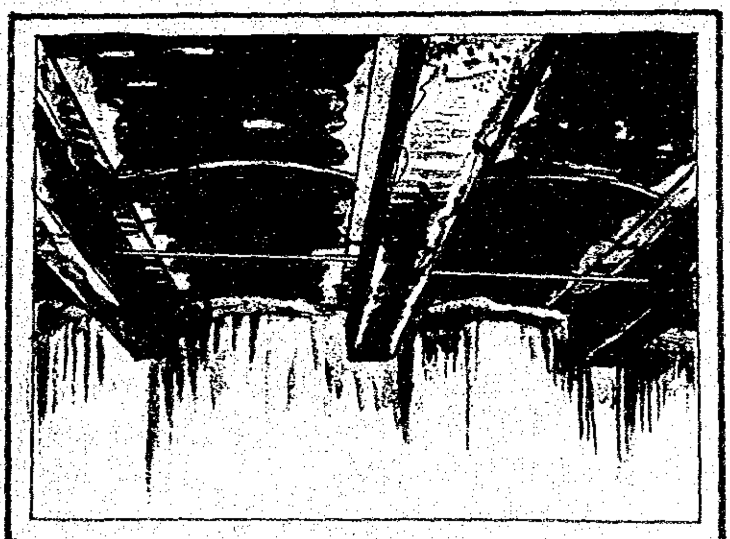
CHAPTER 2

SELECTION OF 100 FEDERAL BRIDGES FOR VISUAL INSPECTION



CHAPTER 2

SELECTION OF 100 FEDERAL BRIDGES FOR VISUAL INSPECTION

2.1 General

With respect to the enormous number of study bridges rated as 3, 4, or SSAL in NALS, the specific number of bridges at various stages was set up in S/W as a maximum of 100 for visual inspection and a maximum of 20 out of these 100 bridges for detailed survey and preliminary design.

Accordingly, the main purpose of this chapter is to select 100 typical bridges for visual inspection which could be representative of all the study bridges. The survey results on these selected bridges were used to establish a selection criteria for 20 bridges and to reflect in formulating a maintenance and rehabilitation program of the discarded bridges.

2.2 Classification of Study Bridges

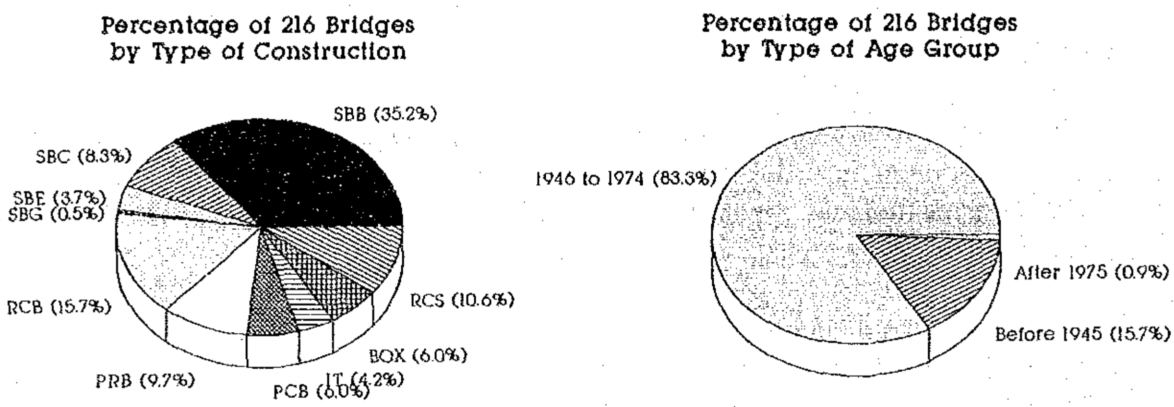
The study bridges, with the main aim of formulating the maintenance and rehabilitation program, are defined as all the bridges located along the federal roads on the Peninsular with condition rating 3, 4 or study category of SSAL in NALS. These study bridges were confirmed jointly with JKR counterparts and amounted to 216 bridges. A list of these bridges which is a computer-output of the bridge inventory prepared under NALS is attached in Appendix-C.

As part of the preparatory study, all the bridges were grouped into different types of bridge construction. Out of a total of 216 bridges, 76 nos (35.2%) are steel beam buckle plate (SBB) bridges, 34 nos (15.7%) are R.C. beam with slab (RCB) bridges, 23 nos (10.6%) are R.C. slab (RCS) bridges, 21 nos (9.7%) are Precast R.C. beam (PRB) bridges, 18 nos (8.3%) are steel beam with R.C. slab (SBC) bridges, 13 nos (6.0%) are Prestressed beam with R.C. slab (PCB) bridges, 13 nos (6.0%) are R.C. Box culverts, 9 nos (4.2%) are Inverted-T (IT) beam bridges, 8 nos (3.7%) are Encased Steel beam with slab (SBE) bridges, and 1 no (0.5%) is a steel box girder bridge.

These bridges were also classified in terms of their age group. The classification is important in the sense that most bridges in Malaysia were known to have been built or designed using the relevant British Standard at that time. The bridges built between 1946 to 1974 are known to have been designed to HA Loading while bridges built after this age group were designed to carry HA load and a check was made for HB guided along their center line.

Bridges built before 1945 are unknown in terms of the loading used as no data is available with regard to the design of these bridges, but they many have been built using the Ministry of War loading. The bridges in the study have been grouped into 3 age groups; 34 nos (15.74%) built before 1945, 180 nos (83.33%) built between 1946 to 1974, and 2 nos (0.93%) built after 1975. The statistics of these bridges by age group and type of construction is shown in Figure 2-1.

Figure 2-1 Statistics of 216 Bridges



2.3 Selection Procedure of 100 Bridges

It was originally planned that the 100 bridges for visual inspection would be selected from the 216 study bridges. However, GOM requested to incorporate the following five special bridges into 100 bridges for visual inspection.

Name of Bridge	Study Category	Capacity
Merdeka	2	STAL
Temerloh	2	MTAL
Batu Pahat	2	STAL
Sultan Yahya Petra[1]	-	-
Kuala Lepar	2	MTAL

Note : (1) This bridge was not covered in NALS

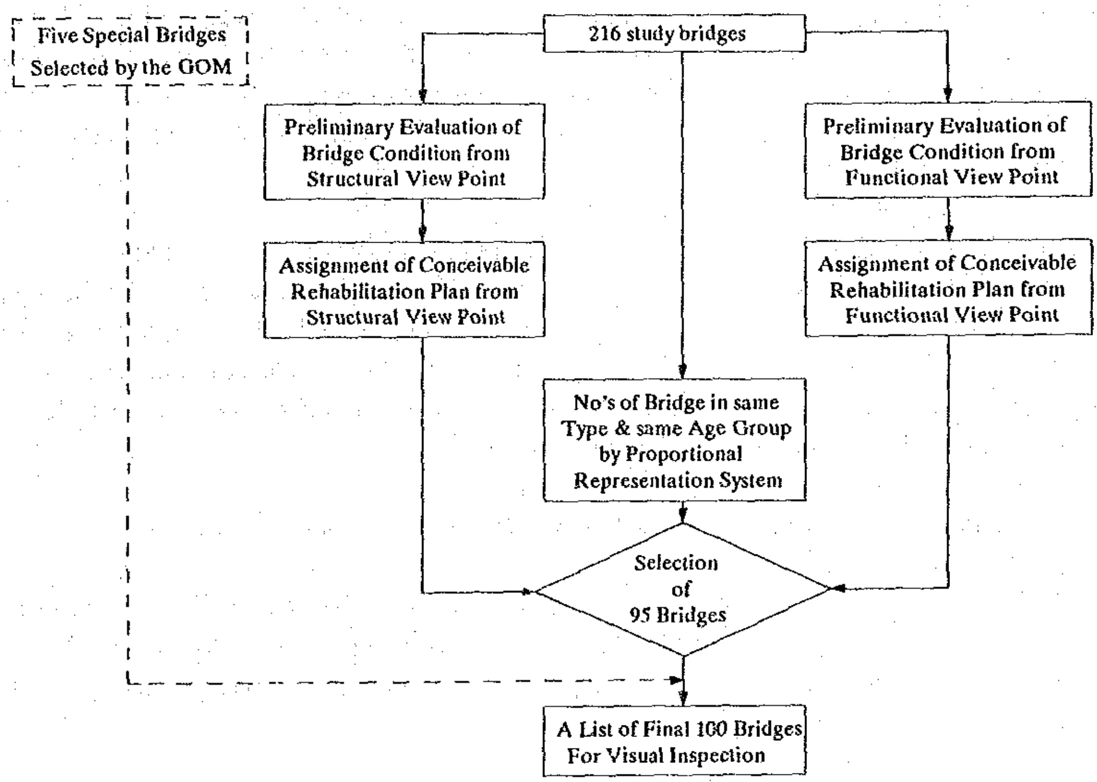
Consequently, the 100 bridges for visual inspection consist of 95 bridges selected from the 216 study bridges and the above five special bridges.

The selection procedure for the 95 bridges is charted in Figure 2-2.

At first, all the 216 bridges were preliminarily evaluated from structural and functional view points. The assignment of conceivable rehabilitation plan from those two view points for each bridge was carried out based on the assessment results.

Secondly, the 216 bridges were classified into the same bridge type and age group. The percentage of bridge in terms of each bridge type and age group was calculated against 216 bridges. Representative bridges which have a large number of conceivable rehabilitation plans were generally selected within the specific number calculated by a proportional representative system in each bridge type and age group.

Figure 2-2 Selection Procedure for 95 Bridges



Finally, 95 bridges selected through the above exercise combine with 5 bridges requested by GOM to form the final 100 bridges for visual inspection.

2.4 Preliminary Evaluation of the Bridges

Preliminary evaluation of the 216 bridges was carried out mainly from structural and functional view points.

2.4.1 Preliminary Evaluation of the Bridges from Structural Viewpoint

The preliminary evaluation from a structural aspect was conducted based on data obtained from computerized bridge inventory and visual inspection sheets prepared in NALS.

To this end, the Study Team mainly reviewed engineers' comments in the visual inspection sheets and notes in the computerized bridge inventory referring to available photos in order to identify the type and degree of damage, deficiency or distress in each structural component part of every bridge.

The evaluation results, type and degree of damage or distress identified in every structural component were recorded on a bridge by bridge basis as shown in Appendix-D.

Preliminary evaluation based on the above data revealed that all the bridges in the Study have suffered various levels of distress on main structural components. The composition of bridges which have deficiency or damage on main structural members are as follows; 52% of bridges have suffered some distresses on beams, 49% on decks, 45% on abutments and 23% on piers.

In addition to the observed structural distress, some of the study bridges have also suffered from various kinds of chemical attack. Preliminary evaluation of the bridges revealed that 14% of the bridges have suffered from chloride attack, 16% have suffered from possible sulphate attack, 5% have suffered acid attack, 0.5% have suffered from possible alkaline aggregate attack, 3% have been in distressed due to carbonation and 1% have suffered some form of chemical attack from the environment.

2.4.2 Preliminary Evaluation of the Bridges from Functional Viewpoint

The main function of a bridge is to cater for vehicle traffic and pedestrian flow and to accommodate flood discharge if a bridge spans over a river/creek. All the bridges were therefore evaluated from these three main aspects i.e. traffic capacity on the bridge, pedestrian flow capacity and bridge opening capacity.

(1) Traffic Capacity on Bridge

The evaluation of traffic on each bridge was conducted based on the bridge data given in the NALS report and traffic data obtained from "Traffic Volume Malaysia 1988 - 1989" issued by HPU. The main objective of this exercise was to determine the traffic capacity on each bridge i.e. whether or not the existing carriageway width can cater for the present traffic demand.

The traffic capacity on each bridge was calculated based on the total service flow rate in both directions for a 2 lane highway and was worked out by the following formula given in the "Highway Capacity Manual" special report 209 (Refer to page 8-1 of this manual):

$$SF_i = 2{,}800 \times (v/c)_i \times f_d \times f_w \times f_{HV}$$

Where:

SF_i = total service flow rate in both directions or prevailing roadway and traffic conditions, for level of service i in vph;

$(v/c)_i$ = ratio of flow rate to ideal capacity for level of service i, obtained from Table 8-1 in the Manual $(v/c)_i = 1.00$ (Level of service = 'E' & level terrain assumed all the bridge locations in general)

f_d = adjustment factor for directional distribution of traffic, obtained from Table 8-4 in the Manual $f_d = 0.97$ (55/45 split)

f_w = adjustment factor for narrow lanes and restricted shoulder width, ob tained from Table 8-5 in the Manual. It is a function of lane width of bridge approach road, effective width of bridge between curbs and assuming level of service "E",

f_{HV} = adjustment factor for the presence of heavy vehicles in the traffic stream, computed as:

$$f_{HV} = 1/[1 + Pr\,(E_r - 1) + P_R(E_R - 1) + P_B(E_B - 1)]$$

where:

Pr = proportion of trucks in the traffic stream, expressed as a decimal. Pr at bridge site is obtained from total proportion of Medium Lorries & Heavy Lorries, in section where bridge is located, figured out in Traffic Volume Malaysia 88-89.

P_R = proportion of RV's in the traffic stream, expressed as decimal : $P_R = 0$.

P_B = proportion of buses in the traffic stream, expressed as decimal P_B at bridge site is obtained from proportion of buses in section where bridge is located, figured out in Traffic Volume Malaysia 88-89.

Er = passenger car equivalent for trucks, obtained from Table 8-6 in Manual $E_r = 2.0$.

E_R = passenger car equivalent for RV's, obtained from Table 8-6 in the Manual $E_R = 1.6$.

E_B = passenger car equivalent for buses, obtained from Table 8-6 in the Manual $E_B = 1.6$.

Moreover, the current demand volume/traffic capacity on bridge ratio (V/C) and capacity year by the following formula are calculated based on data obtained from Traffic Volume Malaysia and the calculated traffic capacity on bridge, *SFi*

$$Cy = 1988 + \frac{\text{Log C - Log V}}{\text{Log (1 + G)}}$$

where:

Cy = Capacity Year

C = Traffic Capacity on Bridge

V = Current demand volume

G = Annual growth rate, expressed as decimal

If the V/C ratio is more than 1.00, the traffic capacity on the bridge is inadequate. Conversely, a V/C ratio of less than 1.00 means traffic capacity on the bridge is adequate.

As a result of the evaluation, it was identified that 4 bridges out of the 216 bridges equivalent to 1.9% were inadequate in terms of traffic capacity.

(2) Pedestrian Flow Capacity

If a bridge is located in an urban area or near public facilities such as schools or mosques, it is presumed that considerable number of pedestrians will cross the bridge. It is however, difficult to collect data concerning the no's of pedestrians who cross a bridge at each bridge site without conducting a counting survey.

In this regard, the Study Team obtained very limited bridge site information, from NALS visual inspection sheets. In some of the sheets it is stated in the site plan or the location notes whether the bridge is located in an urban area or not, distance from town, location of schools or mosques or any significant land marks.

Furthermore, JKR staff who were involved in the NALS Phase I and/or Phase II were also asked to provide similar information for each bridge. Based on the above data, the Study Team deduced a rough estimate of the number of pedestrians and they were whether considerable or not. The result of this evaluation was that 11 numbers out of the 216 bridges were found to be located where a considerable number of pedestrians were expected to cross the bridges without sidewalks.

(3) Bridge Opening Capacity

The main purpose of bridge evaluation from a hydraulic view point is to assess whether the bridge opening can accommodate flood runoff discharge or not, in other words whether the bridge will be submerged or not during the flood season based on the available flood information.

Hydraulic or flood information of each bridge site was, however, very limited in NALS as NALS paid very little attention on this respect. Hence, based on the Study Team's request, each Drainage & Irrigation Department (DID) District office was officially requested by the JKR Bridge Unit to provide flood information and the river training program, if any, for each bridge. The information obtained included flood information such as whether the study bridge has been submerged or not and in case of a submerged bridge, additional information was obtained such as approximate flood frequency per year and flood time duration. No information was obtained with regard to river improvement/training programs which will affect the study bridge. The preliminary evaluation from a hydraulic view point revealed that 6 out of the 216 bridges, which is equivalent to 2.8%, are submerged during flood or have inadequate bridge opening capacity.

All the evaluation results from those three aspects i.e. traffic capacity, pedestrian flow capacity, and bridge opening capacity are shown in Appendix-E on a bridge by bridge basis.

2.5 Assignment of A Conceivable Rehabilitation Plan

Based on the results of preliminary evaluation of each bridge from structural and functional view-points, conceivable rehabilitation plans were then assigned to each bridge from these two aspects.

2.5.1 Assignment of A Conceivable Rehabilitation Plan from A Structural Viewpoint

The conceivable rehabilitation plans were broadly divided into three types i.e. protection, reinforcement and replacement for each main bridge component. The type of conceivable rehabilitation plan for each bridge component generally depends on construction material and type/degree of damage.

Criteria to designate a conceivable rehabilitation plan with corresponding type of damage for each main bridge part is tabulated in Table 2-1. Based on type/degree of damage identified through the preliminary evaluation, conceivable rehabilitation plans for each bridge part in every bridge were assigned referring to Table 2-1. The results for all the bridges are shown in Appendix-D.

Table 2-1 Conceivable Rehabilitation Plan for Every Type of Damage Identified for Main Bridge Component

Main Bridge Component	Type of Damages	Conceivable Rehabilitation Plan	Input Code
Steel Beam / Girder	(1) Corrosion	Protection	SBPR
	(2) Crack (4) Failing off	Reinforcement	SBRF
	(5) Rupture (23) Abnormal Noise (24) Abnormal Vibration (25) Abnormal Deflection (26) Deformation	Replacement	SBRP
Concrete Beam / Girder	(7) Cracks	Protection	CBPR
	(8) Flaking / rebar exposure (9) Free Lime (22) Water Leak (32) Defect	Reinforcement	CBRF
	(24) Abnormal Vibration (25) Abnormal Deflection	Replacement	CBRP
Steel Deck Slab	(1) Corrosion	Protection	DSPR
	(2) Crack (4) Failing off	Reinforcement	DSRF
	(5) Rupture (26) Deformation	Replacement	DSRP
Concrete Deck Slab	(7) Crack	Protection	DCPR
	(8) Flaking / rebar exposure (9) Free Lime (22) Water Leak	Reinforcement	DCRF
	(12) Slipping off	Replacement	DCRP
Bearing	(1) Corrosion	Protection	BPR
	(4) Failing off (28) Settlement	Restoration	BRS
	(5) Rupture (26) Deformation (32) Defect	Replacement	BRP
Abutment – (Concrete)	(7) Crack	Protection	APR
	(8) Flaking / rebar exposure (9) Free Lime (11) Wear / erosion (32) Defect	Reinforcement	ARF
(Foundation)	(31) Scouring	Protection	AFPR
	(28) Settlement (29) Abnormal Movement	Reinforcement	AFRF
Pier – (Concrete)	(7) Crack	Protection	PPR
	(8) Flaking / rebar exposure (9) Free Lime (11) Wear / erosion (32) Defect	Reinforcement	PRF
(Foundation)	(31) Scouring	Protection	PFPR
	(28) Settlement (29) Abnormal Movement	Reinforcement	PFRF
Pier – (Steel)	(1) Corrosion	Protection	SPPR
	(2) Crack (5) Rupture	Reinforcement	SPRF
(Foundation)	(31) Scouring	Protection	PFPR
	(28) Settlement (29) Abnormal Movement	Reinforcement	PFRF
Surfacing	(17) Pot-Hole (18) Paving Crack	Restoration	SFRS
	(16) Difference in Level (19) Rutting	Reinforcement	SFRF
Expansion Joint	(1) Corrosion	Protection	EJPR
	(16) Difference in Level	Restoration	EJRS
	(5) Rupture (22) Water Leak (23) Abnormal Noise (26) Deformation	Replacement	EJRP
Steel Railing	(1) Corrosion	Protection	SRPR
	(2) Crack	Reinforcement	SRRF
	(5) Rupture (26) Deformation	Replacement	SRRP
Concrete Railing	(7) Crack (9) Free Lime	Protection	CRPR
	(8) Flaking / rebar exposure	Reinforcement	CRRF
	(32) Defect	Replacement	CRRP
Bank Slope	(31) Scouring	Protection	BSPR

2.5.2 Assignment of A Conceivable Rehabilitation Plan from A Functional Viewpoint

Assignment of a conceivable rehabilitation plan was also conducted based on the preliminary evaluation results from three main bridge functional aspects i.e. traffic capacity, pedestrian flow capacity, and bridge opening capacity. The conceivable rehabilitation plan for these 3 bridge functional aspects are as follows:

- A conceivable rehabilitation plan for a bridge which has inadequate traffic capacity at present, revealed by the preliminary evaluation of each bridge, would be to widen the bridge.

- A conceivable rehabilitation plan for a bridge which has no sidewalk but where the number of pedestrians is considerable, would be to add a sidewalk.

- A conceivable rehabilitation plan for a bridge which has an inadequate bridge opening i.e. is submerged during flood, would be to raise the grade or extend the bridge length.

These conceivable rehabilitation plans were designated to those bridges which have inadequate capacity and the results are shown in Appendix-E.

2.6 Setting of Screening Criteria

2.6.1 Bridge Type and Bridge Age Grouping

Type and extent of the maintenance and rehabilitation plan generally depend on construction materials, type and age of the bridge.

The 216 bridges were classified into bridge type and three bridge age groups i.e. before 1945, between 1946 to 1974 and after 1975. The percentage of bridges in terms of the same bridge type and age group were calculated against the total number of 216 bridges. Then a figure which indicates the number of bridges to be selected from the same bridge type and age group was worked out by multiplying the percentage of each type and age group by 95.

The number and percentage of bridges for each bridge type and age group against a total of the 216 bridges and 95 bridges to be selected are listed in Table 2-2.

Table 2-2 Number and Percentage of Each Bridge Type and Age Group

Age Group / Bridge Type	Before 1945			1946 to 1974			After 1975			TOTAL		
	No's of Bridges Upon 216	% of the Group	No's of Bridges Upon 95	No's of Bridges Upon 216	% of the Group	No's of Bridges Upon 95	No's of Bridges Upon 216	% of the Group	No's of Bridges Upon 95	No's of Bridges Upon 216	% of the Group	No's of Bridges Upon 95
BOX	1	0.5	1	12	5.6	1 (5)	-	0.0	-	13	6.1	2
IT	-	0.0	-	9	4.2	4	-	0.0	-	9	4.2	4
PCB	-	0.0	-	11	5.1	9 (5)	2	0.9	-	13	6.0	9
PRB	1	0.5	1	20	9.3	8	-	0.0	-	21	9.8	9
RCB	5	2.3	2	29	13.4	14	-	0.0	-	34	15.7	16
RCS	2	0.9	2	21	9.7	9	-	0.0	-	23	10.6	11
SBB	17	7.9	8	59	27.3	24	-	0.0	-	76	35.2	32
SBC	3	1.4	1	15	6.9	6	-	0.0	-	18	8.3	7
SBE	4	1.8	2	4	1.8	2	-	0.0	-	8	3.6	4
SBG	1	0.5	1	0	0.0	-	-	0.0	-	1	0.5	1
TOTAL	34	15.8	18	18	83.3	77	2	0.9	0	216	100.0	95

Note: Figure in ( ) shows no's of bridges originally calculated by proportional representation method, it is however agreed with JKR to reduce numbers of BOX from 5 to 1 and to add these four numbers to PCB in view of bridge importance.

2.6.2 Setting of Screening Criteria

It is important to select representative bridges which will cover all types of defects and conceivable rehabilitation plans from the same bridge type and age group. To assist in selection of these bridges, conceivable rehabilitation plans for each bridge from structural and functional view points were combined together for each bridge. All the 216 bridges with conceivable rehabilitation plans were sorted in order based on the same bridge type and age group and further based on average structural rating.

A representative bridge within the same bridge type and age group which has a large number of major conceivable rehabilitation plans was firstly selected. The next representative bridge which has also a large number of conceivable rehabilitation plans and which are not covered in the earlier selected bridge was subsequently selected. In some cases there are two or three bridges which have the same type and number of conceivable rehabilitation plans. In this case the bridge which is in the worse condition indicated by average rating was selected.

2.7 Selection Results of the 100 Bridges for Visual Inspection

Based on the above criteria, representative bridges which cover all types of defects and conceivable rehabilitation plans were selected in proportion to the number of bridges for each bridge type and age group.

Through the above exercise, 95 bridges were selected and the results are shown in Appendix-F. The bridge statistic in term of the bridge type and age group are charted in Figure 2-3.

Finally, 95 bridges selected through the above selection exercise together with 5 special bridges selected by GOM formed the final 100 bridges for visual inspection. A list of 100 bridges and the locations are shown in Table 2-3 and Figure 2-4 respectively.

Figure 2-3 Statistics of the 95 Bridges Selected

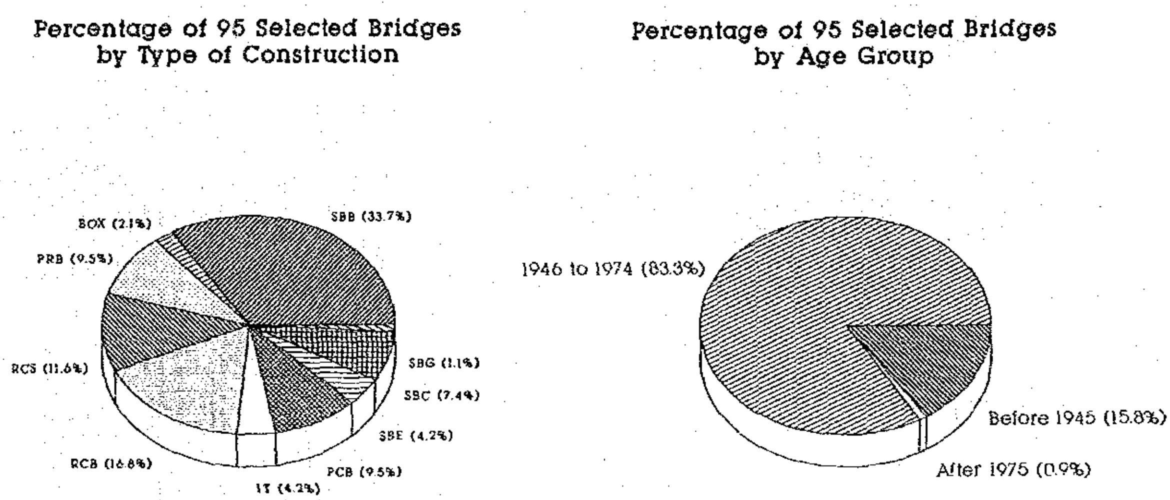


Table 2-3 List of the 100 bridges Selected for Visual Inspection

NO.	KEY	STATE	DISTRICT	YEAR BUILT	STUDY CATEGORY	CAPACITY	MAX. SPAN (M)	NO. OF SPAN	BRIDGE LENGTH (M)	TYPE OF BRIDGE
1	00108100	JOHOR	KLUANG	1954	3	STAL	15.90	3	27.40	Reinforced Concrete Beam
2	00109990	JOHOR	KLUANG	1937	3	MTAL	2.18	1	2.18	Concrete Box Culvert
3	00113780	JOHOR	SEGAMAT	1965	3	STAL	6.83	3	20.34	Reinforced Concrete Beam
4	00114920	JOHOR	SEGAMAT	1955	3	STAL	6.43	2	12.86	Reinforced Concrete Beam
5	00151380	PERAK	BTG PADANG	1969	3	STAL	9.08	7	63.55	Reinforced Concrete Beam
6	00159100	PERAK	KINTA	1948	3	SSAL	11.50	3	31.30	Steel Beam Buckle Plate
7	00181140	PERAK	KINTA	1950	3	STAL	9.77	2	19.11	Steel Beam Buckle Plate
8	00166510	PERAK	LRT MAYANG	1935	3	STAL	10.72	1	10.72	Steel Box Girder
9	00193210	KEDAH	KOTA SETAR	1940	3	SSAL	3.23	1	3.23	Steel Beam Buckle Plate
10	00220970	PAHANG	MARAN	1959	3	STAL	3.03	1	3.03	Concrete Box Culvert
11	00237200	PAHANG	KUANTAN	1960	3	STAL	8.90	3	26.70	Steel Beam R.C.Slab
12	00303220	JOHOR	K.TINGGI	1940	3	P/A	4.84	1	4.84	Encased Steel Beam
13	00303890	JOHOR	K.TINGGI	1940	3	P/A	4.58	2	9.16	Reinforced Concrete Slab
14	00304060	JOHOR	K.TINGGI	1983	3	STAL	38.65	5	92.25	Reinforced Concrete Slab
15	00304390	JOHOR	K.TINGGI	1028	3	STAL	3.35	1	3.35	Steel Beam R.C.Slab
16	00306390	JOHOR	K.TINGGI	1974	3	STAL	16.57	5	64.57	Pretensioned Inverted Tee Beam
17	00306710	JOHOR	K.TINGGI	1969	3	STAL	18.90	7	51.96	Pretensioned Inverted Tee Beam
18	00313150	JOHOR	MERSING	1950	3	STAL	4.40	1	4.40	Encased Steel Beam
19	00313520	JOHOR	MERSING	1960	3	STAL	1.80	2	3.60	Reinforced Concrete Slab
20	00314190	JOHOR	MERSING	1964	3	STAL	5.50	2	11.00	Precast Reinforced Concrete Beam
21	00317000	PAHANG	ROMPIN	1974	3	MTAL	45.78	9	397.32	Prestressed Concrete Beam
22	00319110	PAHANG	ROMPIN	1962	3	SSAL	30.46	7	121.96	Prestressed Concrete Beam
23	00323070	PAHANG	PEKAN	1965	3	STAL	10.42	3	31.26	Reinforced Concrete Beam
24	00326950	PAHANG	PEKAN	1965	3	STAL	5.88	4	23.52	Precast Reinforced Concrete Beam
25	00337240	PAHANG	KUANTAN	1957	3	STAL	6.58	1	6.58	Reinforced Concrete Slab
26	00338580	TRENGGANU	KEMAMAN	1965	3	STAL	28.03	16	219.13	Prestressed Concrete Beam
27	00339210	TRENGGANU	KEMAMAN	1963	3	STAL	15.22	10	152.20	Prestressed Concrete Beam
28	00341800	TRENGGANU	KEMAMAN	1955	3	STAL	12.10	3	36.14	Reinforced Concrete Beam
29	00346740	TRENGGANU	DUNGUN	1973	3	STAL	30.50	9	152.26	Prestressed Concrete Beam
30	00356790	TRENGGANU	K.T.	1959	3	STAL	5.90	9	53.10	Precast Reinforced Concrete Beam
31	00361490	TRENGGANU	BESUT	1960	3	STAL	6.01	3	18.03	Precast Reinforced Concrete Beam
32	00366660	KELANTAN	P.PUTEH	1952	3	STAL	5.41	6	32.46	Precast Reinforced Concrete Beam
33	00507230	JOHOR	PONTIAN	1966	3	STAL	11.77	3	35.21	Prestressed Concrete Beam
34	00507810	JOHOR	PONTIAN	1969	3	STAL	12.09	5	47.83	Pretensioned Inverted Tee Beam
35	00510560	JOHOR	BATU PAHAT	1960	3	STAL	10.42	3	31.24	Reinforced Concrete Beam
36	00514980	JOHOR	MUAR	1955	3	STAL	6.97	9	46.03	Reinforced Concrete Beam
37	00516890	JOHOR	MUAR	1968	3	STAL	6.03	3	17.82	Reinforced Concrete Beam
38	00519360	MELAKA	JASIN	1955	3	STAL	6.22	7	42.70	Reinforced Concrete Slab
39	00519560	MELAKA	JASIN	1940	3	P/A	4.95	1	4.95	Precast Reinforced Concrete Beam
40	00520850	MELAKA	JASIN	1950	3	STAL	4.27	1	4.27	Encased Steel Beam
41	00521300	MELAKA	MELAKA TGH	1950	3	STAL	6.90	1	6.90	Reinforced Concrete Beam
42	00521710	MELAKA	MELAKA TGH	1960	3	STAL	10.72	1	10.72	Reinforced Concrete Beam
43	00521980	MELAKA	MELAKA TGH	1960	3	STAL	7.13	2	14.26	Reinforced Concrete Beam
44	00523620	MELAKA	MELAKA TGH	1960	3	STAL	7.11	2	14.22	Precast Reinforced Concrete Beam
45	00534570	SELANGOR	SEPANG	1960	3	STAL	6.95	6	32.54	Reinforced Concrete Beam
46	00540760	SELANGOR	K.LANGAT	1960	3	STAL	7.30	3	11.94	Reinforced Concrete Beam
47	00540910	SELANGOR	K.LANGAT	1950	2	SSAL	6.29	1	6.29	Steel Beam Buckle Plate
48	00541000	SELANGOR	K.LANGAT	1950	3	STAL	3.24	1	3.24	Steel Beam Buckle Plate
49	00541210	SELANGOR	K.LANGAT	1950	2	SSAL	4.73	1	4.73	Steel Beam Buckle Plate
50	00546560	SELANGOR	K.SELANGOR	1939	3	P/A	6.30	1	6.30	Reinforced Concrete Beam
51	00546960	SELANGOR	K.SELANGOR	1969	3	STAL	10.64	3	30.94	Reinforced Concrete Slab
52	00549550	SELANGOR	K.SELANGOR	1965	3	STAL	12.61	6	63.58	Steel Beam R.C.Slab
53	00553960	PERAK	MANJUNG	1972	3	STAL	14.07	3	41.59	Pretensioned Inverted Tee Beam
54	00567940	PERAK	KINTA	1960	3	STAL	6.06	2	12.12	Precast Reinforced Concrete Beam
55	00701910	KEDAH	KBG.PASU	1970	3	STAL	30.52	3	40.60	Prestressed Concrete Beam
56	00706230	PERLIS	PERLIS	1950	2	SSAL	6.63	1	6.63	Steel Beam Buckle Plate
57	00800350	PAHANG	BENTONG	1950	3	SSAL	3.47	1	3.47	Steel Beam Buckle Plate
58	00803050	PAHANG	RAUB	1950	4	SSAL	9.04	2	18.09	Steel Beam Buckle Plate
59	00834850	KELANTAN	KUALA KRAI	1960	3	STAL	4.63	3	13.71	Reinforced Concrete Slab
60	00838100	KELANTAN	MACHANG	1941	3	P/A	4.86	2	9.72	Reinforced Concrete Slab
61	01105770	NS	JEMPUL	1970	3	STAL	6.18	3	18.32	Precast Reinforced Concrete Beam
62	01900060	PERAK	MANJUNG	1960	3	STAL	3.69	1	3.69	Reinforced Concrete Slab
63	01800870	PERAK	MANJUNG	1950	3	STAL	4.78	1	4.78	Steel Beam R.C.Slab
64	02305040	JOHOR	SEGAMAT	1950	3	STAL	6.29	2	12.28	Steel Beam Buckle Plate
65	02305970	JOHOR	SEGAMAT	1950	4	SSAL	5.66	2	7.60	Reinforced Concrete Slab
66	05001070	JOHOR	BATU PAHAT	1919	2	SSAL	4.77	1	4.77	Steel Beam Buckle Plate
67	05001890	JOHOR	BATU PAHAT	1950	3	SSAL	5.05	1	5.05	Steel Beam Buckle Plate
68	05002590	JOHOR	BATU PAHAT	1940	2	SSAL	4.75	1	4.75	Steel Beam Buckle Plate
69	05100840	NS	SEREMBAN	1950	3	SSAL	9.41	1	9.41	Steel Beam Buckle Plate
70	05200280	NS	SEREMBAN	1932	3	STAL	4.66	1	4.66	Steel Beam Buckle Plate
71	05204870	SELANGOR	U.LANGAT	1964	3	STAL	18.24	3	54.50	Steel Beam R.C.Slab
72	05300960	NS	PD	1950	3	SSAL	6.27	1	6.27	Steel Beam Buckle Plate
73	05301190	NS	PD	1950	3	SSAL	4.84	1	4.84	Steel Beam Buckle Plate
74	05302150	NS	SEREMBAN	1950	3	SSAL	6.31	1	6.31	Steel Beam Buckle Plate
75	05302340	NS	SEREMBAN	1940	3	SSAL	6.70	1	6.70	Steel Beam Buckle Plate
76	05403460	SELANGOR	PETALING	1950	3	STAL	6.56	1	6.56	Reinforced Concrete Slab
77	05801620	PERAK	HLR PERAK	1950	2	SSAL	3.67	1	3.67	Steel Beam Buckle Plate
78	05803340	PERAK	BTG PADANG	1950	3	STAL	4.97	1	4.97	Steel Beam Buckle Plate
79	05903120	PERAK	BTG PADANG	1950	3	STAL	10.88	3	23.19	Steel Beam R.C.Slab
80	05905010	PAHANG	LIPIS	1961	3	STAL	30.74	4	122.36	Prestressed Concrete Beam
81	06000970	PERAK	MANJUNG	1930	3	P/A	3.14	1	3.14	Encased Steel Beam
82	06005070	PERAK	L&M&SELAMA	1950	3	STAL	7.20	4	27.14	Steel Beam R.C.Slab
83	06006050	PERAK	L&M&SELAMA	1950	–	SSAL	5.09	1	5.09	Steel Beam Buckle Plate
84	06403900	PAHANG	JERANTUT	1930	3	SSAL	11.91	1	11.91	Steel Beam Buckle Plate
85	06404270	PAHANG	JERANTUT	1930	3	STAL	10.91	1	10.91	Steel Beam Buckle Plate
86	06404940	PAHANG	JERANTUT	1930	3	STAL	8.21	1	8.21	Steel Beam Buckle Plate
87	06701230	KEDAH	K.MUDA/SIK	1940	3	P/A	6.13	2	12.26	Reinforced Concrete Beam
88	06701690	KEDAH	K.MUDA/SIK	1968	3	STAL	30.64	3	91.52	Prestressed Concrete Beam
89	07000230	PERAK	HLR PERAK	1950	3	STAL	5.88	1	5.88	Steel Beam Buckle Plate
90	07002460	PERAK	BTG PADANG	1950	3	STAL	3.88	1	3.88	Steel Beam Buckle Plate
91	07602330	PERAK	K.KANGSAR	1950	2	SSAL	6.35	1	6.35	Steel Beam Buckle Plate
92	07602460	PERAK	K.KANGSAR	1950	4	SSAL	5.34	1	5.34	Steel Beam Buckle Plate
93	07604030	PERAK	HULU PERAK	1950	3	SSAL	6.35	1	6.35	Steel Beam Buckle Plate
94	07604750	PERAK	HULU PERAK	1950	3	STAL	9.34	1	9.34	Steel Beam Buckle Plate
95	07606390	PERAK	HULU PERAK	1950	3	STAL	3.07	1	3.07	Steel Beam Buckle Plate
	95 Bridges									
	<< SPECIAL Bridges >>									
96	00179210	P. PINANG	SBG PRAI U	1954	2	STAL	57.32	12	271.61	Reinforced Concrete Arch
97	00223500	PAHANG	TEMERLOH	1974	2	MTAL	151.50	19	515.21	Steel Box Girder
98	00371000	KELANTAN	K.BHARU	Yahya Petura						Reinforced Concrete Beam
99	00512040	JOHOR	BATU PAHAT	1965	2	STAL	52.02	5	196.18	Prestressed Concrete Beam
100	01212140	PAHANG	PEKAN	1976	2	MTAL	58.20	7	402.30	Prestressed Concrete Box Girder
	5 Bridges									

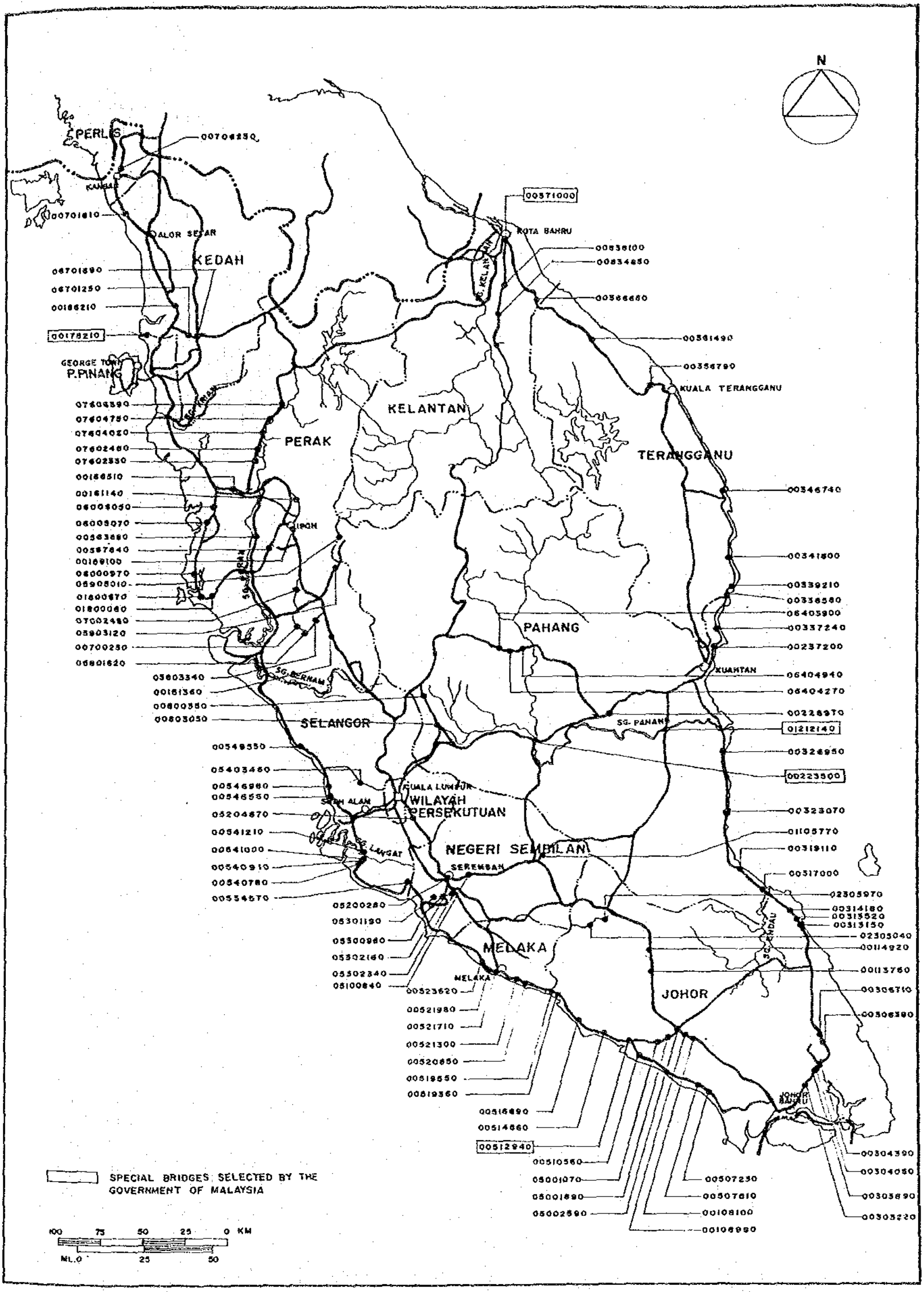
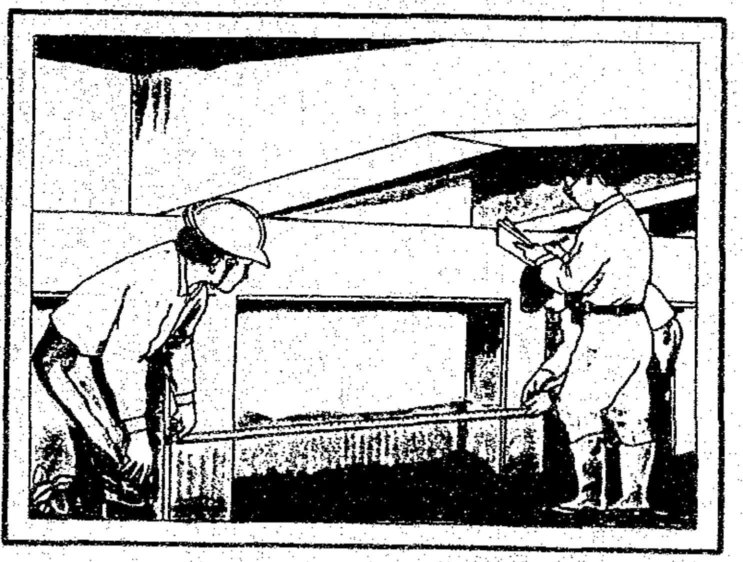


Figure 2-4 Location Map of the 100 Bridges Selected

CHAPTER 3

VISUAL INSPECTION



CHAPTER 3

VISUAL INSPECTION

3.1 General

Visual inspections carried out in the Study were broadly divided into two categories. The first category is visual inspection for the selected 100 bridges on the federal roads in the Peninsular for the purpose of reviewing the visual inspection sheets prepared by the NALS Phase I and Phase II and to identify possible maintenance and rehabilitation works for each of the selected bridges. The second category is visual inspection for 30 federal bridges in Sabah and Sarawak and 40 state bridges in three states of Perak, Selangor and Negeri Sembilan. Those bridges were selected by GOM. The purposes of the latter were to demonstrate field inspection techniques, to introduce inspection recording methods into the States and Districts of JKR, to recommend the required maintenance and rehabilitation works and to reflect those inspection results into the Bridge Inspection, Maintenance and Rehabilitation Manual.

The inspection procedure and findings of the former visual inspections are presented in this Report. Inspection results of the latter visual inspection are described in three (3) separate booklets titled "Visual Inspection Report", one each for the States of Sabah and Sarawak and one report covering the three states on the Peninsular (Perak, Selangor and Negeri Sembilan). These visual inspection reports were submitted to GOM in December 1990.

3.2 Visual Inspection Procedures

3.2.1 Preparatory Work and Staffing

Prior to the commencement of the visual inspection, location and type of the 100 selected bridges were identified referring to the available bridge cards and visual inspection sheets prepared by the NALS Phase I and Phase II. The locations of the bridges were then plotted on the topographic map with a scale of 1 : 500,000 and based on this map a detailed inspection schedule was drawn up with the JKR counterparts with respect to the road condition and distance to the bridge, bridge configuration, and stations where accommodation is available.

Prior to the field trip, a pre-inspection meeting attended by all of the team members and counterparts was held to clarify the purpose of the inspection, the schedule, definition of technical terms, duty of each member, method of completing the inspection forms and the method for using inspection tools/equipment in order to conduct the visual inspection in a systematic and organized manner.

In view of the total number of bridges and their scattered locations across the whole Peninsular, two inspection teams were organized one each for the northern and southern Peninsular. A team in principal consisted of a team leader, two assistant engineers and two-three field technicians.

3.2.2 Field Survey

A field survey which involved field measurement, field interview, condition rating, photographing, and assessment of possible rehabilitation work was carried out at each bridge site.

To assist the inspection team to carry out the field survey, each team was supplied with a set of inspection tools/equipment as listed below.

- Measurement Equipment - 5m & 50m tapes, calipers, stringline with a 5kg counter weight, leveling lots, hammer and plumbob.

- Recording Equipment - camera, blackboard, chalk.

- Access Equipment - rope, ladder, rubber boat, binoculars.

- Safety Equipment - life jackets, safety helmets, goggles, cotton gloves and first aid kit.

- **Field Measurement**

Field measurements to detect defects such as a tilted substructure, local scouring, settlement, abnormal deflection, were conducted. The measured results and defects detected were noted in the field book.

- **Field Interview Survey**

In order to confirm the data related to floods and detours, the Study Team interviewed several local residents living in the vicinity of bridge site. All the information collected through the field interview survey were recorded in the field notes.

- **Damage Condition Rating**

In the course of the visual inspection, it is essential to rate damage or defect in various members as quantitative as possible so that comparison of a rating for the present and consecutive year will show some indication of the development of damages in view of secular change.

To this end, a damage rating check list together with the damage rating criteria, which was originally developed by the Ministry of Construction, Japan [1], was introduced into the Study after some modifications were made to meet the local Malaysian conditions. The blank forms for the damage rating check list and the damage rating criteria were attached in the "Bridge Inspection, Maintenance and Rehabilitation Manual" as Annex-C and Annex-F respectively. All damages detected and degree of deterioration were marked on the damage rating check list based on the field measurement results.

Damage was graded into five ranks and criteria for damage rating in general were defined below.

Rating	**General Definition**
1	No damage found and no maintenance required as the result of the inspection.
2	Damage detected and it is necessary to record the condition for observation purposes.
3	Damage detected is slightly critical and thus it is necessary to implement routine maintenance work.
4	Damage detected is critical and in a large part and thus it is necessary to implement repair work or to conduct a detail inspection to determine whether any rehabilitation works are required.
5	Being heavily and critically damaged, possibly affecting the safety of traffic, it is necessary to implement an emergency temporary repair work immediately or rehabilitation work without delay after provision of a load limitation traffic sign.

* **Photographing**

Every defect and deficiency detected during the inspection and general view of the bridge were photographed at each bridge site. To assist in identifying negatives or photos, the bridge number written on the blackboard was also recorded in the photographs.

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1. Bridge Inspection Manual (ISSN 0386-5878)

- **Assessment of Maintenance and Rehabilitation Work**

With respect to the principal objectives of the Study, i.e. to prepare a bridge rehabilitation program covering 216 bridges and a manual on inspection, maintenance, and rehabilitation works in Malaysia , assessment of the required maintenance and rehabilitation work was carried out for each bridge based on type and degree of damage detected as well as possible causes of the damage. These results were then recorded in the field book.

3.3 Overall Bridge Rating

In order to comprehend the existing bridge condition and to prioritize bridges from bridge safety and maintenance view points, it is useful to assign a simple figurative indicator to each bridge based on the above two viewpoints, even though it is a coarse indication of the bridge condition.

For this purpose, two types of figures, one indicating overall rating from the bridge safety viewpoint and another indicating overall rating from the maintenance viewpoint were presented in the Study. These overall ratings were worked out based on the weighted factors which are the same factors used in the Bridge Management System (BMS) established by the Bridge Unit in JKR except for weighted factors of bearings, surfacing, and expansion joints.

Bridge Component Part	Weighted Factor
Abutment	1.0
Pier	1.0
Bearing	0.7 (0.2)
Beam/Girder	1.0
Deck	0.8
Surfacing	0.5 (0.1)
Wingwall*	0.5
Expansion Joint	0.5 (0.2)
Railing	0.5
Drainage*	0.3
Bank Slope	0.5

* Notes : Figure in ( ) shows weighted factor originally used in BMS.
Bridge component part marked with * is newly introduced in the Study.

These rating methods replaced the rough rating method applied in the NALS Phase I and Phase II. The detailed rating procedures from damage rating done at each bridge site to the overall rating per bridge were explained in Chapter 3 of the "Bridge Inspection, Maintenance, and Rehabilitation Manual."

CHAPTER 4

FINDINGS OF VISUAL INSPECTIONS

CHAPTER 4

FINDINGS OF VISUAL INSPECTIONS

4.1 General

Visual inspections were conducted on 100 bridges consisting of 95 federal bridges selected from a total of 216 study bridges and five special bridges selected by GOM during Phase I(A) of the study period. Taking into account the purpose of the Study and availability of the relevant data in NALS, stresses on the bridge condition rating and on identification of maintenance and rehabilitation methods for each bridge were placed in the inspection.

This chapter "Findings of Visual Inspections" presents the general condition of the bridges and detailed assessment of the visual inspection results which formed a basis for the preparation of standard possible rehabilitation plans.

The visual inspection results including the Study Team's findings and recommendations for the five special bridges are presented separately in Appendix-G of Volume III. One result of the findings was that the Yahya Petra Bridge has suffered inexplicable cracks which are required to be diagnosed in a detailed survey. Merdeka, Batu Pahat, Temerloh and Kuala Lepar bridges could survive their design life span provided some maintenance works such as resurfacing of premix, jacketing of steel piles, replacement/repair of expansion joints, and removal of vegetation took place.

It is important to emphasize that one of the findings is that the NALS data have not covered quantitative damage data, as originally anticipated, which are requisite in the feedback of the inspection results to the discarded bridges for formulating the rehabilitation program covering all the study bridges. Therefore, a supplemental bridge survey covering those bridges was planned to be carried out in the succeeding stage.

4.2 General Condition of the Bridges Inspected

(1) Bridge Condition Rating

Damages detected in various members were ticked together with pattern, degree and extent of damage on the bridge condition checklist. Damage rating in each member, member rating, component part rating, and, finally, overall bridge rating were carried out in accordance with the procedures stated in Chapter 3 of the "Bridge Inspection, Maintenance, and Rehabilitation Manual".

Table 4-1 Summary of Bridge Ratings for Selected 100 Bridges

Bridge Data			Main Parts						Secondary Parts						Overall Rating From Maintenance View Point	Overall Rating From Safety View Point
No.	Key	Type	Fd	Ab	Pr	Bg	B/G	Dk	Sf	Wg	Ej	Rg	Dr	Sp		
1	00108100	RCB	- (-)	2.5 (4)	2.5 (4)	1 (1)	3 (4)	1 (1)	3	1	2	1	-	-	2.0	3.0
2	00108990	BOX	- (-)	3 (3)	- (-)	- (-)	- (-)	1 (1)	1	1	-	-	-	-	1.7	2.1
3	00113780	RCB	- (-)	1 (1)	1 (1)	- (-)	1.7 (3)	1.7 (3)	1	1	2	3	-	-	1.5	1.9
4	00114920	RCB	- (-)	1 (1)	3 (3)	- (-)	2 (3)	1 (1)	1	1	2	1	-	-	1.6	2.1
5	00151360	RCB	- (-)	1 (1)	1 (1)	1 (1)	1.3 (3)	1 (1)	4	1	-	4	3	-	1.6	1.4
6	00159100	SBB	- (-)	2.5 (4)	2 (3)	- (-)	4 (4)	4 (4)	4	1	2	1	-	1	2.8	3.7
7	00161140	SBB	- (-)	2.5 (4)	3 (3)	- (-)	4 (4)	3 (3)	4	1	-	2	-	-	2.9	3.5
8	00166510	SBG	- (-)	2 (3)	- (-)	- (-)	4 (4)	4 (4)	1	1	-	1	-	-	2.5	3.6
9	00186210	SBB	- (-)	1 (1)	- (-)	- (-)	4 (4)	3 (3)	1	1	-	1	-	-	2.1	2.5
10	00228970	BOX	- (-)	3 (3)	- (-)	- (-)	- (-)	3 (3)	1	1	-	1	-	-	2.1	3.0
11	00237200	SBC	- (-)	4 (4)	4 (4)	- (-)	2 (4)	1 (1)	1	-	-	1	1	4	2.5	3.4
12	00303220	SBE	- (-)	3 (3)	- (-)	- (-)	4 (4)	1 (1)	3	4	-	4	-	-	3.1	2.8
13	00303890	RCS	- (-)	2.5 (4)	1 (1)	- (-)	- (-)	1 (1)	1	1	2	1	-	-	1.4	2.1
14	00304060	RCS	- (-)	1 (1)	1 (1)	- (-)	- (-)	1.4 (3)	4	-	2	1	-	-	1.5	1.6
15	00304390	SBC	- (-)	2 (3)	- (-)	- (-)	4 (4)	1 (1)	4	4	-	1	-	-	2.6	2.8
16	00306390	IT	- (-)	1 (1)	1 (1)	- (-)	2 (4)	1 (1)	1	1	2	4	1	-	1.5	1.8
17	00306710	IT	- (-)	1 (1)	1 (1)	1 (1)	1.3 (3)	1 (1)	1	-	2	3	2	-	1.3	1.4
18	00313150	SBE	- (-)	2 (3)	- (-)	- (-)	1 (1)	1 (1)	1	1	-	1	-	-	1.2	1.7
19	00313520	RCS	- (-)	3 (3)	3 (3)	- (-)	- (-)	2.5 (4)	1	3	-	1	-	-	2.4	3.3
20	00314180	PRB	- (-)	2 (3)	1 (1)	- (-)	1 (1)	1 (1)	1	1	2	1	-	-	1.3	1.5
21	00317000	PCB	- (-)	1 (1)	1 (1)	- (-)	1.7 (4)	1.3 (4)	3	-	2	1	-	-	1.5	2.4
22	00319110	PCB	- (-)	3.5 (4)	3 (4)	1 (1)	1.4 (4)	1 (1)	4	-	2	1	3	-	2.2	3.0
23	00323070	RCB	- (-)	2.5 (4)	4 (4)	1 (1)	1 (1)	1 (1)	1	4	2	1	-	-	2.0	2.3
24	00326950	PRB	- (-)	2.5 (4)	4 (4)	- (-)	1.8 (4)	1 (1)	1	1	2	2	-	-	2.1	3.4
25	00337240	RCS	- (-)	4 (4)	- (-)	- (-)	- (-)	1 (1)	1	1	-	1	-	-	1.9	2.7
26	00338580	PCB	- (-)	3.5 (5)	4 (5)	4 (5)	1 (1)	1 (1)	3	-	2	1	1	-	2.4	3.4
27	00339210	PCB	- (-)	4 (4)	3.2 (4)	- (-)	4 (4)	1 (1)	4	-	-	1	1	-	2.9	3.4
28	00341600	RCB	- (-)	4 (4)	4 (4)	4 (4)	2.3 (4)	1 (1)	3	4	-	1	2	-	2.9	3.5
29	00346740	PCB	- (-)	2 (3)	1 (1)	1 (1)	3 (4)	1 (1)	2	-	2	1	1	-	1.6	2.1
30	00356790	PRB	- (-)	1.5 (2)	1 (1)	- (-)	3 (4)	- (-)	2	-	2	2	-	2	1.9	2.3
31	00361490	PRB	- (-)	1 (1)	2.5 (4)	- (-)	1 (1)	- (-)	3	1	-	1	-	1	1.5	2.0
32	00366660	PRB	- (-)	2.5 (4)	3.4 (4)	- (-)	3.8 (4)	- (-)	3	-	-	1	-	-	2.9	4.0
33	00507230	PCB	- (-)	2.5 (4)	4 (4)	4 (4)	1 (1)	1 (1)	1	1	2	1	-	-	2.1	2.8
34	00507810	IT	- (-)	1 (1)	4 (4)	- (-)	1.8 (3)	- (-)	4	1	2	4	-	-	2.5	2.7
35	00510660	RCB	- (-)	2 (3)	2.5 (4)	4 (4)	1 (1)	1 (1)	1	-	2	4	1	-	2.0	2.6
36	00514860	RCB	- (-)	1 (1)	3.9 (4)	- (-)	3.7 (4)	1 (1)	1	-	2	1	-	-	2.2	2.6
37	00516690	RCB	- (-)	1 (1)	4 (4)	4 (4)	3.7 (4)	1 (1)	3	-	2	1	-	-	2.6	2.8
38	00519360	RCS	- (-)	1 (1)	4 (4)	- (-)	- (-)	1.1 (2)	4	-	2	1	1	-	2.1	2.4
39	00519550	PRB	- (-)	3.5 (4)	- (-)	- (-)	1 (1)	- (-)	1	1	-	1	-	-	1.7	2.5
40	00520850	SBE	- (-)	2.5 (4)	- (-)	- (-)	4 (4)	4 (4)	1	-	-	1	-	-	2.8	4.0
41	00521300	RCB	- (-)	2 (3)	- (-)	- (-)	4 (4)	4 (4)	1	1	-	-	-	-	2.7	3.6
42	00521710	RCB	- (-)	4 (4)	- (-)	- (-)	4 (4)	1 (1)	1	1	-	1	-	-	2.4	3.1
43	00521980	RCB	- (-)	3 (3)	4 (4)	- (-)	4 (4)	1 (1)	1	4	2	4	-	-	3.0	3.1
44	00523620	PRB	- (-)	1 (1)	4 (4)	- (-)	4 (4)	- (-)	3	-	2	3	-	-	2.9	3.0
45	00534570	RCB	- (-)	4 (4)	4 (4)	- (-)	1 (1)	1 (1)	1	-	2	2	-	-	2.3	2.6
46	00540780	RCB	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	-	-	-	-	-	-	Remarks;Repaired in 1990	
47	00540910	SBB	- (-)	3 (3)	- (-)	- (-)	1 (1)	1 (1)	1	1	-	1	-	-	1.5	1.7
48	00541000	SBB	- (-)	4 (4)	- (-)	- (-)	3 (3)	3 (3)	1	1	-	1	-	-	2.5	3.4
49	00541210	SBB	- (-)	4 (4)	- (-)	- (-)	4 (4)	3 (3)	3	-	-	1	-	-	3.3	3.7
50	00546560	RCB	- (-)	1 (1)	- (-)	- (-)	4 (4)	3 (3)	1	1	-	2	-	-	2.2	2.6
51	00548980	RCS	- (-)	4 (4)	2 (4)	- (-)	- (-)	2.7 (4)	4	-	2	2	-	-	2.8	4.0
52	00549650	SBC	- (-)	1 (1)	2.8 (4)	4 (4)	1 (1)	1 (1)	2	1	2	1	3	-	1.8	2.1
53	00563260	IT	- (-)	1.5 (2)	4 (4)	- (-)	1 (1)	- (-)	3	-	-	1	-	-	2.1	2.3
54	00567840	PRB	- (-)	2 (3)	1 (1)	- (-)	4 (4)	- (-)	3	-	-	1	-	-	2.3	2.7
55	00701810	PCB	- (-)	2.5 (4)	3 (3)	4 (4)	1 (1)	1 (1)	3	-	2	1	-	-	2.2	2.6
56	00706230	SBB	- (-)	1 (1)	- (-)	- (-)	2 (2)	2 (2)	1	1	-	1	-	-	1.4	1.6
57	00800350	SBB	- (-)	1 (1)	- (-)	- (-)	4 (4)	4 (4)	1	1	-	1	-	-	2.3	2.9
58	00803050	SBB	- (-)	2.5 (4)	4 (4)	- (-)	3.5 (4)	2 (3)	4	1	-	2	-	-	2.6	3.8
59	00834850	RCS	- (-)	1 (1)	4 (4)	- (-)	- (-)	4 (4)	3	4	-	3	-	-	3.1	2.9
60	00838100	RCS	- (-)	1 (1)	3 (3)	- (-)	- (-)	4 (4)	3	1	-	2	-	-	2.4	2.6
61	01105770	PRB	- (-)	4 (4)	1 (1)	- (-)	3 (4)	- (-)	1	4	2	1	3	-	2.4	3.0
62	01800060	RCS	- (-)	1 (1)	- (-)	- (-)	- (-)	4 (4)	1	1	-	1	-	-	1.7	2.3
63	01800670	SBC	- (-)	1 (1)	- (-)	- (-)	4 (4)	4 (4)	1	1	-	2	-	-	2.4	2.9
64	02305040	SBB	- (-)	1 (1)	1 (1)	- (-)	4 (4)	4 (4)	3	1	2	4	-	-	2.4	2.4
65	02305970	RCS	- (-)	2.5 (4)	1 (1)	- (-)	- (-)	2 (3)	1	1	2	1	-	-	1.6	2.6
66	05001070	SBB	- (-)	2 (3)	- (-)	- (-)	4 (4)	1 (1)	1	-	-	1	-	-	2.1	2.8
67	05001590	SBB	- (-)	1 (1)	- (-)	- (-)	3 (3)	1 (1)	1	1	-	1	-	-	1.5	1.7
68	05002590	SBB	- (-)	2 (3)	- (-)	- (-)	4 (4)	3 (3)	1	3	-	1	-	-	2.5	3.4
69	05100840	SBB	- (-)	2 (3)	- (-)	- (-)	1 (1)	1 (1)	1	3	-	1	-	-	1.5	1.7
70	05200280	SBB	- (-)	1 (1)	- (-)	- (-)	3 (3)	1 (1)	1	1	-	1	-	-	1.5	1.7
71	05204870	SBC	- (-)	1 (1)	1 (1)	3.7 (4)	2.3 (3)	1 (1)	1	-	1	1	1	1	1.5	1.9
72	05300960	SBB	- (-)	4 (4)	- (-)	- (-)	3 (3)	3 (3)	1	1	-	2	-	-	2.7	3.4
73	05301190	SBB	- (-)	3.5 (4)	- (-)	- (-)	4 (4)	4 (4)	1	1	-	2	-	-	3.0	4.0
74	05302160	SBB	- (-)	3 (3)	- (-)	- (-)	3 (3)	1 (1)	1	1	-	4	-	-	2.3	2.4
75	05302340	SBB	- (-)	2 (3)	- (-)	- (-)	4 (4)	1 (1)	1	1	-	2	-	-	2.0	2.8
76	05403460	RCS	- (-)	3 (3)	- (-)	- (-)	- (-)	1 (1)	1	-	-	4	-	-	2.3	2.1
77	05801620	SBB	- (-)	2 (2)	- (-)	- (-)	3 (3)	1 (1)	2	1	-	4	-	-	2.2	2.1
78	05803340	SBB	- (-)	1 (1)	- (-)	- (-)	4 (4)	4 (4)	1	1	-	1	-	-	2.3	2.9
79	05903120	SBC	- (-)	2.5 (4)	1 (1)	- (-)	2.7 (4)	2.7 (4)	1	1	-	1	-	-	1.9	3.2
80	05905010	PCB	- (-)	1 (1)	1 (1)	3 (3)	1.8 (3)	1 (1)	4	-	2	4	1	-	1.9	1.8
81	06000970	SBE	- (-)	4 (4)	- (-)	- (-)	4 (4)	- (-)	1	1	-	4	-	-	3.1	4.0
82	06005070	SBC	- (-)	2.5 (4)	1 (1)	- (-)	3.3 (4)	2.8 (4)	3	-	-	1	-	-	2.3	3.2
83	06006050	SBB	- (-)	1 (1)	- (-)	- (-)	4 (4)	4 (4)	2	1	-	1	-	-	2.4	2.9
84	06403900	SBB	- (-)	3.5 (4)	- (-)	- (-)	4 (4)	1 (1)	3	1	-	3	-	-	2.7	3.1
85	06404270	SBB	- (-)	2.5 (4)	- (-)	- (-)	4 (4)	3 (3)	4	1	-	4	-	-	3.1	3.7
86	06404940	SBB	- (-)	2 (2)	- (-)	- (-)	3 (3)	3 (3)	1	3	-	2	-	-	2.4	2.6
87	06701230	RCB	- (-)	1 (1)	1 (1)	- (-)	4 (4)	4 (4)	4	1	-	4	-	-	2.6	2.4
88	06701690	PCB	- (-)	3 (3)	1 (1)	4 (4)	1 (1)	4 (4)	2	3	2	3	2	-	2.4	2.4
89	07000230	SBB	- (-)	3 (3)	- (-)	- (-)	4 (4)	1 (1)	1	1	-	1	-	-	2.2	2.8
90	07002460	SBB	- (-)	4 (4)	- (-)	- (-)	4 (4)	4 (4)	4	1	-	2	-	-	3.4	4.0
91	07602330	SBB	- (-)	1 (1)	- (-)	- (-)	4 (4)	3 (3)	2	1	-	2	-	-	2.3	2.6
92	07602450	SBB	- (-)	4 (4)	- (-)	- (-)	4 (4)	4 (4)	4	3	-	1	-	-	3.5	4.0
93	07604020	SBB	- (-)	3 (3)	- (-)	- (-)	4 (4)	3 (3)	1	1	-	2	-	-	2.7	3.4
94	07604750	SBB	- (-)	2.5 (4)	- (-)	- (-)	4 (4)	3 (3)	2	3	-	4	-	-	3.1	3.7
95	07606390	SBB	- (-)	3.5 (4)	- (-)	- (-)	4 (4)	3 (3)	4	3	-	2	-	-	3.3	3.7
	95	Bridges														
	<< SPECIAL Bridges >>															
1	00178210	CAR	- (-)	1 (1)	1 (1)	2 (2)	1.7 (4)	1 (1)	4	-	1	2	2	-	1.6	1.8
2	00223500	SBG	- (-)	1 (1)	1 (1)	1 (1)	1.2 (3)	1 (1)	4	-	1	1	1	-	1.3	1.4
3	00371000	RCB	- (-)	2.5 (4)	1 (1)	4 (4)	4 (4)	3 (3)	4	-	2	1	2	-	2.7	3.2
4	00512940	PCB	- (-)	1 (1)	2.3 (4)	1 (1)	1 (1)	1 (1)	4	-	2	1	-	-	1.6	1.7
5	01212140	PBX	- (-)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	4	-	1	1	-	-	1.3	1.0
	5 Bridges															

Notes : Fd–Foundation; Ab–Abutment; Pr–Pier; Bg–Bearings; B/G–Beam/Girder; Dk–Deck Slab; Sf–Surfacing
Wg–Wingwall; Ej–Expansion Joint; Rg–Railing; Dr–Drainage; Sp–Slope Protection

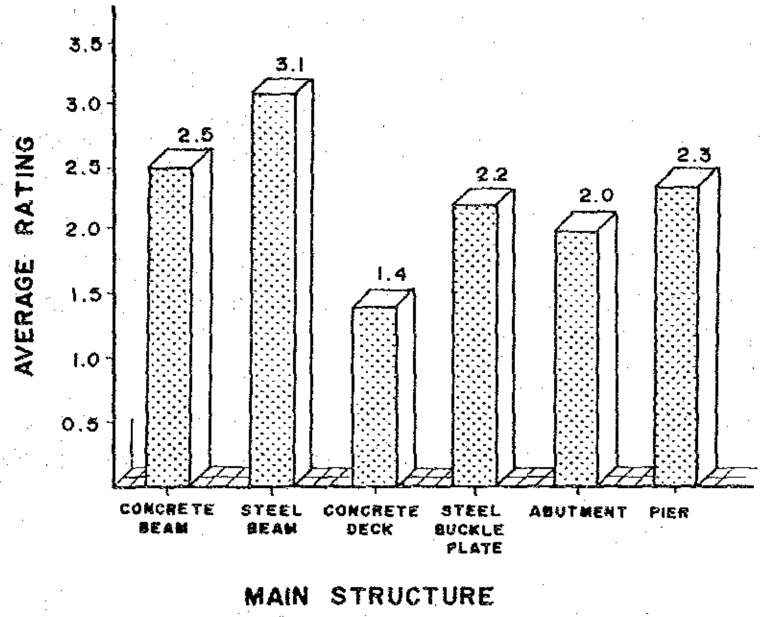
Figure in ( ) Means bridge ratings from safety view point

As a result of the above ratings, the overall bridge ratings from maintenance and bridge safety view points as well as the component part rating of each bridge inspected are summarized in Table 4-1.

(2) General Condition of Each Main Structural Member

Average part rating of each main structure is depicted in Figure 4-1, which revealed the following findings regarding the general condition of each main structure.

Figure 4-1 Average Rating of Each Main Structure

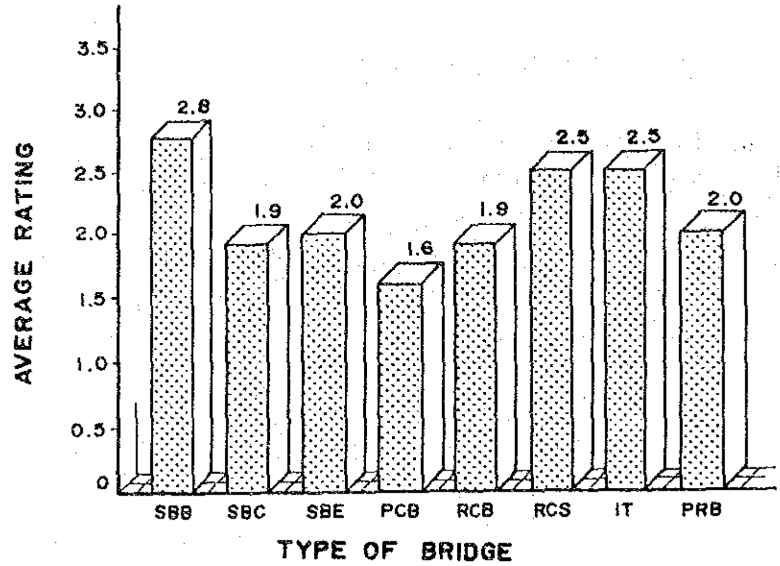


- Steel and concrete beams have deteriorated in advance as compared to other bridge members. The deterioration of steel beams is quite remarkable.
- For bridge decks, concrete slab is in relatively better condition than steel buckle plate, in fact the concrete deck slab is the most sound member among the others.

(3) General Bridge Condition of Each Bridge Type

The general bridge condition of each bridge type is indicated in Figure 4-2 which shows the average bridge rating of each bridge type.

Figure 4-2 Average Rating of Each Bridge Type



- Steel beam buckle plate (SBB) is the most deteriorated type of bridge among other types of bridges.

- Reinforced concrete slab (RCS) and inverted "T" bridges are relatively in worse condition as compared to others such as SBC, SBE and PRB.

- Prestressed concrete beam (PCB) bridges are generally in good condition.

4.3 Detailed Assessment of Visual Inspection Results

4.3.1 Detailed Assessment of Visual Inspection Results from A Structural View Point

The purpose of the assessment is to study the general tendency of the damages observed in each bridge component of the study bridges based on the results of the damage condition rating and to assist in the derivation of possible rehabilitation works which could cope with the corresponding damage in terms of type, degree and extent.

The rating results of each bridge member was further analyzed from several aspects. The result of the analysis is presented in the form of a three dimensional graph with X-axis indicating type of damage while Y and Z axis indicating specific damage ratio(1) and average

1. Specific damage ratio is defined as a percentage of the total number of bridges with a specific structural damage divided by the total number of the bridges with the specific structural member.

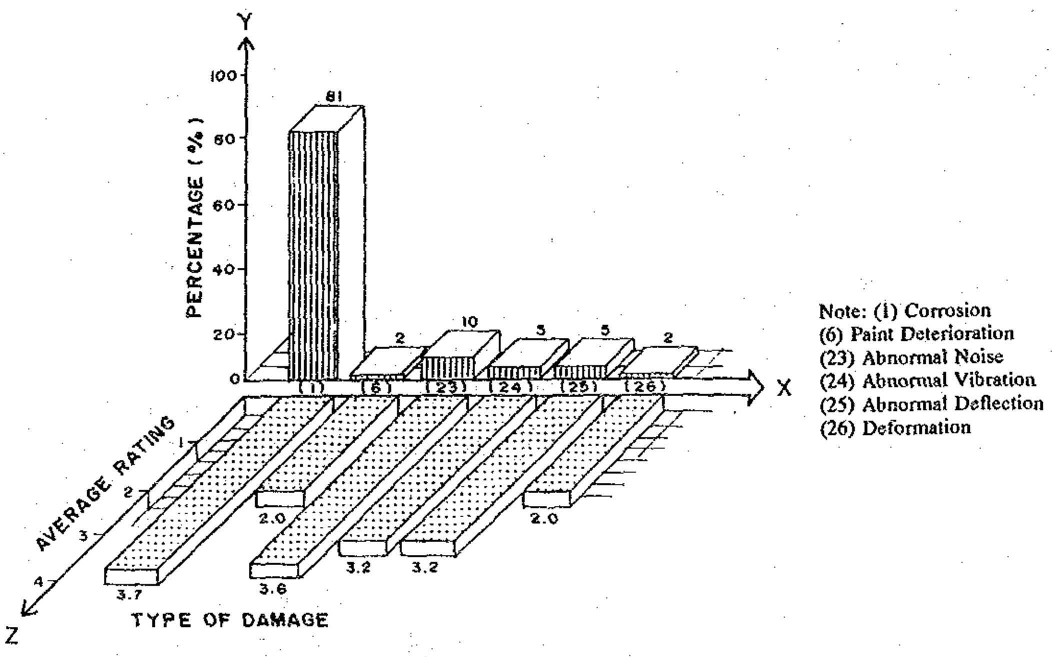
rating of specific damage[1] respectively. These graphs reveal clearly the present bridge member condition for various types of bridges.

(1) Steel Beam/Girder

As indicated in Figure 4-3, a dominant type of damage in steel beam/girder is corrosion and the degree of damage is likely to be in the advanced stage as indicated by the average rating of 3.7. The reasons for the defects are due to not only improper maintenance such as lack of repainting but also in some cases, structural problems such as no drip check at soffit of slab, inadequate length of drainage pipe, no curb or no cantilever slab. Moreover, abnormal noise, abnormal vibration, etc. observed could also be caused by inadequate maintenance, hence aggravating section loss and deterioration.

The possible rehabilitation work will require some reinforcement or partial replacement for this type of advanced corrosion instead of the usual repainting.

Figure 4-3 Damage Ratio and Average Rating in Steel Beam/Girder



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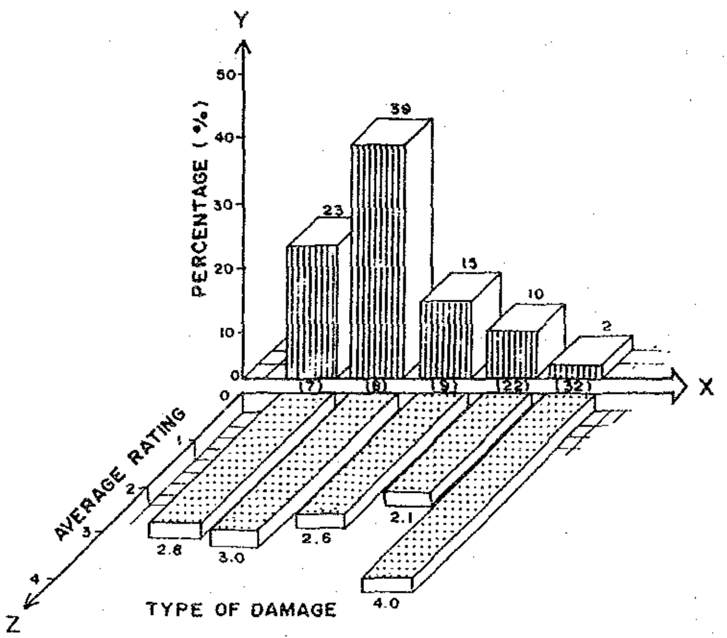
1. Average rating of specific damage is defined as summation of the damage rating of a specific structural member of the bridges divided by the total number of bridges with the specific structural damage.

(2) Concrete Beam

Remarkable defects in concrete beams are cracks and flaking/rebar exposure as shown in Figure 4-4. The damage ratio of flaking being higher than that of crack is most likely caused by inadequate concrete cover and/or poor vibration due to improper construction since the flaking/rebar exposure has been observed without cracks. Free lime and water leakage which occurs mainly in IT and PRB beams at the longitudinal joints between girders indicate that connection between the precast girders is not rigid which results in no transverse load distribution and water leakage through the joints.

The possible rehabilitation work for cracks or flaking could mainly be injection or patching. In case of flexural cracks, flaking together with structural cracks or shear cracks observed at small intervals, some reinforcement will be required for the rehabilitation work.

Figure 4-4 Damage Ratio and Average Rating in Concrete Beams



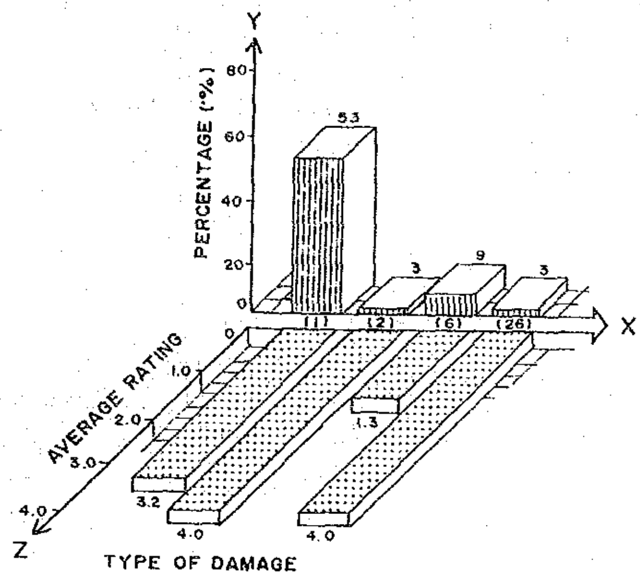
Note: (7) Crack
(8) Flaking/Rebar Exposure
(9) Free Lime
(22) Water Leakage
(32) Defect

(3) Steel Buckle Plate Slab

The dominant damage in steel buckle plate slabs as shown in Figure 4-5 is corrosion which is similar to that found in steel beams. This type of slab is a simple structure which was originally built of steel buckle plate with crusher run overlaid on the plate together with asphalt concrete finish. In such construction it is easy for rainwater to penetrate into the slab which causes corrosion of the steel plate especially at the joints between buckle plates and girders, which have corroded at an advanced stage.

Possible rehabilitation work for corroded steel buckle plate will be fully studied with due consideration of the above mentioned structural problems. The rehabilitation work, for instance, includes repainting after provision of weepholes as a short term rehabilitation plan or replacement of the slab by appropriate type such as R.C. slab to cope with the structural problem as a long term plan.

Figure 4-5 Damage Ratio and Average Rating in Steel Buckle Plate Slabs



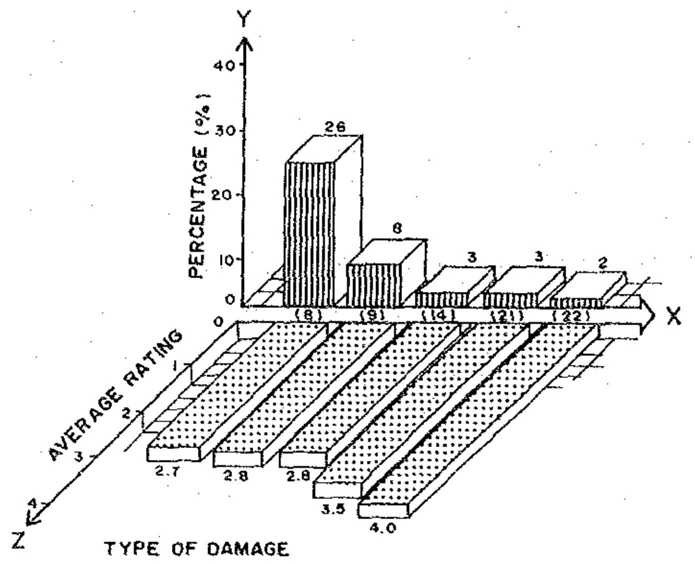
Note: (1) Corrosion
(2) Crack
(6) Paint Deterioration
(26) Deformation

(4) R.C. Deck Slab

The dominant damage observed in R.C.deck slabs is also flaking/rebar exposure which is the same as in concrete beams. However, damage ratios for free lime and cracks in R.C. slab are slightly less than those in concrete beam as shown in Figure 4-6. It also indicates that the slabs are generally in fair condition and suffer only flaking/rebar exposure at isolated areas.

Thus possible rehabilitation work could basically be injection/patching for the general defects observed in R.C. slab or bonding steel plate/shooting with rebars as reinforcement for the exceptional cases.

Figure 4-6 Damage Ratio and Average Rating in R.C.Slabs

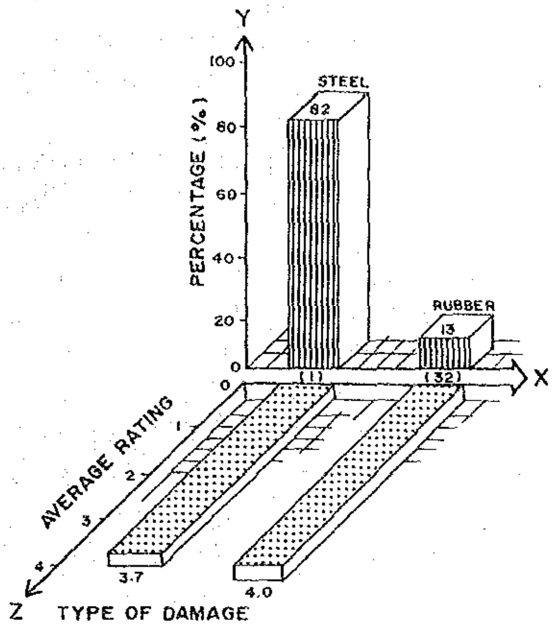


(5) Bearing

Out of 95 bridges covered by the visual inspections, only approximately 20% of the bridges were provided with bearings. About half of the bearings provided consist of steel and the rest is made up of rubber bearing. Main type of damage in steel and rubber bearings is corrosion and defect (material deterioration) which accounted for about 82% and 13% respectively.

Even though the steel bearings have been corroded,they are still functional in general. Thus it is presumed that repainting is adequate as a rehabilitation work for this defect. In case of defective rubber bearings, the cause or reason for material deterioration is investigated further during the detailed survey so that a suitable rehabilitation work could be selected.

Figure 4-7 Damage Ratio and Average Rating in Bearing

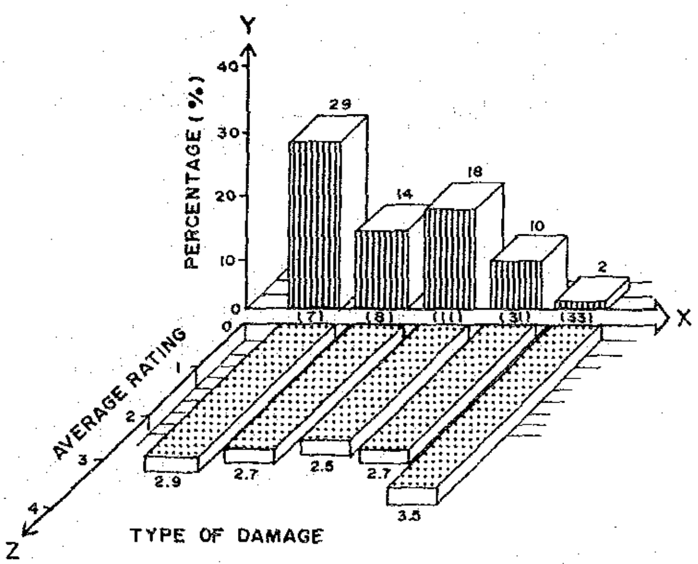


Note: (1) Corrosion
(32)Defect

(6) Abutment

The type of defects observed in abutments as shown in Figure 4-8 in decreasing order are crack, wear/erosion, flaking and scouring. Even though various reasons can be presumed for generation and development of a crack, it is obvious that the cracks in pile bent type abutment located near coastal lines are caused by chloride attack. Characteristics of the pile bent type abutment are low cost and easy construction but usage of these slender members which cause difficulties in keeping adequate cover and it is also susceptible to environmental attacks because of its shape (i.e. larger circumferential area compared with cross sectional area). These structural characteristics of pile bent abutments could easily generate cracks once it is attacked by chloride.

Figure 4-8 Damage Ratio and Average Rating in Abutment



Note: (7) Crack
(8) Flaking/Rebar Exposure
(11) Wear/Erosion
(31) Scouring
(33) Erosion

On the other hand, it has been observed at a considerable number of concrete piles have loss part of their cross section due to wearing. It seems that it could be caused by poor quality concrete, some chemical attack, or abrasion by water containing sand and fine gravel.

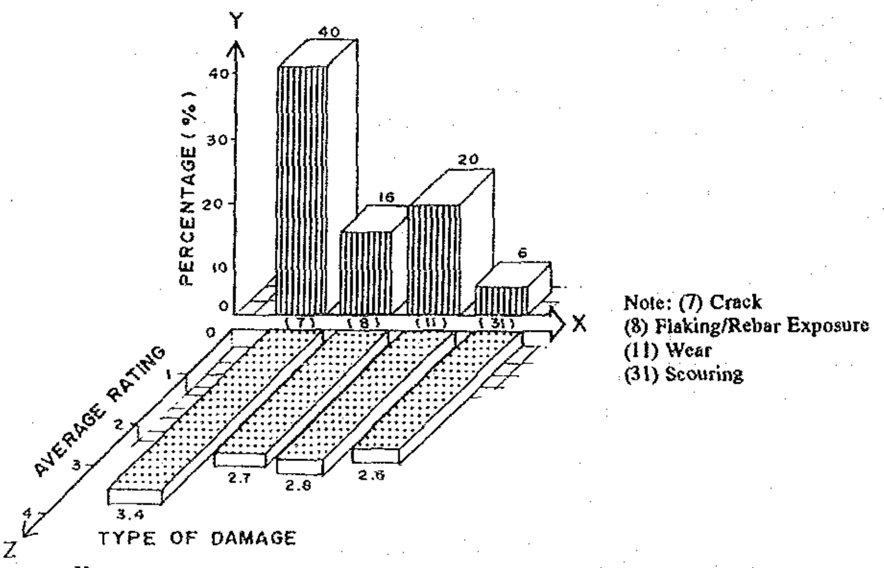
A possible rehabilitation method for the cracks due to drying shrinkage and for partial flaking could be injection, patching, coating or shooting. In the case of cracks and flaking due to progressive reasons such as chloride attack or carbonation and wearing concrete, some reinforcement will be required such as surface lining or total lining.

(7) Pier

The type of damage in the pier structure tends to be the same as that for abutments (refer to Figure 4-8 and 4-9) except for a higher ratio and heavier damage in terms of crack in piers, since the type of piers in the study bridges is pile bent type, in general, which is similar to abutments. In addition, piers are located in a more severe environment than abutments.

Possible rehabilitation plans for the piers could be more or less similar to those for abutments. It is, however, presumed that reinforcement works will be dominant instead of protection since the piers experienced more severe damage due to chloride attack in general than the abutments.

Figure 4-9 Damage Ratio and Average Rating in Piers

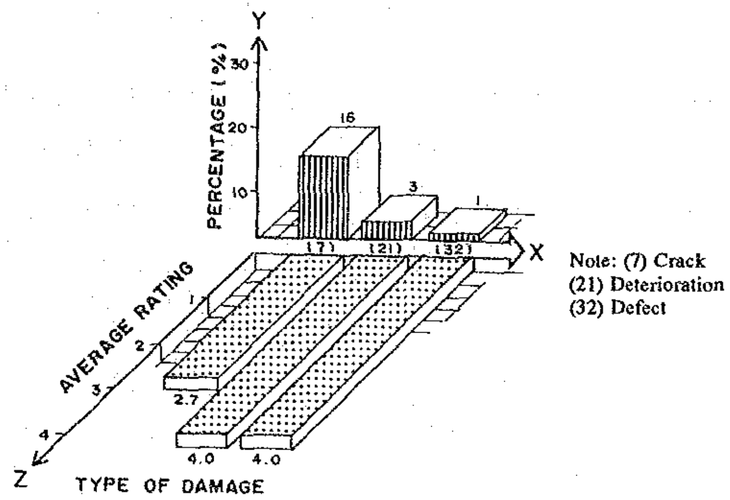


(8) Wingwall

The condition of the wingwalls is, generally, fair since the damage ratio of the crack which is the most dominant type of damage for this type of member is only 16 % as indicated in Figure 4-10.

Taking into account that the members of the wingwall are relatively massive, injection or patching for rehabilitation work would be adequate for this type of damage.

Figure 4-10 Damage Ratio and Average Rating in Wingwalls

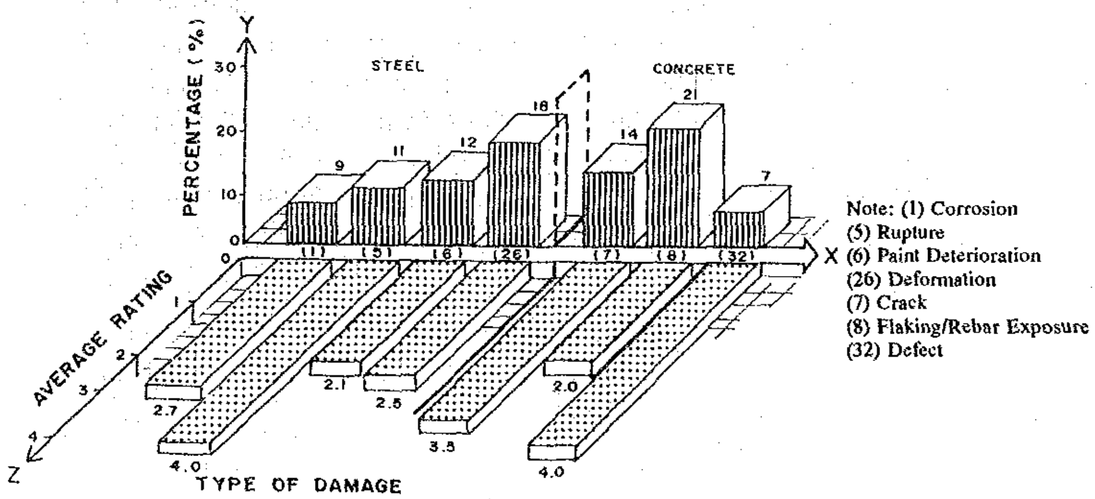


(9) Railing

Steel railing has been observed to have suffered deformation due to vehicle impact, rupture, corrosion or paint deterioration to 9% to 18% of the total number of railings inspected. Concrete railings suffered cracks, flaking or section loss of which the ratios are 7% to 21% of the total as shown in Figure 4-11.

In the case of steel railings, possible rehabilitation works include partial replacement for major rupture and deformation or some reinforcement for minor deformation and rupture or protection by repainting for corrosion and paint deterioration. In the case of concrete railings possible rehabilitation works such as partial replacement for section loss or injection/patching for crack/flaking will be required.

Figure 4-11 Damage Ratio and Average Rating in Railings

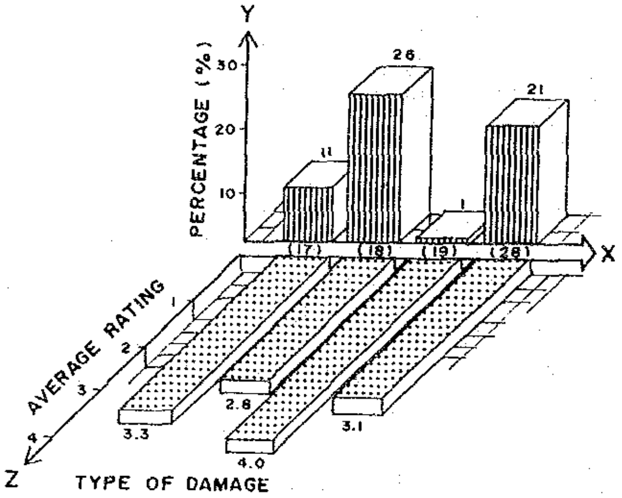


(10) Pavement

As indicated in Figure 4-12, the typical type of damage in surfacing are pavement cracks, 26% of the damage ratio, settlement, 21% and potholes, 11%, which are mainly observed at bridge approaches and less on the bridge deck surface .

The possible rehabilitation works will be patching for potholes and pavement cracks, or overlay for settlement.

Figure 4-12 Damage Ratio and Average Rating in Pavements

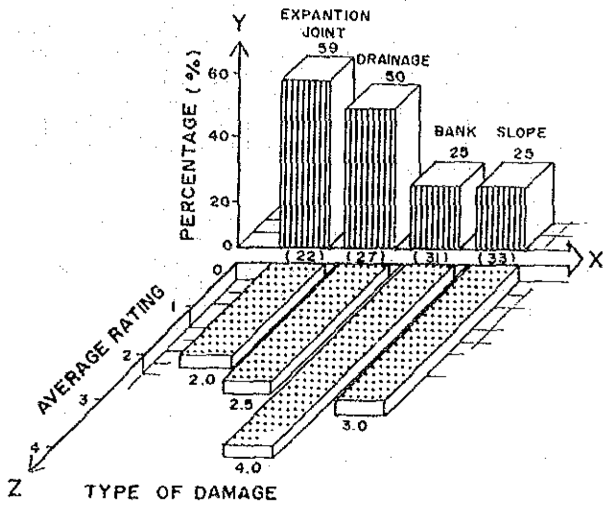


Note: (17) Pothole
(18) Pavement Crack
(19) Rutting
(28) Settlement

(11) Expansion Joint, Drainage, and Bank Slope Protection

Even though most of the joints have not been observed entirely since thick overlays have been applied over the joints, water leakage observed from soffits was detected on 59% of the bridges inspected. Moreover, most of the bridges have no drainage facility except for long span bridges where some drainage is provided. It is, however, observed that 50% of them are clogged and do not function at all. The number of bridges provided with bank slope protection is also very limited and 25% of them have suffered scouring or erosion.

Figure 4-13 Damage Ratio and Average Rating in Expansion Joint, Drainage, and Bank Slope Protection



Note: (22) Water Leakage
(27) Sediment
(31) Scouring
(33) Erosion

Possible rehabilitation plans could mainly be replacement or provision of these bridge parts. Thus, it would be useful to introduce various rehabilitation plans for these bridge parts in a Manual to prevent or cope with these damages.

4.3.2 Detailed Assessment of Visual Inspection Results from A Functional Viewpoint

The evaluation items of a bridge from a functional viewpoint are traffic capacity on a bridge, pedestrian flow capacity, and bridge opening capacity, against flood flow. During preliminary bridge assessment, the traffic capacity on each study bridge was calculated based on the available traffic data and it was checked against the current demand volume. If the former is more than the latter, then widening the carriageway is required. In the visual inspection, the carriageway width of the study bridge and general traffic condition were confirmed on site. In the assessment, 4 bridges as listed in Table 4-2 which are equivalent to about 4% of the total 95 bridges were finally proposed for widening of the carriageway.

Regarding to the necessity of adding a sidewalk, it was observed during the visual inspection whether pedestrian flow sources such as mosques, schools and other public facilities were located in the vicinity of bridge. Based on the inspection results, 9 out of the 95 bridges require the adding sidewalk as listed in Table 4-2. On the other hand, based on the interview survey to several local residents about river opening capacity, i.e. whether bridge opening can accommodate flood runoff discharge, 7-bridges having inadequate bridge opening were identified out of the 95 bridges inspected as listed in Table 4-2.

Table 4-2 List of Bridges which are Inadequate from Functional Viewpoints

Type of Rehabilitation Works of Defects	List of Bridge	Remarks
- Widening of Carriageway	00567840, 00838100 01800060, 01800670	Ratio of traffic capacity to current demand is greater than unity.
- Adding sidewalk	00159100, 00161140 00303890, 00313150 00313520, 00366660 00521300, 00521710 01800060	Bridge without sidewalk is located close to town or public facilities.
- Inadequate bridge opening	00304390, 00346740 00366660, 00546560 00838100, 02305970 05300960	Bridge opening is inadequate to cater for flood flow.

4.4 Preparation of Standard Possible Rehabilitation Plans

Standard possible rehabilitation plans for each main bridge component part from structural and functional viewpoints were prepared based on detected damages in terms of type, degree, and extent and reference was also made to rehabilitation works performed in Malaysia as well as in Japan so as to present comprehensive rehabilitation works.

4.4.1 Standard Possible Rehabilitation Plans from A Structural Viewpoint

At the beginning of the Study, conceivable rehabilitation plans broadly divided into protection, reinforcement and replacement for each bridge component were prepared and assigned to the 216 study bridges based mainly on the review of bridge inventory sheets prepared by NALS. This study formed the bases for selection of the representative 95 bridges for visual inspection in terms of a rehabilitation plan, considering final feedback of the study results to the remaining bridges.

Consequently, the visual inspection results which revealed various damages in terms of type, degree and extent assisted the Team to concretize the conceivable rehabilitation plans and to derive a standard possible rehabilitation method for each bridge component. It is, however, necessary to assess definitive reasons for the damage detected and to evaluate several rehabilitation methods in detail from construction cost, construction period, construction easiness and traffic diversion easiness viewpoints before assigning the optimum rehabilitation method for each bridge component.

Therefore, standard possible rehabilitation methods illustrated in Appendix-H could be used as a reference in the preliminary design. It should be noted that standard possible rehabilitation method for secondary bridge components such as pavement, railing, and expansion joints was not presented since their rehabilitation method is relatively simple and has limited alternatives.

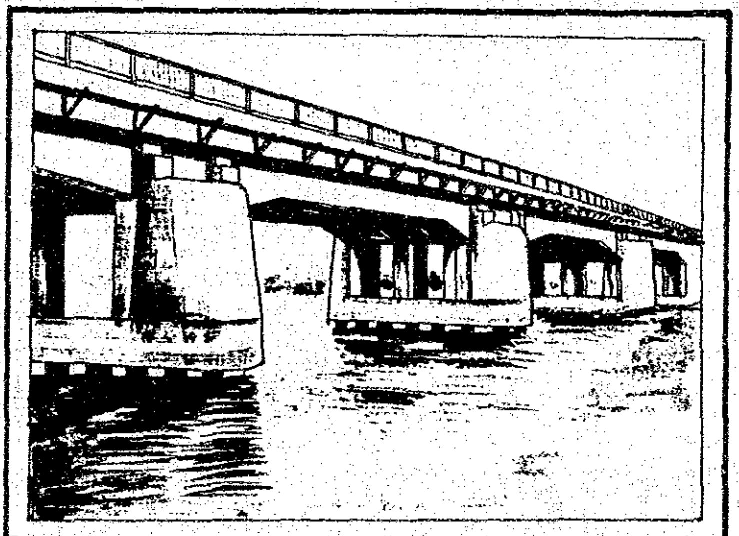
4.4.2 Standard Possible Rehabilitation Method from A Functional Viewpoint

For standard possible rehabilitation methods from a functional view point, i.e. widening carriageways, adding sidewalks, raising grades or extension of bridges, several alternatives can be considered but depend on the type of bridge, river condition at the bridge site and geological condition, in general. Therefore, it is necessary to conduct a comparative study for selection of the optimum rehabilitation method in the preliminary design.

For reference in the preliminary design, the standard possible rehabilitation method for widening the carriageway, adding a sidewalk and raising grades are listed in Appendix-H.

CHAPTER 5

SELECTION OF BRIDGES FOR DETAILED SURVEY



CHAPTER 5

SELECTION OF BRIDGES FOR DETAILED SURVEY

5.1 General

In line with the set up methodology, the main purposes of this chapter are to select 20 typical bridges out of the 95 federal bridges for detailed structural survey and to select 5 bridges out of those 20 bridges for a full scale loading test based on the visual inspection results.

The detailed survey results on the 20 bridges were used to carry out preliminary rehabilitation design of these bridges and to reflect in formulating the maintenance and rehabilitation program of the remaining study bridges as well as in preparation of the inspection, maintenance, and rehabilitation manual, while the primary purpose of full scale loading test is to estimate structural residual loading capacity of main bridge component parts which could be used in preliminary structural analysis.

5.2 Selection of 20 Bridges for Detailed Survey

5.2.1 Selection Procedure for 20 Bridges for Detailed Survey

Out of the five special bridges, requested by GOM, for visual inspections, the necessity to carrying out a detailed survey was judged only for Sultan Yahya Petra Bridge at Kota Bharu. Moreover, GOM requested that a detailed survey be conducted for one bridge in each Sabah and Sarawak from a total of 30 bridges inspected.

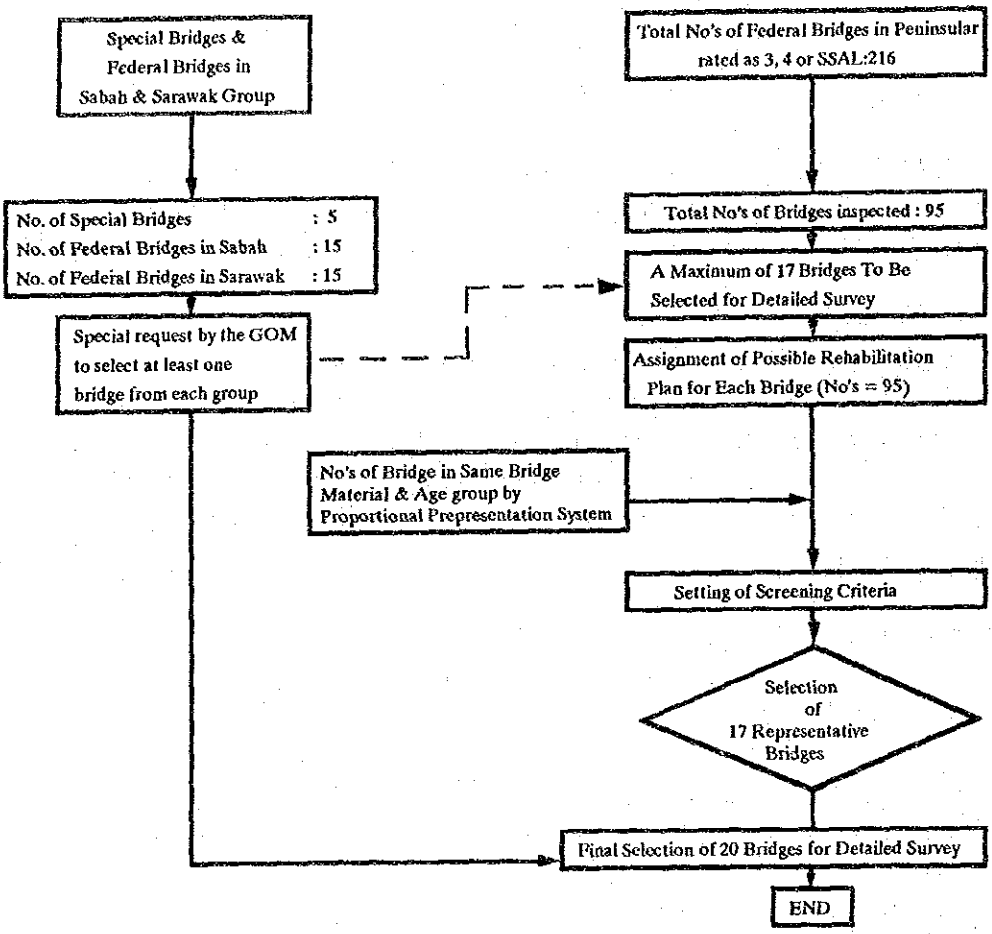
Consequently, 20 bridges which were originally planned to be selected for a detailed survey from a total of 95 bridges were reduced to 17 bridges after subtracting the above 3 bridges.

The selection procedure for the 20 bridges for detailed survey is charted in Figure 5-1.

First of all for the selection, an assignment criteria of possible rehabilitation plans was is established and possible rehabilitation plans were assigned after referring to type, degree, and extent of the damage rated to each main bridge part.

The 95 bridges are classified into the same bridge material and the same bridge age group and then the weighted percentage of bridge number in terms of each bridge material and age group was worked out against the 95 bridges. By using the same screening criteria as applied in the selection of 95 bridges for visual inspection, representative bridges having a large number of possible rehabilitation plans were generally selected within the specific number calculated by a proportional representation system for each bridge material and age group.

Figure 5-1 Selection Procedures of 20 Bridges for Detailed Survey



In the end, 17 bridges selected through the above exercise were combined with the 3 special bridges to form the 20 bridges for detailed survey.

5.2.2 Assignment Criteria and Assignment of Possible Rehabilitation Plan

Taking into account the main study objective which is to formulate a maintenance and rehabilitation program covering all the 216 study bridges, it is crucial for selection that 17 bridges should cover dominant rehabilitation works, so that the survey results of the 17 bridges will be fully utilized in formulating a rehabilitation program for the remaining bridges.

To this end, it is necessary to assign possible rehabilitation plans to each of the 95 bridges based on a certain criteria derived from the visual inspection results and then to select representative bridges which have a large number of possible rehabilitation plans. For this purpose, referring to standard possible rehabilitation plans prepared in Chapter 4 as well as the condition rating results carried out in the visual inspection, a criteria ruling relationship between a possible rehabilitation plan and corresponding damage type, degree, and extent of each main bridge component was established for each concrete and steel member. The criteria for steel and concrete members are shown in Table 5-1 and 5-2 respectively.

Referring to Tables 5-1 & 5-2, possible rehabilitation plans were assigned to each bridge based on the condition rating results of each main bridge component. A result of the assignment to all the 95 bridges is shown in Appendix-I.

Table 5-1 Assignment Criteria of Possible Rehabilitation Plans for Main Steel Components

Type of	Definition of Damage			Damage	Main Bridge Steel Component			
Damages	Pattern	Degree	Extent	Rating	Main Beam	Buckle Plate	Bearing	Pier
(1) Corrosion		Section Loss	Widely	4	Reinforcement(SBRF)	Reinforcement(DCRF)	Protection(BPR)	Reinforcement(SPRF)
			Locally	4	Reinforcement(SBRF)	Reinforcement(DCRF)	Protection(BPR)	Reinforcement(SPRF)
		Surface Rust	Widely	4	Protection(SBPR)	Protection(DSPR)	Protection(BPR)	Protection(SPPR)
			Locally	3	Protection(SBPR)	Protection(DSPR)	Protection(BPR)	Protection(SPPR)
(2) Steel Crack		Detected		4	Reinforcement(SBRF)	Reinforcement(DCRF)		Reinforcement(SPRF)
		No		0	-	-		-
(4) Falling Off			Many	4	Protection(SBPR)	Protection(DSPR)	Protection(BPR)	Protection(SPPR)
			A few	3	Protection(SBPR)	Protection(DSPR)	Protection(BPR)	Protection(SPPR)
(5) Steel Rupture		Detected		4	Reinforcement(SBRF)		Replacement(BRP)	
		No		0	-		-	
(6) Paint Deterioration		Came off	Widely	3	Protection(SBPR)	Protection(DSPR)	Protection(BPR)	Protection(SPPR)
			Locally	2	-	-	-	-
		Colour changed	Widely	2	-	-	-	-
			Locally	1	-	-	-	-
(22) Water Leak/ Ponding Water		Detected		4		Protection(DSPR)	Protection(BPR)	
		No		0		-	-	
(23) Abnormal Noise		Detected		4	Reinforcement(SBRF)			Reinforcement(SPRF)
		No		0	-			-
(24) Abnormal Vibration		Detected		4	Reinforcement(SBRF)			
		No		0	-			
(25) Abnormal Deflection		Detected		4	Reinforcement(SBRF)			
		No		0	-			
(26) Deformation		Remarkable		4	Reinforcement(SBRF)	Reinforcement(DCRF)		Reinforcement(SPRF)
		Slight		2	-	-		-
(27) Sediment/ Vegetation		Remarkable		3			Protection(BPR)	
		Slight		2			-	
(28) Settlement		Remarkable		4			Protection(BPR)	Reinforcement(PFRF)
		Slight		3			-	Reinforcement(PFRF)
(30) DIP		Remarkable		4				Reinforcement(PFRF)
		Slight		3				Reinforcement(PFRF)
(31) Scouring	Direct	Remarkable		4				Protection(PFPR)
		Slight		4				Protection(PFPR)
	Pile, Caisson	Remarkable		4				Protection(PFPR)
		Slight		3				Protection(PFPR)
(33) Erosion		Remarkable		4				-
		Slight		3				-

Table 5-2 Assignment Criteria of Possible Rehabilitation Plans for Main Concrete Components

Type of Damages	Definition of Damage: Pattern	Degree	Extent	Damage Rating	Main Bridge Concrete Component: Main Beam	Deck Slab	Bearing(Rubber)	Abutment	Pier
(7) Cracks	Critical	Wide Line	Interval < 50cm	4	Reinforcement(CBRF)			Reinforcement(ARF)	Reinforcement(PRF)
			Interval > 50cm	4	Protection(CBPR)			Protection(APR)	Protection(PPR)
		Hair Line	Interval < 50cm	3	Protection(CBPR)			Protection(APR)	Protection(PPR)
			Interval > 50cm	3	Protection(CBPR)			Protection(APR)	Protection(PPR)
	Uncritical	Wide Line	Interval < 50cm	4	Protection(CBPR)			Protection(APR)	Protection(PPR)
			Interval > 50cm	3	Protection(CBPR)			Protection(APR)	Protection(PPR)
		Hair Line	Interval < 50cm	2	–			–	–
			Interval > 50cm	1	–			–	–
(8) Flaking Rebar exposure		Rebar Corroded	Area > 0.1 & 1. sq.m	4	Reinforcement(CBRF)	Reinforcement(DCRF)		Reinforcement(ARF)	Reinforcement(PRF)
			Area < 0.1 & 1. sq.m	3	Protection(CBPR)	Protection(DCPR)		Protection(APR)	Protection(PPR)
		Flaking Only	Area > 0.1 & 1. sq.m	3	Protection(CBPR)	Protection(DCPR)		Protection(APR)	Protection(PPR)
			Area < 0.1 & 1. sq.m	2	–	–		–	–
(9) Free Lime			Area > 0.1 & 1. sq.m	4	Protection(CBPR)	Protection(DCPR)		Protection(APR)	Protection(PPR)
			Area < 0.1 & 1. sq.m	3	Protection(CBPR)	Protection(DCPR)		Protection(APR)	Protection(PPR)
(11) Wear/Erosion		Up to rebar	Area > 1. sq.m	4				Reinforcement(ARF)	Reinforcement(PRF)
			Area < 1. sq.m	3				Protection(APR)	Protection(PPR)
		Covering Only	Area > 1. sq.m	3				Protection(APR)	Protection(PPR)
			Area < 1. sq.m	2				–	–
(12) Slipping off		Detected		4		Replacement(DCRP)			
		No		0		–			
(14) Slab Crack	2 Ways	Rust Liquid	Interval < 50cm	4		Reinforcement(DCRF)			
			Interval > 50cm	4		Reinforcement(DCRF)			
		Water Leak	Interval < 50cm	4		Reinforcement(DCRF)			
			Interval > 50cm	3		Protection(DCPR)			
		Crack Only	Interval < 50cm	3		Protection(DCPR)			
			Interval > 50cm	2		–			
	1 Way	Rust Liquid	Interval < 50cm	3		Protection(DCPR)			
			Interval > 50cm	3		Protection(DCPR)			
		Water Leak	Interval < 50cm	3		Protection(DCPR)			
			Interval > 50cm	2		–			
		Crack Only	Interval < 50cm	2		–			
			Interval > 50cm	2		–			
(21) Deterioration		Widely		4	Protection(CBPR)	Protection(DCPR)		Protection(APR)	Protection(PPR)
		Locally		3	Protection(CBPR)	Protection(DCPR)		Protection(APR)	Protection(PPR)
(22) Water Leak/ Ponding Water		Detected		4	Protection(CBPR)	Protection(DCPR)	Protection(BPR)	Protection(APR)	Protection(PPR)
		No		0	–	–	–	–	–
(24) Abnormal Vibration		Detected		4	Reinforcement(CBRF)				
		No		0	–				
(25) Abnormal Deflection		Detected		4	Reinforcement(CBRF)				
		No		0	–				
(26) Deformation		Remarkable		4			Replacement(BRP)		
		Slight		2			–		
(27) Sediment/ Vegetation		Remarkable		3			Protection(BPR)		
		Slight		2			–		
(28) Settlement		Remarkable		4				Reinforcement(AFRF)	Reinforcement(PFRF)
		Slight		3				–	–
(29) Abnormal Movement		Remarkable		4				Reinforcement(AFRF)	Reinforcement(PFRF)
		Slight		3				–	–
(30) DIP		Remarkable		4				Reinforcement(AFRF)	Reinforcement(PFRF)
		Slight		3				–	–
(31) Scouring	Direct	Remarkable		4				Protection(AFPR)	Protection(PFPR)
		Slight		4				Protection(AFPR)	Protection(PFPR)
	Pile, Caisson	Remarkable		4				Protection(AFPR)	Protection(PFPR)
		Slight		3				Protection(AFPR)	Protection(PFPR)
(32) Defect (Section Loss)		Remarkable		4	Protection(CBPR)		Replacement(BRP)		
		Slight		2	–		–		
(33) Erosion		Remarkable		4				Protection(BSPR)	–
		Slight		3				–	–

Notes ; – 0.1 sq.m for Substructure
– 0.01 sq.m for Superstructure

5.2.3 Setting of Screening Criteria

(1) Bridge Grouping

Bridge construction materials mainly consist of prestressed concrete, reinforced concrete and steel, while bridge age was divided into three age groups, before 1945, between 1946 to 1974, and after 1975.

On the other hand, a maintenance and rehabilitation plan is closely related to the construction material, bridge type and bridge age. It depends on type, degree, and extent of damage observed on the bridge material. Thus the 95 bridges were classified into the same bridge construction material and the same bridge age group in order to select representative bridges by a proportional representation system.

Percentage of bridges in terms of construction material and age group was calculated against the total number of 95 bridges and then a figure indicating the number of bridges to be selected from the same bridge construction material and age group was worked out by multiplying the percentage of each material and age group by 17.

The number and percentage of the bridge for each material and age group against a total of 95 bridges and 17 bridges to be selected are listed in Table 5-3.

Table 5-3 Number and Percentage for Each Bridge Material and Age Group

Age Group / Const. Material	Before 1945			1946 to 1974			Total		
	No. of Bridges Upon 95	% of the Group	No. of Bridges Upon 17	No. of Bridges Upon 95	% of the Group	No. of Bridges Upon 17	No. of Bridges Upon 95	% of the Group	No. of Bridges Upon 17
Steel	12	12.6	2	32	33.7	5	44	46.3	7
Prestressed Concrete	0	0	0	13	13.7	4	13	13.7	4
Reinforced Concrete	6	6.3	1	32	33.7	5	38	40.0	6
TOTAL	18	18.9	3	77	81.7	14	95	100.0	17

Note: The figure below decimal in no's of steel & RC bridges against 17 was omitted. Balance due to this omission was added in the number of PC bridge in view of bridge importance.

(2) Setting of Screening Criteria

In selection of a representative bridge for detailed survey, it is essential to choose a bridge which covers major types of possible rehabilitation plan not only from structural but from functional viewpoint.

Taking into account of the above principle, a representative bridge within the same bridge material and age group which has a large number of major possible rehabilitation plans is firstly selected. The next representative bridge of which possible rehabilitation plans are not covered in the earlier selected bridge is subsequently selected. The selection with this criteria is carried out until the number of the bridges selected has been reached proportionate number of bridges for each construction material and age group.

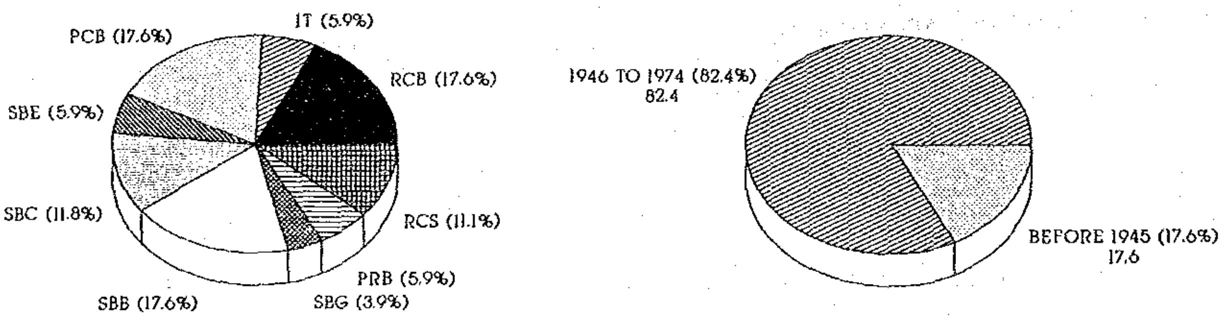
5.2.4 Selection Results for 20 Bridges for Detailed Survey

Through the above exercise, 17 representative bridges were selected and the results are shown in Appendix-I. The statistics of the 17 selected bridges in terms of bridge type and age group were charted in Figure 5-2, which indicated that proportion of each bridge group on the 17 bridges selected is more or less the same as on the 95 bridges.

Figure 5-2 Statistics of the 17 Bridges Selected

Percentage of 17 Selected Bridges by type of construction

Percentage of 17 Selected Bridges by age group



Finally 17 bridges selected and 3 special bridges formed the 20 bridges for detailed survey as listed in Table 5-4 and of which locations are shown in Figure 5-3.

Table 5-4 List of the 20 Bridges Selected for the Detailed Survey

NO.	KEY	STATE	DISTRICT	YEAR BUILT	STUDY CATE-GORY	CAPA-CITY	MAX. SPAN (M)	NO. OF SPAN	BRIDGE LENGTH (M)	TYPE OF BRIDGE
1	00114920	JOHOR	SEGAMAT	1955	3	STAL	6.43	2	12.86	Reinforced Concrete Beam
2	00161140	PERAK	KINTA	1950	3	STAL	9.77	2	19.11	Steel Beam Buckle Plate
3	00166510	PERAK	LRT MATANG	1935	3	STAL	10.72	1	10.72	Steel Box Girder +Reinforced Concrete Beam
4	00237200	PAHANG	KUANTAN	1960	3	STAL	8.90	3	26.70	Steel Beam R.C.Slab +Reinforced Concrete Beam
5	00317000	PAHANG	ROMPIN	1974	3	MTAL	45.78	9	397.32	Prestressed Concrete Beam
6	00319110	PAHANG	ROMPIN	1962	3	SSAL	30.46	7	121.96	Prestressed Concrete Beam
7	00341800	TRENGGANU	KEMAMAN	1955	3	STAL	12.10	3	36.14	Reinforced Concrete Beam
8	00346740	TRENGGANU	DUNGUN	1973	3	STAL	30.50	9	152.26	Prestressed Concrete Beam
9	00520850	MELAKA	JASIN	1950	3	STAL	4.27	1	4.27	Encased Steel Beam
10	00546560	SELANGOR	K.SELANGOR	1939	3	P/A	6.30	1	6.30	Reinforced Concrete Beam
11	00546980	SELANGOR	K.SELANGOR	1969	3	STAL	10.64	3	30.94	Reinforced Concrete Slab (Hollow)
12	00563880	PERAK	MANJUNG	1972	3	STAL	14.07	3	41.59	Pretensioned Inverted Tee Beam
13	00567840	PERAK	KINTA	1960	3	STAL	6.06	2	12.12	Precast Reinforced Concrete Beam
14	00834850	KELANTAN	KUALA KRAI	1960	3	STAL	4.63	3	13.71	Reinforced Concrete Slab
15	05001070	JOHOR	BATU PAHAT	1919	2	SSAL	4.77	1	4.77	Steel Beam Buckle Plate
16	05803340	PERAK	BTG PADANG	1950	3	STAL	4.97	1	4.97	Steel Beam Buckle Plate
17	05903120	PERAK	BTG PADANG	1950	3	STAL	10.88	3	23.18	Steel Beam R.C.Slab
	17 Bridges									
	<< SPECIAL Bridges >>									
1	–	SABAH	PENAMPANG	1964	–	–	25.70	3	50.10	Steel Beam R.C.Slab
2	–	SARAWAK	SAMARAHAN	1965	–	–	19.80	5	71.60	Steel Beam R.C.Slab
3	00371000	KELANTAN	KOTA BHARU	1962	–	–	30.00	29	840.00	Reinforced Concrete Beam

3 Bridges

Grand Total 20 Bridges

In addition to the above, the Study Team is requested to investigate reason of the defects and countermeasure if required for the following bridges.

NO.	KEY	STATE	DISTRICT	YEAR BUILT	STUDY CATE-GORY	CAPA-CITY	MAX. SPAN (M)	NO. OF SPAN	BRIDGE LENGTH (M)	TYPE OF BRIDGE	DETECTED DEFECTS
1	00512960	JOHOR		1965	3	STAL	11.30	3	30.22	RCB	Crack on Abutment
2	00701810	KEDAH		1970	3	STAL	30.52	3	48.60	PCB	Deteriorated Rubber Bearing

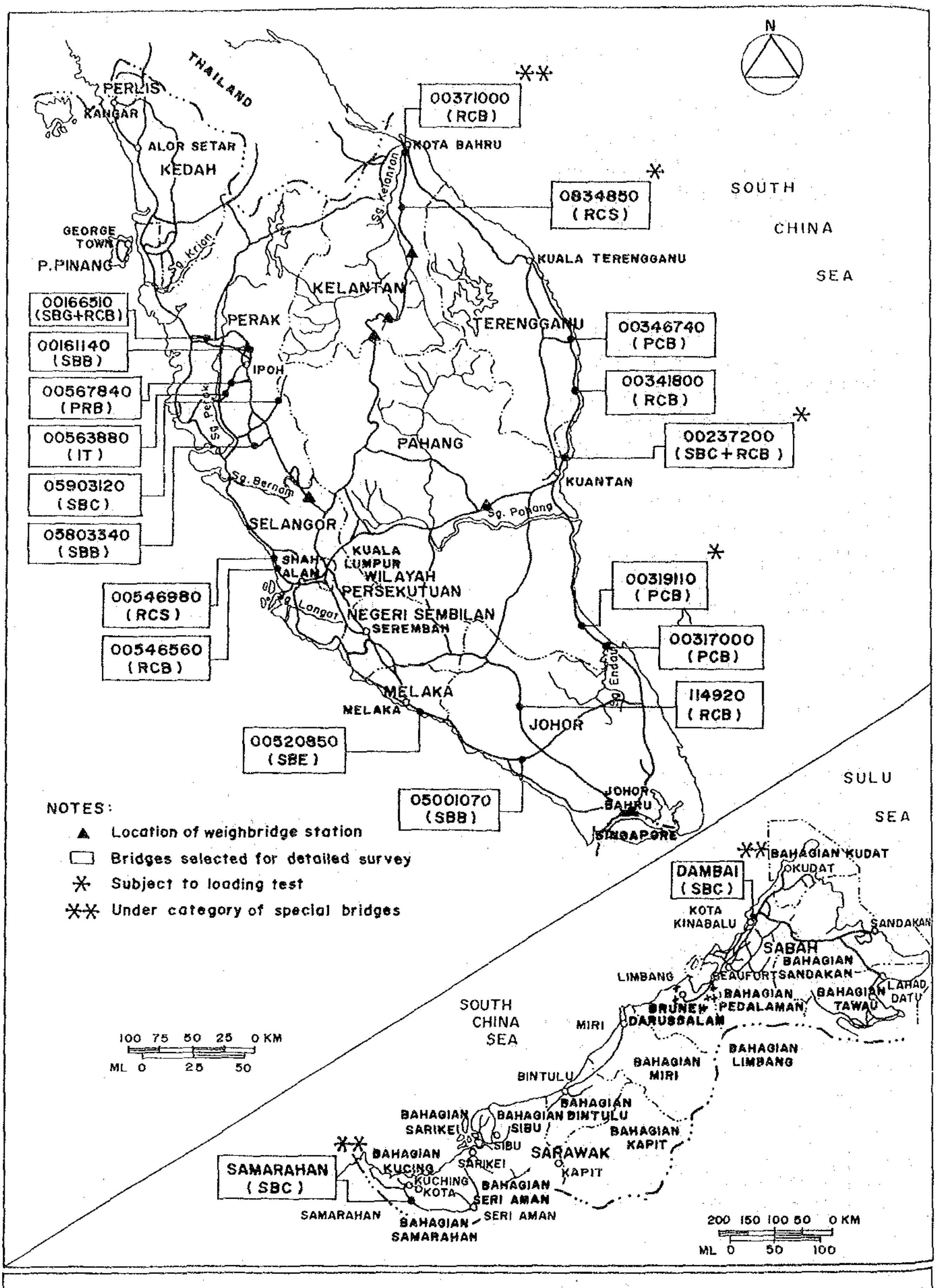


Figure 5-3 Location Map of the 20 Bridges Selected

5.3 Selection of Bridges for Loading Test

5.3.1 Setting of Screening Criteria

In order to select 5 bridges for the loading test from the 20 bridges selected for detailed survey, the 20 bridges were evaluated from the following viewpoints.

(1) Availability of Detour

For the duration of loading test, it is necessary to close road where the bridge is located and to cater for the existing traffic flow by provision of detour road. Thus information about the availability of a detour road was collected during the period of visual inspection from the JKR district office or from local residences living around the bridge site. The data collected for the bridges selected are tabulated in Table 5-5.

The evaluation criteria for the availability of a detour was set up as follows;

Availability of Detour	Rating
Available and length of detour road less than 10 km	Very Good
Available and length of detour road between 11 km to 40 km	Good
Available and length of detour road more than 40 km	Fair
Not available	Bad

(2) Traffic Volume

Traffic volume on the bridge to be selected indicates the degree of difficulty in terms of traffic control during the period of preparation and implementation of the loading test. Thus traffic volume (16 hr) obtained from "Traffic Volume Malaysia 1988-1989" issued by HPU, is listed in Table 5-5 for each bridge.

Evaluation criteria of traffic volume was set up as follows;

Traffic Volume (16 Hrs)	Rating
0 < TV < 3,000	Very Good
3,000 < TV < 8,000	Good
8,000 < TV < 15,000	Fair
15,000 < TV	Bad

(3) Clearance of Working Space

Clearance between, the soffit of girder/slab up to water or ground level governs workability of the loading test. Thus the clearance height of each bridge was taken from data stated in the NALS inventory card and are tabulated in Table 5-5.

Evaluation criteria of bridge clearance for working space was set up as follows;

Height of Clearance (m)	Rating
2.5 < H	Very Good
1.7 < H < 2.5	Good
1.0 < H < 1.7	Fair
H < 1.0	Bad

(4) Applicability of the Test Results

It is essential that the loading test results of a bridge should reflect the load carrying capacity of the other same bridge types. Thus a representative bridge having standard bridge dimension and no critical structural defects shall be selected as the bridge for the loading test.

Evaluation criteria for the applicability of the test results to the other same type of bridges was set up as follows;

Applicability of the Test Result		Rating
Type of Bridge	Reason	
SBB	Thickness of slab and its type of material widely vary and thus experimental values resulting from load test could not be applicable to other SBB bridge	Fair
SBG	This type of bridge is only one out of the 216 study bridges. Thus no applicability at all.	Bad
SBE	Homogeneity of composition degree between steel and concrete widely vary, depending on working load and quality of material. Thus applicability is less.	Fair
IT & PRB	Homogeneity of composition degree between in place and precast concrete governing transversal load distribution also vary, depending on quality of the materials. Thus applicability is less.	Fair
RCB, PCB & SBC	Applicability of the test results of these bridges to the other same type is very reliable.	Very Good

In addition to the above, a skew bridge which presents sophisticated stress distribution was rated as "Bad" as it was not applicable to other bridges.

5.3.2 Selection Results of the Bridges from Loading Tests

In order to select the bridges for a loading test based on the quantitative evaluation of the 20 bridges, the qualitative rating results such as "Very Good", "Good", "Fair" and "Bad" are converted into the corresponding basic point as set up as follows;

Qualitative Rating	Basic Point
Very Good	5
Good	4
Fair	3
Bad	1

The basic point for each of the 4 evaluation items per bridge was then added to obtain the total points for the bridge. The lower number of total points indicates the lower appropriateness of the bridge for the loading test, while the higher the number shows the more appropriate bridge. Although the obtained total points are not of an exact order, they do indicate the general order in which the bridges fall concerning the appropriateness for a loading test.

Based on Table 5-6 showing the quantitative rating results as well as considering accessibility to the bridge location and availability of parking space, the following bridges were finally selected for the loading test.

KEY	STATE	DISTRICT	BRIDGE TYPE
237200	PAHANG	KUANTAN	SBC & RCB
319110	PAHANG	ROMPIN	PCB & PCB
834850	KELANTAN	KUALA KRAI	RCS

The above selection results showed that loading test would be conducted at 3 bridge sites for 5 bridges consisting of 1-steel beam with RC slab, 1-reinforced concrete beam, 2-prestressed concrete beam and 1-reinforced concrete slab.

Table 5-5 Evaluation of the 20 Bridges for the Loading Test

NO.	KEY	STATE	DISTRICT	TYPE OF BRIDGE (SKEW)	MAX. SPAN (M)	NO. OF SPAN	BRIDGE LENGTH (M)	YEAR BUILT	AVAILABILITY OF DETOUR (KM)	16 HOURS TRAFFIC VOLUME	CLEARANCE BELOW GIRDER (M)
1	00114920	JOHOR	SEGAMAT	RCB (90)	6.43	2	12.86	1955	Available (90)	7760	1.33
2	00161140	PERAK	KINTA	SBB (90)	9.77	2	19.11	1950	Not Available (− −)	13460	2.76
3	00166510	PERAK	LRT MATANG	SBG + RCB (90) *1	10.72	1	10.72	1935	Available (20)	13340	2.83
4	00237200	PAHANG	KUANTAN	SBC + RCB (90)	8.90	3	26.70	1960	Available (10)	12600	2.40
5	00317000	PAHANG	ROMPIN	PCB (90)	45.78	9	397.32	1974	Not Available (− −)	5740	7.92
6	00319110	PAHANG	ROMPIN	PCB (90) *2	30.46	7	121.96	1962	Not Available (− −)	1750	6.82
7	00341800	TRENGGANU	KEMAMAN	RCB (90)	12.10	3	36.14	1955	Available (26)	8650	1.40
8	00346740	TRENGGANU	DUNGUN	PCB (90) *2	30.50	9	152.26	1973	Not Available (− −)	8190	2.80
9	00520850	MELAKA	JASIN	SBE (90)	4.27	1	4.27	1950	Available (5)	13900	1.44
10	00546560	SELANGOR	K.SELANGOR	RCB (90)	6.30	1	6.30	1939	Available (3)	7980	0.80
11	00546980	SELANGOR	K.SELANGOR	RCS(H) (90)	10.64	3	30.94	1969	Available (21)	7980	3.50
12	00563880	PERAK	MANJUNG	IT (55)	14.07	3	41.59	1972	Available (40)	10620	2.30
13	00567840	PERAK	KINTA	PRB (90)	6.06	2	12.12	1960	Available (10)	20300	1.08
14	00834850	KELANTAN	KUALA KRAI	RCS (90)	4.63	3	13.71	1960	Available (30)	7000	3.43
15	05001070	JOHOR	BATU PAHAT	SBB (90)	4.77	1	4.77	1919	Available (40)	23660	1.09
16	05803340	PERAK	BTG PADANG	SBB (90)	4.97	1	4.97	1950	Available (35)	4290	1.31
17	05903120	PERAK	BTG PADANG	SBC (75)	10.88	3	23.18	1950	Not Available (− −)	5000	6.90
18 *		SABAH	PENAMPANG	SBC (90)	25.70	3	50.10	1964	Available (10)	−	5.60
19 *		SARAWAK	SAMARAHAN	SBC (90)	19.80	5	71.60	1965	Not Available (− −)	−	7.10
20 *	00371000	KELANTAN	K.BAHRU	RCB (90)	30.00	29	840.00	1962	Available (120)	34000	8.00

NOTE : * Special bridges of which rehabilitation plan will be prepared individually
*1 Widened by RCB
*2 2 girders types

Table 5-6 Evaluation Results and Selection of Bridges for the Loading Test

NO.	KEY	STATE	DISTRICT	TYPE OF BRIDGE (SKEW)	MAX. SPAN (M)	NO. OF SPAN	BRIDGE LENGTH (M)	YEAR BUILT	AVAILABILITY OF DETOUR (POINT)	16 HR TRAFFIC VOLUME (POINT)	CLEARANCE BELOW GIRDER (POINT)	APPLICABILITY TO OTHER BRIDGES (POINT)	TOTAL POINT	FINAL SELECTION
1	00114920	JOHOR	SEGAMAT	RCB (90)	6.43	2	12.86	1953	F (3)	G (4)	F (3)	VG (5)	15	−
2	00161140	PERAK	KINTA	SBB (90)	9.77	2	19.11	1950	B (1)	F (3)	VG (5)	F (3)	12	−
3	00166510	PERAK	LRT MATANG	SBG + RCB (90) *1	10.72	1	10.72	1935	G (4)	F (3)	VG (5)	B (1)	13	−
4	00237200	PAHANG	KUANTAN	SBC + RCB (90)	8.90	3	26.70	1960	VG (5)	F (3)	G (4)	VG (5)	17	SELECTED
5	00317000	PAHANG	ROMPIN	PCB (90)	45.78	9	397.32	1974	B (1)	G (4)	VG (5)	VG (5)	15	−
6	00319110	PAHANG	ROMPIN	PCB (90) *2	30.46	7	121.96	1962	B (1)	VG (5)	VG (5)	VG (5)	16	SELECTED
7	00341800	TRENGGANU	KEMAMAN	RCB (90)	12.10	3	36.14	1955	G (4)	F (3)	F (3)	VG (5)	15	−
8	00346740	TRENGGANU	DUNGUN	PCB (90) *2	30.50	9	152.26	1973	B (1)	F (3)	VG (5)	VG (5)	14	−
9	00520850	MELAKA	JASIN	SBE (90)	4.27	1	4.27	1950	VG (5)	F (3)	F (3)	F (3)	14	−
10	00546560	SELANGOR	K.SELANGOR	RCB (90)	6.30	1	6.30	1939	VG (5)	G (4)	B (1)	VG (5)	15	−
11	00546980	SELANGOR	K.SELANGOR	RCS(H) (90)	10.64	3	30.94	1969	G (4)	G (4)	VG (5)	F (3)	16	−
12	00563880	PERAK	MANJUNG	IT (55)	14.07	3	41.59	1972	G (4)	F (3)	G (4)	B (1)	12	−
13	00567840	PERAK	KINTA	PRB (90)	6.06	2	12.12	1960	VG (5)	B (1)	F (3)	F (3)	12	−
14	00834850	KELANTAN	KUALA KRAI	RCS (90)	4.63	3	13.71	1960	G (4)	G (4)	VG (5)	F (3)	16	SELECTED
15	05001070	JOHOR	BATU PAHAT	SBB (90)	4.77	1	4.77	1919	G (4)	B (1)	F (3)	F (3)	11	−
16	05803340	PERAK	BTG PADANG	SBB (90)	4.97	1	4.97	1950	G (4)	G (4)	F (3)	F (3)	14	−
17	05903120	PERAK	BTG PADANG	SBC (75)	10.88	3	23.18	1950	B (1)	G (4)	VG (5)	B (1)	11	−
18 *		SABAH	PENAMPANG	SBC (90)	25.70	3	50.10	1964	VG (5)	−	VG (5)	VG (5)	19	−
19 *		SARAWAK	SAMARAHAN	SBC (90)	19.80	5	71.60	1965	B (1)	−	VG (5)	VG (5)	15	−
20 *	00371000	KELANTAN	KOTA BAHRU	RCB (90)	30.00	29	840.00	1962	B (1)	B (1)	VG (5)	VG (5)	12	−

NOTE : * Special bridges of which rehabilitation plan will be prepared individually
*1 Widened by RCB
*2 2 girders types
VG : Vary Good G : Good F : Fair B : Bad

CHAPTER 6

TOPOGRAPHIC SURVEY

CHAPTER 6

TOPOGRAPHIC SURVEY

6.1 General

Prior to the commencement of the topographic survey, an extensive data collection exercise/desk study was carried out on 216 bridges with condition rating 3, 4, or study category of SSAL. Although an enormous volume of data had been gathered, topographic survey data for the selected 20 bridge sites in Peninsular Malaysia were not available. However, simple bridge site plans and river cross-sectional profiles were available for the 2 selected bridges in Sabah and Sarawak. This available topographic data can be utilized in conjunction with the supplemental field survey conducted by the Study Team. As a result, a topographic survey was only carried out on the 18 selected bridges located in Peninsular Malaysia. The location map and the extent of topographic survey for the selected bridges is given in Figure 6-1 and Table 6-1, respectively.

The topographic survey is part of the overall detailed engineering field survey. This detailed engineering information is required to enable preliminary engineering design, cost estimation and planning for the maintenance and rehabilitation of bridges.

6.2 Objectives

The primary purpose of the topographic survey is to visualize and illustrate the levels and contours of the surrounding land and river relative to the bridge. The positions of the bridge sites were tied to their respective State Soldner-Cassini Coordinate Systems, while the level control was referenced to the government benchmarks establish by the Survey Department. This topographic survey is essential since it provides the basic data for the following works :-

* Hydraulics analysis.
* Determination of local scour and the extent of rehabilitation and maintenance required for the river bank and scour protection.
* Structural analysis of the substructure.
* Stratigrapy of the subsoil relative to the topography of the land.

TABLE 6-1 EXTENT OF TOPOGRAPHIC SURVEY

No	Key	State	District	Bridge Length (M)	Topograhic Survey: Extent of Survey: Beyond Abutment	Topograhic Survey: Extent of Survey: From Road Central-L	Topograhic Survey: Area to be Covered (Square Meter): (L & W)	Topograhic Survey: Area to be Covered (Square Meter): Area	Topograhic Survey: Scale of Drawing	No of X-Section for River Survey: At 20m C/C	No of X-Section for River Survey: Below Bridge Centre-Line
1	00114920	Johor	Segamat	12.86	15.00	15.00	40 x 30	1200	50	2	1
2	00161140	Perak	Kinta	19.11	30.00	15.00	80 x 30	2400	100	2	1
3	00166510	Perak	Larut Matang	10.72	10S & 20N	30U & 15D	40 x 45	1800	50	2	1
4	00237200	Pahang	Kuantan	26.70	10.00	10.00	45 x 20	900	100	2	1
5	00317000	Pahang	Rompin	397.32	50.00	20.00	500 x 40	20000	500	2(100)*	*1
6	00319110	Pahang	Rompin	121.96	20.00	20.00	160 x 40	6400	200	2(100)*	*1
7	00341800	Terengganu	Kemaman	36.14	20.00	20.00	75 x 40	3000	100	2	1
8	00346740	Terengganu	Dungun	152.26	50.00	20D & 50U	250 x 70	17500	400	2(50)*	*1
9	00520850	Melaka	Jasin	4.27	10.00	10D & 15U	25 x 25	625	50	2	1
10	00546560	Selangor	Kuala Selangor	6.30	30.00	20.00	65 x 40	2600	50	2	1
11	00546980	Selangor	Kuala Selangor	30.94	20.00	30.00	70 x 60	4200	100	2	1
12	00563880	Perak	Manjung	41.59	10.00	15.00	60 x 30	1800	100	2	1
13	00567840	Perak	Kinta	12.12	10.00	20U & 10D	60 x 30	1800	50	2	1
14	00834850	Kelantan	Kuala Krai	13.71	15.00	15.00	45 x 30	1350	50	2	1
15	05001070	Johor	Batu Pahat	4.77	10.00	15.00	25 x 30	750	50	2	1
16	05803340	Perak	Batang Padang	4.97	10.00	10.00	25 x 20	500	50	2	1
17	05903120	Perak	Batang Padang	23.18	10W & 30E	20.00	20 x 40	800	100	2	1
18	00371000	Kelantan	Kota Bharu	840.00	50.00	30.00	950 x 60	57000	1000	2(100)*	*1
							TOTAL	124,625			

1 – Extent on Survey area and dimensions are given in meters
2 – Abbreviations in the above table for the extent of survey are as follows;
S = South, N = North, E = East, W = West, U = Up-stream, D = Down-stream, L = Length, W = Width
3 – Figure in ( ) is the interval of river cross section
4 – Mark with * was surveyed using echo sounding