CHAPTER 7

BRIDGE CONDITION SURVEY AND DESIGN PRESUMPTION

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7.1 PRESENT CONDITION SURVEY

7.1.1 Visual Inspection

In compliance with the method of Survey Level II for visual inspection described in **Section 6.3.1**, the visual inspection survey was carried out for the study bridges, except the Ayala Bridge which requires an in-depth Survey –Level III.

(1) Equipment

The following equipment was employed;

- Inspection Equipment – Field Glasses, Test Hammer, Steel Tape, Caliper, Crack Scale, String and Plumb, Wire Brush
- Record Equipment - Digital Camera, Digital Video Camera, Chalk, Black Board, Marker/Pen, Visual Inspection Sheets 1/3, 2/3 and 3/3, Visual Inspection Sheet, Notepad
- Aid for Inspection – Ladder, Traffic Vest, Traffic Control Tool, Rope, Flash Light
- Others – Life Jacket, Scaffolding, Pontoon, Gondola, Tug Boat, Inspection Car, Helmet

(2) Results of Visual Inspection Survey

Visual inspection survey results were recorded following the inspection formats for each bridge; summary, condition of structural members, condition of accessories and photographs of damages.

Table 7.1.1-1 shows the sample of summary table for visual inspection survey results. The Visual Inspection Survey of the other bridges are presented in **Appendix 7.1.1-1.**

7.1.2 Shape and Dimension Measurement

(1) Shape and Dimension Items

Shape and dimension items included approach road, superstructure, substructure, and deformation of superstructure and inclination of substructures.

Table 7.1.1-1 Sample of Summary Table of Visual Inspection Report

Date of Inspection: Dec. 2, 3, 4, 10 and 11, 2002
Inspector: CT Arenas
Checker: LG Sta. Maria

Name of Bridge : PA2 Jones Bridge

Damage No.	Span No.	Name of Member	Type of Damage	Rank of Damage	Description of Damage					
					Nature	Location/Pattern	Scale	Severity	No. of Damages	Photo No.
1	1	Railing	CR	H	Cracks	Railing Post	Half of Post Area	High	1	1
2	1	Lighting Post	CO	S	Corrosion	Lightning Post	Left and Right Side	Small	6 Post	-
3	1	Lighting Post	PD	M	Painting	Deterioration	Remarkable	Medium	6 Posts	-
4	1	Deck Slab	HC	M	Honeycombs	Bottom of deck	0.1 m^2	Medium	2	2
5	1	Deck Slab	CR	H	Cracks	Bottom of deck	0.3 mm – 0.8 mm	High	Many	3
6	1	Bolts (Rivets)	CO	S	Corrosion	Main Girder Rivets	Almost all rivets	Small	Many	-
7	1	Bolts (Rivets)	M	S	Missing	Rivets	Main Girders	Small	Few	-
8	1	Steel Plate (Weld Portion)	D/D	H	Deterioration	Weld Portion of Steel Plates	Remarkable	High	Many	4
9	1	Main Girder	CO	H	Corrosion	Lower plate of Girders	Remarkable	High	8 Girders	5
10	1	Main Girder	Def	H	Deformation	Bottom of girders near P1	Remarkable	High	2 Girders	6
11	1	Main Girder	PD	S	Paint Deterioration	Exterior and Interior Girders	-	Small	8 Girders	-
12	1	Sway Bracing	PD	S	-	Cross Bracing Whole Members	-	Small	All Braces	-
13	1	Sway Bracing	CO	S	Corrosion	Sway Bracing Members	Remarkable	Small	All Braces	8
14	1	Sway Bracing	M	M	Missing	Sway Bracing	Top memb.	Medium	Many/5 Locations	-
15	1	Sway Bracing	B/R	H	Break	Brace members	Dangerous	High	2 Locations	7
16	1	Expansion Joint	NO	M	Noisy Steel Joint	Beginning of Bridge, A1	Noisy	Medium	Whole Width	-
17	1	Bearing Shoe	CO	H	Corrosion	Abutment No. 1	Whole Shoes	High	8 Shoes	9
18	1	Bearing Shoe	CO	M	Corrosion	Pier No. 1	Whole Shoe	Medium	8	10
19	1	Utilities	CO	H	Corrosion	Abutment No. 1, LS (Steel Duct)	Remarkable	-	1 Location	11
20	1	Abutment Backwall	SER	M	Spalling	Abutment No. 1	Whole width	Medium	1 Location	12
21	1	Pier Coping	CR	S	Cracks	Pier No. 1	Hairline Cracks, <0.3 mm	Small	Many	-
22	1	Pier Body	CR	H	Cracks	Pier No. 1	≥0.3 mm	Medium	1 Location	13
23	2	Railing	FR	H	Fracture	Rightside Sidewalk	Remarkable	High	Railpost and Handrail	14
24	2	Lighting Post	CO	S	Corrosion	Lightning Post	Left and right side	Small	4 Locations	-
25	2	Lighting Post	PD	M	Paint Deterioration	-	Remarkable	Medium	6 Post	15
26	2	Pavement	D/D	S	Deterioration	Bridge Deck right lane	Small	Small	1 Location	-
27	2	Bolt (Rivet)	M	S	Missing	Rivets	Sway Bracing	Small	Many (4 Nos.)	-
28	2	Steel Plate (Welded)	Def	H	Deformation	Interior and Exterior Girders	Remarkable	High	4 Locations	16
29	2	Main Girders	CO	S	Corrosion	All 8 Girders	-	Small	8 Girders	-
30	2	Main Girders	Def	H	Deformation	Bottom Flange	-	High	8 Girders	17
31	2	Main Girders	B/R	H	Break/Rapture	Right side exterior girder web	1 m long	High	1 Location	18
32	2	Sway Bracings	M	M	Missing	Brace members (Top)	Small	Many	6 Units	-
33	2	Sway Bracings	B/R	H	Break or Twisted	Sway Brace	Dangerous	High	2 Steel Members	19
34	2	Bearing Shoe	CO	H	Corrosion	Pier No. 2	Whole	High	8 Steel Shoes	20
35	2	Pier Coping	CR	M	Cracks	Pier No. 2	Remarkable >0.3mm	Medium	4 Locations	21
36	2	Pier Coping	FR	H	Fracture	Pier No. 2 Right Side	0.30 x 0.30 x 0.30m	High	1 Location	22
37	2	Foundation	SER	H	Spalling & Exposed rebars	Top of Footing, Pier No. 2	0.3m2	High	1 Location	23
38	3	Railing	FR	S	Fracture	Right Sidewalk railing	-	Small	1 Location	-
39	3	Lightning Post	CO	S	Corrosion	Left and right side lighting Post	-	Small	6 Post	-
40	3	Lighting Post	PD	M	Paint Deterioration	-	Remarkable	Medium	6 Steel Light Posts	-
41	3	Sidewalk	B/R	H	Breakage	Sidewalk right side	Remarkable	High	1 Place	24
42	3	Deck Slab	D/D	H	Deterioration	Bottom of Deck	Wide Area	High	Many	25
43	3	Deck Slab	CR	H	Cracks	Bottom of deck	0.3 mm to 0.8 mm	High	Many	26
44	3	Deck Slab	SER	H	Exposed rebars	Bottom of deck	0.3 m2	High	1 Location	27
45	3	Bolt (Rivets)	M	S	Missing	Anchor nuts	Bearing Shoe	Small	No. 1	-
46	3	Main Girders	CO	H	Corrosion	Girder lower flange and web	-	Remarkable	Many	28
47	3	Cross Beam (End Diaphragm)	CO	M	Corrosion	Diaphragm at Abutment 2	-	Remarkable	Whole Length	29
48	3	Sway Bracing	M	M	Missing	Sway Top Member	-	Small	5 Locations	30
49	3	Drainage System	CO	M	Corrosion	Drainage Pipe	-	Medium	4 Pipes	31
50	3	Bearing Shoe	CO	H	Corrosion	Abutment No. 2 Left side	Whole shoe	High	8 Pieces	32
51	3	Utilities	CO	H	Corrosion	Abutment No. 2 Left Side (Steel ducts)	Remarkable	High	1 Location	33
52	3	Abutment Backwall	HC	S	Honeycombs	Inner side of backwall	0.3 m2	Small	1 Location	34
53	3	Abutment Backwall	SER	S	Exposed rebars	Inner side of backwall	0.3 m2	Small	1 Location	35
54	3	Abutment Backwall	WLC	H	Water leakage	Inner side of backwall	-	Remarkable	1 Location	36

An engineer was assigned as an inspector who has familiarity with the following items: 1) Dimensions of approach road shall be measured approximately 100m from abutment. 2) Dimension of section length of superstructure shall be measured perpendicular to the bridge centerline. 3) θ is skew angle at bridge end. 4) Fix or moving bearing shoe shall be indicated.

The data obtained from the shape and dimension measurement was used in the preparation of structural drawings of the existing bridges. These drawings are necessary for the analysis and overall safety evaluation of the bridge. In the absence of as-built drawings for the foundation, assumptions were made regarding the kind and number of pile foundation. Length of pile was determined from the available geotechnical data and pile resistance.

Survey points for measurement were described earlier in **Section 6.3.2.**

(2) Shape and Dimension Measurement Form

The forms for shape and dimension survey were described in **Section 6.3.2.**

(3) Equipment

The following equipment was employed.

- Shape and Dimension Measurement Equipment – Steel Tape, Level, String and Plumb, Wire Brush.
- Record Equipment - Digital Camera, Digital Video Camera, Chalk, Black Board, Marker/Pen, Visual Inspection Sheets 1/3, 2/3 and 3/3, Visual Inspection Sheet, Notepad
- Aid for Inspection – Ladder, Traffic Vest, Traffic Control Tool, Rope, Flash Light
- Others – Life Jacket, Scaffolding, Pontoon, Gondola, Tug Boat, Inspection Car, Helmet

(4) Results of Shape and Dimension Measurement

(a) Inventory Report

A sample of inventory report is shown in **Table 7.1.2-1.** The inventory report of the remaining bridges is presented in **Appendix 7.1.2-1.**

Table 7.1.2-1 An Example of Inventory Report (Delpan Bridge)

Name of Bridge : Pa1.1 Delpan Bridge (Upstream)

Reference No.	Pa1.1
Inventory Date	Dec. 13, 14, 19, 20, 2002
Inventory Office	KEI - DCCD

Bridge Type	PC Gerber Box Girder Bridge	Bridge Length	203.70 m	Span Length	26.65/46.00/58.40/46.00/26.65
Name of Road	Bonifacio Drive	Location	Port Area, Manila	Chainage	R-1 / R-10

	Item		
Approach Road	Road Width (m)		23.11 m
	Lane	No.	4 Width 3.50 (m)
	Sidewalk	Type	Concrete Width 1.50/1.61 (m)
	Median	Type	Conc. Curb Width 3.30/4.40 (m)
	Pavement	Type	Asphalt Conc. Thickness (cm)
	Traffic Volume		Both Direction/day
Superstructure	Alignment	Skew	30° Curve None
	Main Girder	Type	PC Gerber Box Girder
		Height	4.66 m (P2)/1.74m (mid-span)
		Number	2
		Space	8.50 m (m)
	Cross Beam	Type	-
		No.	-
	Stringer	Type	-
		No.	-
	Pavement	Type	Asphalt Conc. Thickness 7.5 (cm)
	Slab	Type	Reinf. Conc. Thickness 20.0 (cm)
	Shoe	Type	Steel Bearing Reaction 340 (t)
	Expansion Joint	Type	Steel
	Handrail	Type	Concrete

	Item	
Abutment	Type	Wall Type
	Wall	Height ((6.10)) (m), Width 2.13 (m)
	Footing	Length ((23.10)) (m), Width ((6.00)) (m)
	Foundation	Type ((Timber Pile)) Length ((15.00)) (m)
Pier 1/2	Type	Wall Type
	Coping (Wall)	Height 5.00/3.86 (m), Width 2.00/1.66 (m)
	Column	Height (m), size (m)
	Footing	Length ((23.70/24.00)) (m), Width ((8.50)) (m)
	Foundation	Type ((Timber Pile)) Length ((15.00)) (m)
Design	Specification	Unknown ((AASHO))
	Live Load	((MS18))
	Seismic Coefficient	0.06 DL
	Design Date	Unknown
Construction	Concrete	fc' ((21 MPa, Substructure))
	Reinforcing Bar	fy ((275 MPa, Substructure)), ((Fy=1862 MPa, PC Concrete))
	P.C. Material	fc' ((35 MPa)), f'su (1862 MPa)
	Steel Material	
	Completion Date	((1965))
Remarks		( ) As Built Data (( )) Assumption Data

(b) Field Data of Shape and Dimension Survey

An example of summary of Field Data in Bridge Condition Survey is shown in **Figure 7.1.2-1.** In addition, structural drawings were prepared based on the shape and dimensions survey. Field Data of Condition Survey is shown in **Appendix 7.1.2-1.**

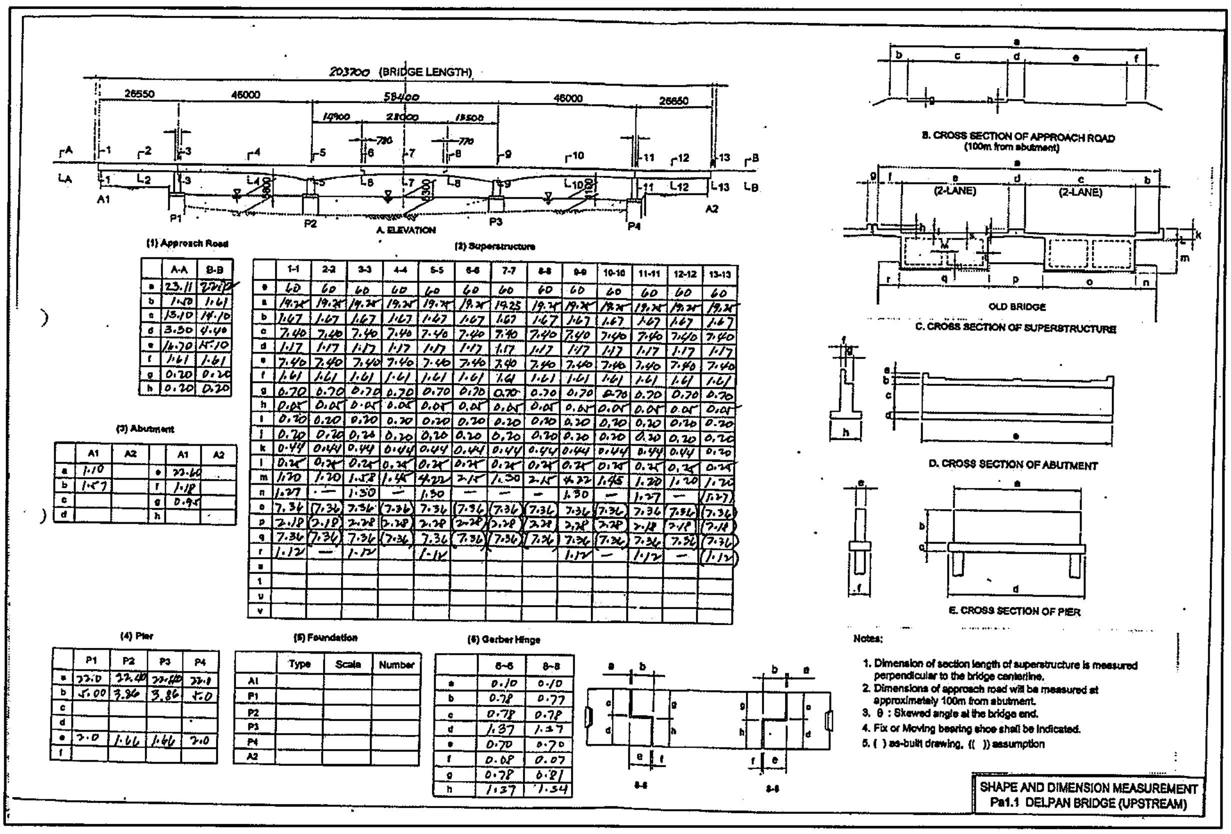


Figure 7.1.2-1 An Example of Summary of Field Data for Bridge Shape and Dimension Survey

(c) Bridge Deck Profile Survey

Bridge Deck profile survey was performed on the bridge with large deck surface deformation or deflection. Obtained values from the field were recorded accordingly. Refer to the **Figures 22.1.3-1** and **24.1.3-1** for the summary methods of profile survey on bridges with large deflection.

7.1.3 Non-Destructive Tests

(1) Schmidt Hammer Test

(a) Method of Schmidt Hammer Test

The method was described in **Section 6.3.1 (4).**

(b) Result of Schmidt Hammer Test

Table 7.1.3-1 shows the average values and their corresponding concrete strength for the 19 bridges included in the Study.

Table 7.1.3-1 Results of Schmidt Hammer Test

Bridge No		Bridge Name	Average Strength of Concrete (kgf/cm^2)		
			Superstructure		Substructure (Pier & Abutment)
			Girder	Slab	
1	Pa1.1	Delpan Bridge (Upstream)	-	292	273
	Pa1.2	Delpan Bridge (Downstream)	334	260	235
2	Pa2	Jones Bridge	-	265	352
3	Pa3	Mac Arthur Bridge	-	208	301
4	Pa4	Quezon Bridge	-	224	254
5	Pa5	Ayala Bridge	-	-	-
6	Pa6	Nagtahan Bridge	-	281	237
7	Pa7	Pandacan Bridge	327	320	297
8	Pa8	Lambingan Bridge	351	315	298
9	Pa9	Makati-Mandaluyong Bridge	364	347	283
10	Pa10.1	Guadalupe Bridge (Central)	-	-	-
	Pa10.2	Guadalupe Bridge (Both Sides)	360	-	360
11	Pa11	C-5 Bridge	431	-	372
12	Pa12	Bambang Bridge	431	-	395
13	Ma1.1	Vargas Bridge (Upstream)	-	-	323
	Ma1.2	Vargas Bridge (Downstream)	-	-	219
14	Ma2	Rosario Bridge	414	-	374
15	Ma3	Marcos Bridge	437	353	325
16	Ma4	Marikina Bridge	450	-	304
17	Ma5	San Jose Bridge	328	-	260

In determining the compressive strength of concrete, the age of concrete ratio, αn must be known and the hammer reading must be obtained. The angle of inclination in conducting the hammer test must also be considered.

(2) Penetrant Test

(a) Method of Penetrant Test

The method was described in **Section 6.3.1 (4).**

(b) Results of Penetrant Test

The results of Penetrant Tests are summarized in **Table 7.1.3-2.**

Table 7.1.3-2 Results of Penetrant Test

Bridge No.	Bridge Name	Test Point No	Location	Result
Pa2	Jones Bridge	1	Span 2, Girder 7	Noted with crack
		2	Span 2, Girder 8	Negative to crack
Pa3	Mac Arthur Bridge	1	Span 2, Girder 7	Negative to crack
		2	Span 2, Girder 6	Negative to crack
Pa5	Nagtahan Bridge	1	Span 1, Truss 2, Bottom Chord/Web Splice Plate	Noted with undercut pinhole, Insufficient web
Pa9.1	Guadalupe Bridge (Central)	1	Panel 35, Grid #10	Negative to crack
		2	Panel 35, Grid #10	Negative to crack
		3	Panel 35, Grid #9	Negative to crack
		4	Panel 36, Grid #8	Negative to crack

7.2 ASSESSMENT OF CRITICAL DAMAGES

The results of bridge condition survey were summarized in **Table 7.2-1** showing the damage rating for the different components. The following items are observed from the summary table.

- The following bridges evaluated with damage rating I require detailed study after taking emergency measures:
  - Jones Bridge
  - Quezon Bridge
  - Lambingan Bridge
  - Guadalupe Bridge (Both Sides)
  - Vargas Bridge (Upstream Side)
- Most of substructures are relatively sound, including the strength of concrete material although some cracks were observed.
- Only Jones Bridge resulted with positive member damager using Dye Penetrant Test.

Table 7.2-1 Assessment of Critical Damages of Each Study Bridge (1/3)

Bridge Name	Member/Location		Type of Damage	Description of Damage	Rating	Field Testing Results	
						Schmidt Hammer	Dye Penetrant
Delpan Bridge (Upstream)	Super.	Span 1: Bottom of box girder (Abut 1)	SER	$0.5m^2$ spalling of concrete with exposed rebars observed due to insufficient vertical clearance for passing trucks resulting to collision.	II	Deck Slab 28.65 Mpa *(OK)*	–
		Span 3: Bottom of box girder at gerber	SER	There are 5 locations of spalling with exposed rebars at gerbers 1 and 2.	II		
		Span 1: Bottom of box girder at midspan	HC	More than $2m^2$ of honeycomb was measured at bottom of girder.	II		
	Sub.	Span 1: Whole Abutment A	D/D	Discoloration of surface is observed over the entire abutment due to unsealed expansion.	III	Substructure 26.78 Mpa *(OK)*	–
		Span 3: Pier 3 body	CR	0.4mm wide vertical crack is observed from top to bottom of Pier.	III		
		Span 3: Pier 3	SER	$1.2m^2$ of spalling with exposed rebars was observed due to vessel collision.	III		
Delpan Bridge (Downstream)	Super.	Span 2,3 & 4 Irregular pattern of cracks due to Alkali-aggregate reaction	CR	Irregular pattern of cracks <0.2mm due to alkali - aggregate reaction.	IV	Girder 32.77 Mpa *(OK)* Deck Slab 25.51 Mpa *(OK)*	–
	Sub.	Span 1: Whole Abutment A	D/D	Discoloration of surface is observed over the entire abutment due to unsealed expansion joint.	IV	Substructure 23.05 Mpa *(OK)*	–
		Span 3: Pier 3 body	SER	Spalling & exposed rebars at pier wall due to insufficient provision of concrete cover and vessel collison	IV		
Jones Bridge	Super.	Main Exterior Girder, G1, Span 2	B/R	Broken of lower flange and $^1/_3$ of web height, girder under side walk, caused by vessel collision.	I	–	Damage members found w/ cracks
		Sway Bracing G1-G2	B/R	Broken sway bracing	I		
		Main Exterior Girder, G8, near P2	DE	Maximum horizontal deformation is 280mm.	I		
		Girders 1~8, All Spans	CO	Corroded, section loss < 10%	III		
		Bearing of Abut. A1 & Pier 2	CO	Rust scattered and generated extensively is observed, section loss is small, less than 10%.	II		
	Sub.	Pier 2 Coping	CR	0.30 mm cracks on 4 locations of pier 2	III	Piers 20 ~ 40 Mpa *(OK)*	–

- : No Test

Table 7.2-1 Assessment of Critical Damages of Each Study Bridge (2/3)

Bridge Name	Member/Location		Type of Damage	Description of Damage	Rating	Field Testing Results	
						Schmidt Hammer	Dye Penetrant
Mac Arthur Bridge	Super.	Span 2: Bottom Flange, G6	Mp	About 200 pieces of rivets were missing/cut at bottom flange due to vessel collision.	II	Deck Slab 20.41 Mpa *(OK)*	No Defects
		Span 2: Bottom of Girder, G4, G7 & G3	DE	Bottom flange of Girder were deformed and out of alignment on 3 locations due to vessel collision.	II		
		Span 3: Sway Bracing	CO	High corrosion at sway bracing due to influence of utilities progressive corrosion.	II		
	Sub.	Abutment A2, downstream side	SER	$3.5m^2$ concrete spall and exposed rebars was noted at A2 wall.	II	Substructure 29.53 Mpa *(OK)*	-
Quezon Bridge	Super.	Top Chord, Bottom Chord and Vertical Members	CO	Corroded section loss = 20 %	II	-	No defects
		Gusset plates, Stringers, Bracings	CO	Corroded section loss = 30 %	I		
	Sub.	Abutment & Pylon	CR	Cracks	IV	17 ~ 29 Mpa *(OK)*	-
Nagtahan Bridge	Super.	Top Chord, Bottom Chord, Vertical Members & Diagonal Members	CO	Corrosion over whole members, Section loss < 10%	III	Deck Slab 27.57 Mpa *(OK)*	No defects
	Sub.	Pier 9 & 10	SER	2.0 m^2 Spalling & exposed rebars	III	Substructure 23.25 Mpa *(OK)*	-
Pandacan Bridge	Super.	Span 2: Bottom of PC Girder, G6	HC	Honeycomb with exposed rebars of $0.42m^2$ at bottom of girder is caused by inadequate compaction of construction works.	III	Deck Slab 31.39 Mpa Girder 32.10 Mpa *(OK)*	-
		Span 2: End pf PC Girder, G1	SER	Exposed rebars ($0.8m^2$) at bottom of girder is the result of improper provision of concrete cover.	III		
	Sub.	Pier 3 & 4 Body (Tie Beam)	SER/ CR	Remarkable damage on pier tie beam due to vessel collision.	III	Substructure 29.13 Mpa *(OK)*	-
Lambingan Bridge	Super.	Girders 1 and 12 at Gerber Hinges	CR	0.2 to 0.3 mm cracks on gerber hinges.	I	Deck Slab 30.90 Mpa Girder 34.43 Mpa *(OK)*	-
		Girders 1 and 12 at Pier Top	CR	0.3 to 0.4 Flexure cracks on girder above pier support.	I		
		Bearing pads at gerber hinges & supports	Mov	Movement associated with tearing of bearing pads.	I		
	Sub.	Anchor bars at supports	CO	Corroded anchor bar, rust generated extensively	III	Abutment 29.43 Mpa Pier 21.40 Mpa *(OK)*	-
Makati-Mandaluyong Bridge	Super.	Span 5: Sideface of web near Pier 4, downstream	CR	0.4 - 0.65mm horizontal parallel cracks	II	AASHTO Girder 34.00 Mpa Box Girder 35.71 Mpa *(OK)*	-
		Span 6: Bottom of end Diaphragm between G4 & G5	HC	$1.5m^2$ honeycomb in one location	II		
	Sub.	Span 1: Abutment A1 Wall	CR	Horizontal crack @ Abutment A1 wall > 0.6 mm width is observed, possibly poor treatment of construction joint	II	Substructure 27.76 Mpa *(OK)*	-
		Span 7: Pier No. 6 Body, Column 4	SER	$1.5m^2$ splitting of concrete & reinforcement due to alkali-aggregate reaction	III		
Guadalupe Bridge (Central)	Super.	Span 1: Lateral Bracing at Panel 33 - Bay 6, Panel 34 - Bay 4, Panel 35 - Bay 7	B/R	Broken by vehicle, 3 locations.	III	-	No defects
		Spans 2 & 3: Sway Bracing at Panel 17 - Bay 8; Bay 9; Panel 6	DE	Deformed member, 4 locations.	IV		
		Span 3: Top Chord at Girder 2, Panel 4 & 6 - Bay 1	CO	Reduction of cross-section due to corrosion, 2 locations.	IV		
	Sub.	Span 1: Abutment A Coping (Coping face)	CR	0.483mm wide random cracks below girder	III	Abutment 33.75 Mpa Piers 36.89 Mpa *(OK)*	-
		Span 2: Pier 2 Wall at Downstream Side	CR	2.794mm wide vertical cracks	III		
Guadalupe Bridge (Both Sides)	Super.	Gerber Hinge 1, Left Side, Ext. Girder 1, Span 2	CR	Wide cracks at gerber hinge with crack widths of 0.5mm to 2mm with some spalling and exposed rebars.	I	AASHTO Girder 35.32 Mpa *(OK)*	-
		Gerber Hinge 1, Left Side, Ext. Girder 5, Span 2	CR	3 locations of wide cracks from 1.5mm to 5mm.	I		
		Gerber Hinge 2, Right, Ext. Girder 5, Span 2	CR	2mm to 5mm wide cracks.	I		
		Gerber Hinge 2, Left, Ext. Girder 8, Span 2	CR	3 Crack locations with crack widths of 1.0mm to 3mm.	I		
	Sub.	Abutment 2	CR	Alligator cracks with thickness of 0.3mm located on the downstream face of abutment	III	Pier Wall 28 ~ 49 Mpa *(OK)*	-

- : No Test

Table 7.2-1 Assessment of Critical Damages of Each Study Bridge (3/3)

Bridge Name	Member/Location		Type of Damage	Description of Damage	Rating	Field Testing Results: Schmidt Hammer	Field Testing Results: Dye Penetrant
C-5 Bridge	Super.	Span 6: Girders 4 & 8 near pier 6 support	HC	0.45 - 1.60m^2 honeycomb on 2 locations.	II	AASHTO Girder 42.28 Mpa (OK)	-
		Span 4: Bottom of slab at Pier 3, bay 6	SER	0.12 to 0.15m^2 of spalling with exposed rebars, 2 locations.	III		
	Sub.	Abut B wall near bearing	CR	0.61mm vertical cracks	III	Abutment 35.22 Mpa Piers 36.98 Mpa (OK)	-
		All restraining bar	CO, B/R Mp	Rust spreads the entire bar, some have missing bars and bolts, some are fractured	III		
Bambang Bridge	Super.	Span 5: End block of Girder 1 & 4 at Pier 5	CR	0.65mm to 0.80mm wide of horizontal & diagonal crack, 2 locations.	III	Girder 42.28 Mpa (OK)	-
		Span 6: End block of Girder 2 & 3 at Pier 5	CR	0.45mm to 0.50mm wide of horizontal & diagonal crack. 2 locations.	III		
	Sub.	Span 9:Abutment B Backwall at Downstream	CR	12.0mm wide of fractured on abutment	IV	Piers 38.75 Mpa (OK)	-
		Span 8: Top of coping at Pier 7 along Bay 8	CR	2.50mm wide of diagonal crack	IV		
Vargas Bridge (Upstream)	Super.	Exterior Main Girder, Girder 1 at Pier 2	CR	One crack only with thickness equal to 2mm, depth of crack d=17mm	I	Girders 55 Mpa (OK)	-
		Exterior Main Girder, Gerber Hinge 1, Left Side, Girder 1 of Span 3	CR	Crack width equal to 1~3mm with spacing of less than 50cm d=44 mm	I		
		Suspended Girder	AD	Deformation at the center of suspended girder and cantilever span	II		
	Sub.	Abutment A1, Backwall	CR	Crack of Backwall of Abutment A1, Crack width = 1mm and spacing of less than 50cm	II	Substructure 46 Mpa (OK)	-
		Pier 1, Pier Coping	SER	Spalling with an area of 0.12sq.m	II		
Vargas Bridge (Downstream)	Super.	Span 3: Cantilever slab at midspan, upstream side	HC CR	1m^2 honeycomb. 0.45mm wide crack, transverse	II	-	-
		Span 3: Bay 2, above Pier 2	CR	1.5mm wide crack, transverse	II		
	Sub.	Span 2: Pier 2 Coping at Bay 1	CR	0.6mm wide vertical crack	III	-	-
Rosario Bridge	Super.	Span 6: Girder 4	CR	1.50mm random crack is caused by splitting of concrete and reinforcement	II	Girder 40.61 Mpa (OK)	-
		Spans 1, 2, 3, 4 & 5: Steel Bearing P1, P2, P3, P4 & P5	CO	Moderate corrosion, reduction of cross section	III		
	Sub.	Span 2, Coping at Pier 5	CR	0.38 mm random cracks caused by increase in load, horizontal force or lack of reinforcing bars.	III	Abutment 33.35 Mpa Piers 37.76 Mpa (OK)	-
Marcos Bridge	Super.	Span 2 at Bay 8: Face of Girder 8	HC	A= 0.16m^2 honeycomb	III	Deck Slab 34.63 Mpa Girder 42.87 Mpa (OK)	-
		Span 3 at Bay 5: Top flange of Girder 6	SER	A = 0.30m^2 spalling with exposed rebar	III		
	Sub.	Spans 1, 2, 3 & 4: Coping of Piers 1, 2, 3, & 4	CR	t = 0.30mm to t = 5.00mm random cracks in 4 locations.	II	Piers 31.88 Mpa (OK)	-
		Spans 1, 2, 4, 5 & 6: Coping of Piers 1, 2, 4, 5 & 6	CR	t = 0.30mm to t = 10.00mm vertical/horizontal crack are mainly caused by lack of reinforcing bars. 5 locations.	II		
Marikina Bridge	Super.	Span 2: Deck slab at Bay 2	CR	0.35mm wide of crack	III	Girder 44.14 Mpa (OK)	-
		Span 2: Bottom of Deck slab at Bay 3	HC	0.18mm^2 area of honeycomb	III		
		Span 3: Bottom of Cantilever Slab	SER	0.30mm^2 area of spall	III		
	Sub.	Face of Abutment A, Wingwall	CR	12.5mm wide of vertical crack	III	Abutment 44.14 Mpa Piers 29.82 Mpa (OK)	-
		Span 2: End of Pier 1 Coping along upstream	CR	0.60mm wide of vertical crack	III		
San Jose Bridge	Super.	Span 4: Top flange of Girder 1	CR	0.35mm longitudinal and random cracks due to shrinkage	III	Girder 32.18 Mpa (OK)	-
		Span 3: End face of girder 1 &3	CR	0.15 to 0.178mm vertical cracks on 2 locations.	IV		
	Sub.	Span 1: Downstream side of backwall	CR	0.10mm vertical cracks on one location	IV	Piers 25.51 Mpa (OK)	-
		Span 1,2,3,4 & 6; Pier 1,2,3,4 &6 Diaphragm wall	CR	0.61 to 2.0mm vertical cracks near center of Pier, 5 locations	II		

- : No Test

7.3 PRESUMPTION OF ORIGINAL STRUCTURAL DESIGN

7.3.1 Procedure for Presumption

If there are complete set of as-built drawings or design drawings, the presumption of original structure design is not required. However, those data are usually not available, especially for old bridges. While shapes and dimensions of visible or exposed parts can be determined from measurement survey, hidden or invisible parts such as substructures and foundations under water or ground, and arrangement or volume of reinforcement bars have to be presumed with analytical method referring to the old code requirements at the time of construction or relevant data and materials.

In cases where as-built drawings does not exist or field conditions make it difficult to perform field measurements and verification, the existing bridge structural drawings were reconstructed, which is referred to as “Presumption of Original Design”.

The flowchart of presumption of original structure design is shown in **Figure 7.3.1-1.**

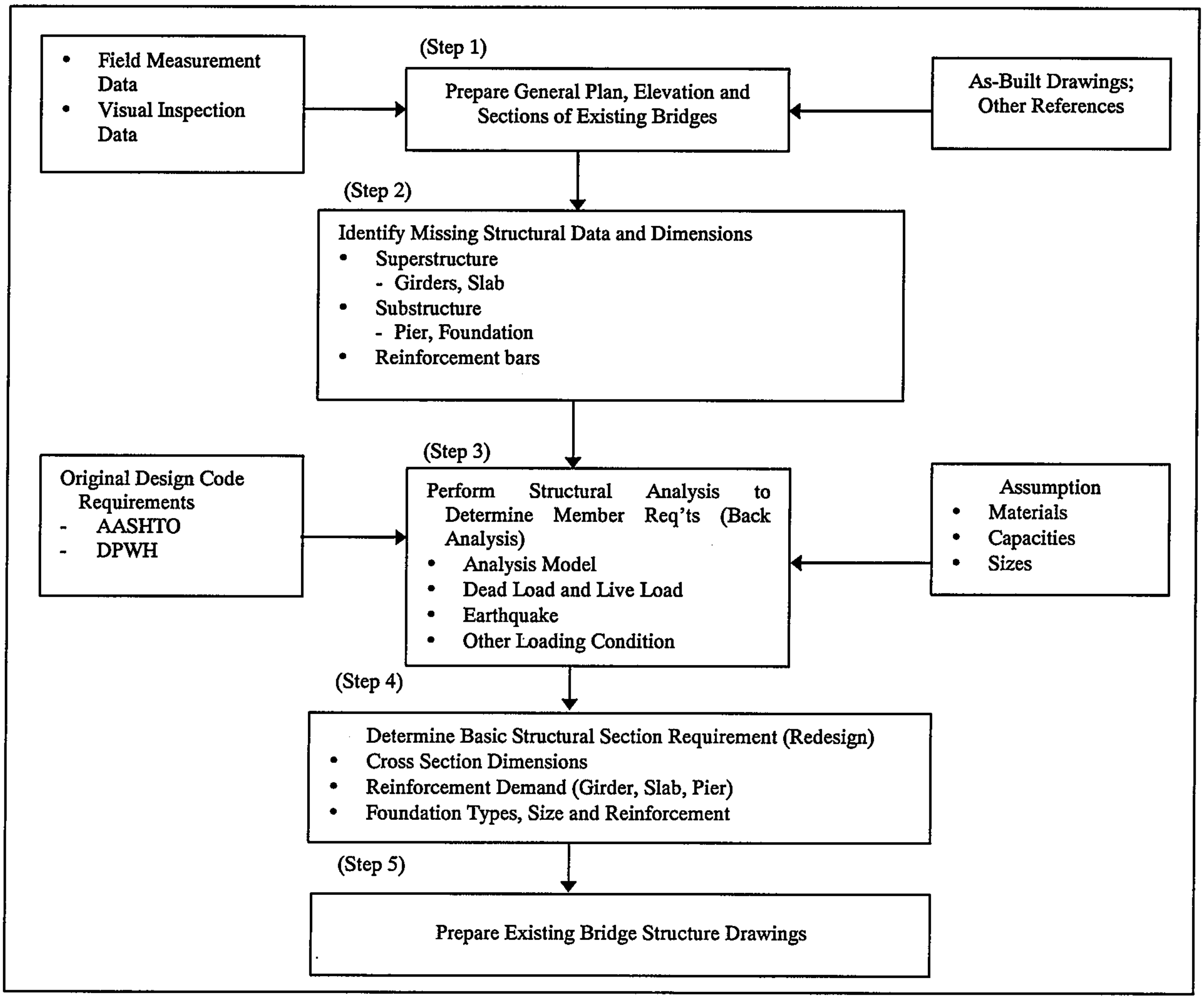


Figure 7.3.1-1 Flowchart of Presumption of Original Structural Design

As illustrated in the flow chart, the procedure took the following steps:

Step 1: Prepare the General Plan, Elevation and Section of the Existing Bridge.

- At this stage, the structure drawings shall be prepared using the available data and information shown in the as-built drawings or other plan references together with the results of field measurements and visual inspection.

Step 2: Identify Missing Structural Data and Information.

- If step 1 could not provide all the necessary information to prepare the structure drawings, such missing data should be identified for both the superstructure and the substructure.

Step 3: Perform Structural Analysis to Determine member Requirements.

- To complete the structure drawings, a back calculation/analysis is necessary for the member requirements identified in Step 2. An analytical model is thus established based on the prevailing code requirements at the time of bridge design or construction. If material properties are unknown, assumptions have to be made based on the materials and technology available during the construction of the bridge.

Step 4: Determine the Basic Structural Section Requirements

- From the results of Analysis in Step 3, the demand section forces can be obtained for the missing members. A back – design shall be performed considering the minimum requirements of the code at the time of construction. Thus, section dimensions including reinforcements can be obtained from this step.

Step 5: Prepare Existing Bridge Structure Drawings.

- Section dimension obtained from Step 4 shall be reflected to the structure drawings to complete this set. This set of structural drawings shall then be used to analyze the structural soundness of the bridge including load rating.

7.3.2 Assumption of Design Conditions

(1) Superstructure

Generally, the superstructure does not need to be assumed because all the dimension details can be measured. However, the pre-stressing cables and steel reinforcements of AASHTO and Box Girders cannot be determined without as-built drawings. In this case, it has to be assumed as shown in **Table 7.3.2-1.**

(2) Substructure

The dimensions of pier body were all measured except for hidden or invisible parts and the main reinforcement which were assumed by using steel ratio and as-built drawings. For the assumption of pier reinforcement, the years of completion were known. The foundation types, including pile cap, however were very hard to determine without as-built plans. In these instances, the foundation types were fixed based on relevant materials at the time, while the number of piles and those length were estimated by the stability analysis with dead load.

Considering the history and sequence of all the bridge's completion year, at the time of Quezon Bridge and from 1946 to 1966, timber piles are commonly used. After the San Fernando earthquake in 1971, the transition of timber piles to PSC piles has occurred. Vargas Bridge (Downstream) was constructed in 1977 and utilized PSC Piles and Steel Pipe Piles. Bored piles are introduced as new construction technology in 1980's.

The assumption or actual measurement of substructures are summarized in **Table 7.3.2-2.**

7.3.3 Analyzed Assumption of Original Structural Design

Figure 7.3.3-1 shows the result of analyzed assumption of original structural design.

- Foundation type was presumed at the time of construction.
- The number and length of piles were determined from stability analysis using the old code and geometrical survey results.
- The scale and type of pier and abutment column / wall were presumed by analysis or shape and dimension survey.
- Reinforcement volumes were determined from the old code requirements.

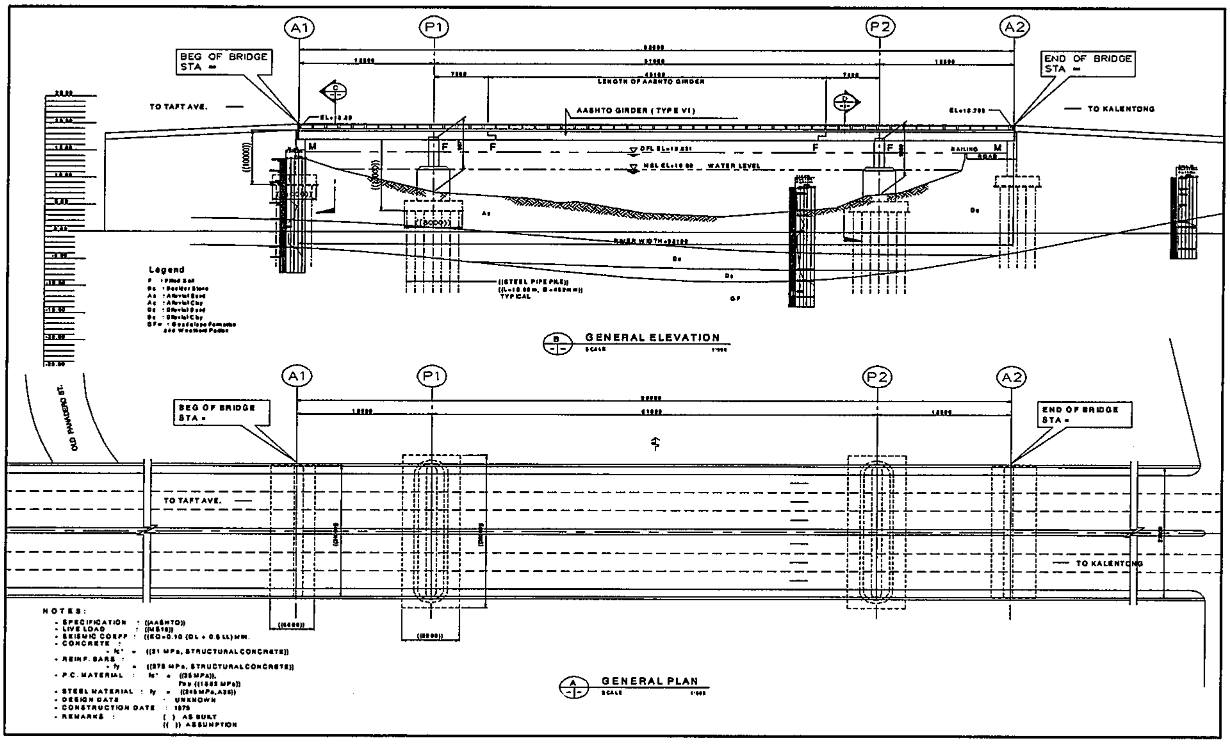


Figure 7.3.3-1 An Example of Analyzed Assumption of Original Structural Design (Lambingan Bridge)

Table 7.3.2-1 Assumption of Superstructure

Bridge No.		Bridge Name	Description	Length of Bridge (m)	Width of Bridge (m)	Main Girder	Cross Beam	Deck Slab
1	Pa1.1	Delpan Bridge (Upstream)	PC Gerber Box Girder Bridge (5-Span)	Measured 203.70 m (26.65 + 46.00 + 58.40 + 46.00 + 26.65)	Measured 19.11 m (1.60 + 7.4 + 1.1 + 7.4 + 1.60)	Measured & Assumed	Assumed	Measured
	Pa1.2	Delpan Bridge (Downstream)	PC Gerber Box Girder Bridge (5-Span)	Measured 202.90 m (26.65 + 46.0 + 57.60 + 46.0 + 26.65)	Measured 16.0 m (1.70 + 14.30)	Measured & Assumed	As-built drawing	Measured
2	Pa2	Jones Bridge	3-Span Continuous Steel Plate Girder Bridge	Measured 114.41 m (35.51 + 43.40 + 35.50)	Measured 21.40 m (2.40 + 7.70 + 1.20 + 7.70 + 2.40)	Measured	Measured	Measured
3	Pa3	Mac Arthur Bridge	3-Span Continuous Steel Plate Girder Bridge	Measured 114.60 m (37.30 + 40.30 + 37.00)	Measured 17.70 m (1.85 + 6.70 + 0.60 + 6.70 + 1.85)	Measured	Measured	Measured
5	Pa5	Ayala Bridge	2-Span Simple Steel Truss Bridge	Measured	Measured	Measured	Measured	Assumed
4	Pa4	Quezon Bridge	Single Span Steel Type Arch Bridge (1-Span)	Measured 102.40 m	Measured 21.90 m (3.0 + 7.70 + 0.50 + 7.70 + 3.0)	Measured	Measured	Measured
6	Pa6	Nagtahan Bridge	3-Span Continuous Truss	Measured App. 117.0m, 148.93m (45.60 + 57.73 + 45.60)+App 165.46m	Measured 24.70 m (1.0 + 11.1 + 0.5 + 11.1 + 1.0)	Measured	Measured	As-built drawing
7	Pa7	Pandacan Bridge	PC I-Girder Bridge (3-Span)	Measured 147.40 m (23.8 + 25.0 + 46.0 + 25.1 + 27.5)	Measured 16.70 m (23.8 + 25.0 + 46.0 + 25.1 + 27.5)	Measured	Measured	Measured
8	Pa8	Lambingan Bridge	PC Gerber I-Girder Bridge (3-Span)	Measured 98.10 m (18.5 + 61.1 + 18.5)	Measured 24.20 m (1.5 + 10.1 + 1.0 + 10.1 + 1.5)	Measured	Measured	Measured
9	Pa9	Makati-Mandaluyong Bridge	PC Box Gerber with I-Girder Drop Span Bridge (3-Span)	Measured 207.49 m (8.29 + 9 + 9 + 8.74 + 30 + 50 + 30 + 7.2 + 7.558 + 7.533 + 8.156 + 7.75 + 8 + 8 + 8.26)	Measured 19.0 m (1.5 + 7.5 + 1.0 + 7.5 + 1.5)	Measured & Assumed	Assumed	Measured
10	Pa10.1	Guadalupe Bridge (Central)	3-Span Continuous Truss Bridge	Measured 114.44 m (35.7 + 42.8 + 35.94)	Measured 25.011 m	Measured	Measured	As-built drawing
	Pa10.2	Guadalupe Bridge (Both Sides)	PC Gerber Girder Bridge (3-Span)	Measured 114.44 m (35.7 + 42.8 + 35.94)	Measured 7.34 m	Measured	Measured	As-built drawing
11	Pa11	C-5 Bridge	PC I-Girder Bridge (10-Span)	Measured 272.96 m (24.85 + 24.95 + 25.12 + 25 + 24.85 + 45.88 + 22.21 + 26.95 + 26.70 + 26.45)	Measured 27.80 m (2.0 + 11.3 + 1.2 + 11.3 + 2.0)	Measured	Measured	As-built drawing
12	Pa12	Bambang Bridge	PC I-Girder Bridge (3-Span)	Measured 163.32 m (12.0 + 11.65 + 11.70 + 25.90 + 40.19 + 25.93 + 12.15 + 11.95 + 11.85)	Measured 10.30 m (1.45 + 7.4 + 1.45)	Measured	Measured	As-built drawing
13	Ma1.1	Vargas Bridge (Upstream)	PC Gerber I-Girder Bridge (4-Span)	Measured 122.44 m (19.3 + 30.5 + 50.6 + 22.04)	Measured 9.52 m (0.85 + 3.66 + 3.66 + 1.35)	Measured	Measured	As-built drawing
	Ma1.2	Vargas Bridge (Downstream)	Steel Plate Girder Bridge (4-Span)	Measured 142.80 m (30.62 + 30.83 + 50.70 + 30.65)	Measured 9.40 m (1.0 + 7.40 + 1.0)	Measured	Measured	Assumed
14	Ma2	Rosario Bridge	PC I-Girder Bridge (6-Span)	Measured 175.35 m (25.5 + 31.2 + 31.19 + 30.98+ 31.07 + 25.41)	Measured 28.34 m (14.17+ 14.17)	Measured	Measured	Assumed
15	Ma3	Marcos Bridge	PC I-Girder Bridge (11-Span)	Measured 311.68 m (22 + 30 + 27.5 + 30.15 + 6@30 + 22)	Measured 13.60 m (1.2 + 11.2 + 1.2)	Measured	Measured	Assumed
16	Ma4	Marikina Bridge	PC I-Girder Bridge (5-Span)	Measured 138.20 m (24.2 + 3@30 + 24)	Measured 13.60 m (1.2 + 11.2 + 1.2)	Measured	Measured	Assumed
17	Ma5	San Jose Bridge	PC I-Girder Bridge (8-Span)	Measured 199.67 m (24.9 + 24.97 + 24.95 + 24.97 + 25 + 24.97 + 24.96 + 24.95)	Measured 20.10 m (2.0 + 7.5 + 1.1 + 7.5 + 2.0)	Measured	Measured	Assumed

Table 7.3.2-2 Assumption of Substructure

Bridge No.		Bridge Name	Cross Section of Topography and River	Geometric Data	PIER			Abutment	Foundation
					Body (Reinforcement)	Location of footing in River	Footing Size		
1	Pa1.1	Delpan Bridge (Upstream)	DPWH Report*	DPWH Report*	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed (Timber Pile)
	Pa1.2	Delpan Bridge (Downstream)	As-built drawing	As-built drawing	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
2	Pa2	Jones Bridge	DPWH Report	DPWH Report	Measured (As-built drawing)	As-built drawing	As-built drawings	Assumed	As-built drawings
3	Pa3	Mac Arthur Bridge	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
4	Pa4	Quezon Bridge	DPWH Report	DPWH Report	-	-	-	Assumed	Assumed
6	Pa6	Nagtahan Bridge	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
7	Pa7	Pandacan Bridge	DPWH Report	DPWH Report	Measured (assumed)	-	-	Assumed	Assumed
8	Pa8	Lambingan Bridge	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
9	Pa9	Makati-Mandaluyong Bridge	DPWH Report	DPWH Report	Measured (As-built drawing)	-	-	As-built drawings	As-built drawings
10	Pa10.1	Guadalupe Bridge (Central)	DPWH Report	DPWH Report	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
	Pa10.2	Guadalupe Bridge (Both Sides)	DPWH Report	DPWH Report	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
11	Pa11	C-5 Bridge	DPWH Report	DPWH Report	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
12	Pa12	Bambang Bridge	KEI Investigation	Assumed	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
13	Ma1.1	Vargas Bridge (Upstream)	DPWH Report	DPWH Report	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
	Ma1.2	Vargas Bridge (Downstream)	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
14	Ma2	Rosario Bridge	DPWH Report	DPWH Report	Measured (As-built drawing)	As-built drawing	As-built drawings	As-built drawings	As-built drawings
15	Ma3	Marcos Bridge	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
16	Ma4	Marikina Bridge	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
17	Ma5	San Jose Bridge	DPWH Report	DPWH Report	Measured (assumed)	Assumed (At river bed)	Assumed (due to pile arrangement)	Assumed	Assumed
5	Pa5	Ayala Bridge	DPWH Report	DPWH Report	-	-	-	-	-

* Detailed engineering Design of Pasig-Marikina River Channel Improvement Project (Volume V), March 2002
CTI Engineering Co.,LTD,Nikken Consultants, Inc., Woodfields Consultants Inc, Basic Technology and Management Corporation

7.4 ANALYSIS OF STRUCTURAL SOUNDNESS BY LOAD RATING

7.4.1 Basic Principle

Bridge load rating provides a basis for determining the safe load capacity and evaluating the structural soundness of a bridge. Such load rating requires engineering judgment in determining the rating value that is to be used to assess the bridge soundness and safe use by establishing the safe load capacity of the members. Bridge load rating calculations shall be performed based on the information of the most recent inspection indicating the present condition of the bridge, including changes in structural condition due to repairs and rehabilitation, dead load and member deterioration.

The flow of load rating and evaluation of bridge soundness is presented in **Figure 7.4.1-1.** For bridges with complete maintenance and inspection records and information, the load rating will be straight-forward considering the present condition of the bridge members. However, when the bridge data are not available, field survey and presumption of original design is necessary. The Presumption of Original Design, as discussed in **Section 7.3**, will have to be done using the data gathered from field survey and measurements.

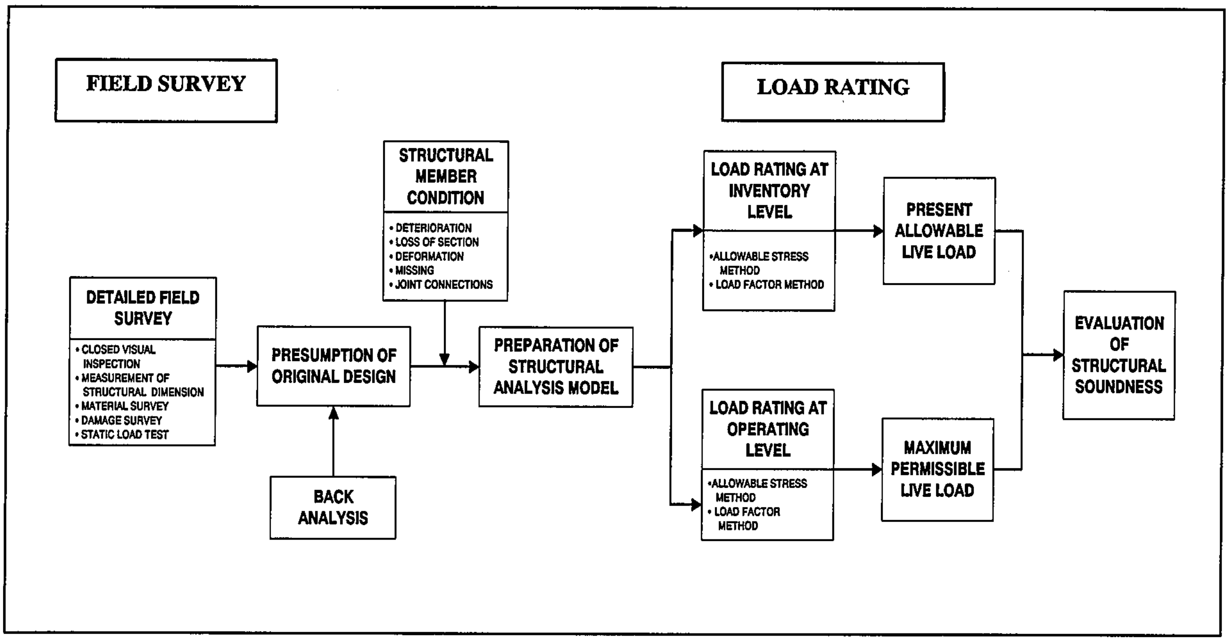


Figure 7.4.1-1 Flow of Load Rating for Superstructure

Load ratings were evaluated at two levels – the *Inventory Level* and the *Operating Level.* The methods used for load rating evaluation include the allowable stress, the load factor, and the load and resistance factor methods. The results of the load rating evaluation indicate the present allowable live load and the maximum permissible live load of the bridge.

7.4.2 Procedure of Load Rating Analysis

(1) Rating Principle

In general, the resistance of a structural member (R) should be greater than the demand (Q) as follows:

$$R \geq Q_D + Q_L + \Sigma Q_I \qquad (7.4.2\text{-}1)$$

where Q_D is the effect of dead load, Q_L is the effect of live load and Q_I is the effect of load i.

In the bridge evaluation process, the maximum allowable live loads need to be determined and by rearranging Equation [7.4.2-1], the maximum allowable live load becomes:

$$Q_L \leq R - \{ QD + \sum Q_I \} \qquad (7.4.2\text{-}2)$$

It then becomes a question of whether a fully loaded vehicle (rating vehicle) can be allowed on the bridge or not, or what portion of the rating vehicle can be allowed on the bridge. The portion of the rating vehicle will be given by the ratio between the available capacity for live load effect and the effect of the rating vehicle. This ratio is called the rating factor (RF) as defined by:

$$RF = \frac{\text{Available capacity for live load effect}}{\text{Rating vehicle load demand}} = \frac{R - \{ Q_D + \sum Q_I \}}{Q_L} \qquad (7.4.2\text{-}3)$$

When the rating factor equals or exceeds unity, the bridge is capable of carrying the rating vehicle. On the other hand, when the rating factor is less than unity, the bridge may be overstressed while carrying the rating vehicle.

Thermal, wind, and hydraulic loads may be neglected in the evaluation process because of the likelihood of occurrence of extreme values during the relatively short live-load loading is small. Thus, the effects of dead and live loads are the only two loads considered in the evaluation process.

Impact should be added to the live load used for the rating, but the live load deflection limitations should not be considered except in special cases.

Longitudinal loads and environmental loads in combination with dead and live load should be done at the Operating level.

Earthquake loads should not be considered in calculating load ratings or in determining live load restrictions. To evaluate the resistance of the structure to seismic forces, the methods described in Division I-A, Seismic Design of the AASHTO Design Specifications may be used.

(2) Rating Method

During the structural evaluation for load rating, the location and type of critical failure mode and section should be first identified – such critical areas and sections differ depending on the structural system and the physical condition of the bridge members.

Although the basic concept of load rating evaluation is the same, three methods are commonly used to check the capacity of the members as given in **Table 7.4.2-1.** The allowable stress method for steel bridges and load factor method for PC bridges were taken in the Study as giving conservative solution, respectively.

Table 7.4.2-1 Load Rating Methods

Rating Method	Description	Safety Factor Principle	Rating Factor
Allowable Stress (AS)	• the actual loading are combined to produce a maximum stress in a member which is not to exceed the allowable or working stress	• safety factors are incorporated in terms of allowable stresses of the material	$RF = \dfrac{R - D}{L(1+I)}$
Load Factor (LF)	• based on analyzing a structure subject to multiples of the actual load (load factor)	• safety factors are treated as load factors to account for load uncertainties and resistance factors to account for uncertainty of response	$RF = \dfrac{\phi R_n - \gamma_D D}{\gamma_L L(1+I)}$ γ_D = 1.3 γ_D = 2.17 (Inventory) γ_D = 1.3 (Operating)
Load and Resistance Factor (LRF)	• the loads and resistances are subject to factors based on probabilities	• Safety factors are based on load and resistance factors based on the probability of loading and resistance	$RF = \dfrac{\phi R_n - \gamma_D D}{\gamma_L L(1+I)}$ * Refer to LRFD method for load and resistance factors.

where

RF	:	Rating Factor
R	:	Allowable stress or capacity/resistance of member
ϕR_n	:	Nominal resistance/capacity
D	:	Effect of dead loads
L	:	Nominal live load effect of rating vehicle
I	:	Impact factor for live load effect
γ_D, γ_L	:	Dead and live load factors

The load effect is the effect of the applied loads in the member, typical of which includes axial force, vertical shear force, bending moment, axial stress, shear stress and bending stresses.

The effect of individual live load vehicles on the members can be obtained by analyzing the bridge using a three dimension analysis for a higher level of load rating determination

However, for the basic load rating evaluation, the analysis can be simplified by assuming that a similar rating vehicle will occupy all the possible lanes to produce the maximum effect on the structure. This assumption will allow the use of AASHTO live-load distribution factor approach to estimate the live load demand and eliminate the need for a three-dimensional analysis.

The Rating Factor (RF) may then be used to determine the Load Rating (LR) of the bridge members as follows:

$$LR = RF \bullet W \qquad (7.4.2\text{-}4)$$

where LR : Load Rating in metric tons

W : Weight of the Rating Vehicles in metric tons

(3) Rating Level

There are two levels of rating to which a bridge should be load rated: the Inventory and Operating Levels.

<u>Inventory Level</u>

This rating level generally corresponds to the customary design level of stress but reflects the existing bridge and material condition with regard to deterioration and loss of section.

The Inventory rating results in a live load that can be safely carried by the bridge for an indefinite period of time

<u>Operating Level</u>

Load rating based on the Operating rating level reflects the absolute maximum permissible live load that can be safely carried by the bridge. Allowing unlimited number of vehicles to use the bridge at the Operating Level may shorten the life of the bridge.

The life of the bridge depends on the fatigue life or serviceability limits of the bridge materials. Higher frequent loading and unloading may affect the fatigue or serviceability of the bridge components and the bridge life itself. Therefore, in order to maintain the bridge for an indefinite period, the live-load carrying capacity available for frequently passing vehicle needs to be estimated at service. This process is then referred to as the Inventory Rating.

On the other hand, less frequent vehicles may not affect the fatigue life or serviceability of a bridge, and thus the live-load carrying capacity available for less frequent vehicles need not be estimated under serviceability criteria. Bridges can then be allowed to carry less frequent vehicles with higher loads than usual. This process of evaluating such load capacity is referred to as the Operating Rating.

7.4.3 Analysis of Load Rating

Table 7.4.3-1 shows the results of the Load Rating indicating the Rating Factor and the proportion of the Rating Live Load in tons. An example of the material and section properties is given in **Appendix 7.4.3-1.**

The following were figured out from **Table 7.4.3-1.**

- Most of the bridges under the present study are basically capable of supporting the rating live load equivalent to 18-ton semi-trailer truck with a total vehicle weight of 32.7 tons.
- Other bridges including Jones, Quezon, Lambingan, Guadalupe (Both Sides) and Vargas Bridge (Downstream) have rating factors less than 1.0 indicating a reduced live load capacity. Since the level of investigation conducted to these bridges is only Level I & II with Visual Assessment, the bridge identified with rating factors less than unity will need a more accurate load rating.
- In the Operating Rating, only Guadalupe Bridge has a rating factor less than unity, which indicates the necessity for urgent rehabilitation of the gerber hinge parts.

From the analysis results, the following five (5) bridges were presumed to be insufficient for the capacity specified in the latest code requirements, because they have the Rating Factor less than 1.0 at Inventory Level.

- Jones Bridge
- Quezon Bridge
- Lambingan Bridge
- Guadalupe Bridge (Both Sides)
- Vargas Bridge (Upstream Side)

The results of load rating analysis are dependent on the results of bridge condition survey conducted. Bridges even rated with rating factors greater than or equal to one will be in need of repair works for damaged portions.

Table 7.4.3-1 Load Rating of Superstructures

No	Ref	Bridge Name	Year Const	Bridge Type	Load Rating				Remarks
					Inventory		Operating		
					RF	MS Truck tons	RF	MS Truck tons	
1	Pal.1	*Delpan Bridge – Upstream*	1965	PC Gerber Box Girder 5-span	1.26	41.20	1.67	54.60	Cable profile assumed similar to downstream bridge
	Pal.2	Delpan Bidge– Downstream	1988	PC Gerber Box Girder 5-span	1.27	41.53	1.69	55.26	–
2	Pa2	**Jones Bridge**	1948	3 –Span Continuous Steel Plate Girder	**Negative**	**0.00**	**0.76**	**24.80**	Ruptured exterior girder
3	Pa3	McArthur Bridge	1948	3 – Span Continuous Steel Plat Girder	1.33	43.49	2.20	71.94	–
4	Pa4	**Quezon Bridge**	1946	Steel Arch 1-span	**0.92**	**30.08**	1.59	51.99	Heavily corroded joint connections of floor system
6	Pa5	Nagtahan Bridge	1966	3-Span Continuous Truss	1.03	33.68	2.10	68.67	–
7	Pa6	Pandacan Bridge	1997	PC I-Girder 5-Span	1.22	39.89	2.39	78.15	Cable profile assumed
8	Pa7	**Lambingan Bridge**	1975	PC Gerber I-Girder 3-span	**0.63**	**20.60**	1.06	34.66	Cracks on Gerber Hinge parts and girder on pier top
9	Pa8	Makati – Mandaluyong Bridge	1986	PC Box Gerber with I-Girder Drop 3-span	1.67	54.61	2.91	95.16	Cable profile assumed
10	Pa9.1	Guadalupe Bridge Central	1962	3-Span Continuous Truss	1.01	33.03	2.07	67.69	–
	Pa9.2	**Guadalupe Bridge Both Sides**	1979	PC Gerber I-Girder 3-span	**0.44**	**14.39**	**0.74**	**24.20**	Cracks at Gerber Hinge parts
11	Pa10	C-5 Bridge	1998	PC I-Girder 10-span	1.02	33.35	2.67	87.31	–
12	Pa11	Bambang Bridge	1991	PC I-Girder 3-span Girder 6-span	1.07	34.99	2.22	72.60	–
13	Pa1.1	**Vargas Bridge – Upstream**	1992	PC Gerber I – Girder 4-span	**0.83**	**27.14**	**1.39**	**45.45**	Cracks on Gerber Hinge parts and girder on pier top
	Pa1.2	Vargas Bridge - Downstream	1973	Steel Plate Girder 4-span	1.00	32.7	1.65	53.96	–
14	Ma2	Rosario Bridge	1952	PCI I-Girder 6-span	1.03	33.68	1.95	63.76	–
15	Ma3	Marcos Bridge	1978	PCI I-Girder 11-span	1.78	58.21	2.98	97.45	–
16	Ma4	Marikina Bridge	1980	PCI I-Girder 6-span	1.01	33.03	2.20	71.94	–
17	Ma5	San Jose Bridge	1980	PCI I-Girder 6-span	1.22	39.89	2.17	70.96	–

Notes:

1. Rating Live Load is AASHTO MS18(HS20-44) Semi Trailer Truck Type with total weight of 32.7 tons.
2. RF : Rating Factor
3. Load Rating in metric tons

CHAPTER 8

OVERALL EVALUATION OF BRIDGE CONDITION

CHAPTER 8

OVERALL EVALUATION OF BRIDGE CONDITION

8.1 FACTORS TO BE CONSIDERED IN OVERALL EVALUATION

In **Table 8.1-1,** an example of the inspection results is presented and summarized to give an overall view of the bridge condition. The table is basically divided into five groups which include:

- *General* – Describes the basic information about the bridge including reference number and name, location, year constructed, geometric data, types of superstructure and substructure, bridge elevation and photographs of damages.

- *Structural Soundness* – The results of damage inspection on bridge members and components are categorized into superstructure, substructure, foundation and accessory. Damages observed on different bridge components are assessed using HMS or XYZ Methods with reason of assessment indicated. The diagnosis evaluation is indicated using Diagnosis Category A, B or C with recommendations on the next action to be done.

- *Vulnerability to Disaster* – The bridge existing physical condition and its environment is assessed to determine its vulnerability to earthquake, wind and typhoon, and flood. Assessment can either be high, moderate or low vulnerability. Comments are included in the evaluation item.

- *Traffic Functionality* – The condition of the bridge to perform its intended function to allow traffic to pass is assessed considering its load capacity, average daily traffic, number of lanes, volume/capacity ratio and level of service and the bridge geometry to allow ideal driving condition. An overall evaluation of the traffic functionality should be given which will be used later for the priority ranking of bridges. The distance and length of the nearest detour route should also be noted.

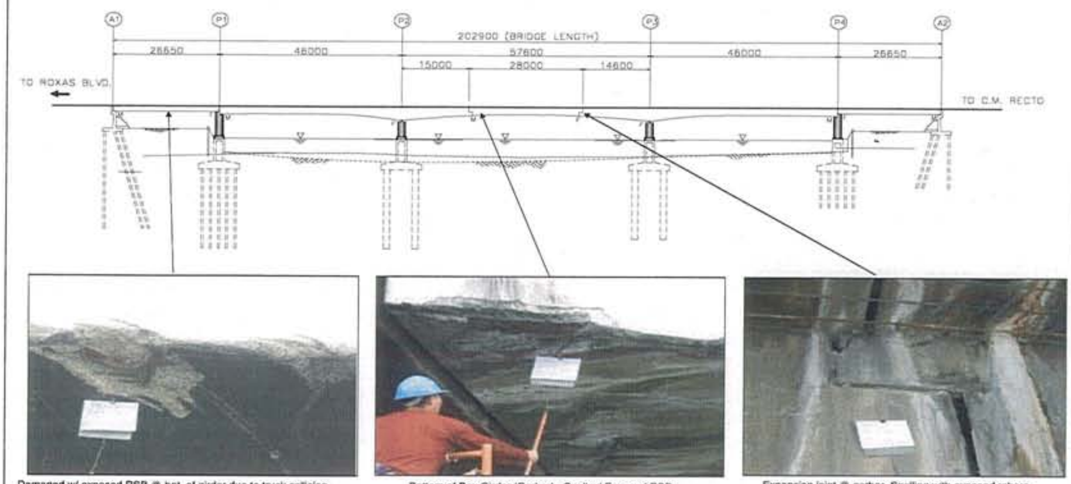
- *Special Issues* – Other special issues included in the overall evaluation are river navigation clearances (both horizontal and vertical) for bridges crossing bodies of water, public/private utilities being supported by the bridge and the presence of informal dwellers.

A descriptive form of the overall evaluation of bridge condition is to be written on the last row of **Table 8.1-1** to give an overall impression of the present state of the bridge and recommended action to be undertaken.

Table 8.1-1 Example of Overall Evaluation of Existing Bridge Condition

Reference/Bridge Name	**Pa1.1 DELPAN BRIDGE (UPSTREAM)**		
Location/Name of Road	**Manila City** **Bonifacio Drive**	**Year Constructed**	**1965**

Elevation



Damaged w/ exposed RSB @ bot. of girder due to truck collision. Bottom of Box Girder (Gerber). Spall w/ Exposed RSB. Expansion joint @ gerber. Spalling with exposed rebars.

Length of Bridge	**203.70m. (26.65 + 46.00 + 58.40 + 46.00 + 26.65)**	**No. of Lane**	**4**
		Lane Width	**3.70m**
Superstructure Type	**PC Gerber Box Girder Bridge (5-Span)**	**Substructure Type**	**Abutment: Wall ((timber pile)), Pier: Wall ((timber pile))**

		Members	Location of Damaged Parks	Damage Assessment *1	Reason for Assessment
Structural Soundness	Superstructure	PC BOX GIRDER	*Span 1: Bottom of box girder (Abut 1)	H	0.5m² spalling of concrete with exposed rebars observed due to insufficient vertical clearance, 4.38m < 4.9m < 5.0m, for passing trucks resulting to collision.
			*Span 1: Bottom of box girder at midspan	H	More than 2m² of honeycomb was measured at bottom of girder.
			*Span 1: Bottom of box girder	H	3.85m² of spalling was observed with exposed rebars due to insufficient vertical clearance for passing trucks resulting to collision .
			*Span 2: Sideface of web (Pier 2)	H	There are many locations of spalling with exposed rebars at bottom of girder.
			*Span 3: Bottom of box girder at gerber	H	There are <u>5 locations</u> of spalling with exposed rebars at gerbers 1 and 2.
			*Span 3: Gerber Hinge	M	0.15m² to 0.30m² spalling was measured on upstream of downstream box.
		DECK SLAB	*Span 1: Bottom of box girder	S	0.13mm hairline cracks on many locations.
			*Span 2: Bottom of box girder	S	0.05mm hairline cracks and freelime in many locations.
				M	
	Substructure	ABUTMENT	*Span 1: Whole Abutment A	M	Discoloration of surface is observed over the entire abutment due to unsealed expansion.
		PIER	Span 3: Pier 3 body	M	0.4mm wide vertical crack is observed from top to bottom of Pier.
			Span 3: Pier 3	M	1.2m² of spalling with exposed rebars was observed due to vessel collision.
	Foundation			S	Maximum inclination at A1 is 1.1 degrees > 1.0 degree: Allowable inclination angle JRA. In-depth survey necessary.
	Accessory	Span 1: Bearing Shoe		M	Corrosion spread over all bearing shoes of Abut 1 & Pier 1.
	Diagnosis Evaluation *2	Category "B"	**: Repairs necessary for box girder concrete damage, spalling, exposed rebars and cracks sealing.**		
			: In-depth study necessary to mitigate vertical clerance of side span road under crossing		
			: In-depth study necessary to check Abutment Al 1.1 degree inclination		
Vulnerability to Disaster	Seismic Resistance	* No as-built drawings. Pier and foundation insufficient under present seismic design requirements. Moderate vulnerability			
		* In-depth study necessary to determine required strengthening.			
	Wind Resistance	Not critical to wind action - Low vulnerability			
	Flood Resistance	Not critical to flood overtapping - Low vulnerability			
	Evaluation	**• Seismic strengthening necessary to comply with new code;**			
		• Bridge sufficient to wind and flood action			
		• Bridge vulnerable to seismic action			
Traffic Capacity & Function	Traffic Limit	AASHTO MS18 (HS20) Semi-Trailer Truck (32.7 tons)			
	Volume/ Capacity	31,651 (2002) 4 Lanes (One Direction) Level of service : D (V/C Ratio = 0.82)			
	Smooth Driving Condition	Non-steep slope at approach road, non-corrugation and curvature on bridge			
	Evaluation	**• Major adjustment necessary to provide sufficient vertical clearance for bridge undercrossing**			
		• Meets minimum traffic functionality requirements			
Special Issues	River Navigation	Vertical clearance > regulated ; Horizontal clearance > preferable			
	Utilities	None			
	Informal Dwellers	Heavy : More than 20 household identified			
	Evaluation	**• Squatters identified needs relocation**			
		• Minimal social and environmental impact			
Overall Evaluation		**• Bridge reasonably sound and satisfies minimum traffic functionality requirements.**			

NOTES

1. Damage Assessment
H : Heavy
M : Medium
S : Small

2. Diagnosis Evaluation
"A" : Urgent measures shall be applied; Conduct In-depth Survey
"B" : Urgent measures not required; Conduct In-depth Survey
"C" : In-depth survey not required

2. Traffic limit in metric tons

8.2 ASSESSMENT ON STRUCTURAL SOUNDNESS

8.2.1 Criteria

(1) Damage Rating Criteria

Assessment on structural soundness was performed in compliance with the methods discussed in **Section 6.3**, including results of condition survey and evaluation of the Load Rating. For reference, the criteria of damage rating and diagnosis are given in **Table 8.2.1-1.**

Table 8.2.1-1 Damage Rating and Diagnosis

<table>
<tr><th colspan="3">Damage Rating</th><th colspan="2">Diagnosis</th></tr>
<tr><th>X, Y, Z Method</th><th>H,M,S Method</th><th>Condition</th><th>Category</th><th>Action to be taken</th></tr>
<tr><td>I*</td><td>HH*</td><td>• Damage is serious
• Traffic safety is in danger</td><td>A</td><td>•Emergency measures shall be taken immediately
•Detailed study shall be conducted to decide remedial measures</td></tr>
<tr><td>II</td><td>H</td><td>• Damage is big
• Detailed survey is necessary to ensure traffic safety</td><td rowspan="2">B</td><td rowspan="2">•Detailed survey or follow-up inspection shall be done to evaluate the severity of damage and to decide necessity of remedial measures
•Remedial measures shall be undertaken after evaluation of damages, if necessary</td></tr>
<tr><td>III</td><td>M</td><td>• Damage is found
• Follow-up inspection is required</td></tr>
<tr><td>IV</td><td rowspan="2">S</td><td>• Small damage is observed
• Damage is recorded</td><td rowspan="2">C</td><td rowspan="2">•No immediate action is necessary
•Ordinary inspection shall be continued</td></tr>
<tr><td>OK</td><td>• No damage is observed</td></tr>
<tr><td colspan="5">* : The Engineer shall decide conclusively through consulting with the road administrator because the highest rank involves sensitive and crucial decision , not decided automatically from inspection result.</td></tr>
</table>

(2) Load Rating Criteria

There are two kinds of rating level for evaluation of structural soundness: Inventory Level and Operating Level. In due consideration of their definition, the results of Inventory Level were used for the load rating criteria, namely the structure shall be evaluated to be dangerous or serious in case that the rating factor is less than 1.0 at Inventory Level.

It should be noted that the rating live load used for load rating is the AASHTO HS20-44 (MS-18) semi-trailer truck with a gross weight of 32.7 tons. Other load rating live load can be used but the present design requirements for bridges in the Philippines is based on the AASHTO HS20-44 live load. This rating corresponds to the 20 tons (English) load limit normally posted on bridges.

8.2.2 Assessment of Structural Soundness

Table 8.2.2-1 is the summary of the bridge condition survey and the Load Rating results, in which necessary actions are recommended with respect to each bridge.

The bridge condition survey revealed the following:

Diagnosis Category A

- Jones Bridge : Two (2) ruptured exterior girders due to vessel collision.
  : Rating Factor $(RF)_{min}$ = Negative (Inventory)
- Quezon Bridge : Heavily corroded joint connections under the floor deck slab and water leaking at abutments stemmed from insufficient maintenance activities
  : RF_{min} = 0.92 (Inventory)
- Lambingan Bridge : Cracks of girders at Gerber Hinge Parts and on pier tops related to bridge design and/or construction quality.
  : Insufficient uplift devices related to bridge design quality.
  : RF_{min} = 0.63 (Inventory)
- Guadalupe Bridge (Both Sides) : Cracks of girders at Gerber Hinge parts related to bridge design and/or construction quality
  : RF_{min} = 0.44 (Inventory)
- Vargas Bridge (Upstream) : Large vertical deformation, and cracks on girders at Gerber Hinge parts and on pier tops related to bridge design and/or construction quality
  : RF_{min} = 0.83 (Inventory)

Diagnosis Category B

- Delpan Bridge (Upstream) : Small cracks on concrete girders due to aging and insufficient maintenance activities.
  : Water leaking due to poor treatment of expansion joint.
  : Insufficient vertical clearance at the side span for road traffic crossing under the bridge.
  : RF_{min} = 1.26 (Inventory)
- Mc Arthur Bridge : Pier inclination, minor cracks of concrete structures and missing rivets due to aging and insufficient maintenance activities.
  : RF_{min} = 1.33 (Inventory)
- Nagtahan Bridge : Corrosion on steel members and cracks of substructures due to aging and insufficient maintenance activities.
  : RF_{min} = 1.03 (Inventory)

- Makati-Mandaluyong Bridge : Cracks on PC box girders and substructures due to aging.
  : RF_{min} = 1.67 (Inventory)

- C5 Bridge : Small cracks of slab and substructures, and honey comb due to increased traffic load.
  : RF_{min} = 1.02 (Invetory)

- Rosario Bridge : Cracks on deck slab due to aging and increased traffic load.
  : RF_{min} = 1.03 (Inventory)

<u>**Diagnosis Category C**</u>

- Delpan Bridge (Downstream) : Minor cracks at the superstructure
  : Spalling out at pier wall due to vessel collision
  : RF_{min} = 1.27 (Inventory)

- Pandacan Bridge : Small cracks on deck slab related to bridge design and/or construction quality
  : RF_{min} = 1.22 (Inventory)

- Guadalupe Bridge (Central) : Small corrosion of steel members
  : Water leaking at the south abutment due to damaged water pipes
  : RF_{min} = 1.01 (Inventory)

- Bambang Bridge : Cracks at the approach spans of superstructure related to bridge design and/or construction quality.
  : RF_{min} = 1.07 (Inventory)

- Marcos Bridge : Many cracks of pier copings of widening portion related to rehabilitation design quality.
  : RF_{min} = 1.78 (Inventory)

- Marikina Bridge : Small cracks on deck slab due to increased traffic load.
  : RF_{min} = 1.01 (Inventory)

- San Jose Bridge : A few cracks on the superstructure and water leaking due to open expansion joints.
  : Exposed foundation due to scouring.
  : RF_{min} = 1.22 (Inventory)

Ayala Bridge is not included in the above list since an In-Depth Survey (Level III Survey) is conducted for this bridge separately.

Table 8.2.2-1 Summary of Assessment of Structural Soundness

No.	Bridge Name	Condition Survey Results		Load Rating		Recommended Actions
		Damage Rating	Diagnosis Category	Inventory	Operating	
1	Delpan Bridge (Upstream)	II	B	1.26	1.67	• Repair damages at concrete box girder such as spalling, exposed rebars and cracks. • Improve vertical clearance of road under bridge crossing. • Check Abutment A1 for stability degree of inclination (1.10 deg)
	Delpan Bridge (Downstream)	IV	C	1.27	1.69	• Repair concrete cracks
2	**Jones Bridge**	**I**	**A**	**Negative**	**0.76**	• **Repair ruptured exterior girder to function as vessel collision protection** • **Provide additional steel girders to take structural function of exterior girders.** • **Maintenance work is necessary to prevent further corrosion and loss of members.**
3	Mc Arthur Bridge	II	B	1.33	2.20	• Monitor pier inclination (2.65 deg.) • Replace missing rivets and members, seal cracks on concrete and paint corroded steel members.
4	**Quezon Bridge**	**I**	**A**	**0.92**	1.59	• **Rehabilitate corroded joint connections at floor system.** • **Maintain periodical inspection of entire floor system.**
5	Ayala Bridge	I	A	Negative	0.10	• Rehabilitate truss and superstructure floor system. • Retrofit substructure to comply with requirements of latest code.
6	Nagtahan Bridge	III	B	1.03	2.10	• Maintain periodical inspection to prevent further member corrosion • Repair cracks at RC Girders of the approach span. • Investigate pier inclination (2.29 deg.)
7	Pandacan Bridge	IV	C	1.22	2.39	• Repair concrete cracks on deck slab.
8	**Lambingan Bridge**	**I**	**A**	**0.63**	1.06	• **Rehabilitate Gerber Hinge support and girder at support.** • **Repair concrete cracks at deck slab.** • **Investigate uplift device.**
9	Makati-Mandaluyong Bridge	II	B	1.67	2.91	• Repair concrete crack. • Investigate longitudinal cracks located on side face of box girder.
10	Guadalupe Bridge (Central)	IV	C	1.01	2.07	• Repair damage/corroded members and concrete cracks of pier wall
	Guadalupe Bridge (Both Side)	**I**	**A**	**0.44**	**0.74**	• **Rehabilitate Gerber Hinge supports.** • **Repair concrete cracks at piers.**
11	C5 Bridge	III	B	1.02	2.67	• Repair cracks and other concrete damages on deck slab.
12	Bambang Bridge	IV	C	1.07	2.22	• Repair concrete cracks.
13	**Vargas Bridge (Upstream)**	**I**	**A**	**0.83**	1.39	• **Rehabilitate Gerber Hinge supports.** • **Provide measure for girder rotation at cantilever portion.**
	Vargas Bridge (Downstream)	IV	C	1.00	1.65	• Repair concrete cracks and corroded steel members
14	Rosario Bridge	III	B	1.03	1.95	• Repair concrete cracks.
15	Marcos Bridge	IV	C	1.78	2.98	• Repair concrete cracks.
16	Marikina Bridge	IV	C	1.01	2.20	• Repair concrete cracks.
17	San Jose Bridge	IV	C	1.22	2.17	• Repair concrete cracks • Replace water tight expansion joint to prevent further corrosion/deterioration of bearing support.

8.3 VULNERABILITY TO DISASTERS

8.3.1 Earthquake

The vulnerability to earthquakes of substructures was discussed in **Chapter 10**. In this section considering analysis levels and information on bridge condition including dynamic soil properties, the vulnerability level fell into three (3) levels according to the capacity demand ratio (C/D Ratio) of columns and foundations under earthquakes specified in the latest seismic code.

- Low Vulnerability: (C/D Ratio > 1.5) — When exposure to shaking from large earthquake should not cause collapse of all or part of the bridge. Where possible, damage that does occur should be readily detectable and accessible for inspection.
- Moderate Vulnerability: (0.5 < C/D Ratio ≦ 1.5) — Total collapse of the bridge is not expected but damages to bridges would take time and difficult to restore.
- High Vulnerability: (C/D Ratio ≦ 0.5) — Probability of collapse under large earthquake could not be overruled, restoration to capacity under present code requirements will be very costly and impractical.

8.3.2 Wind

The vulnerability to wind action can be classified as to:

- Low Vulnerability: Bridge features and geometry stable to wind action
- Moderate Vulnerability: Large-amplitude response can be observed but relatively stable to wind
- High Vulnerability: When bridge features and geometry indicates susceptibility to aerodynamic instability leading to catastrophic response.

As discussed in **Section 2.1.3**, more than 20 cyclones pass the Philippine area of responsibility per year with the maximum number of 32 occurring in 1993. In the vicinity of the bridges under present study, at least one cyclone is expected to pass in a year. As seen in **Appendix 2.1.3**, the maximum cyclone center wind velocity of 225 kph passing Metro Manila was recorded in 1995 with gust velocity reaching to 255 kph.

The National Structural Code of the Philippines (NSCP 2001) recommends a design basic wind speed of 55 m/s (200 kph) in Metro Manila as illustrated in **Figure 8.3.2-1** . However, AASHTO recommends only 44.5 m/s (160 kph) as the basic design wind speed.

Among the bridges under study, only two bridges were constructed after 1995 - C-5 and Pandacan bridges. This indicates that most of the bridges have been exposed to more than 200 kph basic design wind speed specified in the Philippine code. Although the C-5 and Pandacan bridges were exposed only to cyclones of 130 kph (Year 2000) with gust at 160 kph, these bridges are relatively short spans and made of concrete material which are usually stable under wind action. Long span bridges which tends to be lighter are more susceptible to aerodynamic instability.

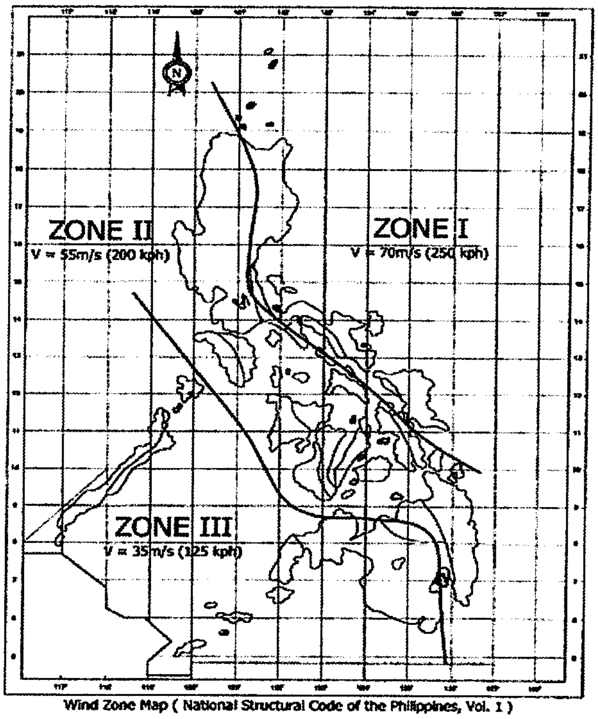


Figure 8.3.2-1 Philippine Wind Zone Map

Therefore, bridges under this study are not critical or have low vulnerability to wind action.

8.3.3 Flood

The vulnerability to flood is defined by:

- **Low Vulnerability:** Little or no possibility of flood over topping with sufficient scour protection.
- **Moderate Vulnerability:** Free-board to 50-year flood is less than 1 meter with minor scour protection.
- **High Vulnerability:** High probability of overtopping by 50-year flood with possible collapse of superstructure and high scouring of substructure.

Tropical cyclones are normally accompanied by strong wind and voluminous rains causing sudden flood in the area where they pass. Damages caused by flood and observed on the bridges under study are very minimal with very small or no probability of flood overtopping these bridges.

All bridges crossing Pasig river have more than 2.2m clearance above the maximum or the design flood water level. On the other hand, bridges crossing Marikina river have more than sufficient clearances with only two bridges – Marcos and Marikina bridges, having only 1.20m clearance from the design flood level.

On the overall, all bridges under the present study are not susceptible to flood overtopping or have low vulnerability to disaster caused by flood.

8.3.4 Assessment of Vulnerability to Disaster

The assessment of all bridges to vulnerability against disaster is shown in **Table 8.3.4-1** below.

Table 8.3.4-1 Assessment for Vulnerability to Disasters

NO	REF	BRIDGE NAME	YEAR CONST	BRIDGE TYPE	VULNERABILITY TO DISASTER ASSESSMENT		
					EARTHQUAKE	WIND	FLOOD
1	Pa1.1	Delpan Bridge - Upstream	1965	PC Gerber Box Girder (5-span)	Moderate	Low	Low
	Pa1.2	Delpan Bridge - Downstream	1988	PC Gerber Box Girder (5-span)	Moderate	Low	Low
2	Pa2	**Jones Bridge**	1948	3-Span Continuous Steel Plate Girder	**High**	Low	Low
3	Pa3	**McArthur Bridge**	1948	3-Span Continuous Steel Plate Girder	**High**	Low	Low
4	Pa4	Quezon Bridge	1946	Steel Arch (1-span)	Moderate	Low	Low
5	Pa5	**Ayala Bridge**	1935/1950	Simple Steel Truss (2-span)	**High**	Low	Low
6	Pa6	**Nagtahan Bridge**	1966	3-Span ContinuousTruss	**High**	Low	Low
7	Pa7	Pandacan Bridge	1997	PC I-Girder (5-span)	Low	Low	Low
8	Pa8	Lambingan Bridge	1975	PC Gerber I-Girder (3-span)	Moderate	Low	Low
9	Pa9	Makati-Mandaluyong Bridge	1986	PC Box Gerber with I-Girder Drop (3-span)	Moderate	Low	Low
10	Pa10.1	Guadalupe Bridge (Central)	1962	3-Span Continuous Truss	Moderate	Low	Low
	Pa10.2	**Guadalupe Bridge (Both Sides)**	1979	PC Gerber I-Girder (3-span)	**High**	Low	Low
11	Pa11	C-5 Bridge	1997	PC I-Girder (10-span)	Moderate	Low	Low
12	Pa12	Bambang Bridge	1991	PC I-Girder (3-span)	Low	Low	Low
13	Ma1.1	Vargas Bridge - Upstream	1992	PC Gerber I-Girder (4-span)	Low	Low	Low
	Ma1.2	Vargas Bridge - Downstream	1973	Steel Plate Girder (4-span)	Moderate	Low	Low
14	Ma2	Rosario Bridge	1952	PC I-Girder (6-span)	Moderate	Low	Low
15	Ma3	Marcos Bridge	1978	PC I-Girder (11-span)	Moderate	Low	Low
16	Ma4	Marikina Bridge	1980	PC I-Girder (5-span)	Moderate	Low	Low
17	Ma5	**San Jose Bridge**	1980	PC I-Girder (8-span)	**High**	Low	Low

8.4 EVALUATION OF TRAFFIC CAPACITY AND FUNCTIONALITY

8.4.1 Level of Service

The definitions of the Level of Service (LOS) and its capacity are given in Table 8.4.1-1.

Table 8.4.1-1 Level-of-Service Criteria and Capacity for Multilane Highway

	FREE-FLOW SPEED							
	80 km/h				72 km/h			
Level of Service	Max Density (PC/MI/LN)	Average Speed (MPH)	Max *v/c*	Max Service Flow Rate (PCPHPL)	Max Density (PC/MI/LN)	Average Speed (MPH)	Max *v/c*	Max Service Flow Rate (PCPHPL)
A	12	50	0.30	600	12	45	0.28	540
B	20	50	0.50	1,000	20	45	0.47	900
C	28	50	0.70	1,400	28	45	0.66	1,260
D	34	49	0.84	1,670	34	44	0.79	1,500
E	43	47	1.00	2,000	45	42	1.00	1,900

NOTE: The exact mathematical relationship between density and *v/c* has not always been maintained at LOS boundaries because of the use of rounded values. Density is the primary determinant of LOS. LOS F is characterized by highly unstable and variable traffic flow. Prediction of accurate flow rate, density, and speed at LOS F is difficult.

The concept of level of service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by road users. The six (6) level of service are rated as; A - the best operating condition, B - the good operating condition, C - the fair operating condition, D - the poor operating condition, E - the bad operating condition, and F - the worst operating condition.

Vehicle capacity represents the maximum number of *vehicles* that can pass a given point during a specified period under prevailing roadway, traffic and control conditions. This definition assumes no influence of downstream traffic operation, such as backing up of traffic over the analysis points. The capacities for each LOS are defined in **Table 8.4.1-1** at the maximum service flow rate.

8.4.2 Evaluation of Traffic Capacity and Functionality

Traffic capacity and functionality were assessed on the following four (4) factors.

- Traffic capacity and functionality Load Limit
- Level of Service (discussed in **Section 5.4**)
- Smooth Driving Condition
- Vertical Clearance for Road Traffic Crossing under bridges

Table 8.4.2-1 shows the assessment of traffic capacity and functionality for bridges.

Table 8.4.2-1 Evaluation of Traffic Capacity and Functionality

Bridge Name	Traffic Load Limit Based on AASHTO to MS-18[1] (Inventory Level)	Level of Service (V/C ratio) (Year 2002)	Smooth Driving Condition	Vertical Clearance for Road Traffic Assessment
Delpan Bridge (Upstream side)	Full Capacity	D (0.82)	Good	Insufficient
Delpan Bridge (Downstream side)	Full Capacity	D (0.82)	Good	Sufficient
Jones Bridge	Negative (Exterior Girder)	D (0.74)	Fair	-
Mc Arthur Bridge	Full Capacity	C (0.52)	Fair	-
Quezon Bridge	92%	F (1.22)	Good	-
Ayala Bridge	Negative (Floor System)	E (0.80)	Fair	-
Nagtahan Bridge	Full Capacity	D (0.73)	Good	-
Pandacan Bridge	Full Capacity	B (0.32)	Good	-
Lambingan Bridge	63%	C (0.53)	Fair	-
Makati-Mandaluyong Bridge	Full Capacity	D (0.70)	Fair	Sufficient
Guadalupe Bridge (Central)	Full Capacity	F (1.23)	Fair	-
Guadalupe Bridge (Both Sides)	44%	F (1.23)	Good	-
C5 Bridge	Full Capacity	E (0.85)	Fair	Sufficient
Bambang Bridge	Full Capacity	D (0.77)	Fair	-
Vargas Bridge (Upstream side)	83%	E (0.85)	Fair	-
Vargas Bridge (Downstream side)	Full Capacity	E (0.85)	Fair	-
Rosario Bridge	Full Capacity	F (1.22)	Fair	Sufficient
Marcos Bridge	Full Capacity	E (0.88)	Fair	-
Marikina Bridge	Full Capacity	D (0.77)	Fair	Sufficient
San Jose Bridge	Full Capacity	A (0.06)	Fair	-

Notes :
1. The rating live load used in the analysis is the AASHTO MS-18 (HS-20-44) live load. The load limit is the expressed as a percentage of this rating live load with full capacity pertaining to 100% capacity under rating live load.
2. MS-18 (HS-20-44) refers to semi-trailer with total weight of 32.7 tons.
3. Other traffic limit refers to proportion semi-trailer truck.
4. Traffic Load limit in metric tons

8.5 ASSESSMENT ON SPECIAL ISSUES

8.5.1 Vessel Collision

Detail discussion on the topic of the vessel collision are done in **Chapter 11.** However, in this section, only major findings of the present conditions of the vessel collision are presented as shown in **Table 8.5.1-1.**

Table 8.5.1-1 Bridge Condition in Relation to Vessel Collision

	No.	Bridge Name	Clearance (m)		Evidence of Collision	Existing Countermeasures
			Horizontal	Vertical		
PASIG RIVER	1	Delpan Bridge	46.5	4.0-6.0	No	No
	2	Jones Bridge	**40.8**	**3.6**-4.8	Ruptured Exterior Girders at Center Span	Pier Protection (Expanded Footing)
	3	Mc Arthur Bridge	**36.6**	4.0	No	No
	4	Quezon Bridge	81.9	6.1	No	No
	5	Ayala Bridge	60.2	**3.50**	Ruptured/Broken Sway Bracing	No
	6	Nagtahan Bridge	54.1	4.4	No	Pier Protection (Expanded Footing)
	7	Pandacan Bridge	44.5	8.2	No	No
	8	Lambingan Bridge	58.0	3.8	Cracks at the center span of exterior girder of upstream side	Pier Protection (Expanded Footing)
	9	Makati-Mandaluyong Bridge	48.6	5.6	No	No
	10	Guadalupe Bridge	**34.2**	8.3	Broken Existing Pier Protection	Pier Protection (RC Rigid Fender Type Connected with Footing)
	11	C-5 Bridge	**42.5**	8.2	Broken Existing Pier Protection	Pier Protection (Independent RC Fender Type)
	12	Bambang Bridge	**38.7**	4.6	No	Pier Protection (Expanded Footing and Wooden Feeder Type)
MARIKINA RIVER	13	Vargas Bridge	**40.4**	5.7	Exposed Rebars at Pier (Downstream Side)	Pier Protection for Downstream side (Expanded Footing) No Protection for Downstream side pier
	14	Rosario Bridge	**28.7**	5.2	No	Pier Protection (Expanded Footing)
	15	Marcos Bridge	25.6	4.9	No	No
	16	Marikina Bridge	26.3	5.7	No	No
	17	San Jose Bridge	24.0	5.7	No	No

Note: Bold numbers are insufficient for regulatory or recommended clearances.

8.5.2 Utilities

Utility pipes on urban bridges are common part of the structure. This includes electrical, waterlines, and telephone lines. Almost all the bridges have utility pipes except for Delpan, Pandacan and C-5 bridges. The existing utilities are tabulated in **Table 8.5.2-1.**

Table 8.5.2-1 List of Existing Utilities Along the Study Bridges

No.	BRIDGE NAME	LEFT		CENTER		RIGHT	
Pa1.1	Delpan Bridge (Upstream)	-	-	-	-	-	-
Pa1.2	Delpan Bridge (Downstream)	-	-	-	-	-	-
Pa2	Jones Bridge	46-Φ100 PVC Telephone	2- Φ 100mm GI Telephone	1- Φ 340 mm GI Waterline	1- Φ 100 mm PVC Electrical	-	-
Pa3	Mc Arthur Bridge	12- Φ 100 Asbestos Telephone	-	-	-	1- Φ 340 mm GI Waterline	-
Pa4	Quezon Bridge	-	1-340mm Φ GI Waterline	1-340mm Φ GI Waterline	-	1- Φ 340 mm GI Waterline	-
Pa6	Nagtahan Bridge	8- Φ 100 mm PVC Telephone	-	8- Φ 100 mm PVC Telephone	-	-	-
Pa7	Pandacan Bridge	-	-	-	-	-	-
Pa8	Lambingan Bridge	-	-	-	-	2-650mm Φ GI Waterline	-
Pa9	Makati - Mandaluyong Bridge	-	-	-	-	-	-
Pa10.1	Guadalupe Bridge (Central)	1- Φ 450 mm Steel Sewerline	-	1- Φ 250 mm Steel Waterline		1- Φ 500mm Steel Waterline	12- Φ 100mm PVC Telephone
Pa10.2	Guadalupe Bridge (Both Sides)				20- Φ 100mm PVC Telephone		
Pa11	C - 5 Bridge	-	-	-	-	-	-
Pa12	Bambang Bridge	6- Φ 100 mm PVC Telephone					
Ma1.1	Vargas Bridge (Upstream)	8- Φ 100 mm PVC Telephone					
Ma1.2	Vargas Bridge (Downstream)	1- Φ 500 mm Steel Waterline					12- Φ 100mm PVC Telephone
Ma2	Rosario Bridge	4- Φ 100 mm PVC Telephone				12- Φ 100mm PVC Telephone	
Ma3	Marcos Bridge						4- Φ 100mm PVC Telephone
Ma4	Marikina Bridge	1- Φ 300 mm Steel Waterline				4- Φ 100mm Steel Waterline	1- Φ 150mm
Ma5	San Jose Bridge	-	-	-	-	-	4 Cable Lines (Bare)

8.5.3 Informal Settlers

Table 8.5.3-1 presents the information on the informal settlers in the vicinity of the 17 bridges along Pasig and Marikina Rivers. The densities of squatters are classified into:

None	:	No squatters found
Light	:	Less than 10 households
Medium	:	More than 10 but less than 20 households
Heavy	:	More than 20 households

A more detailed discussion regarding the informal settlers is presented in **Chapter 4.**

Table 8.5.3-1 Distribution of Informal Settlers

	Bridge	Location	Density of Squatters	Barangays	No. of Respondents
1	Delpan Bridge	Manila	Heavy	Bgy. 286 Zone 26 Bgy. 275 Zone 25	23
2	Jones Bridge	Manila	None		0
3	Mac Arthur Bridge	Manila	None		0
4	Quezon Bridge	Manila	Medium	Bgy. 306 Zone 30 Bgy. 384 Zone 39	18
5	Ayala Bridge	Manila	Light	Bgy 659A Zone 71	1
6	Nagtahan Bridge	Manila	Heavy	Bgy. 636 Zone 64 Bgy. 830 Zone 90	22
7	Pandacan Bridge	Manila	Heavy	Brgy. 836 Zone 91 Brgy. 838 Zone 91 Brgy. 630 Zone 63	20
8	Lambingan Bridge	Manila	Light	Brgy. 888 Zone 98	9
9	Makati-Mandaluyong Bridge	Makati – Mandaluyong	Light	Brgy. Hulo	9
10	Guadalupe Bridge	Makati – Mandaluyong	Light	Brgy. Ilaya	2
11	C-5 Bridge	Pasig City	Heavy	Brgy. West Rembo Brgy. Bagong Ilog	32
12	Bambang Bridge	Pasig City	Light	Brgy. Bambang	3
13	Vargas Bridge	Pasig City	Heavy	Brgy. Bagong Ilog	26
14	Rosario Bridge	Pasig City / Quezon City	Heavy	Brgy. Ugong South Brgy. Ugong North	32
15	Marcos Bridge	Marikina City	None	Brgy. Industrial Valley/Brgy. Barangka/ Brgy. Calumpang/ Brgy. Santolan(Pasig)	0
16	Marikina Bridge	Marikina City	None	Brgy. Jesus dela Peña/ Brgy. Sta. Elena/ Brgy. Sto. Niño	0
17	San Jose Bridge	Montalban Rizal	Light	Brgy. San Jose	3

Note: 250m from approach of the bridge, 50m in length, 30m from the bank

8.5.4 Vertical Clearance of Existing Road Under Crossing

Based on the AASHTO-Geometric Design of Highway and Streets, vertical clearances for new or reconstructed structures should provide 4.9 m clear over the entire roadway width. Existing structures that provide 4.3 m clearance, if allowed by local statute may be retained. In highly urbanized area, a minimum clearance of 4.3 m may be provided if there is one route with 4.9 m clearance. Structures should provide additional clearance for future resurfacing of the underpassing road.

DPWH officials stated during a formal meeting, that the present requirement is 5.0 m. clearance. Future wearing surface and elevating the existing road level of underpass is the main consideration of this requirement. The Delpan Bridge(Upstream) is the best example in this case of insufficient vertical clearance. Traffic collisions with the girder of the Delpan Bridge was observed due to insufficient vertical clearance.

8.6 OVERALL EVALUATION OF BRIDGE CONDITION

8.6.1 Summary Tables of Evaluation Results

Table 8.6.1-1 to **8.6.1-5** show some examples of summary tables for overall evaluation. The summary table of other bridges are reported in **Appendix 8.6.1-1.**

The overall evaluation with respect to each bridge was made in terms of the following items as discussed in this chapter.

- Structural Soundness
- Vulnerability to Disasters
- Traffic Capacity and Function
- Special Issues

From the summary tables, the following five (5) bridges were judged to have very serious damages other than the Ayala Bridge.:

- Jones Bridge : Rupture Exterior Girders
- Quezon Bridge : Heavily Corroded Joint Connections of Floor System
- Lambingan Bridge : Cracks on Gerber Hinge Parts and Girders on Pier Top, Vertical Deformation of Superstructure.
- Guadalupe Bridge (Both Side) : Cracks on Gerber Hinge
- Vargas Bridge (Upstream Side) : Cracks on Gerber Hinge Parts and Girders on Pier Top, Vertical Deformation of Superstructure

8.6.2 Overall Evaluation of Bridge Condition

The overall condition evaluation for all of the bridges is summarized in **Table 8.6.2-1**

On the overall, the following summarizes the assessment of the study bridges:

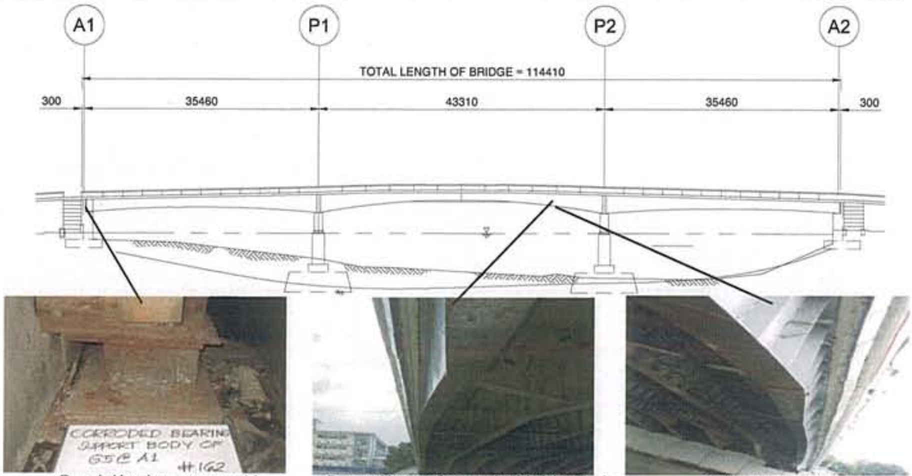
- Most of the bridge superstructures under the study had local damages such as concrete cracks, steel corrosion, reinforcing bar exposure and corrosion, etc. However, due to lack of bridge inventory data particularly on old bridges, a more in-depth study/survey should be conducted to determine extent of damages and the degree of the seismic resistance and stability of the substructures and foundations of most bridges under this study.

- Old bridges, especially steel bridges are assessed relatively more sound compared to newer concrete bridges. Defects on concrete bridges could be traced to construction quality and workmanship on site. With steel members/girders being fabricated in the fabrication yard, the quality of workmanship is properly controlled resulting to a more durable structure.

- Lack of daily and periodic maintenance, including cleaning and painting, lead to the deterioration of steel structures.

- Damages on piers and superstructure soffits are usually caused by vessel collision. Proper vessel collision protection and measures should be placed on the bridge to prevent further collisions.

Table 8.6.1-1 Overall Evaluation of Jones Bridge

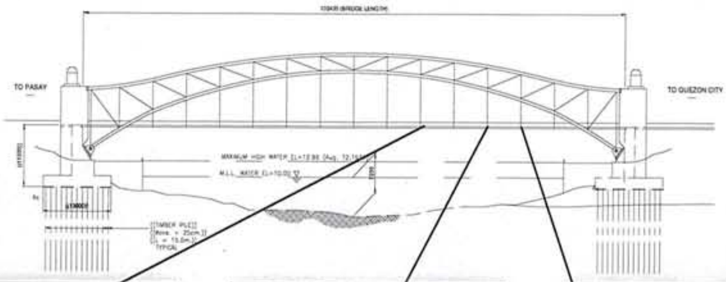
Reference / Bridge Name	JONES BRIDGE		
Location / Name of Road	City of Manila / Q. Paredes St.	Year Constructed	1948
Elevation	Corroded bearing supports at A1 / Ruptured bottom flange and 1/3 height of web / 280mm Lateral deformation		
Length of bridge	114.43m (35.46m + 43.31m + 35.46m)	No. of Lanes: 4 Lane Width: 2 – 7.66 m	
Superstructure Type	Steel I-Girder (3-span continuous)	Substructure Type	Abutment: Wall (footing), Pier: Wall (existing caisson)

		Member	Location of Damage Members	Damage Assessment (XYZ) *1	Damage Assessment (HMS) *2	Reason for Assessment
Structural Soundness	Superstructure	Steel I-Girder	Span 1: Weld portion of steel plates	II	H	Remarkable deterioration due to corrosion.
			Span 1: Lower plate of main girders (near A1)	II	H	Extensive corrosion of **8 girders**.
			Span 2: Bottom flange and web of exterior girder at upstream side	I	HH	Ruptured bottom flange and 1/3 height of web due to vessel collision.
			Span 2: Main girder, G8, Near P2	II	H	Lateral deformation is 280mm due to vessel collision.
			Span 2: Sway bracings	II	H	Ruptured sway braces on **2 locations**.
			Span 1,2,3: Sway bracings	II	H	Missing top members in **10 locations**.
			Span 3: Sway bracing (A2)	II	H	Corrosion spreads over entire member.
			Span 3: Downstream exterior girder	III	M	Lateral deformation is 50mm.
			Span 3: Interior girder G4, Near A2	II	H	Extensive corrosion.
		Deck Slab	Span 3: Bottom of Deck Slab	III	M	Cracks at bottom deck with width of 0.3 – 0.8 mm
			Span 3: Bottom of Deck Slab	III	M	Wide area of deterioration to poor construction
	Substructure	Abutment	Abutment A2 Wall	IV	S	Horizontal cracks on wall.
		Pier	Pier 1 Body	IV	S	Vertical cracks of pier body
		Foundation	Existing Caisson	II	H	Does not meet latest code requirement
	Accessory	Bearing Shoe	Abutment A1 Bearing Shoes	II	H	Extensive corrosion of bearing shoes at Abutment A1
			Pier 2 Bearing Shoes	II	H	Extensive corrosion of bearing shoes at Pier 1.
	Diagnosis Evaluation *3	Category "A"	**• Urgent measure for Ruptured Exterior Girder at upstream side is necessary. • In-depth study necessary to determine permanent repair/rehabilitation of ruptured girder. • Repair / maintenance work necessary to prevent further corrosion and loss of members.**			
Vulnerability to Disaster	Seismic Resistance	• Pier and Foundation (Existing Caisson) are insufficient under latest code seismic requirements, In-depth study is needed to determine required strengthening . • High vulnerability.				
	Wind Resistance	Not critical to wind action. Low Vulnerability				
	Flood Resistance	Not critical to flood. Low Vulnerability				
	Evaluation	**• Bridge is highly vulnerable to seismic forces. In-depth study is needed to determine required strengthening of substructure. • Bridge is sufficient to wind and flood action.**				
Traffic Capacity and Function	Traffic Limit	Negative on exterior girder				
	Volume / Capacity	57,216 (2002) 4 Lanes Level of Service: D (0.74) Load Rating: 0.00 Inventory Level, 0.76 Operating Level (Exterior Girder, Upstream Side)				
	Smooth Driving Condition	Fair				
	Evaluation	**Traffic functionality reduced by decrease in live load capacity and steep slope at approach.**				
Special Issues	River Navigation	Vertical Clearance < Regulated (Near Piers); Horizontal Clearance: Preferable				
	Utilities	46 – φ100 mm PVC Telecommunication Pipe, 2 – φ100 mm GI Telephone Line, 1 – φ100 mm PVC Electrical Line, 1 – φ340 mm Water Line				
	Informal Dwellers	No informal dwellers under Jones Bridge				
	Evaluation	**Minimal social and environmental impact**				
Overall Evaluation		**Major rehabilitation of ruptured girder and sway braces are needed, minor measures necessary to improve traffic functionality. Provide vessel collision protection**				

Notes:

1. Damage Assessment (XYZ Method)
   - I : Damage is serious, Traffic safety is in danger
   - II : Damage is big, detailed survey is necessary
   - III : Damage is found, follow-up inspection is required
   - IV : Small damage is observed, damage is recorded
   - OK : No damage is observed
2. Damage Assessment (HMS Method)
   - HH : Extremely Heavy
   - H : Heavy
   - M : Medium
   - S : Small
3. Diagnosis Evaluation
   - "A" : Urgent measures shall be applied: Conduct In-depth Survey
   - "B" : Urgent measures not required; Conduct In-depth Survey
   - "C" : In-depth Survey not required

Table 8.6.1-2 Overall Evaluation for Quezon Bridge

Reference / Bridge Name	QUEZON BRIDGE		
Location / Name of Road	City of Manila / Quezon Boulevard	Year Constructed	1946
Elevation	  Corroded Tie Beam  Corroded Vertical Hanger  Corroded Gusset Plate		
Length of bridge	102.40m.	No. of Lanes	4
		Lane Width	3.70 m.
Superstructure Type	Single Span Steel Arch Bridge	Substructure Type	Abutment: Wall Type (timber pile)

		Member	Location of Damage Members	Damage Assessment (XYZ) *1	Damage Assessment (HMS) *2	Reason for Assessment
Structural Soundness	Superstructure	Arch Member	Truss A,B,C – Bottom Chord Members	II	H	Corrosion of Member Connections
			Truss A C – Top Chord Members	II	H	Corrosion of Member Connections
			Truss A,B,C – Vertical Members	II	H	Corrosion of Member Connections
			Truss A,B – Hangers	II	H	Corrosion of Member Connections
		Floor System	Longitudinal Tie Beam	I	HH	Extensive corrosion and loss of section of members
			Gusset Plates	I	HH	Extensive corrosion and loss of section of members
			Ends of Braces	I	HH	Extensive corrosion and loss of section of members
			Ends of Stringers (abutments)	I	HH	Extensive corrosion and loss of section of members
			Additional stringers at abutment	I	HH	Extensive corrosion and loss of section of members
			Stringers supporting the sidewalks	I	HH	Extensive corrosion and loss of section of members
	Substructure	Abutment	Abutments & Pylons	III	M	Cracks on the face of the wall
		Foundation	-	-	-	Not accessible for inspection.
	Diagnosis Evaluation *3	Category "A"	• **Heavily corroded joint connections under the floor deck slab and water leaking at abutments stemmed from insufficient maintenance activities.**			
Vulnerability to Disaster	Seismic Resistance	• Pier and Foundation (timber piles) are insufficient under latest code seismic requirements, In-depth study is needed to determine required strengthening . • Moderate Vulnerability.				
	Wind Resistance	Not critical to wind action. Low Vulnerability.				
	Flood Resistance	Not critical to flood. Low Vulnerability.				
	Evaluation	• **Bridge is moderately vulnerable to seismic forces.** • **Bridge is sufficient to wind and flood action.**				
Traffic Capacity and Function	Traffic Limit	92% of MS-18				
	Volume / Capacity	85, 137 (2002) 4 Lanes Level of Service: F (1.22) Load Rating: 0.92 Inventory Level, 1.59 Operating Level (deck frame, gusset plate and joint connections)				
	Smooth Driving Condition	Good				
	Evaluation	**Traffic functionality reduced by decrease in live load capacity.**				
Special Issues	River Navigation	Vertical Clearance > Regulated ; Horizontal Clearance > Regulated				
	Utilities	3 - 340mmϕ G.I. pipe water lines				
	Informal Dwellers	Medium – 18 households identified				
	Evaluation	**Moderate social and environmental impact**				
Overall Evaluation		**Replacement / Rehabilitation of corroded connections of deck frame system, minor measures necessary to improve traffic functionality.**				

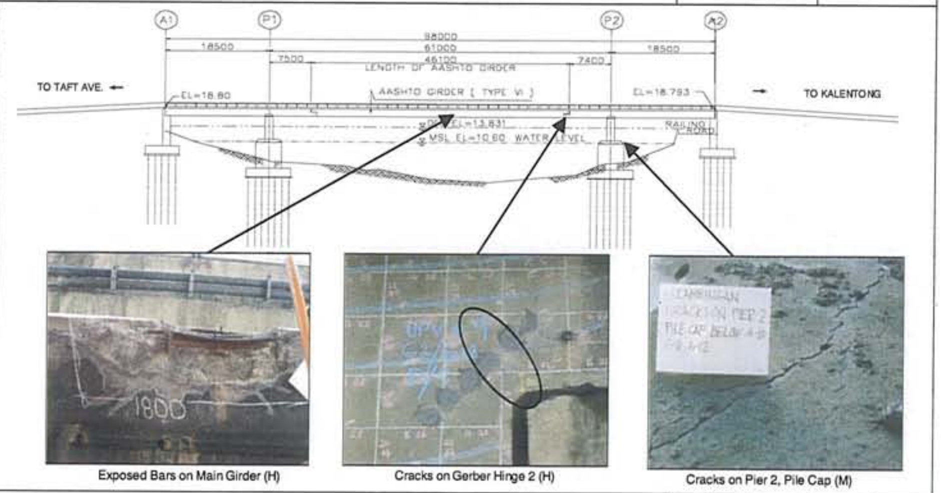
Notes:

1. Damage Assessment (XYZ Method)
   - I : Damage is serious, Traffic safety is in danger
   - II : Damage is big, detailed survey is necessary
   - III : Damage is found, follow-up inspection is required
   - IV : Small damage is observed, damage is recorded
   - OK : No damage is observed

2. Damage Assessment (HMS Method)
   - HH : Extremely Heavy
   - H : Heavy
   - M : Medium
   - S : Small

3. Diagnosis Evaluation
   - "A" : Urgent measures shall be applied: Conduct In-depth Survey
   - "B" : Urgent measures not required; Conduct In-depth Survey
   - "C" : In-depth Survey not required

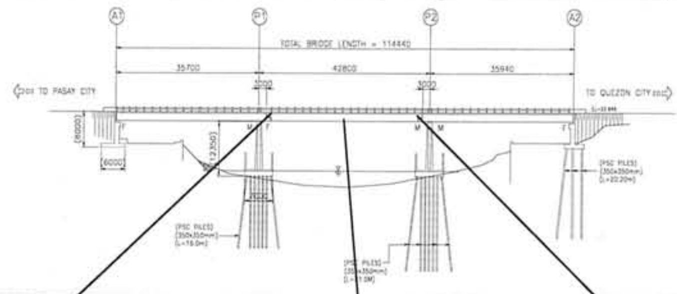
Table 8.6.1-3 Overall Evaluation of Lambingan Bridge

Reference/Bridge Name		LAMBINGAN BRIDGE				
Location/Name of Road		Manila City Bonifacio Street			Year Constructed	1975
Elevation		 Exposed Bars on Main Girder (H) / Cracks on Gerber Hinge 2 (H) / Cracks on Pier 2, Pile Cap (M)				
Length of bridge		98.10m (18.50m + 61.10m + 18.50m)			No. of Lanes: 6 Lane Width: 3.20m	
Superstructure Type		PC Gerber I Girder Bridge (3-Span)			Substructure Type	Abutment: Wall Type((steel pipe pile)), Pier: Wall Type((steel pipe pile))
		Member	Location of Damage Members	Damage Assessment (XYZ) *1	Damage Assessment (HMS) *2	Reason for Assessment
Structural Soundness	Superstructure	PC I-Girder	Span 2: Bot of G12	III	M	0.2m^2 Spalling of concrete due to crack progressing on the girder
			Span 2: Bot of G12	II	H	0.75m^2 of exposed rebars
			Side of Girder G12	III	M	< 0.3m^2 of exposed rebars
			Span 2 near P2: Side of Girder G12	III	M	0.18m^2 of exposed rebars due to insufficient provision of concrete cover
			Span 2 , Gerber Hinges 1 and 2	I	H	Cracks on exterior girder at gerber hinges due to insufficient hanger and longitudinal tendons, **4 locations.**
			Exterior girders at pier supports	II	H	Flexural cracks on exterior girders due to tension stresses at service loads, **4 locations.**
			Span 2, Midspan of Girder 12	II	H	Longitudinal cracks and exposed rebars caused by vessel collision
		Deck Slab	Span 2: Bottom of Diaphragm between G8 & G7	III	M	0.2m^2 of honeycomb caused by inferior compaction of concrete
			Span 2: Diaphragm between G7 & G6	III	M	Crack width of 0.35mm.
			Span 2: Diaphragm between G1 & G2	III	M	0.25m^2 honeycomb caused by inferior compaction of concrete
			Span 2: Diaphragm between G5 & G6	III	M	Crack width of 0.40mm.
	Substructure	Abutment	Span 1: Abutment 1	IV	S	0.3mm cracks on two locations
			Span 1, Abutment A1	II	H	Corroded anchor bars, **12 sets (24 pieces).**
			Span 3, Abutment A2	II	H	Corroded anchor bars, **12 sets (24 pieces).**
		Pier	Span 3: Pier 3 Body (Tie Beam)	III	M	Remarkable damage on pier tie beam due to vessel collision.
			Span 4: Pier 4 Body (Tie Beam)	III	M	Remarkable damage on pier tie beam due to vessel collision.
			Span 4: Pier 4 Body (Tie Beam)	III	M	Remarkable damage on pier tie beam due to vessel collision.
	Foundation	-		IV	S	Maximum inclination is 0.34 degree longitudinal at A1
	Accessory	Span 1: Bearing Pad at A1, downstream girder		III	M	Deformation of elastomeric pad due to excessive loading.
	Diagnosis Evaluation *3	Category "A"	• **Repairs of concrete cracks necessary** • **Cracks at Gerber hinge parts related to bridge design and/or construction quality.**			
Vulnerability to Disaster	Seismic Resistance	No as-built plans. Pier and foundation details need to be checked under seismic action. Moderate vulnerability				
	Wind Resistance	Not critical to wind action. Low Vulnerability				
	Flood Resistance	Not critical to flood overtopping. Low Vulnerability.				
	Evaluation	• **Needs In-depth study on pier and foundation to check adequacy/safety under seismic action.** • **Not critical to wind and flood action.**				
Traffic Capacity and Function	Traffic Limit	63% of MS-18.				
	Volume / Capacity	31,973 (2002) 6 Lanes Level of Service: B Load Rating: 0.63 Inventory Level, 1.06 Operating Level (Gerber Hinge Part)				
	Smooth Driving Condition	Steep slope at approach roads, corrugation on bridge				
	Evaluation	• **Minor profile adjustment necessary at approach** • **Limitation on traffic load reduces functionality**				
Special Issues	River Navigation	Vertical Clearance > regulated; horizontal clearance > preferred				
	Utilities	Water leakage, Right: 2-650 ϕ GI Waterline				
	Informal Dwellers	Light – 9 Households Identified				
	Evaluation	**Minimal social and environmental impact**				
Overall Evaluation		**Bridge needs in-depth study to check superstructure adequacy and improve traffic functionality.**				

Notes:

1. Damage Assessment (XYZ Method)
   - I : Damage is serious, Traffic safety is in danger
   - II : Damage is big, detailed survey is necessary
   - III : Damage is found, follow-up inspection is required
   - IV : Small damage is observed, damage is recorded
   - OK : No damage is observed
2. Damage Assessment (HMS Method)
   - HH : Extremely Heavy
   - H : Heavy
   - M : Medium
   - S : Small
3. Diagnosis Evaluation
   - "A" : Urgent measures shall be applied: Conduct In-depth Survey
   - "B" : Urgent measures not required; Conduct In-depth Survey
   - "C" : In-depth Survey not required

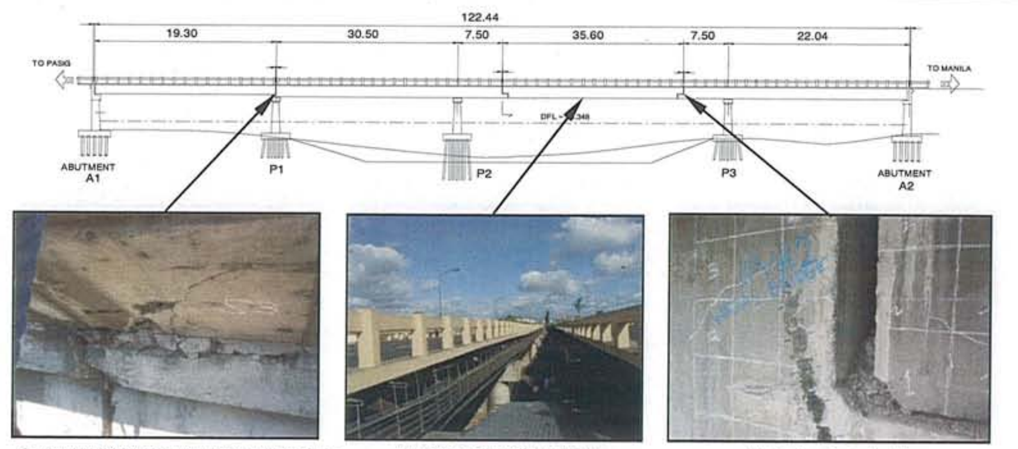
Table 8.6.1-4 Overall Evaluation of Guadalupe Bridge (Both Sides)

Reference / Bridge Name		GUADALUPE BRIDGE (BOTH SIDES)				
Location / Name of Road		EDSA			Year Constructed	1979
Elevation		 Cracks at Gerber Hinge  Exposed Rebar and Concrete Spalling at Girder  Cracks at Gerber Hinge				
Length of bridge		114.44m. (35.70 + 42.80 + 35.94)			No. of Lanes: 4; Lane Width: 3.00 m.	
Superstructure Type		PC Gerber Girder Bridge (3-Span)			Substructure Type	Abutment: Wall Type (spread, PSC pile), Pier: Wall Type (PSC Pile)
		Member	Location of Damage Members	Damage Assessment (XYZ) *1	Damage Assessment (HMS) *2	Reason for Assessment
Structural Soundness	Superstructure	Prestressed Concrete Girder	Span 2 : Gerber Hinge 1 of Girder 5 to 8	II	H	Corrosion of Exposed Rebars
			Span 2 : Middle span of Girder 5	II	H	Corrosion of Exposed Rebars
			Span 2 : Gerber Hinge 2 of Girder 1	II	H	Corrosion of Exposed Rebars
			Span 1 : Bottom of Center span of Girder 1, 3, 4 to 8	III	M	Cracks and Corrosion of Exposed Rebars
			Span 2 : Gerber Hinge 1 of Girder 1 & 5 to 8	I	HH	Wide Cracks at Gerber Hinge, Spalling and Exposed Rebars
			Span 2 : Middle of Girder 8	III	M	Cracks and Corrosion of Exposed Rebars
			Span 2 : Gerber Hinge 2 of Girder 1, 5, 6 & 8	I	HH	Wide Cracks at Gerber Hinge, Spalling and Exposed Rebars
	Substructure	Abutment	Abutment A2	II	H	Cracks on the face of the abutment
		Pier	Pier 2 Wall (U/S & D/S)	III	M	Corrosion of Exposed Rebars
	Accesory		Bearing of Girder 8, Pier 1	III	M	Rust is scattered extensively
			Bearing of Girder 5, Pier 2	III	M	Rust is scattered extensively
	Diagnosis Evaluation *3	Category "A"	• **Cracks at Gerber hinge parts related to bridge design and/or construction quality.**			
Vulnerability to Disaster	Seismic Resistance	• Pier and Foundation (PSC piles) are insufficient under latest code seismic requirements, In-depth study is needed to determine required strengthening . • High Vulnerability.				
	Wind Resistance	Not critical to wind action. Low Vulnerability				
	Flood Resistance	Not critical to flood. Low Vulnerability				
	Evaluation	• **Bridge is highly vulnerable to seismic forces.** • **Bridge is sufficient to wind and flood action.**				
Traffic Capacity and Function	Traffic Limit	44% of MS-18				
	Volume / Capacity	188,659 (2002) 4 Lanes Level of Service: F (1.23) Load Rating: 0.44 Inventory Level, 0.74 Operating Level (Gerber Hinge parts)				
	Smooth Driving Condition	Non-steep slope, corrugation and curvature				
	Evaluation	**Traffic functionality reduced by level of service and load limitations.**				
Special Issues	River Navigation	Vertical Clearance > Regulated ; Horizontal Clearance < Regulated				
	Utilities	20 – 100mmϕ PVC Telephone lines				
	Informal Dwellers	Light : 2 households identified				
	Evaluation	**Low social and environmental impact**				
Overall Evaluation		**Urgent measures necessary for repair of gerber hinge connections, traffic functionality is insufficient.**				

Notes:

1. Damage Assessment (XYZ Method)
   - I : Damage is serious, Traffic safety is in danger
   - II : Damage is big, detailed survey is necessary
   - III : Damage is found, follow-up inspection is required
   - IV : Small damage is observed, damage is recorded
2. Damage Assessment (HMS Method)
   - HH : Extremely Heavy
   - H : Heavy
   - M : Medium
   - S : Small
3. Diagnosis Evaluation
   - "A" : Urgent measures shall be applied: Conduct In-depth Survey
   - "B" : Urgent measures not required; Conduct In-depth Survey
   - "C" : In-depth Survey not required

Table 8.6.1-5 Overall Evaluation of Vargas Bridge

Reference / Bridge Name	VARGAS BRIDGE (Upstream)
Location / Name of Road	City of Pasig / Pasig Boulevard Extension — Year Constructed: 1992
Elevation	Crack w/ spall @ bottom of cantilever slab & flange; Large deflection of superstructure; Vertical crack at gerber hinge
Length of bridge	122.44 m (19.30m + 30.5m + 50.6m +22.04m) — No. of Lanes: 2; Lane Width: 3.70 m
Superstructure Type	PC Gerber AASHTO Girder — Substructure Type: Abutment: Wall Type(steel pipe pile), Pier: Column bent (steel pipe pile)

		Member	Location of Damage Members	Damage Assessment (XYZ) *1	Damage Assessment (HMS) *2	Reason for Assessment
Structural Soundness	Superstructure	Steel I-Girder	Span 1: Top flange of Girder 3 at Pier 1	I	HH	1.00mm wide vertical crack.
			Span 3: Face of Girder 1 at Gerber GH1	III	M	Spalling with exposed rebar A=0.45m².
			Span 3: Face of Girder 1 at Gerber GH2	III	M	Spalling with exposed rebar A=0.24m².
			Span 2: Girder G1 at top of Pier 2	II	H	Flexural Crack width 2mm, depth of crack 17mm
			Span 3: Girder G1, GH1, L,	I	HH	Crack width 1-3mm, depth of crack 44m
			Span 3: Top flange of Girder 4 at Pier 2	I	HH	0.45mm wide vertical crack
			Bridge Deck Profile	II	H	Settlement of Span 3, **4 giders**
			Bridge Deck Profile	II	H	Lift-up of Span 2 and Span 4, **8 girders**
		Deck Slab	Span 1: Bottom of slab	III	M	0.30m² area of spalling at bottom
			Span 3: Bottom of Cantilever Slab	II	H	3.0mm wide crack at bottom, 1.44m² area of honey comb
	Substructure	Abutment	Abutment A1, Backwall	III	M	Crack width 1.0mm
		Pier	Pier 3 Coping	III	M	Wide cracks near bottom of coping, width=5mm
		Foundation	Pier P2 Steel Pile	OK	S	Foundation sufficient in latest code requirement
	Accessory		-	-	-	-
			-	-	-	-
	Diagnosis Evaluation *3	Category "A"	• **Repair of cracks in girders necessary.** • **In-depth study on deflection and rotation of girder slab necessary to verify safety/adequacy of bridge.**			
Vulnerability to Disaster	Seismic Resistance	• Reasonably sufficient under present seismic load requirement but needs improvement on confinement reinforcement. • Low vulnerability.				
	Wind Resistance	Not critical to wind action. Low Vulnerability				
	Flood Resistance	Not critical to flood. Low Vulnerability				
	Evaluation	• **Bridge is moderately vulnerable to seismic forces but needs improvement on confinement reinforcement.** • **Bridge is sufficient to wind and flood action.**				
Traffic Capacity and Function	Traffic Limit	83% of MS-18				
	Volume / Capacity	27,799 (2002) 2 Lanes Level of Service: E (0.85) Load Rating: 0.83 Inventory Level, 1.39 Operating Level (Gerber Hinge Part)				
	Smooth Driving Condition	Fair				
	Evaluation	**Traffic functionality reduced by decrease in live load capacity.**				
Special Issues	River Navigation	Vertical Clearance > Regulated; Horizontal Clearance: Preferable mitigate				
	Utilities	8 – ϕ100 mm PVC Telephone Line				
	Informal Dwellers	Heavy: More than 20 households identified				
	Evaluation	**Moderate social and environmental impact**				
Overall Evaluation		**Measure on Cracks of PC Girders is necessary, pier protections are needed**				

Notes:

1. Damage Assessment (XYZ Method)
   - I : Damage is serious, Traffic safety is in danger
   - II : Damage is big, detailed survey is necessary
   - III : Damage is found, follow-up inspection is required
   - IV : Small damage is observed, damage is recorded
   - OK : No damage is observed
2. Damage Assessment (HMS Method)
   - HH : Extremely Heavy
   - H : Heavy
   - M : Medium
   - S : Small
3. Diagnosis Evaluation
   - "A" : Urgent measures shall be applied: Conduct In-depth Survey
   - "B" : Urgent measures not required; Conduct In-depth Survey
   - "C" : In-depth Survey not required

Table 8.6.2-1 Summary of Overall Evaluation of Bridge Condition (1/2)

No	Bridge Name (Construction Year)	Bridge Type (Length)	Past Rehabilitation Works (Years)	Assessment: Structure Soundness	Assessment: Vulnerability to Disaster	Assessment: Traffic Functionality	Assessment: Special Issues	Overall Evaluation	Recommended Action
1	**Delpan Bridge (Upstream) (1965)**	PC Box Girder Gerber Brigde (204m)	• Retrofitting (1997)	• Cracks on concrete box girder due to aging of concrete and increase of traffic load. B	• Earthquake: Moderate • Wind: Low • Flood Low	• **Level of Service: D** (V/C = 0,82) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Good • Insufficient vertical clearance for traffic crossing under the bridge	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Heavy • Road Traffic Collision: Insufficient Vertical Clearance at side span.	• Bridge is totally sound but needs adjustment to satisfy traffic functionality.	• Repair concrete cracks, spalling and exposed rebars on PC Box Girder. • Improve vertical clearance of road under bridge. • Investigate Abutment A1 for stability.
	Delpan Bridge (Downstream) (1988)	PC Box Girder Gerber Bridge (203m)	• Retrofitting (1997)	• Minor cracks at superstructure and substructure. C	• Earthquake: Moderate • Wind • Low	• **Level of Service: D** (V/C = 0.82) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Good • Meets minimum requirement for traffic functionality	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Heavy	• Bridge is totally sound but small repair works are necessary.	• Repair concrete cracks on PC Box Girders and Substructures.
2	**Jones Bridge (1948)**	3-Span Continuous Steel Girder (114m)	• Rehabilitation (1992) • Retrofitting (1997) • Retrofitting (1997)	• Ruptured exterior girder at upstream side due to vessel collision. • Corrosion of bearings at P2 & Abutment A1 due to water seepage. A	• Earthquake: High • Wind: Low • Flood: Low	• **Level of Service: D** (V/C = 0.74) • Load Limit: Negative on exterior girder • Smooth Driving Condition: Fair • Traffic functionality is reduced by decrease in live load capacity	• Vessel Collision: Insufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: None	• Major Rehabilitation of ruptured girder and sway braces urgently necessary. • Vessel collision protection is necessary.	• Rehabilitate ruptured exterior girder to function as vessel collision protection. • Provide additional girders to take structural functions of exterior girders. • Repair ruptured sway braces.
3	**McArthur Bridge (1948)**	3-Span Continuous Steel Girder Bridge (115m)	• Rehabilitation (1992) • Retrofitting (1997)	• Corroded steel members due to water seepage. • Missing rivets and cracks on deck slab. B	• Earthquake: High • Wind: Low • Flood: Low	• **Level of Service: C** (V/C = 0.52) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair	• Vessel Collision: Insufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: None	• Bridge is totally sound but repair works are necessary.	• Clean and paint corroded steel members • Seal concrete cracks. • Replace missing rivets. • Investigate pier stability.
4	**Quezon Bridge (1946)**	Steel Arch Bridge (103 m)	• Rehabilitation (unknown)	• Heavily corroded joint connections at floor system due to water seepage between deck slab and vertical hangers. A	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: F** (V/C = 1.22) • Load Limit: 92% MS-18 • Smooth Driving Condition: Good • Traffic functionality is reduced by decrease in live load capacity	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Heavy	• Rehabilitation of corroded joint connections at floor system is necessary.	• Replacement of corroded joint connection at floor system. • Clean and paint corroded steel members. • Provide water sealant at hanger to prevent water seepage to floor system.
5	**Ayala Bridge (1950)**	Steel Truss Bridge (142 m)	• Repair (2003)	• Heavily corroded floor system. • Ruptured stringers and section loss of lower chords. • Bearing shoes heavily corroded. • Pier and Foundation does not meet latest code requirement A	• Earthquake: High • Wind: Low • Flood: Low	• **Level of Service: E** (V/C = 0.64) • Load Limit: Negative (Floor System) • Smooth Driving Condition: Fair • Insufficient traffic functionality	• Vessel Collision: Insufficient Vertical Navigational Clearance • Informal Settlers: Light	• Major rehabilitation of superstructure and retrofit of substructure are necessary.	• Rehabilitate superstructure steel truss system. • Repair concrete cracks. • Retrofit substructure to meet latest code requirement.
6	**Nagtahan Bridge (1966)**	RC Girder / 3 span continuous Truss (432 m)	• Widening (1980) • Retrofitting (1997)	• Cracks on substructures due to aging and increase traffic load. • Corrosion of steel members due to poor construction quality. B	• Earthquake: High • Wind: Low • Flood: Low	• **Level of Service: D** (V/C = 0.74) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Good	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Heavy	• Bridge is totally sound but repair works are necessary.	• Repair cracks on RC girder. • Investigate Pier stability. • Maintain periodic cleaning and Painting of steel members.
7	**Pandacan Bridge (1979)**	PCI AASHTO Girder Gerber Bridge (145 m)		• Cracks on deck slab due to poor construction quality. C	• Earthquake: Low • Wind: Low • Flood: Low	• **Level of Service: B** (V/C = 0.32) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Good • Traffic functionality is sufficient	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Heavy	• Bridge is totally sound but repair works are necessary.	• Repair concrete cracks on deck slab.
8	**Lambingan Bridge (1975)**	PC AASHTO Girder Gerber Bridge (98m)	• Retrofitting (unknown)	• Cracks at Gerber Hinge parts due to insufficient reinforcement. • Cracks on girder at pier top due to insufficient longitudinal tendons. A	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: C** (V/C = 0.53) • Load Limit: 63% MS-18 • Smooth Driving Condition: Fair • Traffic functionality is reduced • due to the decrease in live load capacity	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Light	• Cracks at Gerber Hinge parts reducing live load capacity urgent measures is necessary.	• Rehabilitate Gerber Hinge parts. • Repair concrete cracks at PC Girder at top of pier.
9	**Makati-Mandaluyong Bridge (1986)**	PC Box Girder with Gerber AASHTO Girder Bridge (207 m)	-	• Cracks on concrete members due to aging and poor construction quality. • Horizontal cracks at anchorage block due to insufficient reinforcement. C	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: D** (V/C = 0.70) • Load Limit: MS=18 (Full) • Smooth Driving Condition Fair • Sufficient traffic functionality	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Light • Road Traffic Collision: Insufficient Vertical Clearance at side span	• Bridge is totally sound but repair works are necessary.	• Clean and paint of concrete steel members • Repair cracks at pier wall. • Repair crack of concrete at anchorage block.

Note: ☐ - Diagnosis Category

A - Emergency measured shall be taken immediately.
B - Remedial measures shall be undertaken after evaluation of damages.
C - No immediate action is necessary, ordinary inspection shall be continued.

Table 8.6.2-1 Summary of Overall Evaluation of Bridge Condition (2/2)

No	Bridge Name (Construction Year)	Bridge Type (Length)	Past Rehabilitation Works (Years)	Assessment: Structure Soundness	Assessment: Vulnerability to Disaster	Assessment: Traffic Functionality	Assessment: Special Issues	Overall Evaluation	Recommended Action
10	**Guadalupe Bridge (Central) (1962)**	3-Span Continuous Truss Bridge (114 m)	• Widening (unknown) • Retrofitting (1997)	• Corrosion of steel members due to water leakage at damage pipes. • Cracks at concrete pier/wall due to increase traffic load. C	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: F** (V/C = 1.23) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Traffic functionality reduced by level of service	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Settlers: Light	• Bridge is totally sound repainting of steel members are necessary.	• Clean and paint of concrete steel members. • Repair cracks at pier wall.
	Guadalupe Bridge (Both Sides) (1979)	Gerber PC AASHTO Girder Gerber Bridge (114 m)	• Retrofitting (unknown)	• Serious cracks at Gerber Hinge parts due to insufficient reinforcement. A	• Earthquake: High • Wind: Low • Flood: Low	• **Level of Service: F** (V/C = 1.23) • Load Limit: 44% MS-18 • Smooth Driving Condition: • Good • Traffic functionality is reduced by load limit and level of service	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Settlers: Light	• Cracks at Gerber Hinge parts reduce the live load capacity, urgent measure is necessary.	• Rehabilitate serious cracks at Gerber Hinge parts.
11	**C5 Bridge (1997)**	PC AASHTO Girder Gerber Bridge (273 m)	-	• Cracks at deck slab and substructure due to increased traffic load. C	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: E** (V/C = 0.85) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Traffic functionality is limited by level of service	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Settlers: Heavy	• Bridge is totally sound but repair works are necessary.	• Repair cracks at concrete deck slab. • Repair pier protection.
12	**Bambang Bridge (1991)**	PC AASHTO Girder Gerber Bridge (163 m)	• Retroffitting (1997)	• Concrete cracks at deck slab due to poor construction quality. C	• Earthquake: Low • Wind: Low • Flood: Low	• **Level of Service: D** (V/C = 0.46) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Meets minimum traffic functionality requirement	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Settlers: Light	• Bridge is totally sound but small repair works are necessary.	• Repair cracks of concrete at deck slab.
13	**Vargas Bridge (Upstream) (1992)**	PC AASHTO Girder Gerber Bridge (122 m)	• Retrofitting (1997)	• Cracks at gerber hinge support due to insufficient reinforcement. • Cracks of girder at pier top due to Insufficient longitudinal tendons. • Rotation of girder at cantilever. A	• Earthquake: Low • Wind: Low • Flood: Low	• **Level of Service: E** (V/C = 0.85) • Load Limit: 83% MS-18 • Smooth Driving Condition: • Fair • Traffic functionality reduced by level of service	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Settlers: Heavy	• Cracks at Gerber Hinge parts reduced live load capacity, urgent measure is necessary.	• Rehabilitate Gerber Hinge parts and the cracks of girder at top of pier. • Measure needed for girder rotation at cantilever portion. • Provide pier protection.
	Vargas Bridge (Downstream) (1973)	Steel Plate Girder Bridge (143 m)	• Retrofitting (1997)	• Cracks on concrete deck slab due to aging. • Corrosion of steel members due to insufficient maintenance. C	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: E** (V/C = 0.85) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Traffic functionality reduced by level of service	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Setters: Heavy	• Bridge is totally sound but repair works are necessary.	• Repair of concrete cracks at deck slab. • Clean and paint concrete steel members.
14	**Rosario Bridge (1952)**	PC AASHTO Girder Gerber Bridge (175m)	• Widening (1978) • Retrofitting (1997)	• Cracks on deck slab due to aging and increased traffic load. B	• Earthquake: Moderate • Wind Low • Flood: Low	• **Level of Service: F** (V/C = 1.22) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Traffic functionality is limited by level of service	• Vessel Collision: Insufficient Horizontal Navigational Clearance • Informal Settlers: Heavy	• Bridge is totally sound but repair works are necessary.	• Repair concrete cracks.
15	**Marcos Bridge (1978)**	PC AASHTO Girder Gerber Bridge (312 m)	• Retrofitting (1997)	• Cracks on pier copings at widening portion to poor construction quality. C	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: E** (V/C = 0.88) • Load Limit: MS-18 (Full) • Smooth Driving Condition: • Fair • Traffic functionality is limited by level of service	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: None	• Bridge is totally sound but small repair works are necessary.	• Repair concrete cracks.
16	**Marikina Bridge (1980)**	PC AASHTO Girder Gerber Bridge (138 m)	• Retrofitting (1997) • Retrofitting (1997)	• Cracks on deck slab due to increased traffic load. C	• Earthquake: Moderate • Wind: Low • Flood: Low	• **Level of Service: D** (V/C = 0.77) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Traffic functionality meets minimum requirements	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: None	• Bridge is totally sound but small repair works are necessary.	• Repair concrete cracks.
17	**San Jose Bridge (1980)**	PC AASHTO Girder Gerber Bridge (200 m)	-	• Cracks on deck slab. • Corrosion of bearing support due to water seepage . • Exposed foundation due to scouring. C	• Earthquake: High • Wind: Low • Flood: Low	• **Level of Service: A** (V/C = 0.06) • Load Limit: MS-18 (Full) • Smooth Driving Condition: Fair • Traffic functionality meets requirements.	• Vessel Collision: Sufficient Vertical and Horizontal Navigational Clearance • Informal Settlers: Light	• Bridge is totally sound but small repair works are necessary.	• Repair of concrete cracks. • Provide measurement of corroded support.

Note: ☐ - Diagnosis Category

A - Emergency measured shall be taken immediately.
B - Remedial measures shall be undertaken after evaluation of damages.
C - No immediate action is necessary, ordinary inspection shall be continued.