Level of Service
<b>LR</b>	: Load Rating
<b>LRF</b>	: Load and Resistance Factor
<b>LRFD</b>	: Load Resistance Factor Design
<b>LTFRB</b>	: Land Transportation Franchising and Regulatory Board
<b>LTO</b>	: Land Transportation Office
<b>LTPBMC</b>	: Long Term Performance Based Maintenance Contract
<b>MARINA</b>	: Maritime Industry Authority
<b>MBA</b>	: Maintenance By Administration
<b>MBC</b>	: Maintenance By Contract
<b>MBE</b>	: Manila Bay Expressway

<b>MCGS</b>	: Marikina Central Gate Structure
<b>MCTE</b>	: Manila-Cavite Toll Expressway
<b>MGB</b>	: Mines and Geosciences Bureau
<b>MHHW</b>	: Mean Higher High Water
<b>MMDA</b>	: Metro Manila Development Authority
<b>MMD</b>	: Monitoring and Method Division
<b>MMETROPLAN</b>	: Metro Manila Transport, Land Use and Development Planning Project
<b>MMUEN</b>	: Metro Manila Urban Expressway Network
<b>MMUESS</b>	: Metro Manila Urban Expressway System Study
<b>MMUSTRAP</b>	: Metro Manila Urban Transportation Strategy Planning Project
<b>MMUTDP</b>	: Metro Manila Urban Transportation Development Plan
<b>MMUTIP</b>	: Metro Manila Urban Transportation Improvement Project
<b>MMUTIS</b>	: Metro Manila Urban Transportation Integration Study
<b>MMUTPS</b>	: Metro Manila Urban Transportation Planning Study
<b>MNT</b>	: Manila North Tollway
<b>MOOE</b>	: Maintenance, Operations and Other Expenses
<b>MPH</b>	: Ministry of Public Highways
<b>MPW</b>	: Ministry of Public Works
<b>MPWH</b>	: Ministry of Public Works and Highways
<b>MRT</b>	: Metro Rail Transit
<b>MSHW</b>	: Mean Springs High Water Level
<b>MSL</b>	: Mean Sea Level
<b>MTC</b>	: Ministry of Transportation and Communication
<b>MTDP</b>	: Medium-Term Transportation Development Plan
<b>MTPDP</b>	: Medium-Term Philippine Development Plan
<b>MVFS</b>	: Marikina Valley Fault System
<b>MVUC</b>	: Motors Vehicle Users Charge
<b>NAIA</b>	: Ninoy Aquino International Airport
<b>NAPOCOR</b>	: National Power Corporation
<b>NEDA</b>	: National Economic Development Authority

<b>NEPC</b>	: National Environmental Protection Council
<b>NG</b>	: National Government
<b>NHA</b>	: National Housing Authority
<b>NHI</b>	: National Historical Institute
<b>NLE</b>	: North Luzon Expressway
<b>NLEE</b>	: North Luzon Expressway East
<b>NPV</b>	: Net Present Value
<b>NRIMP</b>	: National Roads Improvement and Management Program
<b>NSCB</b>	: National Statistical Coordination Board
<b>NSCP</b>	: National Structural Code of the Philippines
<b>NSO</b>	: National Statistics Office
<b>NCR</b>	: National Capital Region
<b>NHI</b>	: National Historical Institute
<b>OD</b>	: Origin Destination
<b>OSG</b>	: Office of Solicitor General
<b>PAF</b>	: Project Affected Families
<b>PAGASA</b>	: Philippine Atmospheric Geophysical Astronomical Services Administration
<b>PAP</b>	: Project Affected Person
<b>PAR</b>	: Philippine Area of Responsibility
<b>PCB</b>	: Polychlorinated Biphenyls
<b>PCG</b>	: Philippine Coast Guard
<b>PCU</b>	: Passenger Car Unit
<b>PHIVOLCS</b>	: Philippine Institute of Volcanology and Seismology
<b>PHMMS</b>	: Philippine Highway Maintenance Management System
<b>PIAM</b>	: Participatory Impact Assessment Method
<b>PIP</b>	: Public Investment Program
<b>PLDT</b>	: Philippine Long Distance Telephone Company
<b>PMO</b>	: Project Management Office
<b>PMP</b>	: Preventive Maintenance Program
<b>PNCC</b>	: Philippine National Construction Corp.

<b>PPA</b>	: Philippine Ports Authority
<b>PPD</b>	: Planning and Programming Division
<b>PPP</b>	: Public-Private Partnership
<b>PPP</b>	: Piso Para sa Pasig
<b>PRDP</b>	: Pasig River Development Program
<b>PRRC</b>	: Pasig River Rehabilitation Commission
<b>PRRP</b>	: the Pasig River Rehabilitation Program
<b>PS</b>	: Planning Service
<b>PSCG</b>	: Pre-stressed Concrete Girder
<b>PSG</b>	: Presidential Security Group
<b>PTFRPR</b>	: Presidential Task Force on the Rehabilitation of the Pasig River
<b>PTM</b>	: Philippine Transverse Mercator
<b>PUB</b>	: Public Utility Bus
<b>PUJ</b>	: Public Utility Jeep
<b>PW</b>	: Present Worth
<b>PWA</b>	: the Public Works Act
<b>QA</b>	: Quarterly
<b>RA</b>	: Republic Act
<b>RBIA</b>	: Road and Bridge Information Applications
<b>RDC</b>	: Regional Development Council
<b>RF</b>	: Rating Factor
<b>RHT</b>	: Recorded Highest Tide
<b>RIS</b>	: Road Information System
<b>RMS</b>	: Root-Mean-Square
<b>RO</b>	: Regional Office
<b>ROW</b>	: Right-of-Way
<b>RRS</b>	: River Rehabilitation Secretariat
<b>SAPROF</b>	: Special Assistance for Project Formation
<b>SLE</b>	: South Luzon Expressway
<b>STTC</b>	: Saving Travel Time Cost

<b>SVOC</b>	: Saving Vehicle Operating Cost
<b>TCM</b>	: Traffic Capacity Manual
<b>TD</b>	: Tropical Depression
<b>TSC</b>	: Transportation Systems Center
<b>TSP</b>	: Total Suspended Particulate
<b>TSS</b>	: Total Suspended Soil
<b>TT</b>	: Tropical Typhoon
<b>TTC</b>	: Travel Time Cost
<b>TWG</b>	: Technical Working Group
<b>UFG</b>	: Ultrasonic Flaw Detection Test
<b>UP-NCTS</b>	: National Center for Transportation Study
<b>UPV</b>	: Ultrasonic Pulse Velocity
<b>URPO</b>	: Urban Road Projects Office
<b>UTG</b>	: Ultrasonic Thickness Gauging
<b>UTSMMA</b>	: Urban Transport Study in the Manila Metropolitan Area
<b>VFC</b>	: Vehicle Fixed Cost
<b>VOC</b>	: Vehicle Operating Cost
<b>WDDT</b>	: Daily Traffic Volume at Weekday
<b>WEDT</b>	: Daily Traffic Volume at Weekend
<b>WVF</b>	: West Valley Fault

# **PART III**

## **FEASIBILITY STUDY OF AYALA BRIDGE IMPROVEMENT PLAN**



# **CHAPTER 13**

## **DETAILED BRIDGE SURVEY AND ASSESSMENT**

## CHAPTER 13

### DETAILED BRIDGE SURVEY AND ASSESSMENT

#### 13.1 REVIEW OF DESIGN AND REPAIR WORKS

The detailed bridge survey and assessment is discussed in line with the flow chart shown in **Figure 13.1-1**. This survey level corresponds to the “Feasibility Study Level” as defined in the Manual prepared by the Study Team.

##### 13.1.1 Review of Design

###### (1) Outline of Ayala Bridge

The following information are contained in the Design Notes of the Ayala Bridge As-Built drawings obtained by the Study Team:

- The east and middle trusses of the north span were constructed in 1935,
- The west truss of the north span was constructed in 1950,
- Three trusses of the south span were constructed in 1950,
- The east and middle trusses of the south span were replaced with the present two trusses,
- Two east trusses of the south span were originally constructed in the early 1900, but were reconstructed in 1950 due to bridge widening,
- The west parts of the abutment and the pier were added to the existing substructures in 1950.

###### (2) General Notes of Reconstruction of Ayala Bridge in 1950

- 1949 A.A.S.H.O. Standard Specifications For Highway Bridge
- Live Load MS18, Design Unit Stresses:  $f_s = 124$  MPa,  $f_c = 6.9$  MPa,  $n = 10$ .
- Philippine Government Standard Specifications for Highways and Bridges (August 1948) was adopted.

###### (a) Dimensions

Dimensions and elevations are based on the following sources of information:

- 1935 Bureau of Public Works Plan for the Original Bridge Addition.
- 1947 Plan of Bridge Site Survey by the Office of the City Engineer Manila
- 1948 Bureau of Public Works Plan for Bailey Addition; site of the west roadway.

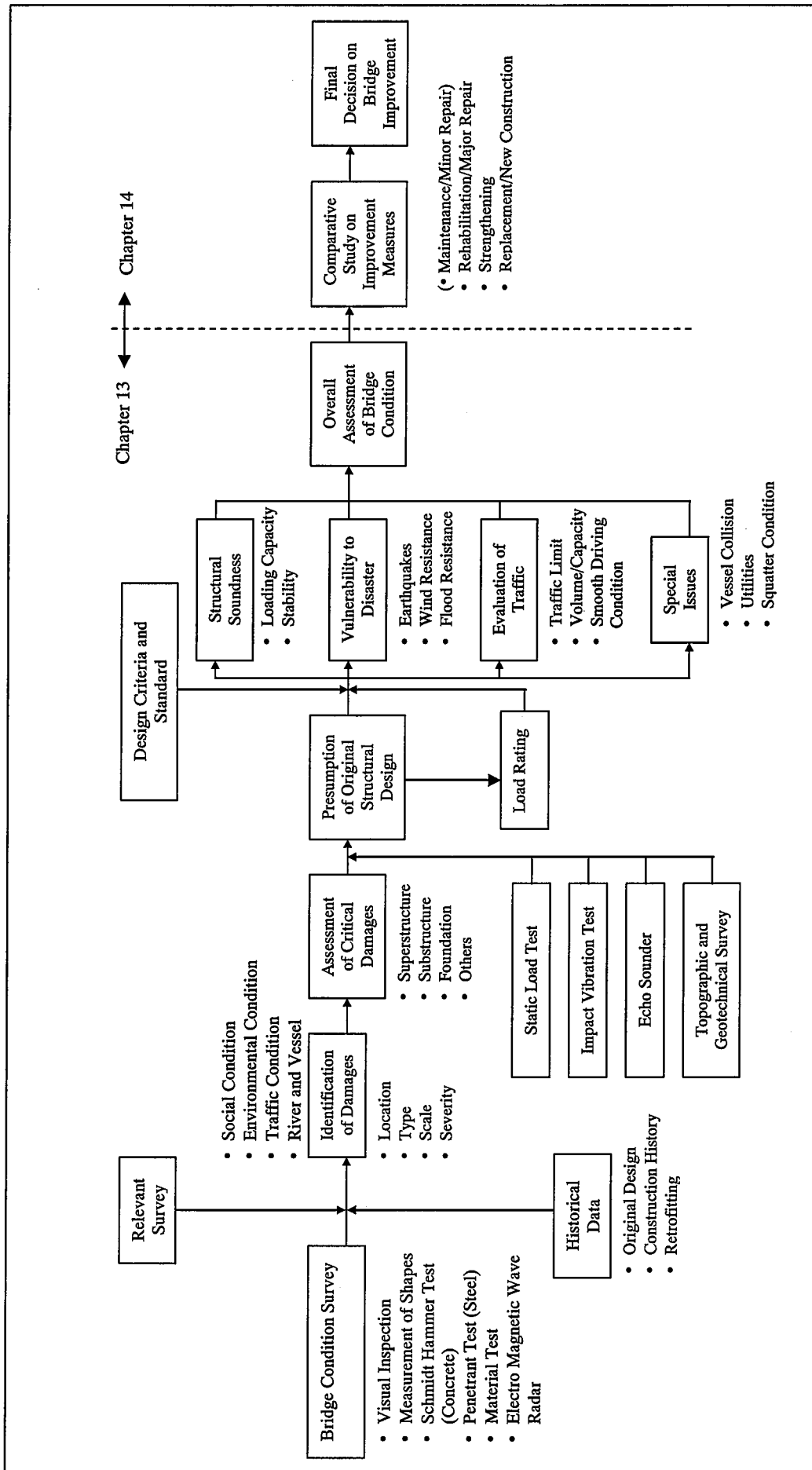


Figure 13.1-1 Flow Chart of Detailed Bridge Survey and Assessment

- 1945 U.S. Army Plan for Pony Trusses (At the site of the east roadway, south span)
- 1949 Joint Details and Camber Information Supplied by the Office of the City Engineer on the Basis of field measurement.
- 1949 U.S. Bureau of Public Road field measurements.

### (b) Construction Materials

#### Concrete

Concrete used is Class “A” concrete with  $f_c = 6.9$  MPa.

#### Reinforcing Steel

Reinforcing steel bars used has allowable stress,  $f_s = 124$  MPa.

#### Structural Steel

Structural Steel with allowable stress of  $f_s = 248$ MPa was used with  $\phi 22$ mm rivets.

### 13.1.2 Review of Rehabilitation Works

Figure 13.1.2-1 shows a comparison of the bridge condition before and after the rehabilitation works done using local funds for the Ayala Bridge in 2002.

#### (a) Outline of the Works

##### Rehabilitation of Lower Chords

After surface preparation with wire brushes, the lower chords were strengthened by welding steel plates and angle bars, as shown in Figure 13.1.2-2 (a) and (b).

##### Joint Area of Lower Chords

Joint area of lower chords were strengthened by fillet welding of steel plates onto existing gusset plates as shown in Figure 13.1.2-2 (c).

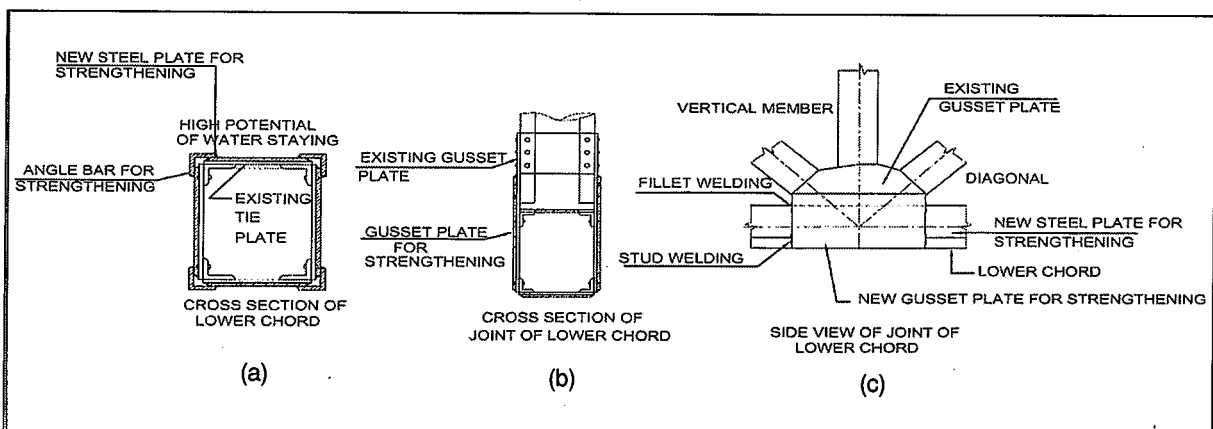


Figure 13.1.2-2 Rehabilitation of Lower Chords

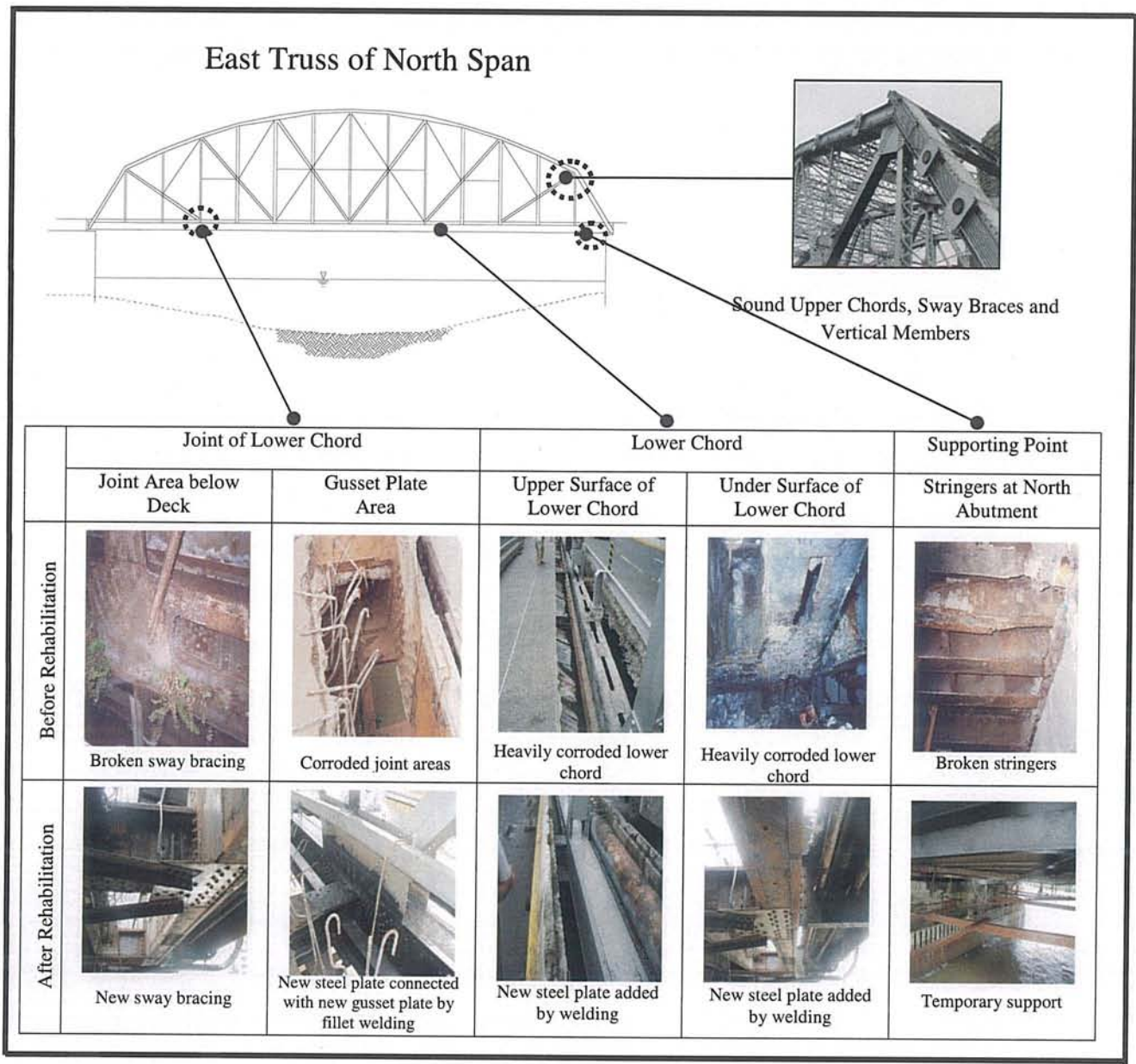


Figure 13.1.2-1 Before and After Rehabilitation Works for Ayala Bridge (Year 2002)

### **Floor System**

The ends of stringers were heavily corroded and partially broken. Under the rehabilitation works, broken stringers on the upstream side of the north span were supported by a temporary structure support, as shown in **Figure 13.1.2-1**.

#### **(b) Problems/Issues of Past Rehabilitation**

An In-Depth Survey was recommended for the Ayala Bridge considering the conditions below following the rehabilitation works.

- The fillet welding of steel plates for strengthening onto existing gusset plates is considered to be insufficient in terms of the increase of structural capacity. Prime members should be connected (butt welded) with each other.



- Stud welding between steel plates strengthening for lower chords and gusset plates is considered to be insufficient for strong tension forces. New gusset plates should overlap with adequate length with new steel plates for strengthening.
- The level of present rehabilitation is considered to be a temporary emergency countermeasure because broken stringers are just supported by only a temporary structure.
- The inner faces of lower chords have high potential for corrosion because they are not closed completely. This will accelerate corrosion of the inner steel plate.
- New steel plate added to existing one of the lower chords is connected by two angle bars on each side as shown in **Figure 13.1.2-2 (a)**. Leaking water will easily stay because water flow is blocked by these angle bars. This will accelerate corrosion of the new steel plate.

### 13.1.3 Historical Background

In 1871, the construction of two bridges was recommended, to connect the two opposite banks of the Pasig River. The first bridge would connect the Arrabal of San Miguel with the Isla de Convalecencia, which is located at the center of the Pasig River. The second bridge would connect the Isla de Convalecencia with the Barrio of Concepcion.

The project began in 1872 and the Ayala Bridge was opened to the public in 1880. When completed, the bridge was called as the Puente de Convalecencia. However, several years later, it was commonly referred to as the Puentes de Ayala, after the famous industrial factory owned by the Ayala-Roxas family at the Arrabal of San Miguel to which the bridge led.

**Figure 13.1.3-1** shows the Ayala Bridge constructed in 1876, which crossed the river in two independent sections that converged on Convalecencia Island. Three low arches and a lower platform, all of which were timber-built, formed each of these sections.

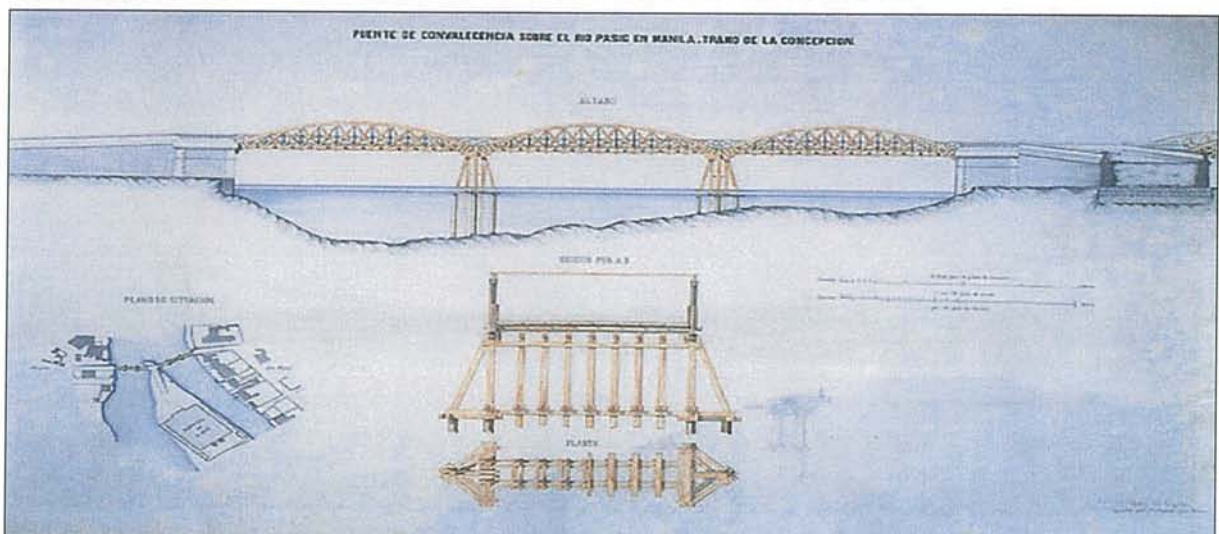


Figure 13.1.3-1 Ayala Bridge (South Span Side)



In 1882, repair works were made in the bridge, following which another re-assessment of the bridge was conducted for possible repairs to be executed as shown in **Figure 13.1.3-2**. Although scarcely ten years had passed since it was opened, by 1889 the Ayala Bridge was in a dangerous condition. The section between the island and the San Miguel district collapsed, and only a few months later the conception section followed suit.



Figure 13.1.3-2 Ayala Bridge After Repair Works (Added Pier at the Center of Right Span) in 1890 (South Span Side)

During the early American period, a new proposal to replace the old bridge with a new steel superstructure was made. New construction started in March 1906. The bridge which originally was composed of two bridges, thus plural nomenclature of Puentes de Ayala, became one continuous riveted structure with pin bearings, made up of two spans of Pratt double type with a curved upper chord, having a clear roadway width of 6.70m and two sidewalks of 1.75m wide. The new bridge was opened to public traffic on August 13, 1906. This new bridge became the original shape of the present Ayala Bridge.

In 1950 after the Second War, the replacement and additional new bridge construction works were conducted. Through these major works the present Ayala Bridge was constructed and has maintained its original configuration like the curved upper chord since 1906, as shown **Figure 13.1.3-3**.

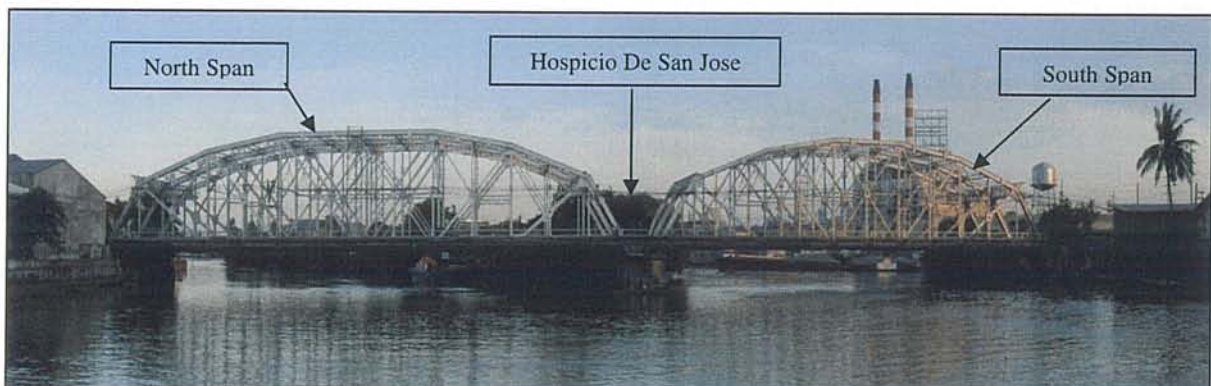


Figure 13.1.3-3 Panoramic View of Present Ayala Bridge (Looking East)

The National Historical Institute (NHI), which is one of government organizations endorsing the issuance of the ECC, has declared the Ayala Bridge as a historical legacy and landmark which should be preserved for posterity.

## 13.2 NATURAL CONDITION SURVEY

### 13.2.1 Topographic Survey

#### (1) Control Monuments

The control monument for the topographic survey is Station MMA-47, from Roxas Boulevard turning right to CCP Complex along Vicente Sotto Road. It is located in the center island of the said road between No. 2 and No. 3 round plant box about 25m from Roxas Blvd. fronting the Traders Hotel and North East side of CCP vicinity lawn. Station mark is the head of a 2 in. copper nail centered in cement putty with inscription "MM-47, 1995".

WGS84 Coordinates: N  $14^{\circ} 33' 28.92840''$  / E  $120^{\circ} 59' 13.27127''$  Ellipsoidal Ht: 48.6524 m

The established station was used as take-off points and a closed loop traverse was conducted within the project area as prescribed in the Manual for Land Surveys in the Philippines. The elevation was established using the three wire differential leveling method.

#### (2) Stationing

The longitudinal stationing was reckoned from the center of the pier, which is Sta. 0+169.049 based on the original plan. The following are the established control points:

Station	Northing	Easting	Elevation	Description
BM 1 = GPS 1	1,613,829.09	498,348.90	12.159	A concrete monument with concrete nail driven on top, located inside the Muslim compound, 20 m. away from a basketball court and 1 m. from a wall, 70 m. downstream of the 2 <sup>nd</sup> bridge approach.
BM 2 = GPS 2	1,613,687.53	498,342.31	11.89	A concrete monument with concrete nail driven on top, located at the bank of Pasig River, 15 m. away from Ayala Bridge, left of the 1 <sup>st</sup> approach.
BM 3	1,613,596.90	498,434.76	13.269	A concrete monument with concrete nail driven on top, located near a sari sari store beside the PLDT Compound, 100 m. right of the 1 <sup>st</sup> approach.
BM 4	1,613,660.13	498,490.81	11.801	A concrete monument with concrete nail driven on top, located beside the canteen inside the Hospicio de San Jose compound. It is parallel to BM No. 3, 2 m. from a wall.
BM 5	1,613,730.19	498,515.07	12.106	A concrete monument with concrete nail driven on top, located inside Hospicio de San Jose, 3 m. from boundary wall, 110 m. from Ayala Bridge.
BM 6	1,613,782.35	498,522.40	12.022	Located on top of footpath at the right side of Pasig River and is beside the DBM Building, 3 m. away from the boundary wall, 90m. from the bridge.

#### (3) Topographic Survey

Topographic survey was conducted using the established control points and through the use of a Total Station with an Electronic Field Book, sideshots were taken at all natural and man-made features. Also, sideshots were taken at ground points at suitable interval to come-up

with a terrain model reflecting the true topography of the site. The scope of work is listed in **Table 13.2.1-1** and the result is given in **Appendix 13.2.1-1**.

Table 13.2.1-1 Scope of Work

Description	Original Scope	Actual Work
Control Point Survey (GPS)	1	2
Profile Leveling	Bridge Section (150m), and 200 m. each of approach road on both sides of the bridge, TOTAL = 550m.	Bridge Section (150m), and 200 m. each of approach road on both sides of the bridge, TOTAL = 500m.  Six (6) intersecting Roads, TOTAL = 755m.
Cross Sectioning	Bridge section (150 m): 10m interval Approach Road (400 m): 20m. interval Width: Bridge width 25m+50m. each on both sides (125 m.) TOTAL = 35 sections	Bridge section (150 m): 10m. interval Approach Road (400 m): 20m. interval Width: Bridge width 25m+50m. each on both sides (125 m.), TOTAL = 38 sections  Bridge section showing the river cross section, TOTAL = 14 sections
Topographic Survey	500m length by 125m width, TOTAL = 6.9 ha.	580m length by 240m width, TOTAL = 9.8 ha.  Topo (features) of Hospicio de San Jose, TOTAL = 3.5 ha.
River Cross-Section Survey	Both sides of bridge: 2 sections, upstream side: 2 sections, downstream side : 2 sections, TOTAL = 6 sections	Both sides and centerline of bridge: 3 sections, upstream side: 3 sections, downstream side: 3 sections, TOTAL = 9 sections  1.0m interval sounding at abutments and pier, TOTAL = 0.162 ha.

### 13.2.2 Geotechnical Survey

One borehole was drilled near the bridge pier, which was accessed through the Hospicio de San Jose.

The borehole was advanced from the ground surface down to the 44.83m by the wash boring and rotary drilling method. The drilling on the upper 12m of the soil revealed clayey to non-plastic sands that exhibited loose to medium dense soil conditions. SPT values appeared erratic with no noticeable increasing/decreasing trend. Beneath -12m is a 4m thick layer of clay that relate to soft to very stiff consistency. Below is a 1.0m lens of medium dense, non-plastic silt. Following this layer is a two-meter thick, very loose, silty sand layer with SPT values that are less than 5 blows per 305mm sampler penetration.

Comprising the remainder of the drilling depths are 12m thick, moderate to highly plastic clays that exhibited medium to hard consistencies. It was noted that the continuous refusal blow counts, relating to more than 50 blows stated at -40.78m. The materials nearest to the bottom of the drilling (below -41.69m and until -44.83m) are very dense sands with refusal blow counts. Subsurface conditions are presented in the form of soil profile and boring logs, these are shown in **Appendix 13.2.2-2**.



### 13.2.3 Scour Survey

An Echo Sounder (Hondex PS-7 LCD Digital Sounder) combined with Total Station was used for the determination of the riverbed configuration, with observations taken at every 1 meter intervals at the abutments and pier.

#### Preparation of the Plan

The processing of the topographic and hydrographic data was done using SDR Mapping and Design Software. The processing includes Feature Codes and contour generation.

The riverbed configuration covering 115 meters downstream and 115 meters upstream portion with an estimated area of 2.85 hectares has been determined through the use of a Hondex PS-7 LCD Digital Sounder for depth measurement and a Total Station for position/coordinate.

River cross-sections parallel along the bridges structure were taken at 15, 40, 65 and 115 meters upstream and downstream portion of the river and along the centerline of the bridge structure.

Sufficient side shots and observations were taken at closer interval around the location of the substructures in order to determine a more detailed riverbed configuration. The scour survey results are illustrated in **Figure 13.2.3-1**.

From these results, scouring around foundation was not observed.

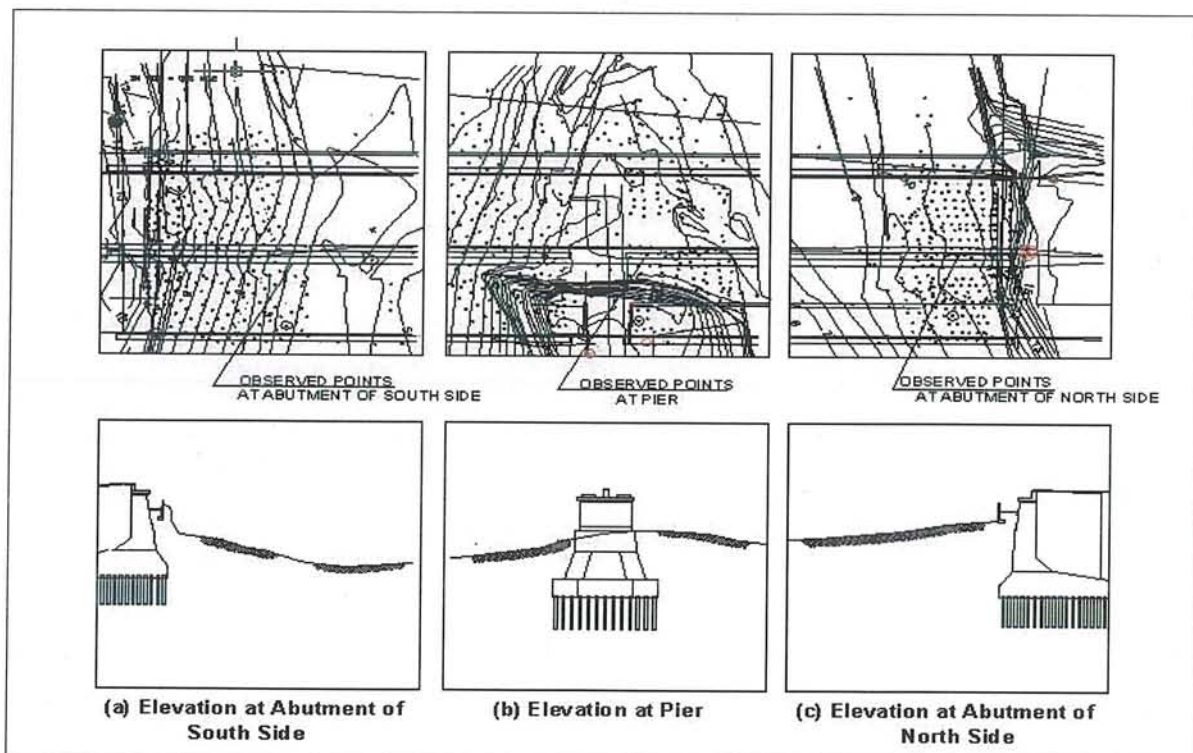


Figure 13.2.3-1 Results of Scour Survey at Abutment and Pier