1. General

Malaysia was once ruled by the British and as a result, bridges in Malaysia have traditionally been designed to British Standard. Throughout the years various revision of the British Standard and modification on the application of the standard to suit Malaysian condition has been carried out resulting in bridges being designed to various loading and design specification. Even today various standard has been used in bridge design, JKR Bridge Design Manual for example, adopted BS153 as its design standard while the current applicable British Standard is BS 5400 which is used by some bridge designers in Malaysia. For the purpose of this study the design criteria to be applied are based on JKR bridge design practice except where the specification is not clear then The Japanese Bridge Design Specification will suffice. The design criteria covers the following aspect of design:-

- Geometric design standard
- Bridge clearance
- Bridge width
- Bridge loading
- Design method
- Material and allowable stress
- Superstructure design
- Substructure design
- Applicable bridge design standard

2. Geometric Design Standard.

The geometric design standard to be applied in this study is based on the JKR "ARAHAN TEKNIK (JALAN) 8/86". The summary of the design standard is as follows:-

-	Design speed........................	70 - 100 Km/Hr
-	Lane width for 2-lane............	3.5m
-	Shoulder (general area)	3.0m
	(mountainous area).....	1.5m
-	Sidewalk..........................	2.0m
-	Vertical Clearance (over road)..	5.0m
	(over rail)..	6.5m
-	Crossfall.........................	2.5%
-	Superelevation rates(max)........	0.10 m/m
-	Horizontal radius (min.).........	465m
-	Vertical Gradient................	6%

3. Bridge Width.

In the study, design standard of R5 road is applied in principle. However the width of the bridge depends on whether there is side walk or not. The difference between this two type of bridge width requirements is shown in the Figure N-1 and N-2 below;

Figure N-1 Normal Bridge Cross-Section

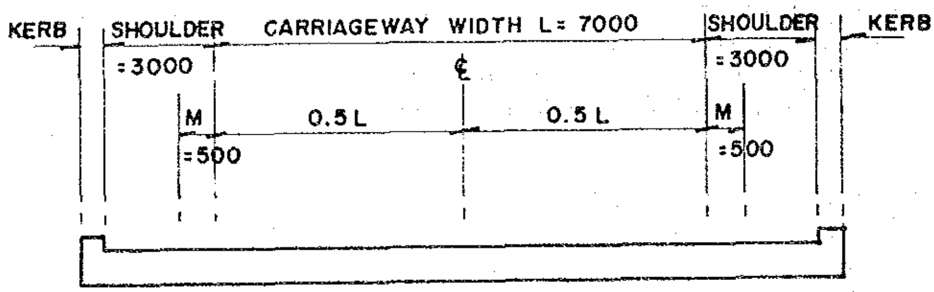
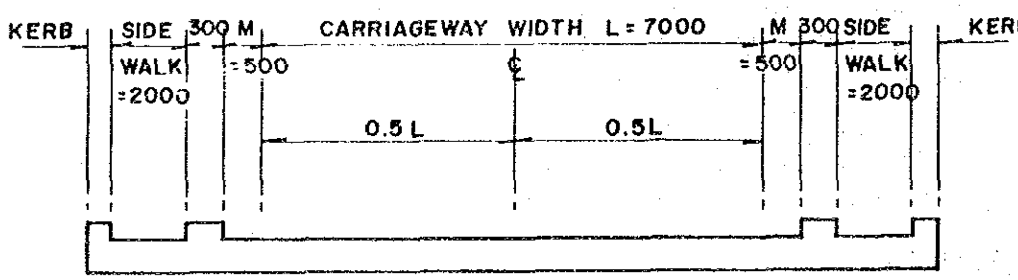


Figure N-2 Cross-Section of a Bridge With Sidewalk



4. Free Board.

Hydraulic analysis shall be carried out based on DID Hydrological procedures (either Hp No.5, Hp No.11 or Hp No.4). The free board requirement is not clearly stated in the JKR bridge Design Manual, thus the recommendation given in the Japanese bridge design specification is adopted. For this study the soffit of the bridge deck shall be designed such that it is above the designed flood level with a free board as tabulated in Table N-1.

Table N-1 Free Board For Bridge Over River

Free Board	Size of River	Design flood flow Q_f (cumec)
0.50m	Small river	$Q_f < 500$
1.00m	Medium river	$500 < Q_f \leq 2000$
1.50m	Big river	$Q_f > 2000$

5. Bridge Loading

Loads acting on the bridge structure includes Dead Load, Live Load, Load due to centrifugal force, Tractive/Braking Force, collision load on bridge parapet, collision load on bridge support, Wind Load, Load due to creep, shrinkage and temperature; buoyancy or uplift force and Forces of Stream Current and Debris. Since the study is only concerned on the preliminary design, the bridge loading which is not critical to all type of bridges in the study will not be considered in the analysis. Hence the load to be considered shall be limited to the following type of loadings:-

+ Dead Loads.
+ Primary Live Loads.
+ Tractive/Braking force.
+ Centrifugal force
+ Collision load on bridge support
+ Collision load on bridge parapet
+ Pedestrian load (sidewalk loading)
+ Load due to temperature.
+ Forces due to stream current, debris and floating log.
+ Forces due to earth pressure.

(1) Dead Loads

The unit weight of bridge construction material as given in Table N-2 below may be used for calculation of the dead load:-

Table N-2 The Unit Weight of Bridge Construction Material

Material	Unit Weight (kN/cu.m)
Reinforced Concrete	25
Prestressed Concrete	25
Asphalt Pavement	23
Steel or Cast Steel	77
Cast Iron	71
Alluminium Alloys	28
Timber	8
Stone masonry	27
Bituminous water proofing material	11
Compacted sand, earth or gravel	19
Loose sand, earth or gravel	16

The unit weight of ancillary bridge construction material as given in Table N-3 below may be used for calculation of superimposed dead load:-

Table N-3 The Unit Weight of Ancillary Bridge Construction Material

Material	Unit Weight
100mm nom.dia. water main	0.24 (kN/m)
150mm nom.dia. water main	0.46 (kN/m)
200mm nom.dia. water main	0.73 (kN/m)
250mm nom.dia. water main	1.13 (kN/m)
300mm nom.dia. water main	1.47 (kN/m)
380mm nom.dia. water main	2.08 (kN/m)
10.0m high Lamp Post	1.31 (kN)
12.0m high Lamp Post	1.71 (kN)
RC Parapet + Handrail	7.32 (kN/m)
Std.Kerb + Handrail	4.21 (kN/m)
Std.Kerb Divider	1.80 (kN/m)

(2) Primary Live Loads

Live load to be applied in the study shall be LTAL loading which is applied on each notional lane. Details of the application of the LTAL is as follows:-

- **Notional Lanes.**

The width of each notional lane is fixed at 2.5m within the carriageway of the structure. Only integer numbers of the notional lanes shall be used. Areas of the carriageway not covered by the notional lanes shall be loaded with the minimum pedestrian loading of 5 kN/m^2.

- **LTAL Loading.**

LTAL Loading consists of a uniformly distributed Load and a Knife-Edge Load combined, or a twin wheel load. The Nominal Uniformly Distributed Load (UDL) to be applied on a 2.5m lane width is as shown in Table N-4 below:-

Table N-4 LTAL Load For Various Loaded Length

Loaded Length L(m)	LTAL (kN/m/Lane)
$L \leq 20m$	$w = 176.8 \cdot L^{-0.6}$
$20m < L \leq 40m$	$w = (93.6+4.16 \cdot L) \cdot L^{-0.6}$
$40m < L \leq 50m$	$w = 260 \cdot L^{-0.6}$

where:

"L" is the Loaded length in meter and "w" is the load intensity in kN per meter of notional lane width.

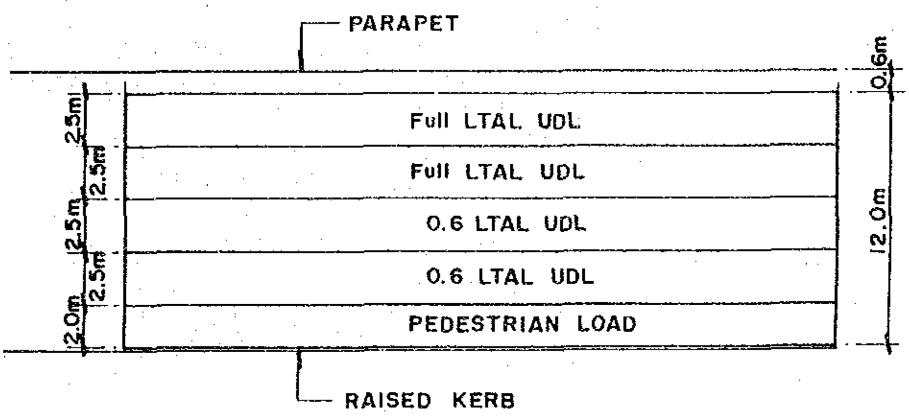
The KEL per notional lane width shall be taken as 100 kN. No dispersal shall be assumed for UDL and KEL.

Twin nominal wheel load alternative to UDL and KEL consist of two 112 kN wheels spaced at 1.8m apart. Each of the wheel is uniformly distributed over a circular or square contact area with effective pressure of 1.1 N/mm² (i.e. 360 mm diameter and 320mm side effectively). The wheel load is dispersed at spread-to-depth ratio of 1 horizontal to 2 vertical through asphalt and 1 horizontal to 1 vertical through structural concrete.

- **Application of LTAL Loading.**

The UDL and KEL loads shall be applied on two notional lanes so as to give the worst effects on the structure. The rest of the notional lanes shall be loaded with 0.6 times LTAL UDL and KEL as illustrated in Figure N-3 below. The carriageway width shall be taken as the width between raised herbs. In the absence of raised herbs, it is the width between safety fences, less set back of 0.6m.

Figure N-3 Application LTAL UDL and KEL Load



NOTE: LANE LOADINGS ARE INTERCHANGEABLE FOR THE MOST SEVERE EFFECTS

(3) Load Due To Temperature.

Load effect due to temperature difference can generally be ignored in the preliminary design. However the following data may be used if required :-

- The overall bridge temperature shall be taken as 20°C.
- Coefficient of thermal expansion for structural steel and for concrete shall be taken as 12×10^{-6} and 10×10^{-6} respectively.

(4) Centrifugal Load

Centrifugal load on curved bridges shall be applied on any two notional lane at 50m centres acting radially at the surface of the road and parallel to it. The centrifugal force shall be determined as follows:-

$$F_c = \frac{30000}{(r+150)}$$

where F_c = Centrifugal force (kN)
r = Radius of curvature of lane (m)

Each load F_c shall be either taken as a single load or subdivided into two parts of $^1/_3$ F_c and $^2/_3$ F_c at 5 m centres longitudinally, whichever gives the lesser effect. A vertical live load of 300 kN, distributed uniformly over the notional lane for a length of 5m shall be considered to be acting together with each F_c and coincide with it. Where the centrifugal load is subdivided, the vertical live load shall be subdivided in the same proportions.

(5) Collision Load on Bridge Support

The nominal collision loads on bridge support at bridges over the highway are given in Table N-5 below together with their direction and height of application.

Table N-5 Collision Load on Bridge Support

Type of load transmitted	Load normal to the carriageway below (kN)	Load parallel to the carriageway below (kN)	Point of application on bridge support.
Load transmitted from guard rail	150	50	Any one bracket attachment point or, for free standing fences, any one point 0.75m above carriage-way level.
Residual load above guard rail	100	100	At the most severe point between 1m and 3m above carriageway level.

Bridge supports shall be capable of resisting the load transmitted from the guard rail applied simultaneously with the residual load above the guard rail. Loads normal to the carriageway are to be considered separately from loads parallel to the carriageway. No other primary live loads is required to be considered on the bridge.

(6) Collision Load on Bridge Parapet

Elements supporting bridge parapet shall be designed to resist loads due to vehicle collision with the parapets. The nominal load shall be as given in Table N-6 below:-

Table N-6 Collision Load on Bridge Parapet

Type of parapet	Collision load on parapet	
	High level containment	Normal level containment
Concrete	Moment 25 kNm/m	Moment 12.5 kNm/m
Metal	Force 50 kN	Force 25 kN

For concrete parapet the moment shall be applied uniformly at the parapet base. The transverse collision force on metal parapet shall be applied equally between the number of effective longitudinal members and acting at the centroid of the members. The associated primary live load to be applied shall be twin wheel load of 112 kN each spaced at 1.8m apart.

(7) Sidewalk Loading

Sidewalk loading to be used in the study shall be taken as 5 kN/m^2 for span length up to 50m.

(8) Tractive/Braking Force.

The longitudinal load resulting from traction or braking of vehicles shall be applied at the road surface and parallel to it in one notional lane only. The nominal tractive/braking load shall be taken as follows:-

$T = 8 \cdot L + 200$ (kN); *(but not more than 450 kN)*

where; L is Loaded length (m).

(9) Forces of Stream Current, Debris and Floating Log.

- Force due to Stream Current

All piers and other parts of the structure which are subjected to the forces of flowing water, or debris shall be assessed accordingly. The force induced shall be calculated as follows:-

$$P = K \cdot V^2 \cdot A$$

The forces induced by flowing water shall be taken to be acting at 0.6H from river bed

where :

P = Pressure (kN).
V = Maximum current velocity (m/s).
A = Vertically projected area of pier (m^2).
H = Depth of water (m).
K = Constant determined by the shape of the pier as shown in table N-7 below.

Table N-7 Resistance Coefficient of Bridge Pier

Shape of the end of bridge pier facing the stream	Constant
	0·07
	0·04
	0·02

- **Force due to debris blockade.**

Where blockage by debris is likely to occur, allowance shall be made for hydrodynamic forces acting on the minimum depth of 1.2m of debris. The length of debris blockage affecting any pier shall be taken as half the sum of the adjacent spans. However, for minor bridges, the debris loadings need not be considered if the free board over the maximum flood level is more than 1.5m. The pressure P, induced by the debris on the pier shall be taken as follows;

$$P = 0.517 \cdot V^2 \quad (kN/m^2)$$

Where V is the approach flow velocity (m/s).

- **Forces due to log impact**

Where floating logs are likely, the force exerted by 10 tonne logs traveling at normal stream velocity shall be assessed. However the force due to log impact shall **not** be applied concurrently with debris force. The force due to log impact shall be calculated as follows;

$$F = 0.1 \cdot W \cdot V \quad (t)$$

Where :
W = Weight of log (10 Tonne)
V = Normal stream velocity (m/s)

(10) Forces due to Earth Pressure.

Structures which retain earthfills shall be assessed to withstand pressure as given by Rankine's formula. In normal bridge design, because horizontal granular backfill is often used behind abutments, ground water conditions can be ignored. The earth pressure acting on the abutment depends on whether the abutment is movable type or not and also the type of soil. For preliminary design the following formula shall be used:-

- Earth pressure acting on movable walls;

(a) Sandy soil

$$P_a = K_a \cdot r \cdot h + K_a \cdot q$$

$$P_p = K_p \cdot r \cdot h + K_p \cdot q$$

(b) Cohesive soil

$$P_a = K_a \cdot r \cdot h - 2 \cdot c \cdot \sqrt{K_a} + K_a \cdot q$$

$$P_p = K_p \cdot r \cdot h + 2 \cdot c \cdot \sqrt{K_p} + K_p \cdot q$$

(2) Earth pressure acting on fixed wall;

$$P_a = K_s \cdot r \cdot h + K_s \cdot q$$

where;
r = Bulk density of earth (kN/m³).
P_a = Active earth pressure (kN/m²).
P_p = Passive earth pressure (kN/m²).
K_a = Coulomb's active earth pressure coefficient.
K_p = Coulomb's passive earth pressure coefficient.
K_s = Coefficient of earth pressure at rest.
h = Height of abutment (m).
c = Soil cohesion (kN/m²).
q = Surcharge (kN/m²).

The internal angle of friction of granular backfill material behind abutments shall be assumed to be 30°. Live Load surcharge for suitable material properly consolidated shall be taken as 20 kN/m².

6. Design Method Applied.

The assessment of the existing bridges and rehabilitation work jointed directly to the existing bridges shall be in accordance with elastic design method (allowable design stress method), while for an adding sidewalk which is not attached to the existing bridge or a completely new bridge for rehabilitation by total replacement, the design shall be carried out using ultimate limit design method.

The reasons for adopting these two different design methods in the preliminary design are :

- All the study bridges were designed to BS153 which follows the elastic design principal.
- Quality of materials used in the study bridges is scattered (i.e. strength variation is very wide)

Thus, it is safe to apply elastic design method for the assessment and the rehabilitation design. However, quality of material and accuracy of design for an independant structure can be controlled properly within very low tolerance. Therefore, it is rational to apply ultimate limit design method only for an independant structure which will not be attached to the existing bridge.

The elastic design method shall be based on the guidelines given in JKR Bridge Design Manual, while for ultimate limit design the provisions prescribed in BS5400 shall be applied.

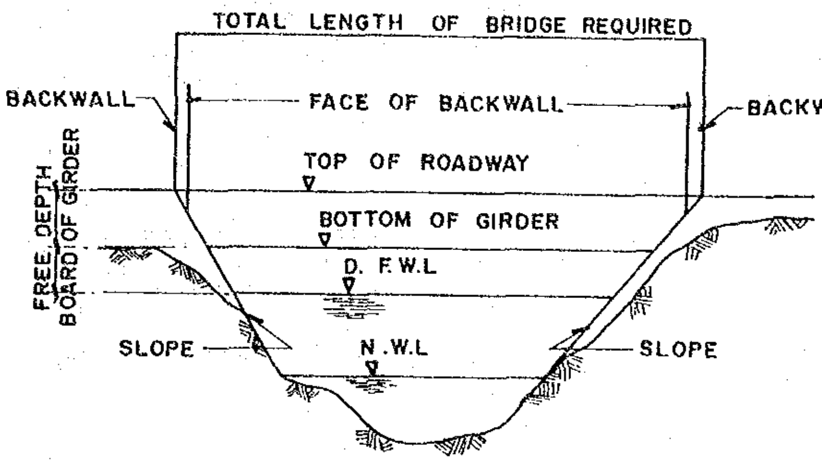
7. Bridge Planning (Applicable to only total bridge replacement)

- Determination of Bridge Length

The clearances of a bridge controls the bridge's length as indicated in the following. From the intersection of ordinary water level and ground surface as shown in the sketch below, the proposed slopes of protection work follow the slope of the bank as close as possible, having in mind not to constrict the area of the water way required. Then the top of roadway elevation was determined based on the Design Flood Water Level (DFWL).

The distance between the intersections of the slopes of protection work and the top of roadway elevation represents the length of bridge required, which is the total distance between the back of backwalls. Minor adjustments shall be made, if necessary, to suit the length of standard type of superstucture to be adopted.

Free board under a bridge shall be determined taking into consideration the necessary space needed for river navigational ways and maintenance, etc. The river administrative clearance from the bottom of the bridge girder or beam to design flood water level will vary from 0.5m to 1.5m depending on the size of river.



The design elevation of the bottom of bridge girder shall not be lower than the highest water level plus the free board.

Free board (below the bridge) - For non navigable river; general clearance between D.F.W.L. and the bottom of the lowest member of superstructure shall comply with the requirement stated in Table N-1.

Vertical Clearance (Navigable river); The DID or Marine Department shall be consulted for determining the minimum horizontal and vertical clearances under a bridge before preparing the final design and plans of the proposed bridge.

- Applicable Bridge Types

To select the applicable types of superstructure, substructure and foundation, the basic and important factors to be taken into consideration shall include economical construction, stability and safety, shorter construction period and ease of maintenance and operation.

Figure N-4 Applicable Types of Concrete Bridge

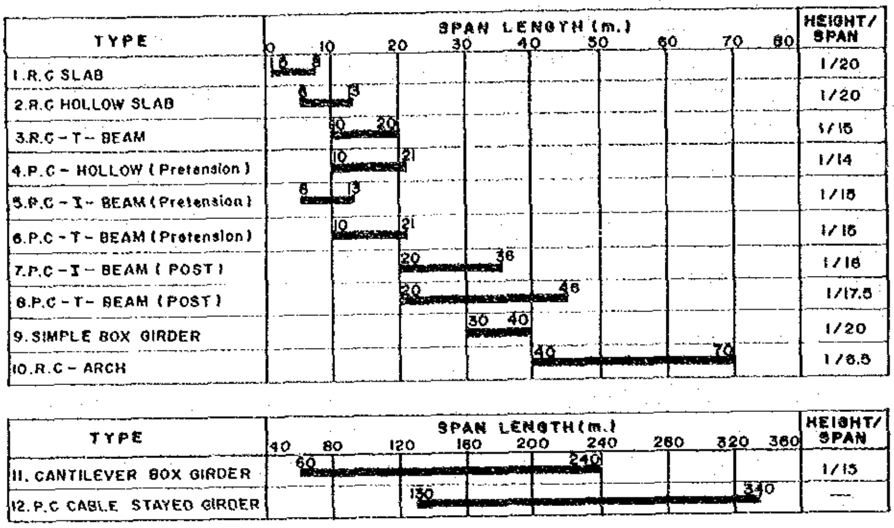


Figure N-5 Applicable Types of Steel Bridge

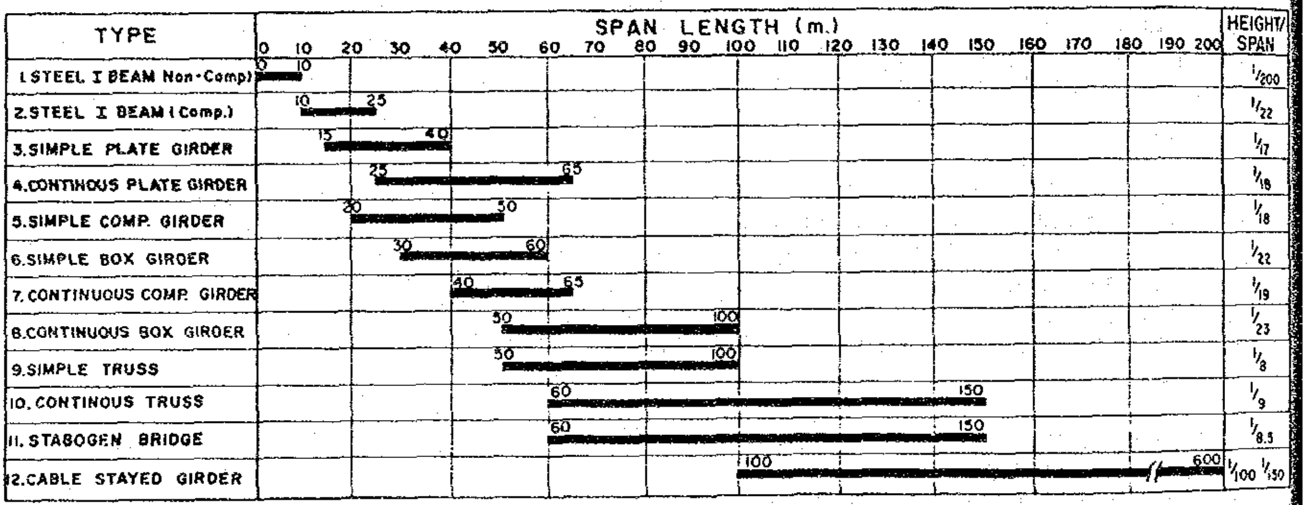


Figure N-4 and Figure N-5 show the relationship between the superstructure type and the span length based on the samples of bridges. The following items are fundamental in the selection of superstructure types :

- Reinforced concrete structures are initially considered except for special requirements of steel structure because of easier maintenance.

- Reinforced concrete beam and steel I-beam types are applicable for short span length (10m to 15m).

- Prestressed concrete girder, and steel plate girder types are applicable for medium span length (20m to 50m).

- Prestressed concrete box girder, steel through truss and ranger girder types are to be applied for long span length (60m to 150m).

Figure N-6 Applicable Types of Pier

	TYPE	HEIGHT(m) 0 10 20 30 40	REMARKS
P-1	COLUMN TYPE	0 — 15	
P-2	RIGID FRAME TYPE (1 STOREY)	5 — 15	
P-3	RIGID FRAME TYPE (2 STOREY)	15 — 25	
P-4	WALL TYPE	10 — 30	
P-5	WALL TYPE (1 STOREY)	25 — 40	

Figure N-7 Applicable Types of Abutment

	TYPE	HEIGHT(m) 0 10 20 30	REMARKS
A-1	CHAIR TYPE	3	
A-2	GRAVITY TYPE	4	
A-3	SEMI GRAVITY TYPE	4 — 6	
A-4	INVERSE T-TYPE	6 — 10	
A-5	BUTTRESSED TYPE	10 — 15	
A-6	BOX TYPE	10 — 20	
A-7	SUSTAINING WALL TYPE	10 — 15	

Figure N-6 and N-7 show the applicable substructure types in accordance with the required structural height of a bridge. The selection of substructure types is based not only on specified figures but also on the following considerations :

- Reinforced concrete structures.
- The cross section of pier column in the river is circular or elliptical and rectangular shape with no re-

strcted conditions.

- Non sliding of the back fill materials behind abutment structure is considered in the selection in the abutment type to avoid the approach settlement.

Figure N-8 Applicable Types of Foundation

	TYPE		DEPTH (m.) (0 10 20 30 40 50 60 70 80 90 100)	USABLE DIA.(m.)	SOIL CONDITION CLAYEY	SOIL CONDITION SANDY
F-1	SPREAD FOUNDATION		0 – 10	–	O	O
F-2	R. C. PILE	DRIVEN PILE	5 – 15 – 25	0.3 – 0.5	△	△
F-3	P.C. PILE	DRIVEN PILE	12 – 30 – 40	0.35 – 0.5	△	△
F-4	STEEL-PIPE PILE	DRIVEN PILE	20 – 60	0.5 – 0.8	O	O
F-5	CAST IN PLACE W/CASING	CAST-IN PLACE PILE	10 – 30 – 40	1.0 – 1.2		△
F-6	EARTH AUGER	CAST-IN PLACE PILE	10 – 30	1.0 – 1.5	O	X
F-7	REVERSE CIRCULATION DRILL	CAST-IN PLACE PILE	25 – 60 – 90	1.0 – 1.2	O	X
F-8	SHINSO PILE	CAST-IN PLACE PILE	10 – 25	2.0 – 5.0	—	—
F-9	OPEN CAISSON	CAISSON	5 – 55 – 70	–	—	—
F-10	PNEUMATIC CAISSON	CAISSON	10 – 30	–	—	—

NOTE:
O : APPLICABLE
△ : CONSIDERABLE
X : NOT APPLICABLE

Figure N-8 shows the applicable foundation types in accordance with the required effective depth to sustain the upper-structures. The following are considered in selecting the foundation type :

- Possible construction depth is studied in consideration of soil conditions.

- The advantageous type is considered for works above water e.g. reverse circulation drill pile.

- The prefabricated pile types are advantageous when the bearing stratum is within a shallow range.

8. Superstructure Design.

In principal, JKR standard design of superstructure shall be applied if applicable.

The design method and manners of the superstructures such as Reinforced Concrete, Prestressed Concrete and Steel Structure shall be based on the provisions prescribed in BS5400.

9. Substructure Design

The present practices of substructure design in Malaysia is based on BS8004. Since foundation design is universal and for practical purpose, Standard Specification of Highway Bridges in Japan for substructure design is adopted in this manual. Thus, followings are presented for reference.

The substructure could be founded on spread footing, caisson or pile. In general the type of foundation could be classified accordance to table N-8 and N-9 below.

Table N-8 Classification of Spread Footing and Caisson Foundation

Type of Foundation	Ratio of D_f/B
Spread footing	$D_f/B \leq 1/2$
Caisson	$D_f/B > 1/2$

D_f: Effective embedded depth
B : Shorter width of foundation

Table N-9 Classification of Caisson and Pile Foundation

Type of foundation	Pile or Caisson Characteristic
Caisson	$\beta.L \leq 1$
Short pile	$1 < \beta.L \leq 3$
Long pile	$\beta.L > 3$

where;

L = embedded length of caisson or pile (m)
ß = characteristic value of caisson or pile $= \sqrt[4]{kD/4EI}$ (m^{-1})
EI = flexural rigidity of caisson or pile (kNm^2).
D = Diameter of caisson or pile (m).
k = coefficient of horizontal subgrade reaction of caisson or pile (kN/m^3)

note:-
1. 'k' for caisson shall be taken as a mean value from ground surface to the point of ½ depth.
2. 'k' for pile shall be taken as a mean value from ground surface to the point of $^1/_\beta$ depth.

In principle the foundation shall be designed so that it is stable against bearing, overturning and horizontal movement.

(1) Footing Foundation

The depth of footings shall be determined depending on the type and characteristic of the foundation material. In general, for footing not founded on rock, the base of footing should be founded at depth preferably not less than 1.2m below the stream bed for abutment and 1.8m for pier. This preferred minimum depth shall be increased depending on the site condition. For assessment and preliminary design purposes and where subsoil data is not available, the assumed bearing capacity and angle of internal friction for a broad basic soil type shall be as given in the Table N-10 and N-11 respectively.

Table N-10 Allowable Bearing Pressure For Spread Footing

Type of Bearing Material	Consistency	Allowable Bearing Pressure kN/m²	
		Ordinary Range	Recommended for use
Alluvial Soil	Soft Medium Very stiff to hard	0 - 80 100 - 200 200 - 400	50 150 250
Homogeneous inorganic clay, sandy or silty clay	Soft Medium to stiff Very stiff to hard	50 - 80 100 - 300 300 - 500	50 200 300
Fine to Medium Sand	Loose Medium Dense Very Dense	100 - 200 200 - 300 300 - 400	100 200 300
Gravel, gravel-sand mixtures, boulder-gravel mixtures	Loose Medium Dense Very Dense	200 - 300 400 - 600 600 - 800	200 400 700

Table N-11 Angle of Internal Friction For A broad Basic Soil Ty

Type of Bearing Material	Angle of friction
Alluvial Soil	25 - 30
Moist Sand	30 - 35
Submerged Sand	25 - 30
Gravel	35 - 40

In the preliminary design of footing, an appropriate safety factor has to be applied. The allowable bearing capacity of the footing shall not be more than 1/3 the ultimate bearing capacity of the ground. The horizontal reaction of the foundation shall not exceed 1/1.5 of the passive resistance of the ground. The spread footing shall have the safety factors of 1.5 against sliding. The sliding resistance at base of footing shall be obtained as follows:-

$$H_u = C \cdot A + V \cdot \tan \phi$$

where;

H_u = Maximum sliding resistance (t)
C = cohesion of foundation and ground (t/m^2)
ϕ = friction angle between foundation and ground (°)
A = effective loaded area (m^2)
V = vertical load (t), excluding buoyancy

(2) Pile Foundation.

Generally the pile should penetrate not less than 3.0m into hard cohesive or dense granular material. In addition to that, for pile bents type pier, the pile should penetrate not less than $^1/_3$ of the total length of pile. The bearing capacity of pile shall be estimated based on the following formula;

$$Ra = \{(Ru - Ws)/n\} + Ws - W$$

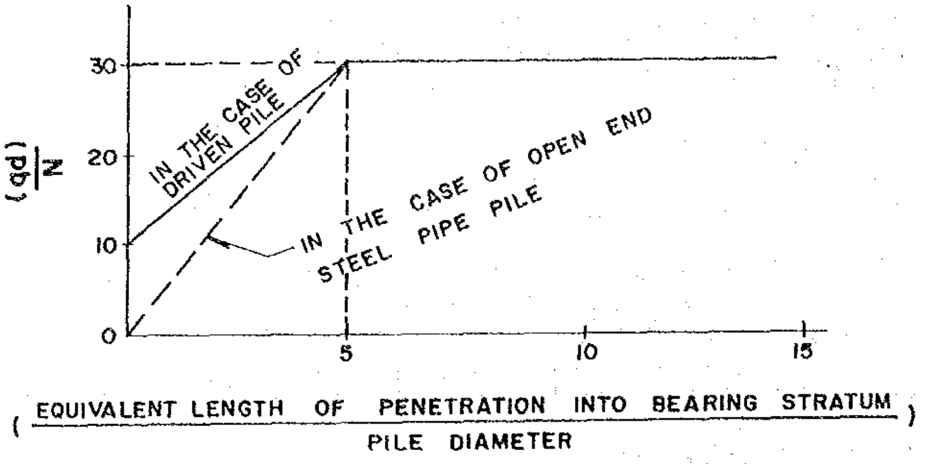
where;
R_a = Allowable load carrying capacity of pile (t).
n = Safety factor (refer to Table N-12).
W_s = Eff. wt of soil replaced by the pile (t).
W = Eff. wt of pile and earth in it (t).
R_u = Ultimate bearing capacity of pile (t) = $q_d A + U \partial l_i f_i$
A = Cross-sectional pile tip.
q_d = Ultimate bearing capacity per unit area at pile tip.
U = Circumference of the pile.
l_i = Penetration Length of pile/depth of stratum where skin friction is considered (m).
f_i = Maximum skin frictional resistance (t/m^2).

Table N-12 Pile Safety Factor

Type of Pile	Safety Factor (n)
Load Bearing	3
Friction	4

In case of driven piles, the ultimate bearing capacity per unit area at the pile tip may be estimated from figure N-9 below;

Figure N-9 Chart For Calculating The Ultimate Bearing Capacity of The Ground at Pile Tip Per Unit Area



In figure N-9 above 'q_d/N' is given as a function of the ratio of the length of the of the pile embedded into the bearing stratum. The bearing capacity shall be taken as the sum of the end bearing capacity and skin friction capacity. In general, the bearing stratum could be considered to be `good' when N-value for sand and gravel exceeds 30 and for cohesive soil N value is above 20 (ie q_u exceeds 0.4 N/mm²). The following formula shall be used to calculate Ñ to be used for estimating the bearing capacity of a driven pile (ie. based on Figure N-9 above).

$$\bar{N} = \frac{(N_1 + N_2)}{2}$$

where;

Ñ = N value of the ground for design (but ≤ 40)
N_1 = N value of pile tip.
N_2 = Mean N value within the range of 4D upward from pile-tip.

(If N value tend to decrease from pile tip downward, the mean value within the range of 2D from the pile tip shall be taken for N_2).

The equivalent penetration length shall be taken as the distance from the pile-tip to the point where the two equal areas surrounded by the N-value distribution curve and the line of Ñ.

The friction force depends on the type of pile and soil. The maximum friction force in Table F-13 below may be used for preliminary design.

Table N-13 Skin Friction Force

Soil Type	Skin friction force (t/m²)	
	Cast in place	Cast in place driven
Sandy Soil	N/5 ($\leq$ 10)	N/2 ($\leq$ 12)
Cohesive Soil	C or N	c/2 or N/2

Note;

C = cohesion of the ground surrounding the pile and it may be assumed to be ½ of the unconfined compressive strength of the undisturbed soil sample.

For preliminary design the N value need not be modified. The minimum distance between the centers of the piles in the outermost row and the edge of the footing may be 1.25 times the pile diameter in the case of driven piles and equal to the pile diameter in the case of cast-in-place concrete piles. The centre to centre spacing of both type of pile shall be 2.5 times the diameter of pile.

(3) Caisson Foundation.

In the preliminary design of caisson foundation, the vertical loads shall be supported at the base of the caisson only. The allowable bearing capacity may be obtained based on the following formula:-

$$q_a = 1/n \cdot (q_d - r_2 \cdot D_f) + r_2 \cdot D_f$$

$$q_d = \alpha \cdot C \cdot N_c + \tfrac{1}{2} \cdot \beta \cdot r_1 \cdot B \cdot N_r + r_2 \cdot D_f \cdot N_q$$

where;

q_a = Allowable bearing capacity (t/m²)
q_d = Ultimate bearing capacity (t/m²)
n = Safety factor = 3
c = Cohesion of the soil at base of caisson (t/m²)
r_1 = bulk density of ground at base of caisson (t/cu.m)
r_2 = bulk density of earth surrounding the caisson
α, β = shape factor of the base of caisson as in table N-14
D_f = effective embedded length
N_c, N_q, N_r = Coefficient of bearing capacity (Fig.F-10)

Figure N-10 Coefficient of Bearing Capacity

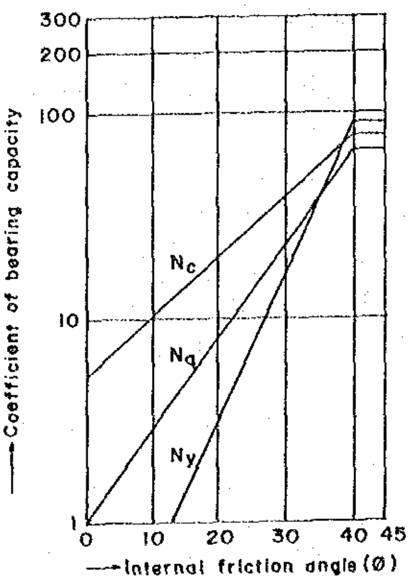


Table N-14 Shape Factor of the Base of Caisson

Shape factor	Shape factor of various shape of caisson			
	Strip	Square	Oval	Circular
α	1.0	1.3	1+ 0.3B/L	1.3
β	1.0	0.6	1- 0.4B/L	0.6

where;

B = width of the total side Diameter of caisson (m)
L = width of front side of caisson (m)

note; *If B/L > 1 than B/L shall be taken as unity.*

The allowable horizontal bearing capacity of ground shall be similar to footing design.

10. Load Combination.

- **Allowable design method**

Load combination for allowable stress design shall be as specified in BS 153-Part 3B and as summaries in the Table N-15 below:-

Table N-15 Load Combination For Allowable Stress Design

Load Combination	Loading	Incremental coefficient for allowable stresses
1	D + L	1.00
2	D+L+F+S	1.25
3	D+L+CS+S	1.25
4	D+L+CP+S	1.25
5	D+L+CL+S	1.25
6	D+L+BK+S	1.25

where;

D = Dead Load.
L = Live Load.
F = Centrifugal force.
CS = Collision load on bridge support.
CP = Collision load on bridge parapet.
CL = Collision load due to log impact.
BK = Tractive/Breaking force.
S = Stream current debris.

Based on engineering judgement, forces from load combination 2, 3 and 4 is not critical for all bridges in the study. Therefore for the purpose of preliminary design and assessment of bridges in the study, only load combination 1, 5 and 6 will be used.

- **Ultimate Limit Design**

For the purpose of design at Ultimate LImit State (ULS), the load combination given in Table N-16 below shall be considered:-

Table N-16 Load Combination At ULS And Appropriate Partial Factor, γ_{fL}

No	Loading	Load Combination					
		1	2	3	4	5	6
1	D(Concrete) (Steel)	1.15 1.05	1.15 1.05	1.15 1.05	1.15 1.05	1.15 1.05	1.15 1.05
2	SIDL	1.75	1.75	1.75	1.75	1.75	1.75
3	S	1.10	1.10	-	1.10	1.10	1.10
4	L	1.50	1.50 L^1	-	1.25 L^2	1.25	1.25
5	F	-	1.50	-	-	-	-
6	CS	-	-	1.25	-	-	-
7	CP	-	-	-	1.25	-	-
8	CL	-	-	-	-	1.25	-
9	BK	-	-	-	-	-	1.25

Note;

L^1: Live load to be applied shall be the appropriate live load as described in (4) above.
L^2: Live load to be applied shall be the appropriate live load as described in (6) above.
SIDL : Superimposed Dead Load

11. Material And Allowable Stress

(1) Allowable Stress Design

The allowable stresses for reinforced concrete design shall be as specified in BE 1/73 and for steel design shall be as specified in BS 153 : Part 3B.

- **Concrete**

The allowable compressive stresses and allowable shear stress of concrete shall be as given in Table N-17 below.

Table N-17 The Allowable Compressive and Shear Stress of Concrete

Class of Concrete denoted by specified 28 day work cube strength	Permissible Stresses in Concrete				
	Compression		Shear	Bond	
	Direct	Bending		Average	Local
N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
30	7.6	10	0.87	1.00	1.47
25 L1	6.3	8.3	0.80	0.90	1.34
22.5	5.7	7.5	0.72	0.85	1.27
20	5.1	6.7	0.70	0.80	1.20

Notes:-
L1 is applicable for the assessment in the study.

- **Steel Reinforcement**

The permissible stresses in steel reinforcement shall be as given in Table N-18 below;

Table N-18 The Permissible Stresses in Steel Reinforcement

Type of Stress	Permissible Stresses in rebar (N/mm²)		
	Mild Steel Bars		All cold work & hot rolled high yield bar
	$\phi \leq$ 40mm L1	$\phi >$ 40mm	
Tensile stress other than in shear reinforcement	140	125	230
Tensile stress in shear reinforcement. That is stirrups and main bars, bent up to resist shear	140	125	175
Compressive stress	125	110	175
Range of stress	265	235	325

Note : L1 is applicable for the assessment in the study

- **Structural Steel.**

The permissible stresses in structural steel shall be as given BS 153:Part 3B which is summaries in Table N-19 below;

Table N-19 The Permissible Stresses in Structural Steel

Steel Grade	Yield Stress (N/mm²)	Permissible Stresses (N/mm²)				
		Bending			Direct/ Axial on effective X-Area.	Shear
		Plate & Hollow section	Rolled section	Plate Girder		
Grade 43	215	140	133	126	129	80
	230 L1	150	142	135	138	85
	245	160	151	144	147	91
	280 L2	183	173	165	168	107
Grade 50	325	212	201	191	191	120
	340	222	210	200	200	126
	355	232	219	209	209	131
Grade 55	400	261	247	235	235	148
	415	271	256	244	244	154
	430	281	265	253	253	159
	450	294	278	265	265	167

Note :

L1 is applicable for the assessment in the study except Samarahan Bridge.

L2 is applicable to Samarahan Bridge.

(2) Ultimate Limit State Design

- **Concrete.**

The design strength of materials for ultimate limit state are expressed in terms of the 'characteristic strength' of the material multiplied by r_m, the partial safety factor for material.

o Extreme fibre stress in compression, f_c.....$0.67 f_{cu}/m$

o (r_m shall be taken as 1.5)

o Ultimate Bearing stress, f_b................$0.4f_{cu}$

o Ultimate shear stress, V_c shall be as follows;

$$V_c = \frac{0.27}{r_m} \left[\frac{100 \cdot A_s}{b_w \cdot d}\right]^{1/3} \cdot f_{cu}^{\ 1/3}$$

where;

A_s = Area of Longitudinal rebar
b_w = Breadth of web or rib of member.
d = Effective depth of tension rebar.
f_{cu} = Characteristic concrete cube strength.
r_m = 1.25

- **Reinforcing Steel.**

o The ultimate tensile strength, $f_s = 0.8f_y/m$

o (r_m shall be taken as 1.15)

o Characteristic strength of reinforcement, f_y is as follows;

Mild steel....................250 N/mm².
High Yield steel...............410 N/mm²

- **Structural Steel.**

Nominal yield stress for steel complying with BS4360 is as follows:-

Steel Grade	Nominal Yield stress (N/sq.mm)	
	t ≤ 16mm	16mm < t < 40mm
40	235	225
43	275	265
50	355	345
55	450	430

12. Design Standard.

In deriving the design criteria, the JKR bridge Design Manual is referred. In addition, reference were also made to BS 153, BE 1/73, BS 5400 Part 1,2,3,and 4; and Specification for Highway Bridges published by Japan Road Association.

APPENDIX – O

RESULTS OF ANALYTIC ASSESSMENT ON EACH EXISTING BRIDGE

APPENDIX – O
RESULTS OF ANALYTIC ASSESSMENT ON EACH EXITING BRIDGE

Bridge No. : 00114920
Bridge Type : RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
RCB	Slab	N/mm2	Bending Moment	31.5	140	−77.5	Main Rebar
				22.0	140	−84.3	Distri. Rebar
	Beam	N/mm2	Bending Moment	136.1	140	−2.8	Main Rebar
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	1022.2	1263.9	+23.6	

Bridge No. : 00161140
Bridge Type : SBB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBB	Buckle Plate	N/mm2	Bending Moment	190.6	142	34.2	
	Main Beam	N/mm2	Bending Moment	236.0	142	+66.2	
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN		2243.6	2526.6	+12.6	

Bridge No. : 00166510
Bridge Type : SBG/RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBG	Slab	N/mm2	Bending Moment	85.7	140	−38.8	Main Rebar
				72.2	140	−48.4	Distri. Rebar
	Box Girder	N/mm2	Bending Moment	80.0	142	−43.7	
RCB	Main Beam	N/mm2	Bending Moment	261.4	140	+86.7	Main Rebar
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Abut	KN	Reaction Force	1147.2	1232.9	+7.5	

Bridge No. : 00341800
Bridge Type : RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
RCB	Slab	N/mm2	Bending Moment	27.4	140	−80.4	Main Rebars
				22.3	140	−84.1	Distri. Rebars
	Beam	N/mm2	Bending Moment	130.5	140	−6.8	Main Rebars
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	1909.1	2166.9	+13.5	

Bridge No. : 00346740
Bridge Type : PCB

Identical with Bridge No. 319110 except total bridge length.

Bridge No. : 00520850
Bridge Type : SBE

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBE	Slab	N/mm2	Bending Moment	62.6	140	−55.3	Main Rebar
				55.8	140	−60.1	Distri. Rebar
	Main Beam	N/mm2	Bending Moment	131.0	142	−7.7	I−Beam
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Abut	KN	Reaction Force	6707.0	676.4	+0.8	

Bridge No. : 00546560
Bridge Type : RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
RCB	Slab	N/mm2	Bending Moment	74.4	140	−46.9	Main Rebars
				134.0	140	−4.3	Distri. Rebars
	Main Beam	N/mm2	Bending Moment	167.6	140	19.7	Main Rebar
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	797.8	911.8	+14.3	

Bridge No.	: 00237200
Bridge Type	: SBC/RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBC	Slab	N/mm2	Bending Moment	65.5	140	−53.2	Main Rebars
				102.6	140	−26.7	Distri. Rebars
	Main Beam	N/mm2	Bending Moment	145.0	142	+2.1	
RCB	Slab	N/mm2	Bending Moment	101.5	140	−27.5	Main Rebars
				51.3	140	−63.4	Distri. Rebars
	Beam	N/mm2	Bending Moment	102.0	140	−27.1	Main Rebars
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	1711.1	2061.0	+20.4	

Bridge No.	: 00317000
Bridge Type	: PCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
PCB	Slab	N/mm2	Bending Moment	147.6	210	−29.7	Main Rebar
				151.3	210	−28.0	Distri. Rebar
	Main Beam	N/mm2	Bending Moment	11.2	14.0	−20.0	Top Fibre <1
				4.1	>0.0	−	Bottom Fibre
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	5370.3	5638.8	+5.0	

Note <1 : The effective prestressing forceis taken from JKR DRG No. STD B06/III/C dated November 1978.

Bridge No.	: 00319110
Bridge Type	: PCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
PCB	Slab (15m span)	N/mm2	Bending Moment	64.4	140	−54.0	Main Rebar
				130.7	140	−6.6	Distri. Rebar
				HA A	LTAL B	Ratio (%) (B−A)/A	
	Main Beam	KN.m	Bending Moment	1083.1	1174.5	+8.4	15m span <1
				2059.9	1990.6	−3.4	30m span
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	2456.8	2710.4	+10.3	

Note : <1 The assessment made based on bending moment comparisons between HA and LTAL Loading.

Append−O

Bridge No.	: 00546980
Bridge Type	: RCS

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
RCS	Slab	N/mm2	Bending Moment	132.4	140	−5.4	Main Rebar
				334.3	140	+138.7	Distri. Rebar
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	3089.8	3379.8	+9.4	

Bridge No.	: 00563880
Bridge Type	: IT

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (B−A)/A	REMARKS
IT	Main Beam	KNm	Bending Moment	193.2	169.1	−12.4	<1
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	2642.2	2655.9	+0.5	

Note : <1 The assessment made based on bending moment comparisons between HA and LTAL loadings.

Bridge No.	: 00567840
Bridge Type	: PRB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
PRB	Main Beam	N/mm2	Bending Moment	119.2	140	−14.9	Main Rebar
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	1230.4	1531.2	+24.4	

Bridge No.	: 00834850
Bridge Type	: RCS

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
RCS	Slab	N/mm2	Bending Moment	101.1	140	−27.8	Main Rebar
				137.0	140	−2.1	Distri. Rebar
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	1265.8	1354.0	+7.0	

Bridge No.	: 05001070
Bridge Type	: SBB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBB	Buckle Plate			−	−	−	Similar to Bridge No. 161140
	Main Beam	N/mm2	Bending Moment	292.2	142	+105.8	
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Abut	KN	Reaction Force	789.2	851.4	+7.9	

Bridge No.	: 05803340
Bridge Type	: SBB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBB	Buckle Plate			−	−	−	Similar to Bridge No. 161140
	Main Beam	N/mm2	Bending Moment	171.3	142	+20.6	
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Abut	KN	Reaction Force	482.4	593.8	+18.8	

Bridge No.	: 05903120
Bridge Type	: SBC

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses A	Allowable Stresses B	Ratio (%) (A−B)/B	REMARKS
SBC	Slab	N/mm2	Bending Moment	127.9	140	−8.6	Main Rebar
				243.5	140	+73.9	Distri. Rebar
	Main Beam	N/mm2	Bending Moment	143.0	142	+0.7	
				Dead Load + HA A	Dead Load + LTAL B	Ratio (%) (B−A)/A	
	Pier	KN	Reaction Force	1555.0	1803.6	+16.0	

Bridge No.	: Dambai
Bridge Type	: SBC

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses	Allowable Stresses	Ratio (%)	REMARKS
				A	B	(A−B)/B	
SBC	Slab	N/mm2	Bending Moment	148.8	140	+6.3	Main Rebar
				115.3	140	−17.6	Distri. Rebar
	Main Beam	N/mm2	Bending Moment	191.0	142	+34.5	
				Dead Load + HA	Dead Load + LTAL	Ratio (%)	
				A	B	(B−A)/A	
	Pier	KN	Reaction Force	3546.4	3976.6	+12.1	

Bridge No.	: Samarahan
Bridge Type	: SBC / RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses	Allowable Stresses	Ratio (%)	REMARKS
				A	B	(A−B)/B	
SBC	Slab	N/mm2	Bending Moment	124.5	140	−11.1	Main Rebar
				279.9	140	+99.9	Distri. Rebar
	Main Beam	N/mm2	Bending Moment	205.0	165	+24.2	
RCB	Main Beam	N/mm2	Bending Moment	122.0	140	−12.8	Main Rebar
				Dead Load + HA	Dead Load + LTAL	Ratio (%)	
				A	B	(B−A)/A	
	Pier	KN	Reaction Force	4561.5	4597.8	+3.6	

Bridge No.	: 00371000
Bridge Type	: RCB

Bridge Type	Member	Unit	Type of Sectional Force	Working Stresses	Allowable Stresses	Ratio (%)	REMARKS
				A	B	(A−B)/B	
RCB	Slab	N/mm2	Bending Moment	89.0	140	−36.4	Main Rebar
				129.8	6140.0	−7.3	Distri. Rebar
				Dead Load + HA	Dead Load + LTAL	Ratio (%)	
				A	B	(B−A)/A	
	Main Beam	KN.m	Bending Moment	1944.9	1798.0	−7.6	
	Pier	KN	Reaction Force	5443.0	5393.8	−0.9	

APPENDIX – P

SUMMARY OF BRIDGE ASSESSMENT

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No. : 114920	District : Segamat	Bridge Type : RCB	Year Built : 1955	Bridge Length : 13.36 m	No's of Span : 2

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Rebar Exposure	- Beam soffit	- Inadequate cover	o Guniting all soffit of superstructure
- Spalling	- Web of beams	- Inadequate cover	
- Longitudinal crack	- Beam Soffit	- Inadequate cover	
- Rebar exposure and spalling	- Slab soffit	- Carbonation	
- Rebar exposure and wearing	- All piers	- Acid attack	- Concrete Lining
- Moss and water stain	- Beams	- Inadequate length of drainage pipe	- Extension of drainage pipes
(2) Loading Capacity Defect - None -			
(3) Functional Defect - None -			

Bridge No. : 161140	District : Kinta	Bridge Type : SBB	Year Built : 1950	Bridge Length : 19.76 m	No's of Span : 2

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Corrosion, paint deterioration and water stain	- All beams	- Water leak through buckle plate and lack of maintenance	o Removal of rust and repainting
- Corrosion, paint deterioration and water stain	- Buckle plate	- Water leak and lack of maintenance	
- Flaking of plaster	- Abutments	- Inferior quality mortar	o Concrete Lining to abutments
(2) Loading Capacity Defect			
- Inadequate	- Buckle plate	- Less rigidity of Slab →	o Replacement by R.C. Slab
- Inadequate	- Steel beam	- Less rigidity of Slab	o <1
(3) Functional Defect			
- Threat to Pedestrian	- Bridge width	- Too narrow and no sidewalk	o Adding side walk to both sides
(4) Hydraulic Defect			
- Scouring	- Pier	- Local scouring	o Installation of river bed protection (P1)
	- Abutment	- Local scouring	o Installation of slope protection (A1 & A2)

Note: <1 After replacement of buckle plate by R.C. Slab of which rehabilitation increases rigidity of the slab, all beams have adequate LTAL load carrying capacity because of effect of the lateral load distribution.

Bridge No.: 166510	District : Larut Matang	Bridge Type :SBG&RCB	Year Built : 1935	Bridge Length : 10.1 m	No's of Span : 1

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Corrosion, paint deterioration	- Steel box girder	- Lack of maintenance	o Repainting
- Water Stain	- Steel box girder	- Water leak through joints and slab crack	o Replacement of expansion joint
- Wide flacking	- RCB	- Inferior concrete	o Patching
- Flacking, Free lime	- Slab soffit	- Advanced carbonation	o Guniting of slab soffit
- Open cracks	- Abutments	- Differential settlement due to local scouring	o Replacement of Abutment by installation of new abutment (Rigid Frame Type)
(2) Loading Capacity Defect			
- Inadequate	- R.C. Beam		o Steel plate bonding at beam soffit
(3) Functional Defect			
- Threat to pedesterian	- Bridge width	- Too narrow and no sidewalk	o Adding sidewalk.
(4) Hydraulic Defect			
- Decreasing bridge opening	- Bridge Opening	- Sedimentation	o Widening river channel with slope protection
- Local scouring and river bank erosion (Right side)	- Chanel	- Bridge is located at bight of river	o Changing channel alignment by installation of river bank with revetment

Recommendation: It seems like the work listed above beyond economic rehabilation. Thus alternative study is required to select economical optimum rehabilation plan including possible possible replacement of bridges.

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No. : 237200	District : Kuantan	Bridge Type:RCB&SBC	Year Built : 1960	Bridge Length : 27.9 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Longitudinal crack	- Piers (1 & 2)	- Inadequate concrete cover and chloride attack	o Concrete Lining
- Honey comb & spalling	- Deck slab soffit	- Poor workmanship	o Patching
- Water stain & sedimentation	- Bridge Seats	- Defective expansion joint	o Replacement of expansion joint
- Paint deterioration	- Steel beams	- Deterioration	o Repainting
- Corrosion & water stain	- Steel beams	- Inadequate length of drainage pipe	o Extension of drainage pipe
(2) Loading Capacity			
- None -			
(3) Functional Defect			
- None -			
(4) Hydraulic Defect			
- Slope failure	- Abutment	- Insufficient footing depth	o Reconstruction of slope protection around both abutments

Bridge No. : 317000	District : Rompin	Bridge Type : PCB	Year Built : 1974	Bridge Length : 398.35 m	No's of Span : 9

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Spalling & Honey Comb	- Cross Beams, Main Beams, Soffit of Deck Slab	- Poor workmanship, boat collision	o Patching
- Rebar and PC Cable exposure	- Cross beams, Main Beams of Span 1 & 9	- Submarged and chloride attack	o Raising of Grade
- Water stain	- Bridge seat	- Defective expansion joint	o Replacement of expansion joints
(2) Loading Capacity Defect			
- None -			
(3) Functional Defect			
- None -			
(4) Hydraulic Defect			
- Submergence	- Beams of Span 1 & 9	- Inadequate bridge clearance at both end spans	o Raising of Grade
- Washed way	- Foot protection of Endau side	- Local scouring →	o Installation of foot protection
- Vertical cracks	- Concrete wall at Endau side	- Settlement due to local scouring →	(o Installation of foot protection)

Note: Alternative study is required to select an optimum rehabilitation plan of raising grade.

Bridge No. : 319110	District : Rompin	Bridge Type : PCB	Year Built : 1962	Bridge Length : 131.62 m	No's of Span : 7

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Vertical crack	- PC Beams of Span 4	- Shrinkage Cracks	o Injection and protective coating
- Vertical crack	- PC Beams of Span 1, 5	- Bending Cracks →	(o Steel plate bonding to 2 girder type bridge)
- Alligator cracks	- Pier cap (All piers)	- Alkali – Aggregate Reaction	o Injection and Protective coating
- Longitudinal cracks	- Almost all piles	- Inadequate cover or AAR	o Concrete Lining
- Water stain and Moss	- Beam webs	- Leaking water through defective expansion joints	o Replacement of expansion joint
- Water stain and moss	- Beam webs	- Inadequate length of drainage pipe	o Extension of all drainage pipes
			o Provision of water drop
(2) Loading Capacity Defect			
- Inadequate capacity for B.M.	- Main beams of 2 girder type bridge	- Concentration of live load →	o Steel plate bonding to 2 girder type bridge
(3) Functional Defect			
- None -			
(4) Hydraulic Defect			
- None -			

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No. : 341800	District : Kemaman	Bridge Type : RCB	Year Built : 1955	Bridge Length : 36.27 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Honey comb and flaking	- Beams & Slab	- Poor workmanship	o Patching to all the defective portion
- Longitudinal crack and rebar exposure	- Cross head and piles	- Inadequate concrete cover and cholide attack	o Total concrete lining
- Water stain	- Beams end	- Water leak through defective expansion joint	o Installation of expansion joint
(2) Loading Capacity Defect - None -			
(3) Functional Defect			
- Threat to pedesterian	- Bridge width	Too Narrow and no side walk	o Adding side walk at both sides
(4) Hydraulic Defect			
- Protection failure .	- Slope protection	o Insufficient depth of foundation	o Reconstruction of slope protection at both abutments

Bridge No. : 346740	District : Dungun	Bridge Type : PCB	Year Built : 1973	Bridge Length : 152.5 m	No's of Span : 9

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Vertical crack (<0.2 mm)	- All beams	- Shrinkage on the surface	o Protective coating
- Honey comb, rebar exposure and spalling	- Beam soffit (Span 9), Cross beam pile head	- Poor workmanship and inadequate concrete cover	o Patching
- Water Stain and moss	- Beam web	- Inadequate length of drainage pipe	o Extension of drainage pipe o Installation of water drop at cantilever slab
(2) Loading Capacity Defect			
- Inadequate capacity for B.M.	- Main beams of 2 girder type	- Concentration of live load	o Steel plate bonding to 2 girder type bridge
(3) Functional Defect - None -			
(4) Hydraulic Defect			
- Inadequate free board		- Inadequate bridge opening	o Excavation of both side banks and construction of slope protection
- Local scouring	- Pier 5 & 6	- Bridge is located at natural construction	o Installation of river bed protection
- Right bank erosion	- Upstream	- Meandering river	o Installation of spur dikes

Bridge No. : 520850	District : Jasin	Bridge Type : SBE	Year Built : 1950	Bridge Length : 3.7 m	No's of Span : 1

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Rebar exposure and spalling	- Deck Slab Soffit	- Carbonation	o Guniting of slab soffit
- Rebar exposure and flaking	- Encased steel beams	- Corrosion of bottom flange and rebar due to carbonation	o Patching to all defective portion o Coating to beam surface
- Plaster drop off	- Abutments	- Inferior mortar or inadequate bonding	o Partial lining to abutments
(2) Loading Capacity Defect - None -			
(3) Functional Defect - None -			
(4) Hydraulic Defect - None -			

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No.: 546560	District : K. Selangor	Bridge Type : RCB	Year Built : 1939	Bridge Length : 6.3 m	No's of Span : 1

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Rebar Exposure, wear and flaking	- All beams	- Abrasion due to water flow	o Prepacked concrete lining with additional rebar
- Flaking and Rebar Exposure	- Slab soffit	- Abrasion due to water flow	o Patching
(2) Loading Capacity Defect			
- Inadequate	- Beams	- Section loss	
(3) Functional Defect - None -			
(4) Hydraulic Defect			
- Submerged beams		- Inadequate bridge opening	o <1

Note: <1 Dredging and revetment work of the channel are being carried out by DID. Thus raising of grade or extention of bridge length to increase the bridge opening is not required.

Bridge No.: 546980	District : K. Selangor	Bridge Type : RCS	Year Built : 1969	Bridge Length : 32.91 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Honey comb, flaking and wear	- Slab soffit	- Poor workmanship	o Patching
- Water stain	- Slab soffit	- Inadequate design - Defective expansion joints	o Provision of water drop o Replacement of expansion joint
- Longitudinal cracks and flaking	- Pile and cross head	- Inadequate concrete cover and chloride attack	o Total concrete lining
(2) Loading Capacity Defect			
- Inadequate	- Slab	- Inadequate amount of distribution rebar	o Steel plate bonding at slab soffit along longitudinal wide crack
- Tilted abutment	- Both abutments	- Consolidation settlement and lateral soil movement	o Construction of rigid flame type abutments
(3) Functional Defect - None -			
(4) Hydraulic Defect - None -			

Bridge No. : 563380	District : Manjung	Bridge Type : IT	Year Built : 1972	Bridge Length : 47.5 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Longitudinal crack	- Piles of Pier 1 & 2	- Inadequate cover and chloride attack	o Concrete lining to piles
- Flaking and crack	- Pier crosshead and abutment	- Poor workmanship, collision of debris	o Patching
- Water stain	- Slab end	- Water leak through defective expansion joints	o Replacement of expansion joints
- Water stain and moss	- Cantilever slab	- Missing water drop	o Installation of water drop
(2) Loading Capacity Defect - None -			
(3) Functional Defect - None -			
(4) Hydraulic Defect - None -			

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No. : 567640	District : Kinta	Bridge Type : PRB	Year Built : 1960	Bridge Length : 12.44 m	No's of Span : 2

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Water stain	- Slab soffit	- Inferior joint between beams	o Provision of water proof layer on top of slab
- Flacking and Honey Comb	- Abutment & Pier	- Poor workmanship or inferior concrete	o Patching of all flaking and honey comb area
(2) Loading Capacity Defect - None -			
(3) Functional Defect			
- Inadequate Traffic Capacity	- Width	- Too narrow	o Widening of Cariageway
(4) Hydraulic Defect - None -			

Bridge No. : 834850	District : Kuala Krai	Bridge Type : RCS	Year Built : 1960	Bridge Length : 12.8 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Crack, spalling, honey comb, flaking and rebar exposure	o Slab soffit	o Inferior concrete, poor workmanship and inadequate concrete cover	o Prepacked concrete lining with rebar (Distribution bar only) o Installation of water proof layer on top of the concrete slab
- Flaking, Rebar Exposure cracks	o Crosshead, pier and abutment	o Inferior concrete and poor workmanship	o Patching to all of defective area
(2) Loading Capacity Defect - None -			
(3) Functional Defect - None -			
(4) Hydraulic Defect - None -			

Bridge No. : 5001070	District : Batu Pahat	Bridge Type : SBB	Year Built : 1919	Bridge Length : 5.25 m	No's of Span : 1

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
- Corrosion, paint deterioration and water stain	- All beams	- Water leak through buckle plate and lack of maintenance	o Removal of Rust and Repainting
- Corosion and paint deterioration	- Buckle plate	- Water leak and lack of maintenance	
- Loss of concrete matrix	- Surface of abutment	- Inferior concrete and acid attack	o Partial concrete lining
(2) Loading Capacity Defect			
- Inadequate	- Buckle plate	- Less rigidity of slab & beam	o Replacement by R.C. slab
- Inadequate	- Steel beam	- Less rigidity of slab & beam	o <1
(3) Functional Defect - None -			
(4) Hydraulic Defect - None -			

Note: <1 After replacement of buckle plate by R.C. slab of which rehabilitation increases rigidity of the slab, all beams have adequate LTAL load carrying capacity because of effect of the lateral load distribution and composite effect.

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No. : 5503340	District : Btg. Padang	Bridge Type : SBB	Year Built : 1950	Bridge Length : 5.35 m	No's of Span : 1

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
– Paint deterioration, corrosion and water stain	– All main beams	– Water leak through slab and joint	o Repainting
– Paint deterioration, corrosion	– Buckle Plate	– Water leak through slab	
– Abrasion	– All piles	– Inferior concrete	o Concrete lining
(2) Loading Capacity Defect			
– Inadequate	– Steel beam	– Less rigidity of slab	o <1
– Inadequate	– Buckle plate	– Less rigidity of slab & beam	o Replacement by R.C. Slab
(3) Functional Defect – None –			
(4) Hydraulic Defect – None –			

Note: After replacement of Buckle Plate by R.C. slab of which rehabilitation increase rigidity of the slab, all beams have adequate LTAL load carrying capacity because of effect of the lateral load distribution considered.

Bridge No. : 5903120	District : Btg. Padang	Bridge Type : SBC	Year Built : 1950	Bridge Length : 24.0 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
– Corrosion, paint deterioration and water stain	– All beams	– Water leak through joint, lack of maintenance	o Repainting o Installation of expansion joint
– Spalling, exposed rebar	– Deck slabs of 3 spans	– Inadequate concrete cover – Carbonation – Differential deflection of main beams due to skew effect	o Concrete lining by guniting with additional rebars
(2) Loading Capacity Defect			
– Inadequate	– Deck slab	– Inadequate rebars	o Provision of cross beams at central span
(3) Functional Defect – None –			
(4) Hydraulic Defect – None –			

Bridge No.: Dambai	State : Sabah	Bridge Type : SBC	Year Built : 1964	Bridge Length : 02.7 m	No's of Span : 3

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect			
– Corrosion, paint deterioration Water stain	– All beams	– Water leak and lack of maintenance	o Repainting
– Wide longitudinal crack	– Slab joint	– Improper design	
– Rebar exposure, flaking	– Slab soffit	– Carbonation	
– Water leak	– Expansion joint	– Defective joint	o Replacement of expansion joints
– Corrosion, paint deterioration	– Pier column	– Abrasion and lack of maintenance	o Concrete protection lining to steel pier columns
(2) Loading Capacity Defect			
– Extremely inadequate	– All beams	– Inadequate section modulus	o Installation of additional beams
– Inadequate	– Deck Slab	– Inadequate amount of rebar	o Replacement by R.C. Slab
(3) Functional Defect – None –			
(4) Hydraulic Defect			
– Erosion	– Right side river bank	– Bridge location at bight of river	o Construction of slope protection and revetment at right side bank (up-stream)

APPENDIX-P SUMMARY OF BRIDGE ASSESSMENT

Bridge No:Samarahan	State : Sarawak	Bridge Type : SBC	Year Built : 1965	Bridge Length : 71.58 m	No's of Span : 5

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect – Lateral cracks	– Slab soffit	– Inadequate distribution rebar	o Epoxy injection to slab soffit
(2) Loading Capacity Defect – Inadequate – Inadequate	– Deck slab – Steel beam	– Inadequate distribution rebar – Inadequate section modulus	o Bonding steel plate o Attachment of steel plate by high tension bolt
(3) Functional Defect – None –			
(4) Hydraulic Defect – None –			

Bridge No. : 371000	District : Kota Bahru	Bridge Type : RCB	Year Built : 1962	Bridge Length : 840.0 m	No's of Span : 29

Defect	Member	Cause	Selected Rehabilitation Plan
(1) Deterioration Defect – Vertical cracks – Spalling & Flaking	– Beam web of all spans – Cross beam of span 29	– Shrinkage Crack – Poor workmanship	o Epoxy injection o Patching
(2) Loading Capacity Defect – None –			
(3) Functional Defect – None –			
(4) Hydraulic Defect – Slope protection (Tanah Merah Side) failure	– Revetment	– Local scouring	o Reconstruction of slope protection and revetment with foot protection (Tanah Merah Side)

APPENDIX – Q

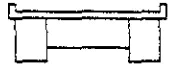
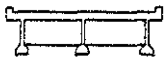
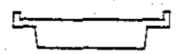
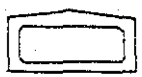
SUMMARY OF BRIDGE REHABILITATION PLAN COVERING 216 STUDY BRIDGES

ABBREVIATIONS AND CODES (1)

BRIDGE TYPE	MEMBER CODE	TYPE OF DAMAGE			CONCEIVABLE REHABILITATION PLAN			POSSIBLE REHABILITATION PLAN		
		Bridge Component Part	Type of Damage	Input Codes	Main Bridge Component	Conceivable Rehabilitation Plan	Input Code	Main Bridge Component	Possible Rehabilitation Plan	Input Code
– SBB Steel Beam		Steel Beam /	Corrosion	(1)	Steel Beam /	Protection	SBPR	Steel Beam /	Protection	SBPR
Buckle Plate	Ms – Steel Girder	Girder	Crack	(2)	Girder	Reinforcement	SBRF	Girder	Reinforcement	SBRF
			Falling Off	(4)		Replacement	SBRP		Replacement	SBRP
	Mc – Concrete Girder		Rupture	(5)						
			Abnormal Noise	(23)						
– SBC Steel Box	Cs – Steel Cross Beam		Abnormal Vibration	(24)	Concrete Beam /	Protection	CBPR	Concrete Beam /	Protection	CBPR
R.C Slab			Abnormal Deflection	(25)	Girder	Reinforcement	CBRF	Girder	Reinforcement	CBRF
	Cc – Concrete Cross		Deformation	(26)		Replacement	CBRP		Replacement	CBRP
	Beam	Concrete Beam /	Crack	(7)						
		Girder	Flaking/Rebar Exposure	(8)						
– SBG Steel Box	Ss – Steel Stringer		Free Lime	(9)	Steel Deck Slab	Protection	DSPR	Steel Deck Slab	Protection	DSPR
Girder			Water Leak	(22)		Reinforcement	DSRF		Reinforcement	DSRF
	Sc – Concrete Stringer		Abnormal Vibration	(24)		Replacement	DSRP		Replacement	DSRP
			Defect	(32)						
	Sw – Sway Bracing	Steel Deck Slab	Corrosion	(1)						
– SBE Encased			Crack	(7)	Concrete Deck	Protection	DCPR	Concrete Deck	Protection	DCPR
Steel Beam	Lb – Lateral Bracing		Falling Off	(4)	Slab	Reinforcement	DCRF	Slab	Reinforcement	DCRF
			Rupture	(5)		Replacement	DCRP		Replacement	DCRP
	Ds – Buckle Plate		Deformation	(26)						
		Concrete Deck	Crack	(7)						
	Dc – Concrete Deck	Slab	Flaking/Rebar Exposure	(8)	Bearing	Protection	BPR	Bearing	Protection	BPR
– PCB Prestressed			Free Lime	(9)		Reinforcement	BRS		Reinforcement	BRS
Concrete Beam	Bs – Steel Bearing		Sliping Off	(12)		Replacement	BRP		Replacement	BRP
			Water Leak	(22)						
	Br – Rubber Bearing	Bearing	Corrosion	(1)						
			Falling Off	(4)	Abut–(Concrete)	Protection	APR	Abut–(Concrete)	Protection	APR
	Sa – Anchor Bolt		Rupture	(5)		Reinforcement	ARF		Reinforcement	ARF
– IT Pretensioned			Deformation	(26)	– (Foundation)	Protection	AFPR	– (Foundation)	Protection	AFPR
Inverted	As – Steel Abut Body		Settlement	(28)		Reinforcement	AFRF		Reinforcement	AFRF
T–Beam			Defect	(32)						
	Ac – Concrete Abut Body	Abutment / Pier –	Crack	(7)						
		(Correction)	Flaking/Rebar Exposure	(8)	Pier–(Concrete)	Protection	PPR	Pier–(Concrete)	Protection	PPR
	Ps – Steel Pier Body		Free Lime	(9)		Reinforcement	PRF		Reinforcement	PRF
– RCB Reinforced			Wear/Erosion	(11)	– (Foundation)	Protection	PFPR	– (Foundation)	Protection	PFPR
Concrete	Pc – Concrete Pier Body		Settlement	(28)		Reinforcement	PFRF		Reinforcement	PFRF
Beam			Abnormal Movement	(29)						
	Fs – Steel Foundation		Scouring	(31)						
			Defect	(32)	Surfacing	Restoration	SFRS	New Construction	Widening	WING
	Fc – Concrete Foundation	Pier – (Steel)	Corrosion	(1)		Reinforcement	SFRF		Adding Sidewalk	ASW
– RCS Reinforced			Rupture	(5)					Raising of Grade	RG
Concrete	Rs – Steel Railing		Settlement	(28)						
Slab			Scouring	(31)	Expansion Joints	Protection	EJPR			
	Rc – Concrete Railing	Surfacing	Difference in Level	(16)	Concrete	Reinforcement	EJRS			
			Pot–Hole	(17)		Replacement	EJRP			
	Pa – Asphalt Pavement		Paving Crack	(18)						
– PRB Precast			Rutting	(19)						
Reinforced	Pp – Concrete Pavement	Expansion Joint	Corrosion	(1)	Steel Railing	Protection	SRPR			
Concrete			Rupture	(5)		Reinforcement	SRRF			
Beam	Js – Steel Joint		Difference in Level	(16)		Replacement	SRRE			
			Water Leak	(22)						
	Jr – Rubber Joint		Abnormal Noise	(23)						
– BOX Concrete Box			Deformation	(26)	Concrete Railing	Protection	CRPR			
Culvert	Dr – Drainage	Steel Railing	Corrosion	(1)		Reinforcement	CRRF			
			Crack	(7)		Replacement	CRRP			
	Rb – River Bank		Rupture	(5)						
	Protection		Crack (Deck)							
– PBX Prestressed			Deformation	(26)	Bank Slope	Protection	BSPR			
Concrete		Concrete Railing	Crack	(7)						
Box Girder	Ww – Wing Wall		Flaking/Rebar Exposure	(8)						
			Free Lime	(9)	New Construction	Widening	WING			
			Defect	(32)		Adding Sidewalk	ASW			
		Bank Slope	Scouring	(31)		Raising of Grade	RG			

ABBREVIATION AND CODES (1)

BRIDGE TYPE

	Bridge Type	
- SBB	Steel Beam Buckle Plate	
- SBC	Steel Box R.C Slab	
- SBG	Steel Box Girder	
- SBE	Encased Steel Beam	
- PCB	Prestressed Concrete Beam	
- IT	Pretensioned Inverted T-Beam	
- RCS	Reinforced Concrete Beam	
- RCS	Reinforced Concrete Slab	
- PRB	Precast Reinforced Concrete Beam	
- BOX	Concrete Box Culvert	
- PBX	Prestressed Concrete Box Girder	

MEMBER CODE

Ms	- Steel Girder
Mc	- Concrete Girder
Cs	- Steel Cross Beam
Cc	- Concrete Cross Beam
Ss	- Steel Stringer
Sc	- Concrete Stringer
Sw	- Sway Bracing
Lb	- Lateral Bracing
Ds	- Buckle Plate
Dc	- Concrete Deck
Bs	- Steel Bearing
Br	- Rubber Bearing
Ba	- Anchor Bolt
As	- Steel Abut Body
Ac	- Concrete Abut Body
Ps	- Steel Pier Body
Pc	- Concrete Pier Body
Fs	- Steel Foundation
Fc	- Concrete Foundation
Rs	- Steel Railing
Rc	- Concrete Railing
Ps	- Asphalt Pavement
Pp	- Concrete Pavement
Js	- Steel Joint
Jr	- Rubber Joint
Dr	- Drainage
Rb	- River Bank Protection
Ww	- Wing Wall

TYPE OF DAMAGE

Bridge Component Part	Type of Damage	Input Codes
Steel Beam / Girder	Corrosion	(1)
	Crack	(2)
	Falling Off	(4)
	Rupture	(5)
	Abnormal Noise	(23)
	Abnormal Vibration	(24)
	Abnormal Deflection	(25)
	Deformation	(26)
Concrete Beam / Girder	Crack	(7)
	Flaking/Rebar Exposure	(8)
	Free Lime	(9)
	Water Leak	(22)
	Abnormal Vibration	(24)
	Defect	(32)
Steel Deck Slab	Corrosion	(1)
	Crack	(7)
	Falling Off	(4)
	Rupture	(5)
	Deformation	(26)
Concrete Deck Slab	Crack	(7)
	Flaking/Rebar Exposure	(8)
	Free Lime	(9)
	Sliding Off	(12)
	Water Leak	(22)
Bearing	Corrosion	(1)
	Falling Off	(4)
	Rupture	(5)
	Deformation	(26)
	Settlement	(28)
	Defect	(32)
Abutment / Pier - (Correction)	Crack	(7)
	Flaking/Rebar Exposure	(8)
	Free Lime	(9)
	Wear/Erosion	(11)
	Settlement	(28)
	Abnormal Movement	(29)
	Scouring	(31)
	Defect	(32)
Pier - (Steel)	Corrosion	(1)
	Rupture	(5)
	Settlement	(28)
	Scouring	(31)
Surfacing	Difference in Level	(16)
	Pot-Hole	(17)
	Paving Crack	(18)
	Rutting	(19)
Expansion Joint	Corrosion	(1)
	Rupture	(5)
	Difference in Level	(16)
	Water Leak	(22)
	Abnormal Noise	(23)
	Deformation	(26)
Steel Railing	Corrosion	(1)
	Crack	(7)
	Rupture	(5)
	Crack (Deck)	
	Deformation	(26)
Concrete Railing	Crack	(7)
	Flaking/Rebar Exposure	(8)
	Free Lime	(9)
	Defect	(32)
Bank Slope	Scouring	(31)

CONCEIVABLE REHABILITATION PLAN

Main Bridge Component	Conceivable Rehabilitation Plan	Input Code
Steel Beam / Girder	Protection	SBPR
	Reinforcement	SBRF
	Replacement	SBRP
Concrete Beam / Girder	Protection	CBPR
	Reinforcement	CBRF
	Replacement	CBRP
Steel Deck Slab	Protection	DSPR
	Reinforcement	DSRF
	Replacement	DSRP
Concrete Deck Slab	Protection	DCPR
	Reinforcement	DCRF
	Replacement	DCRP
Bearing	Protection	BPR
	Reinforcement	BRS
	Replacement	BRP
Abut-(Concrete)	Protection	APR
	Reinforcement	ARF
- (Foundation)	Protection	AFPR
	Reinforcement	AFRF
Pier-(Concrete)	Protection	PPR
	Reinforcement	PRF
- (Foundation)	Protection	PFPR
	Reinforcement	PFRF
Surfacing	Restoration	SFRS
	Reinforcement	SFRF
Expansion Joints Concrete	Protection	EJPR
	Reinforcement	EJRS
	Replacement	EJRP
Steel Railing	Protection	SRPR
	Reinforcement	SRRF
	Replacement	SRRE
Concrete Railing	Protection	CRPR
	Reinforcement	CRRF
	Replacement	CRRP
Bank Slope	Protection	RTPR
New Construction	Widening	WING
	Adding Sidewalk	ASW
	Raising of Grade	RG

POSSIBLE REHABILITATION PLAN

Main Bridge Component	Possible Rehabilitation Plan	Input Code
Steel Beam / Girder	Protection	SBPR
	Reinforcement	SBRF
	Replacement	SBRP
Concrete Beam / Girder	Protection	CBPR
	Reinforcement	CBRF
	Replacement	CBRP
Steel Deck Slab	Protection	DSPR
	Reinforcement	DSRF
	Replacement	DSRP
Concrete Deck Slab	Protection	DCPR
	Reinforcement	DCRF
	Replacement	DCRP
Bearing	Protection	BPR
	Reinforcement	BRS
	Replacement	BRP
Abut-(Concrete)	Protection	APR
	Reinforcement	ARF
- (Foundation)	Protection	AFPR
	Reinforcement	AFRF
Pier-(Concrete)	Protection	PPR
	Reinforcement	PRF
- (Foundation)	Protection	PFPR
	Reinforcement	PFRF
New Construction	Widening	WING
	Adding Sidewalk	ASW
	Raising of Grade	RG

APPENDIX－Q SUMMARY OF BRIDGE REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bearing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
00102590	Johor	Johor Bahru	1955	3	STAL	1.8	2	3.6	BOX	4	2			4	3.3	DCPR－WPL (33sq.m), DCPR－PAT (0.2sq.m), APR－PAT (WWRS) (0.6sq.m), APR－INJ (1m), APR－PAT (WWRS) (0.7sq.m), PPR－PAT (0.2sq.m), SCFD (36sq.m)	
00108100	Johor	Kluang	1954	3	STAL	15.9	3	27.4	RCB	4	4	1	4	1	3.0	CBPR－PAT (1.9sq.m), CBPR－SHT (9.2sq.m), CBPR－COT (127sq.m), PFPR－RBP (20sq.m), APR－INJ (WWPR) (5.4m) CRRF (54.8m), EJIN (16m), SCFD (274sq.m)	
00108990	Johor	Kluang	1937	3	MTAL	2.2	1	2.2	BOX	3				1	2.1	DCPR－PAT (0.1sq.m), APR－PAT (9sq.m), SFRS (21sq.m), SCFD (21.8sq.m)	
00112630	Johor	Batu Pahat	1960	3	STAL	6.3	1	6.3	RCS	1				3	1.9	CBPR－PAT (2.4sq.m), WWRP (4cu.m), CRRE (12.5m), EJIN (15m), SFRS (21sq.m), DRRS (4no), SCFD (62.7sq.m)	
00113760	Johor	Segamat	1955	3	STAL	6.8	3	20.3	RCB	1	1		3	3	1.9	CBPR－PAT (0.6sq.m), DCPR－PAT (1.6sq.m), APR－PAT (WWPR) (0.5sq.m), SRRF (24m), EJIN (7m), SCFD (203.4sq.m)	ADD－IS(81sq.m)
00114920	Johor	Segamat	1955	3	STAL	6.4	2	12.9	RCB	1	3		3	1	2.1	Included detailed survey	
00116580	Johor	Segamat	1947	3	STAL	2.4	2	4.9	BOX	3	1			3	2.3	DCPR－PAT (0.1sq.m), ARF－PAL (15.2sq.m), CFDM (H=1.0 2no), SCFD (48.6sq.m)	
00121260	Johor	Segamat	1955	3	STAL	2.4	1	2.4	BOX							Brigde has been replaced	
00121280	Johor	Segamat	1950	3	STAL	2.8	1	2.8	BOX							Bridge has been replaced	
00125250	N. Sembilan	Tampin	1940	3	P/A	6.7	1	6.7	RCB	1			3	4	2.6	CBPR－INJ (0.5m), DCPR－PAT (0.3sq.m), SRRE (13.4m), SCFD (67sq.m)	
00128254	N.Sembilan	Rembau	1930	2	SSAL	9.6	1	9.6	SBC	2		4	3	1	2.5	SBPR－REP (48.9sq.m), EJIN (17.3m), CRRF(19.2m) BPR－REP (8no), SCFD (95.8sq.m)	
00145100	Selangor	U.Selangor	1935	3	MTAL	1.9	1	1.9	SBE	1			1	4	1.9	SFRS (2.3sq.m), DCPR－PAT (4.2sq.m), SCFD (18.5sq.m)	
00146800	Selangor	Ulu Selangor	1965	3	STAL	12.1	3	25.9	IT	4	1		4	1	2.6	CBPR－INJ (0.5m), DCPR－WPL (178sq.m), APR－INJ (2.5m), AFPR－REV (41sq.m), SFRS (2.3sq.m), EJIN (11m), SCFD (259.1sq.m)	
00148800	Perak	Btg Padang	1962	3	MTAL	2.4	1	2.4	BOX	1				4	2.3	DCPR－PAT (6.1sq.m), SCFD (24sq.m)	
00149820	Perak	Btg. Padang	1963	3	STAL	12.1	3	36.2	IT	4	1		4	1	2.6	DCPR－WPL (104sq.m), APR－INJ (M) (0.6m), SRRF (3m), CRRF (72.5m), SFRS (0.1sq.m), EJIN (11m)	
00151360	Perak	Btg. Padang	1960	3	STAL	9.1	7	63.6	RCB	1	1	1	3	1	1.4	SRRF (17m), CRRF (127.1m), EJIN (63.7m), SFRS (1sq.m)	
00155590	Perak	Kinta	1970	3	STAL	1.8	2	3.6	BOX	1	1			4	1.9	DCRF－LIG (75sq.m), ARF－PAL (40sq.m), PRF－PAL (40sq.m), CFDM (2no), CFDM (H=1.0 1no), SCFD(36.2sq.m)	
00159100	Perak	Kinta	1948	3	SSAL	11.5	3	31.3	SBB	4	3		4	4	3.7	Bridge has been replaced	
00161140	Perak	Kinta	1950	3	STAL	9.8	2	19.1	SBB	4	3		4	3	3.5	Included detailed survey	
00161290	Perak	Kinta	1955	3	STAL	8.1	2	16.2	SBB	1	3		4	3	2.7	SBPR－REP (273sq.m), DSRP－TOR (156sq.m), AFPR－REV (41sq.m), BRP－TOR (S) (36), DETOUR (56.2m)	ADD－IS(67sq.m)
00166220	Perak	Larut Mtg	1945	2	SSAL	5.7	1	5.7	SBB	4			4	4	4	SBPR－REP (53sq.m), DSRP－TOR (54sq.m), ARF－TOL (13.2sq.m) BRP－TOR (S) (14), CFDM (H=1.0 2no), DETOUR (45.7m)	
00166510	Perak	L.Matang	1935	3	STAL	10.7	1	10.7	SBG	3			4	4	3.6	Replace the bridge with Inverted T beam bridge 195sq.m	
00184400	Kedah	Kota Setar	1950	6	SSAL	2.6	2	12.2	RCB	4			4	3	3.7	CBRF－BSP (25.4sq.m), DCPR－WPL (176sq.m), ARF－TOL (16m), EJIN (27.7m), ASIN (2), SRPR (24.4m), CFDM (H=1.0 2no), SCFD (122sq.m)	
00184900	Kedah	Kota Setar	1950	3	STAL	5.2	1	5.2	RCS	4				4	4.0	DCRF－SWR (30sq.m), ARF－PAL (27sq.m), SRPR (10.4m), SFRS (15sq.m), DCPR－WPL (44sq.m), CFDM (H=1.0 2no), SCFD (52sq.m)	
00184960	Kedah	Kota Setar	1950	3	STAL	4.6	1	4.6	RCS	2				1	1.6	SRPR (9.3m), EJIN (14m), ASIN (2)	
00186210	Kedah	Kota Setar	1940	3	SSAL	3.2	1	3.2	SBB	1			4	3	2.6	SBPR－REP (25sq.m), DSRP－TOR (22sq.m), APR－INJ (6m), BRP－TOR (S) (16), DETOUR (43.2 m)	
00228540	Pahang	Maran	1955	2	SSAL	6.3	1	6.3	SBB	1			4	4	2.9	SBPR－REP (7.6sq.m), DSRP－TOR (57.1sq.m), BRP－TOR (S) (14no) DETOUR (46.3m)	
00228970	Pahang	Maran	1965	3	STAL	3.0	1	3.0	BOX	3				3	3.0	DCPR－SHT (62sq.m), APR－PAL (83sq.m), CFDM (H=1.0 2no), SCFD (30.3sq.m)	
00230850	Pahang	Kuantan	1967	3	STAL	6.4	1	6.4	PRB	4			3	1	2.8	DCPR－WPL (43.4sq.m), ARF－SP (7.8m), EJPR (15.6m), SRRE (12.8m), SFRS (6sq.m), WWRS (6cu.m)	

APPENDIX-Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
00231790	Pahang	Kuantan	1960	1	SSAL	7.8	1	7.8	RCB	1				1	1.0	– No defect detected –	
00232880	Pahang	Kuantan	1963	3	STAL	11.1	1	11.1	PRB	4			3		3.5	DCPR–WPL (76.4sq.m), ARF–TOR (32m), ARF–SP (29.4m), EJPR (19no), CFDM (H=1.0 2no)	
00237200	Pahang	Kuantan	1960	3	STAL	8.9	3	26.7	SBC	4	4		4	1	3.4	Included detailed survey	
00303220	Johor	Kota Tinggi	1940	3	P/A	4.8	1	4.8	SBE	3			4	1	2.8	CBPR–PAT (2.5sq.m), SBPR–REP (3.6sq.m), ARF–PAL (WWRS) (40sq.m), SRRE (15m), PFPR (40sq.m), CFDM (H=1.0 2no), SCFD (48.4sq.m)	
00303430	Johor	K.Tinggi	1940	3	STAL	4.9	1	4.9	SBC	3			4	4	3.6	SBPR–REP (42sq.m), DCPR–PAT (5sq.m), DCPR–WPL (47sq.m) ARF–PAL (44sq.m), AFPR–FPO (72sq.m), CFDM (H=1.0 2no), SCFD (49sq.m)	
00303890	Johor	Kota Tinggi	1940	3	P/A	4.6	2	9.2	RCS	4	1			1	2.1	DCPR–PAT (0.1sq.m), DCPR–WPL (60.6sq.m), ARF–PAL (14m), SRRE (19m), CFDM (H=1.0 2no), SCFD (91.6sq.m)	ADD–IS(38sq.m)
00304060	Johor	K.Tinggi	1963	3	STAL	36.7	5	92.3	RCS	1	1			3	1.6	DCPR–INJ (27m), DCPR–PAT (3.2sq.m), SFRS (644.8sq.m) EJPR (30m), ASIN (2 no), SCFD (922.5)	
00304390	Johor	Kota Tinggi	1928	3	STAL	3.4	1	3.4	SBC	3			4	1	2.8	SBPR–REP (32sq.m), ARF–PAL (60sq.m), RTPR (16sq.m), CFDM (H=1.0 2no), SCFD (33.5sq.m), DETOUR (43.4m)	RING–SUP (38.9sq.m)
00306390	Johor	K.Tinggi	1974	3	STAL	16.6	5	64.6	IT	1	1		4	1	1.8	CBPR–PAT (0.4sq.m), DCPR–WPL (466.3sq.m), EJRP (45.4m), SCFD (645.7sq.m)	
00306710	Johor	Kota Tinggi	1969	3	STAL	18.9	7	52.0	IT	1	1	1	3	1	1.4	DCPR–WPL (412sq.m), DCPR–PAT (0.2sq.m), PPR–PAT (0.4sq.m), SFRS (40sq.m), SRRE (40m), EJIN (50.6m),SCFD (519.6sq.m)	
00313150	Johor	Mersing	1950	3	STAL	4.4	1	4.4	SBE	3			1	1	1.7	DCPR–INJ (1m), CBPR–PAT (0.5sq.m), ARF–PAL (55sq.m) WWRS (36cu.m), SRRE (8.8m), EJPR (18.5m), CFDM (H=1.0 2no), SCFD (44sq.m)	ADD–IS (17.6sq.m)
00313520	Pahang	Mersing	1960	3	STAL	1.8	2	3.6	RCS	3	3			4	3.3	DCPR–PAT (1sq.m), ARF–PAL (32sq.m), PRF–PAL (35sq.m) APR–INJ (WWPR) (3.2m), EJIN (16.2m), CFDM (H=1.0 2no), CFDM (H=1.0 1no), SCFD (36sq.m)	ADD–IS(23sq.m)
00314180	Johor	Mersing	1964	3	STAL	5.5	2	11.0	PRB	3	1		1	1	1.5	AFPR–REV (20sq.m), EJPR (23.7m), PRF–TOL (15m), ASIN (2 no) WWRP (20cu.m), DRRF (4no), SRPR (22m), RTRE–SD (488sq.m), CFDM (H=2.0 1no)	
00316745	Pahang	Mersing	1965	3	STAL	3.7	1	5.7	RCS	4				4	4.0	DCRF–SWR (36sq.m), DCPR–WPL (31sq.m), ARF–PAL (WWRS) (26.6sq.m), SRRE (10m), EJIN (13.3m) CFDM (H=2.0 2no), SCFD (56.7sq.m)	
00317000	Pahang	Rompin	1974	3	STAL	45.8	9	397.3	PCB	1	1		4	4	2.4	Included detailed survey	
00319110	Pahang	Rompin	1962	3	SSAL	30.5	7	122.0	SBC	4	4	1	4	1	3.0	Included detailed survey	
00319690	Pahang	Rompin	1960	3	STAL	5.7	2	11.3	PRB	4	4		3	1	3.1	DCPR–WPL (85sq.m), EJRP (25m), AFPR–REV (56sq.m) PRF–TOL (15m), WWRP (9cu.m), ASIN (2 no), CFDM (H=2.0 1no)	
00323070	Pahang	Pekan	1965	3	STAL	10.4	3	31.3	RCB	4	4	1	1	1	2.3	APR–INJ(M)(1.5m), ARF–PAL(15m), AFPR–REV (40sq.m), WWRP (13.5cu.m), PRF–PAL (30m), SRPR (62.5m), CFDM (H=1.0 2no), CFDM (H=2.0 2no)	
00326020	Pahang	Pekan	1965	3	STAL	5.7	1	5.7	PRB	5			4	1	3.5	DCPR–WPL (37.6sq.m), ARF–PAL (16m), SRRE (12.2m), EJIN (12.3m), CFDM (H=2.0 2no)	
00326950	Pahang	Pekan	1965	3	STAL	5.9	4	23.5	PRB	4	4		4	1	3.4	DCPR–WPL (45.2sq.m), PRF–TOL (36m), APR–PAL (16m), EJPR (36.9m), SRPR (47m), CFDM (H=2.0 3no), CFDM (H=1.0 2no)	
00336310	Pahang	Kuantan	1958	3	STAL	12.0	3	36.0	RCB	3	4	4	2	1	2.8	BPR–REP (30), EJRP (31.2m), PRF–PAL (30m), PPR–PAT (0.4sq.m), SRPR (72m), CFDM (H=1.0 2no)	ADD–IS (74.4m)
00337240	Pahang	Kuantan	1957	3	STAL	6.6	1	6.6	RCS	4				1	2.7	APR–PAL (38.5sq.m), EJRP (13.4m), CFDM (H=1.0 2no)	
00338580	Terengganu	Kemaman	1965	3	STAL	28.0	16	219.1	PCB	5	5	5	1	1	3.4	– Construct a new bridge (2848.69sq.m) –	
00339210	Terengganu	Kemaman	1963	3	STAL	15.2	10	152.2	PCB	4	4		4	1	3.4	CBRF–FRP (80sq.m), CBRF–UG (183sq.m), APR–PAT (4sq.m), PPR–PAT (36sq.m), SFRS (135sq.m), SCFD (1552sq.m)	
00341800	Terengganu	Kemaman	1955	3	STAL	12.1	3	36.1	RCB	4	4	4	4	1	3.5	Included detailed survey	
00346740	Terengganu	Dungun	1973	3	STAL	30.5	9	152.3	PCB	3	1	1	4	1	2.1	Included detailed survey	
00354190	Terengganu	K.T'ganu	1960	2	SSAL	5.6	2	11.2	PRB							Bridge has been replaced	

APPENDIX－Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bearing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
00354830	Terengganu	K.T'ganu	1963	3	STAL	6.0	3	17.9	PRB	3	3		3	2	2.8	DCPR－WPL (135sq.m), EJPR (36m), CBPR－PAT (1.6sq.m), SFFD (178.5sq.m)	
00356790	Terengganu	K.T'ganu	1959	3	STAL	5.9	9	53.1	PRB	2	1		4		2.3	DCPR－WPL (370sq.m), APR－INJ (1.2m), CRRE (106.2m)	
00357200	Terengganu	K.T'ganu	1959	3	STAL	5.9	3	5.9	PRB	3	3		4	3	3.3	CBPR－PAT (6.9sq.m), CRPR (11.9m), EJPR (31.6m), APR－INJ (1m), DCPR－WPL (124sq.m),SCFD (59.4sq.m)	
00357270	Terengganu	K.T'ganu	1957	3	STAL	5.9	2	11.8	PRB	1	1		4	3	2.2	CBPR－PAT (8sq.m); DCPR－WPL (82.2sq.m), EJPR (23.8m), CRPR (23.6m), ASIN (2 no) SCFD (117.8sq.m)	
00361490	Terengganu	Besut	1960	3	STAL	6.0	3	18.0	PRB	1	4		1		2.0	DCPR－WPL (125.1sq.m), APR－PAT (0.2sq.m), EJRP (13.3m) PRF－TOL (32m), ASIN (2 no), DRRF (12 no), CFDM (H=2.0 2no)	
00363630	Terengganu	Besut	1965	3	STAL	5.8	1	5.8	PRB	4			3	1	2.8	ARF－SP (17.9m), DCPR－WPL (55sq.m), SFRE (2.4sq.m), SRRE (12.2m)	
00366650	Kelantan	P.Puteh	1952	3	STAL	5.4	6	32.5	PRB	4	4		4		4.0	CBPR－PAT (22.1sq.m), PPR－PAL (100m), ARF－SP (7m), EJRP (42.1m), SFRS (67.3sq.m), CFDM (H=2.0 5no), DETOUR (72.5m)	RING－SUP (193sq.m) ADD－IS (130sq.m)
00366890	Kelantan	P.Puteh	1951	3	STAL	4.8	2	9.6	RCS	3			1	4	2.6	DCRF－SWR (81sq.m), APR－PAL (24m), PPR－PAL (12m) SFRS (62.4sq.m), CFDM (H=2.0 1no), CFDM (H=2.0 2no), SCFD (95.8sq.m)	
00368300	Kelantan	P.Puteh	1955	3	STAL	4.8	2	9.7	RCS	4	3			4	3.6	DCRF－SWR (38sq.m), EJPR (15.2m), DCPR－PAT (3sq.m) ARF－PAL (24m), APR－PAT (0.1sq.m), PRF－PAL (18m), SFRS (1sq.m), CFDM (H=2.0 1no), CFDM (H=1.0 2no), SCFD (96.8sq.m)	
00505380	Johor	Pontian	1966	3	STAL	11.9	4	47.5	RCS	3	4			3	3.4	DCPR－PAT (2sq.m), PPR－PAT (2.0sq.m), PRF－PAL (84sq.m) PPR－INJ (2m), EJPR (75.9m), DRRF (24 no), AFPR－REV (25.6sq.m), CFDM (H=3.0 3no), SCFD (475.2sq.m)	
00506570	Johor	Pontian	1971	3	STAL	15.1	3	36.2	IT	1	4		1	1	1.6	DCPR－WPL (141sq.m), PRF－PAL (42m), EJPR (38.6m) SRPR (72.3m), DRRF (30 no), CFDM (H=2.0 2no)	
00507230	Johor	Pontian	1966	3	STAL	11.8	3	35.2	PCB	4	4	4	1	1	2.8	APR－INJ (2m), BPR－REP (24 no), PRF－PAL (36m), EJRS (29.2m), APR－PAT (0.3sq.m), AFPR－REV (36sq.m) SFRS (267sq.m), ASIN (2 no), CFDM (H=2.0 2no)	
00507810	Johor	Pontian	1968	3	STAL	12.1	5	47.8	IT	1	4		3		2.7	CBPR－PAT (0.3sq.m), AFPR－REV (20sq.m), EJRP (56.6m), PRF－PAL (72m), CFDM (H=3.0 4no), SCFD (478.3sq.m)	
00510560	Johor	B.Pahat	1960	3	STAL	10.4	3	31.2	RCB	3	4	4	1	1	2.6	BPR－REP (20 no), ARF－PAL (15m), ASIN (2 no), EJPR (14.6m) PRF－PAL (30m), PPR－PAT (0.6sq.m), CFDM (H=1.0 2no), CFDM (H=2.0 2no)	
00512960	Johor	B.Pahat	1965	3	STAL	11.3	3	30.2	RCB	4	4		1	1	2.6	PRF－PAL (42m), SFRE (864.8sq.m), ASIN (2 no) SRPR (70.4m), ABUT.REPLACE (46m), CFDM (H=2.0 2no) Proposed to replaced both abutment with a frame type abutment while concrete lining or jacketing has to be done to the pier.	
00514300	Johor	B.Pahat	1960	3	STAL	10.5	3	22.1	IT	4	2		3	1	2.6	DCPR－WPL (293.2sq.m), EJPR (12.7m), AFPR－REV (76.2sq.m), PPR－INJ (12.7m), PPR－PAT (1.2sq.m), ASIN (2 no), SRPR (46.2m)	
00514370	Johor	B.Pahat	1950	3	STAL	6.3	1	6.3	RCB	4			4	1	3.1	CBRF－BSP (10.6sq.m), ARF－PAL (12sq.m), SRRF (14m) CFDM (H=1.0 2no), SCFD (63.1sq.m)	
00514860	Johor	Muar	1955	3	STAL	7.0	9	46.0	RCB	1	4		4	1	2.6	This bridge will be replaced with a 3 span inverted T beam 16m each span. Now at tendering stage.	
00516890	Johor	Muar	1966	3	STAL	6.3	3	17.8	RCB	1	4	4	4	1	2.8	CBPR－PAT (3.9sq.m), PRF－TOL (30m), BPR－REP (25 no), CFDM (H=2.0 2no), SCFD (176.2sq.m)	
00519360	Melaka	Jasin	1955	3	STAL	6.2	7	42.7	RCS	1	4			2	2.4	PRF－TOL (90m), DCPR－WPL (292sq.m), SRRE (85.7m), DCPR－PAT (1.4sq.m), CFDM (H=2.0 6no), SCFD (427sq.m)	
00519550	Melaka	Jasin	1940	3	P/A	5.0	1	5.0	PRB	4			1		2.5	APR－PAT (6.8sq.m), DCPR－PAT (0.2sq.m), SCFD (49.5sq.m)	
00519700	Melaka	Jasin	1961	3	STAL	4.9	1	4.9	PRB	4			1	1	2.1	APR－INJ (1.5m), APR－PAL (24m), APR－PAT (6.4sq.m) SRPR (9.8m), CFDM (H=1.0 2no)	ADD－IS (23sq.m)
00520130	Melaka	Jasin	1960	3	STAL	6.5	1	6.5	PRB	2				3	2.4	DCPR－WPL (62.8sq.m), SRRE (14.2m), SFRS (5.7sq.m)	
00520850	Melaka	Jasin	1950	3	STAL	4.3	1	4.3	SBE	4			4	4	4.0	Included detailed survey	

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REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
00521300	Melaka	Melaka Tg	1950	3	STAL	6.9	1	6.9	RCB	3			4	4	3.6	CBRF-UG (24sq.m), DCPR-PAT (6sq.m), APR-PAT (4sq.m) SCFD (69sq.m)	ADD-IS(28sq.m)
00521710	Melaka	Melaka Tg.	1960	3	STAL	10.7	1	10.7	RCB	4			4	1	3.1	CBRF-UG (26.6sq.m), APR-PAT (1.8sq.m), ARF-PAL (24m), WWRP (3.5cu.m), CFDM (H=1.0 2no), SCFD (107.2sq.m)	ADD-IS(45sq.m)
00521980	Melaka	Melaka Tg	1960	3	STAL	7.1	2	14.3	RCB	3	4		4	1	3.1	CBRF-UG (32.6sq.m), APR-PAT (0.6sq.m), PRF-PAL (61.4sq.m) CRPR (28.5m), EJRP (14.7m), CFDM (H=2.0 1no), SCFD (142.6sq.m)	
00522760	Melaka	MPM	1930	3	P/A	7.5	1	7.5	SBE	4			4	4	4.0	CBPR-PAT (1sq.m), DCRF-SWR (26sq.m), APR-INJ (M) (1m), SRRE (12.6m), SCFD (74.7sq.m)	
00523300	Melaka	Melaka Tg.	1950	3	STAL	9.3	1	9.3	SBE	1			3	3	2.3	CBRF-PAT (1.2sq.m), APR-INJ (M) (WWPR) (3m), SFRS (6sq.m), CRPR (16.7m), SCFD (93.3sq.m)	
00523620	Melaka	Melaka Tg	1960	3	STAL	7.6	2	15.2	PRB	1	4		4		3.0	DCPR-WPL (124sq.m), PRF-TOL (25m), SRRF (39m) SFRE (123sq.m), EJRP (22.5m), CFDM (H=2.0 1no)	
00524420	Melaka	Melaka Tg.	1950	3	STAL	3.6	1	3.6	RCS	4			4	4	4.0	DCRF-SWR (13.5sq.m), ARF-PAL (WWRS) (27.4sq.m), APR-INJ (0.5m), CRPR (7.2m), EJIN (11.7m), SFRS (5sq.m), CFDM (H=1.0 2no), SCFD (36sq.m)	
00524990	Melaka	Alor Gajah	1960	3	MTAL	1.9	1	1.9	BOX	1				3	1.9	DCPR-PAT (7sq.m), SRRE (7.1m), SFRE (22sq.m), SCFD (18.5sq.m)	
00529600	N.Sembilan	P.Dickson	1950	2	SSAL	3.1	1	3.1	SBB	4			4	4	4.0	SBPR-REP (23sq.m), DSRP-TOR (14.1sq.m), APR-PAT (0.8sq.m), WWRS (48cu.m), SRPR (6.1m), SFRS (17.6sq.m) BRP-TOR (S) (10 no), DETOUR (43.1m)	
00532850	N. Sembilan	P. Dickson	1970	3	STAL	11.0	5	53.2	RCB	4	5	1	1	1	2.6	APR-INJ (0.5m), PRF-PAL (160m), PPR-INJ (8m),ARF-PAL (34sq.m) CFDM (H=2.0 4no), CFDM (H=1.0 2no)	
00534450	N.Sembilan	P.Dickson	1965	3	STAL	8.8	4	35.3	RCB	2	4	4	3	1	2.8	DCPR-PAT (0.4sq.m), EJPR (40m), PRF-TOL (60m), BPR-REP (40no), SRPR (70.6m), DRRF (16no), CFDM (H=2.0 3no), SCFD (353.2sq.m)	
00534570	Selangor	Sepang	1960	3	STAL	7.0	4	32.5	RCB	4	4		1	1	2.6	CBRF-BSP (33sq.m), DCPR-PAT (2sq.m), DCRF-SWR (35sq.m), APR-INJ (2m), ARF-PAL (36m), PRF-PAL (90m), CFDM (H=1.0 2no), CFDM (H=3.0 3no), SCFD (325.4sq.m)	
00535660	Selangor	Sepang	1960	3	STAL	14.7	5	61.3	RCB	4	4		4	2	3.6	SBPR-REP (72sq.m), PRF-TOL (200m), APR-INJ (4m), ASIN (2 no), DRRF (32 no), BPR-REP (60 no), EJPR (40m) SFRS (16.1sq.m), CFDM (H=3.0 4no), SCFD (613.4sq.m)	
00538970	Selangor	K. Langat	1950	4	SSAL	2.3	1	2.3	BOX	1				3	1.9	DCRF-SWR (34sq.m), AFPR-REV (10sq.m), SCFD (23sq.m)	
00540780	Selangor	K.Langat	1960	3	STAL	7.3	3	11.9	RCB							- Replaced with twin cell 3.0 x 3.0 box culvert, construction completed on 20/7/85. Designed by JKR HQ with the design load BS 153 and HB at centreline , supported by 100mm Bakau Pile 6m length	
00540910	Selangor	K. Langat	1950	2	SSAL	6.3	1	6.3	SBB	3			1	1	1.7	DSRP-TOR (42sq.m), ARF-PAL (45.4sq.m), SBPR-REP (50sq.m), BRP-TOR (S) (12no), CFDM (H=1.0 2no), DETOUR (46.3m)	
00541000	Selangor	K. Langat	1950	3	STAL	3.2	1	3.2	SBB	4			3	3	3.4	DSRP-TOR (73sq.m), ARF-PAL (25sq.m), SBPR-REP (56.5sq.m), BRP-TOR (S) (14no), CFDM (H=1.0 2no), DETOUR (43.2m)	
00541210	Selangor	K.Langat	1950	2	SSAL	4.7	1	4.7	SBB	4			4	3	3.7	SBPR-REP (22sq.m), DSRP-TOR (36sq.m), APR-INJ (1m), BRP-TOR (S) (14 no), ASIN (2 no), DETOUR (44.7m)	
00546560	Selangor	K.Selangor	1969	3	STAL	10.6	3	30.9	RCS	1			4	3	2.6	Included detailed survey	
00546980	Selangor	K.Selangor	1969	3	STAL	10.6	3	30.9	RCS	4	4			4	4.0	Included detailed survey	
00549550	Selangor	K.Selangor	1965	3	STAL	12.6	6	63.6	SBC	1	4	4	1	1	2.1	BPR-REP (60 no), PPR-PAT (4.3m), ASIN (2 no), EJRP (40m) DRRF (48 no), SRRF (130m)	WD-SS construction on progress
00555290	Perak	Hilir Perak	1960	3	STAL	2.5	2	4.9	BOX	1	4			1	2.1	PRF-PAL (25.5sq.m), SRRE (9.8m), RTPR (80sq.m), CFDM (H=1.0 1no)	
00556900	Perak	Hilir Perak	1958	3	STAL	7.3	1	7.3	RCS	2				1	1.6	SRPR (14.7m), WWRP (3cu.m), ARF-TOL (24m), CFDM (H=2.0 2no)	
00563880	Perak	Manjung	1972	3	STAL	14.1	3	41.6	IT	2	4		1		2.3	Included detailed survey	
00567840	Perak	Kinta	1960	3	STAL	6.1	2	12.1	PRB	3	1		4		2.7	Included detailed survey	

APPENDIX-Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
00569630	Perak	Kinta	1950	3	SSAL	2.8	1	2.8	SBB +	1			4	3	2.6	DSRP-TOR (27sq.m), BRP-TOR (S) (10no), DETOUR (42.8m)	
00700660	Kedah	Kota Setar	1964	3	STAL	18.4	1	18.4	PCB	1			4	4	2.9	ASIN (1 no), SRPR (36.8m), SFRS (36sq.m), DCPR-PAT (3.9sq.m), CBPR-COT (12sq.m), SCFD (184sq.m)	ADD-IS(75.6sq.m)
00700750	Kedah	K. Setar	1970	3	STAL	15.4	1	15.4	RCS	1		2		1	1.3	CRRF (30m), EJIN (24.6m), DETOUR (55.4m)	RING-SUP (192sq.m)
00701810	Kedah	Kbg Pasu	1970	3	STAL	30.5	3	46.6	PCB	4	3	4	1	1	2.6	EJRP (34.7m), SFRS (8sq.m), PPR-PAT (7.5sq.m), SRPR (97.2m) ASIN (2 no)	
00702630	Kedah	Kbg. Pasu	1960	3	STAL	9.5	1	9.5	RCB	1		4	1	1	1.6	BPR-REP (14 no), ARF-PAL (37.6sq.m), SRPR (19.1sq.m), EJIN (25.7m), CFDM (H=2.0 2no)	
00703330	Perlis	Perlis	1963	3	STAL	24.8	1	24.8	PCB	2			1	1	1.4	APR-PAT (2.2sq.m), EJPR (8.2m), SRRE (50.8m)	
00706230	Perlis	Perlis	1950	2	SSAL	6.6	1	6.6	SBB	1			2	2	1.6	Bridge has been replaced	
00800350	Pahang	Bentong	1950	3	SSAL	3.5	1	3.5	SBB	1			4	4	2.9	SBPR-REP (7.5sq.m), DSRP-TOR (20sq.m), BRP-TOR (S) (10no), DETOUR (43.5m)	
00803050	Pahang	Raub	1950	4	SSAL	9.0	2	18.1	SBB	4	4		4	3	3.8	DSRP-TOR (94sq.m), ARF-PAL (18sq.m), AFPR-REV (15sq.m), PFPR-RBP (53sq.m), BRP-TOR (S) (20no), CFDM (H=1.0 2no), DETOUR (58.1m)	
00803900	Pahang	Raub	1952	2	SSAL	5.5	2	10.9	SBB	3	3		4	1	2.8	SBPR-REP (145sq.m), DSRP-TOR (68sq.m), APR-INJ (WWPR) (6.5m), ARF-PAL (30sq.m), PRF-PAL (35sq.m), PFPR-RBP (80sq.m), BRP-TOR (S) (24), CFDM (H=1.0 2no), CFDM (H=2.0 1no), DETOUR (50.9m)	
00810120	Pahang	K. Lipis	1950	4	SSAL	6.9	1	6.9	SBB	1			4	4	2.9	SBPR-REP (64sq.m), DSRP-TOR (40sq.m), APR-INJ (WWPR) (1m), BRP-TOR (S) (12no), DETOUR (46.9m)	
00813470	Pahang	K. Lipis	1960	3	STAL	11.7	1	11.7	PRB	4			1	4	2.9	DCPR-WPL (72sq.m), ARF-PAL (30m), WWRP (12cu.m), EJIN(15m), SRPR (23.3m), CRPE (23.3m), SFRS (65sq.m), AFPR-REV (7.5sq.m), CFDM (H=1.0 2no)	
00818060	Pahang	K. Lipis	1980	3	MTAL	30.5	1	30.5	PCB	1		1	1	1	1.0	No defect detected	
00822340	Kelantan	G. Musang	1982	3	MTAL	31.1	3	90.9	PCB	1	1	1	1	1	1.0	SRPR (181.8m), EJIN (73m)	
00834850	Kelantan	Kuala Krai	1960	3	STAL	4.6	3	13.7	RCS	1	4			4	2.9	Included detailed survey	
00834950	Kelantan	K. Krai	1980	3	STAL	3.3	1	3.3	RCS	3				3	3.0	SFRS (16sq.m), DETOUR (43.3m)	RING-SUP (29.2sq.m)
00836900	Kelantan	Machang	1960	3	STAL	6.7	2	12.0	RCB	2	3		3	4	2.9	CBPR-PAT (1.3sq.m), DCPR-PAT (4.3sq.m), DCPR-WPL (78sq.m), PRF-PAL (15m), APR-INJ (M) (0.3m), SRPR (24m), EJIN (7.3m) CFDM (H=2.0 1no), SCFD (120.2sq.m)	
00838100	Kelantan	Machang	1941	3	P/A	4.5	2	9.7	RCS	1	3			4	2.6	DCPR-PAT (11.7sq.m), DCPR-WPL (63sq.m), PPR-PAT (2sq.m), CRPR (19.4m), EJIN (15.5m), DETOUR (49.7m)	WID-SS (63sq.m), RING-SUP (67sq.m)
00901360	N. Sembilan	K. Pilah	1960	3	STAL	5.7	1	5.7	RCS	4				4	4.0	DCRF-SWR (42sq.m), APR-INJ (1.4m), AFPR-REV (5.6sq.m), SFRS (21sq.m), EJIN (7.8m),SCFD (57.4sq.m)	
00901420	N. Sembilan	K. Pilah	1950	2	SSAL	3.2	1	3.2	SBB	3			4	4	3.6	SBPR-REP (25sq.m), SBRF-WSP (2sq.m), DSRP-TOR (42sq.m), ARF-PAL (30sq.m), PFPR-RBP (22sq.m), BRP-TOR (S) (10no), CFDM (H=1.0 2no), DETOUR (43.2m)	
00901700	N.Sembilan	K.Pilah	1950	2	SSAL	3.6	1	3.6	SBB	1			3	3	2.3	DSRP-TOR (23.1sq.m), SBPR-REP (20.5sq.m), BRP-TOR (S) (10 no), DETOUR (43.6m)	
00901960	N. Sembilan	K. Pilah	1950	2	SSAL	9.1	2	18.1	SBB	4	4		4	4	4.0	SBPR-REP (178sq.m), DSRP-TOR (142sq.m), ARF-PAL (31sq.m), PRF-PAL (20m), BRP-TOR (S) (20no), CFDM (H=2.0 1no), CFDM (H=1.0 2no), DETOUR (58.1m)	
00902270	N.Sembilan	K.Pilah	1950	2	SSAL	3.1	1	3.1	SBB	1			4	4	2.9	SBPR-REP (17.5sq.m), DSRP-TOR (20sq.m), BRP-TOR (S) (10 no) DETOUR (43.1m)	
00902360	N. Sembilan	K. Pilah	1950	2	SSAL	3.1	1	3.1	SBB	4			4	4	4.0	SBPR-REP(15sq.m), DSRP-TOR (42sq.m), BRP-TOR (S) (10 no), ARF-PAL (WWRS) (27.4sq.m), RTPR (10sq.m), CFDM (H=1.0 2no), DETOUR (43.1m)	
00902430	N.Sembilan	K.Pilah	1950	2	SSAL	3.1	1	3.1	SBB	3			4	4	3.6	SBPR-REP (31.8sq.m), DSRP-TOR (36sq.m), BRP-TOR (S) (10 no), RTPR (116sq.m), DETOUR (43.1m)	
00902440	N. Sembilan	K. Pilah	1950	2	SSAL	3.1	1	3.1	SBB	4			4	4	4.0	SBPR-REP (32sq.m), DSRP-TOR (37sq.m), APR-PAT (0.1sq.m), BRP-TOR (S) (10no), DETOUR (43.1m)	

APPENDIX-Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating						Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
										Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)		
00904330	N.Sembilan	K.Pilah	1950	2	SSAL	7.8	1	7.8	SBB	1			4	4	2.9	SBPR-REP (69.6sq.m), DSRP-TOR (44.3sq.m), BRP-TOR (S) (10 no), DETOUR (47.8m)	
00906190	N. Sembilan	Jempul	1950	2	SSAL	9.5	1	9.5	SBB	1			4	3	2.6	SBPR-REP (99sq.m), DSRP-TOR (57sq.m), BRP-TOR (S) (12no) DETOUR (49.5m)	
00907010	N. Sembilan	Jelebu	1930	2	SSAL	6.4	1	6.4	SBB	3			4	3	3.4	SBPR-REP (51sq.m), DSRP-TOR (36sq.m), APR-PAT (0.1sq.m), BRP-TOR (S) (12no), DETOUR (46.4m)	
00908400	N. Sembilan	Jelebu	1935	3	P/A	10.7	5	36.7	SBE	3	5	1	5	4	3.8	CBPR-PAT (0.2sq.m), CBRF-BSP (40.2sq.m), DCPR-PAT (1sq.m), PRF-PAL (40m), APR-INJ (M) (3m), EJIN (13.2m), SRPR (73.4m) CFDM (H=2.0 4no), SCFD (367sq.m)	
00911990	Pahang	Bentong	1951	2	SSAL	10.8	4	33.0	SBB	3	2		4	4	3.2	SBPR-REP (237.3sq.m), DSRP-TOR (201.1sq.m), BRP-TOR (S) (30 no), WWRS (18cu.m), DETOUR (73m)	
01105770	N. Sembilan	Jempul	1970	3	STAL	6.2	3	18.3	PRB	4	1		4		3.0	DCPR-WPL (122sq.m), CBPR-PAT (4sq.m), AFPR-REV (86sq.m), APR-INJ (WWPR) (9m), PPR-INJ (1.2m), EJIN (13.5m), RTPR (30sq.m), DRRF (2no), SCFD (183.2sq.m)	
01800060	Perak	Manjung	1960	3	STAL	3.7	1	3.7	RCS	1				4	2.3	DCPR-SHT (20sq.m), SCFD (36.8sq.m)	WID-SS (20sq.m)
01800670	Perak	Manjung	1950	3	STAL	4.8	1	4.8	SBC	1			4	4	2.9	SBPR-REP (68sq.m), DCPR-PAT (11.7sq.m), APR-PAT (0.9sq.m), SCFD (47.8sq.m)	WID-SS (68sq.m)
02305040	Johor	Segamat	1950	3	STAL	6.3	2	12.3	SBB	1	1		4	4	2.4	SBPR-REP (48sq.m), DSRP-TOR (68sq.m), BRP-TOR (S) (20 no), PFPR-RBP (2sq.m), DETOUR (52.3m)	
02305970	Johor	Segamat	1950	4	STAL	5.7	2	7.6	RCS	4	1			3	2.6	DCPR-PAT (0.1sq.m), APR-PAT (0.6sq.m), PPR-PAT (0.2sq.m), CRPE (15.2m), SFRS (0.1sq.m), EJIN (15.5m), DETOUR (47.6m)	RING-SUP (51.3sq.m)
05001070	Johor	Bt. Pahat	1919	2	SSAL	4.8	1	4.8	SBB	3			4	1	2.8	Included in detailed survey	
05001890	Johor	Batu Pahat	1950	3	SSAL	5.1	1	5.1	SBB	1			3	1	1.7	SBPR-REP (43sq.m), DSRP-TOR (78.1sq.m), BRP-TOR (S) (14no), DETOUR (45.1m)	
05002590	Johor	Batu Pahat	1940	2	SSAL	4.8	1	4.8	SBB	3			4	3	3.4	SBPR-REP (30sq.m), DSRP-TOR (66sq.m), BRP-TOR (S) (14no) DETOUR (44.8m)	
05100840	N.Sembilan	Seremban	1950	3	SSAL	9.4	1	9.4	SBB	3			1	1	1.7	This bridge will be replaced by a single span prestress I beam which is under construction at present	
05101360	N. Sembilan	Seremban	1940	3	SSAL	3.3	1	3.3	SBB	3			4	4	3.6	SBPR-REP (43sq.m), DSRP-TOR (46sq.m), BRP-TOR (S) (16 no), APR-PAT (0.2sq.m), DETOUR (43.3m)	
05101460	N.Sembilan	Seremban	1950	2	SSAL	3.3	1	3.3	SBB	1			4	3	2.6	SBPR-REP (14sq.m), DSRP-TOR (40.7sq.m), BRP-TOR (S) (14 no) DETOUR (43.3m)	
05102060	N. Sembilan	K. Pilah	1950	3	SSAL	4.7	1	4.7	SBB	4			4	4	4.0	SBPR-REP (33sq.m), DSRP-TOR(48.5sq.m), BRP-TOR (S) (12 no) APR-INJ (M) (1m), DETOUR (44.7m)	
05102280	N.Sembilan	K.Pilah	1960	3	SSAL	4.8	1	4.8	SBB	1			3	4	2.6	SBPR-REP (28sq.m), DSRP-TOR (28sq.m), BRP-TOR (S) (10 no) DETOUR (44.8m)	
05102380	N. Sembilan	K. Pilah	1960	3	STAL	3.2	1	3.2	SBB	1			4	4	2.9	WWRP (5cu.m), DETOUR (43.2m) Ok	RING-SUP (18sq.m)
05102570	N.Sembilan	K.Pilah	1960	3	STAL	3.2	1	3.2	SBB	1			4	4	2.9	SBPR-REP (28.8sq.m), DSRP-TOR (42.5sq.m), BRP-TOR (S) (10 no), DETOUR (43.2m)	ADD-IS (16.6sq.m)
05103030	N. Sembilan	K. Pilah	1950	3	SSAL	3.8	1	3.8	SBB	1			4	3	2.6	SBRF-WSP (1sq.m), DSRP-TOR (28.3sq.m), BRP-TOR (S) (10no) DETOUR (43.8m)	
05103300	N.Sembilan	K.Pilah	1958	3	SSAL	9.6	2	16.1	SBB	1	2		1	1	1.3	SBPR-REP (58sq.m), DSRP-TOR (108.9sq.m), BRP-TOR (S) (20no), PPR-INJ (2m), DETOUR (56.1m)	
05200280	N.Sembilan	Seremban	1932	3	STAL	4.7	1	4.7	SBB	1			3	1	1.7	SBPR-REP (39sq.m), DSRP-TOR (92sq.m), BRP-TOR (S) (14no), DETOUR (44.7m)	
05202450	Selangor	U. Langat	1955	3	STAL	12.1	1	12.1	RCB	4			3	3	3.4	CBRF-BSP (25sq.m), DCPR-INJ (11m), APR-PAT (0.3sq.m), AFPR-REV (42sq.m), SCFD (121.1sq.m)	
05203510	Selangor	U. Langat	1950	3	STAL	1.6	2	3.2	BOX	2	1			1	1.4	AFPR-REV (10sq.m), SRRE (6m)	
05204870	Selangor	U. Langat	1964	3	STAL	18.2	3	54.5	SBC	1	1	4	3	1	1.9	SBPR-REP (780sq.m), BPR-REP (30no), DCPR-PAT (0.6sq.m), EJIN (39.9m), SCFD (545sq.m)	

APPENDIX-Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
05300470	N.Sembilan	P.Dickson	1950	3	SSAL	9.4	1	9.4	SBB	3			4	4	3.6	SBPR-REP (88sq.m), DSRP-TOR (80sq.m), BRP-TOR (S) (16), ARF-PAL (40.4sq.m), CFDM (H=2.0 2no), DETOUR (49.4m)	
05300960	N. Sembilan	P. Dickson	1950	3	SSAL	6.3	1	6.3	SBB	4			3	3	3.4	SBPR-REP (11.5sq.m), DSRP-TOR (58sq.m), APR-INJ (M) (3m), BRP-TOR (S) (16no), DETOUR (46.3m)	RING-SUP (58sq.m)
05301190	N. Sembilan	P. Dickson	1950	3	SSAL	4.8	1	4.8	SBB	4			4	4	4.0	To be replaced with box culvert —construction is on progress—	
05302050	N. Sembilan	Seremban	1950	3	SSAL	8.5	1	8.5	SBB	2			3	1	2.1	SBPR-REP (2.5sq.m), DSRP-TOR (68sq.m), APR-PAT (0.2sq.m), WWRP (4cu.m), BRP-TOR (S) (12no), DETOUR (48.5m)	
05302160	N. Sembilan	Seremban	1950	3	SSAL	6.3	1	6.3	SBB	3			3	1	2.4	SBPR-REP (49.7sq.m), APR-INJ (5.4m), DSRP-TOR (49.3sq.m), AFRP-REV (20sq.m), BRP-TOR (S) (12 no), DETOUR (46.3m)	
05302340	N. Sembilan	Seremban	1940	3	SSAL	6.7	1	6.7	SBB	3			4	1	2.8	DSRP-TOR (45sq.m), ARF-PAL (37sq.m), RTPR (30sq.m), BRP-TOR (S) (10no),CFDM (H=1.0 2no), DETOUR (45.7m)	
05403460	Selangor	Petaling	1950	3	STAL	6.6	1	6.6	RCS	3				1	2.1	ARF-PAL (38.8sq.m), SRRE (13.1m), DCPR-PAT (0.4sq.m), RTPR (33m), CFDM (H=1.0 2no), SCFD (65.6sq.m)	
05403570	Selangor	Petaling	1960	3	STAL	3.1	1	3.1	BOX	4				4	4.0	DCRF-UG (45.4sq.m), ARF-PAL (59.6sq.m), CFDM (H=1.0 2no), SCFD (30.5sq.m)	
05801510	Perak	Hilir Perak	1950	-	SSAL	5.6	1	5.6	SBB	3			4	4	3.6	SBPR-REP (39sq.m), DSRP-TOR (36.7sq.m), BRP-TOR (S) (12no) APR-INJ (3.8m), DETOUR (45.6m)	
05801520	Perak	Hilir Perak	1950	2	SSAL	3.7	1	3.7	SBB	2			3	1	2.1	SBPR-REP (25.2sq.m), DSRP-TOR (23.8sq.m), BRP-TOR (S) (12no), ARF-PAL (13.6sq.m), CFDM (H=1.0 2no), DETOUR (43.7m)	
05803340	Perak	Btg Padang	1950	3	STAL	5.0	1	5.0	SBB	1			4	4	2.9	Included in detailed survey	
05901000	Perak	Btg. Padang	1950	3	STAL	4.9	1	4.9	SBC	3			3	4	3.3	SBPR-REP (40sq.m), DCRF-SWR (34sq.m), CBPR-PAT (0.4sq.m), AFPR-REV (10sq.m), SRPR (9.8m), SCFD (48.8sq.m)	
05901070	Perak	Btg. Padang	1950	3	STAL	4.7	1	4.7	SBC	3			3	4	3.3	SBPR-REP (34sq.m), DCPR-PAT (0.7sq.m), CBPR-PAT (0.7sq.m), ARF-PAL (41.5sq.m), AFPR-REV (10sq.m), SRRF (0.7m), CRRF (9.4m), SFRS (7sq.m), CFDM (H=1.0 2no), SCFD (47.1sq.m)	
05901480	Perak	Btg. Padang	1950	3	STAL	2.0	2	3.9	SBC	4	3		4	4	3.7	SBPR-REP (34sq.m), DCPR-PAT (3.3sq.m), PRF-PAL (35sq.m), ARF-PAL (35sq.m), AFPR-REV (20sq.m), SRPR (7.8m), SFRS (0.1sq.m), EJIN (17.6m), CFDM (H=1.0 2no), CFDM (H=1.0 1no), SCFD (39sq.m)	
05901580	Perak	Btg. Padang	1950	3	STAL	7.6	1	7.6	SBC	3			3	1	2.4	SBPR-REP (42sq.m), CBPR-PAT (0.7sq.m), AFPR-REV (10sq.m), SRPR (15.3m), EJIN (16.7m), SCFD (76.3sq.m)	
05901690	Perak	Btg. Padang	1950	3	STAL	9.5	1	9.5	SBC	3			3	4	3.3	SBPR-REP (87sq.m), DCRF-SWR (59sq.m), AFPR-REV (10sq.m), SRPR (19.1m), EJIN (16.7m), SCFD (95.3sq.m)	
05902030	Perak	Btg. Padang	1950	3	STAL	3.6	1	3.6	SBC	1			3	4	2.6	SBPR-REP (19sq.m), DCPR-PAT (0.1sq.m), CBPR-PAT (0.4sq.m), DCPR-WPL (20.5sq.m), SRPR (7.1m), EJIN (16.4m), SCFD (35.6sq.m)	
05902230	Perak	Btg. Padang	1950	3	STAL	8.2	1	8.2	SBC	1			4	4	2.9	SBPR-REP (78sq.m), CBPR-PAT (0.3sq.m), DCPR-WPL (51.2sq.m), AFPR-REV (WWPR) (16.5sq.m), SRPR (8m), SRRE/CRRE (8m), EJIN (15.4m), SCFD (82.1sq.m)	
05902690	Perak	Btg Padang	1950	3	STAL	6.8	1	6.8	SBC	2			3	1	2.1	EJRP (17.6m), SBPR-REP (45sq.m), SFRS (7sq.m),SCFD (68sq.m)	
05902920	Perak	Btg. Padang	1950	3	STAL	8.8	1	8.8	SBC	2			3	4	2.9	SBPR-REP (45sq.m), DCPR-PAT (4.5sq.m), ARF-PAL (67sq.m), SRPR (17.5m), SFRS (1sq.m), EJIN (16.7m), CFDM (H=1.0 2no), SCFD (87.7sq.m)	
05903120	Perak	Btg Padang	1950	3	STAL	10.9	3	23.2	SBC	4	1		4	4	3.2	Included in detailed survey	
05905010	Pahang	Lipis	1961	3	STAL	30.7	4	122.4	PCB	1	1	3	3	1	1.8	CBPR-PAT (56.2sq.m), BPR-REP (20 no), DCPR-WPL (1049.6sq.m) EJRP (17m), SRRF (3m), SCFD (1223.6sq.m)	
05905290	Pahang	Lipis	1930	3	STAL	6.1	1	6.1	SBB	4			1	1	2.1	DSRP-TOR (47sq.m), AFPR-REV (11sq.m),BRP-TOR (S) (14) DETOUR (46.1m)	
05906010	Pahang	Lipis	1930	3	STAL	6.4	1	6.4	SBB	1			1	1	1.0	SBPR-REP (47sq.m), DSRP-TOR (44.8sq.m), BRP-TOR (14 no), DETOUR (46.4m)	
06000970	Perak	Manjung	1930	3	P/A	3.1	1	3.1	SBE	4			4		4.0	— This bridge should be replaced with a new bridge —	

APPENDIX-Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating: Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)	Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
06001330	Perak	Manjung	1960	3	STAL	5.0	1	5.0	RCB	1			4	4	2.9	SRPR (11m), DCRF-SWR (26.5sq.m), CBRF-BSP (5.3sq.m) SCFD (50.2sq.m)	
06005070	Perak	L.Mtg & Selama	1950	3	STAL	7.2	4	27.1	SBC	4	1		4	4	3.2	SBPR-REP (159.6m), DCPR-PAT (14.1sq.m) DCPR-WPL (45.5sq.m), APR-INJ (3m), SRPR (54.3m) ASIN (2 no), SCFD (271.4sq.m)	
06005220	Perak	L.Mtg & Selama	1960	3	STAL	7.0	1	7.0	RCB	1			1	4	1.9	SRPR (14m), SFRS (7sq.m), ASIN (2 no), CBPR-PAT (0.3sq.m) DRRF (6no), SCFD (70.1sq.m)	
06005740	Perak	L.Mtg & Selama	1960	3	STAL	5.8	3	22.0	RCB	2			4	4	3.3	CBPR-PAT (3sq.m), DCPR-PAT (1.6sq.m), APR-PAT (0.1sq.m), EJRP (13.8m), SFRS (4.5sq.m), SCFD (219.5sq.m)	
06006050	Perak	L.Mtg & Selama	1950	–	SSAL	5.1	1	5.1	SBB	1			4	4	2.9	SBPR-REP (28sq.m), DSRP-TOR (26sq.m), BPR-TOR (S) (10 no), APR-TOL (28.4sq.m), CFDM (H=1.0 2no), DETOUR (45.1m)	
06403300	Pahang	Jerantut	1930	3	SSAL	12.3	1	12.3	SBB	1			4	3	2.6	SBPR-REP (129sq.m), DSRP-TOR (75sq.m), APR-INJ (M) (WWPR) (6.5m), BRP-TOR (S) (12), DETOUR (52.3m)	
06403900	Pahang	Jerantut	1930	3	SSAL	11.9	1	11.9	SBB	4			4	1	3.1	SBPR-REP (113.5sq.m), DSRP-TOR (65sq.m), BRP-TOR (S) (12no) DETOUR (51.9m)	
06404270	Pahang	Jerantut	1930	3	STAL	10.9	1	10.9	SBB	4			4	3	3.7	SBPR-REP (94.5sq.m), DSRP-TOR (60sq.m), BRP-TOR (S) (10no) DETOUR (50.9m)	
06404940	Pahang	Jerantut	1930	3	STAL	6.2	1	6.2	SBB	2			3	3	2.6	SSPR-REP (48sq.m), DSRP-TOR (34sq.m), BRP-TOR (S) (10no) ARF-PAL (72sq.m), ARF-SP (6.6m), WWRP (7cu.m), CFDM (H=1.0 2no), DETOUR (46.2m)	
06405650	Pahang	Jerantut	1930	3	P/A	6.3	1	6.3	SBB	3			4	1	2.8	SBPR-REP (45sq.m), DSRP-TOR (34sq.m), AFPR-REV (11.7sq.m), BRP-TOR (S) (10no), DETOUR (46.3m)	
06406250	Pahang	Jerantut	1930	3	P/A	4.8	1	4.8	SBB	4			4	4	4.0	SBPR-REP (17sq.m), DSRP-TOR (26sq.m), ARF-PAL (WWRS) (21sq.m), BRP-TOR (S) (10no), CFDM (H=1.0 2no), DETOUR (44.6m)	ADD-IS(18.5sq.m)
06701200	Kedah	K.Muda & Sik	1930	3	P/A	6.1	1	6.1	RCB	1			1	2	1.3	DCPR-PAT (2.6sq.m), SRPR (12.1m), SCFD (60.5sq.m)	
06701230	Kedah	K.Muda & Sik	1940	3	P/A	6.1	2	12.3	RCB	1	1		4	4	2.4	CBPR-PAT (0.2sq.m), DCPR-PAT (4sq.m), PRF-PAL (12m), AFPR-REV (15sq.m), SRRE (26m), SFRS (40sq.m), CFDM (H=1.0 1no), (H=1.0 1no), SCFD (122.6sq.m)	
06701690	Kedah	K.Muda & Sik	1968	3	STAL	30.6	3	91.5	PCB	3	1	4	1	4	2.4	DCPR-WPL (684sq.m), WWRS (32cu.m), SFRS (187sq.m), EJRP (29.2m), DRRF (4 no)	
06702050	Kedah	Baling	1950	3	STAL	7.2	1	7.2	SBE	1			1	1	1.0	SRPR (14.3m), SFRS (25sq.m)	ADD-IS(28sq.m)
07000230	Perak	Hilir Perak	1950	3	STAL	5.9	1	5.9	SBB	3			4	1	2.8	SBPR-REP (41sq.m), ARF-PAL (24m), ASIN (2 no), DSRP-TOR (42sq.m), BRP-TOR (S) (12 no), CFDM (H=1.0 2no), DETOUR (45.9m)	
07001790	Perak	Hilir Perak	1970	3	STAL	14.8	3	44.4	IT	1	4	1	1	1	1.7	EJPR (19m), PRF-PAL (76sq.m), SFRS (14.5sq.m), ASIN (2 no), CFDM (H=2.0 2no)	
07002430	Perak	Btg Padang	1950	3	STAL	3.9	1	3.9	SBB	4			4	4	4.0	SBPR-REP (25.2sq.m) DSRP-TOR (23.5sq.m), BRP-TOR (S) (10no) ARF-PAL (28sq.m), CFDM (H=2.0 2no), DETOUR (43.9m)	
07602330	Perak	K. Kangsar	1950	2	SSAL	6.4	1	6.4	SBB	1			4	3	2.6	DSRP-TOR (35sq.m), BRP-TOR (S) (10), DETOUR (46.4m)	
07602480	Perak	K. Kangsar	1950	4	STAL	5.3	1	5.3	SBB	4			4	4	4.0	SBPR-REP (6sq.m), DSRP-TOR (30sq.m), AFPR-REV (18sq.m), WWRP (36cu.m), BRP-TOR (S) (10no), DETOUR (45.3m)	
07604020	Perak	Hulu Perak	1950	3	SSAL	6.4	1	6.4	SBB	3			4	3	3.4	SBPR-REP (34sq.m), DSRP-TOR (34sq.m), ARF-PAL (36sq.m), BRP-TOR (S) (10no), CFDM (H=1.0 2no), DETOUR (46.4m)	ADD-IS(22.5sq.m)
07604160	Perak	Hulu Perak	1950	3	SSAL	3.2	1	3.2	SBB	1			4	3	2.6	SBPR-REP (14sq.m), DSRP-TOR (17.5sq.m), BRP-TOR (S) (10no) DETOUR (43.2m)	ADD-IS(12.5sq.m)
07604750	Perak	Hulu Perak	1950	3	STAL	9.3	1	9.3	SBB	4			4	3	3.7	SBPR-REP (97sq.m), DSRP-TOR (63sq.m), AFPR-REV (14sq.m), APR-INJ (M) (WWPR) (1.5m), BRP-TOR (S) (12no), DETOUR (49.3m)	
07606390	Perak	Hulu Perak	1950	3	STAL	3.1	1	3.1	SBB	4			4	3	3.7	SBPR-REP (16sq.m), DSRP-TOR (17sq.m), BRP-TOR (S) (10no), WWRS (2.1cu.m), AFPR-REV (10sq.m), DETOUR (43.1m)	
08601000	N.Sembilan	Seremban	1950	3	STAL	9.6	1	9.6	SBB	4			4	2	3.4	SBPR-REP (67sq.m), DSRP-TOR (72.3sq.m), BRP-TOR (S) (12no), ARF-SP (10m), DETOUR (49.6m)	

APPENDIX-Q SUMMARY OF BRIDGE
REHABILITATION PLAN COVERING 216 STUDY BRIDGES

Key	State	District	Year Built	Study Category	Capacity	Max Span (m)	No of Spans	Bridge Length (m)	Type of Bridge	Damage Rating						Rehabilitation Plans from Structural View Point	Rehabilitation Plans From Functional View Point
										Abut	Pier	Bear-ing	Beam	Deck	Overall (for safety)		
08601190	N. Sembilan	Seremban	1950	2	SSAL	4.6	1	4.6	SBB	1			4	3	2.6	SBPR-REP (27sq.m), DSRP-TOR (23sq.m), APR-INJ (WWPR) (1m), WWRS (13.5cu.m), APR-PAT (WWPR) (0.1sq.m), BRP-TOR (S) (10no) DETOUR(44.6m)	
08601410	N.Sembilan	Seremban	1950	3	SSAL	3.7	1	3.7	SBB							Bridge to be replaced with precast U box culvert Construction is on progress	
08601830	N.Sembilan	Seremban	1950	3	SSAL	3.8	1	3.8	SBB	1				4	2.3	DSRP-TOR (33sq.m), BRP-TOR (S) (12 no), DETOUR (43.8m)	
08602160	N. Sembilan	Seremban	1950	3	SSAL	3.7	1	3.7	SBB	1			3	1	1.7	SBPR-REP (9.5sq.m), DSRP-TOR (25sq.m), BRP-TOR(S) (12no) DETOUR (43.7m)	
08602600	N. Sembilan	Jelebu	1950	3	SSAL	3.0	1	3.0	SBB	1			4	4	2.9	APR-INJ (M)(WWPR) (1.2m), DETOUR (43m) Ok	
08602840	N. Sembilan	Jelebu	1960	3	STAL	3.1	1	3.1	RCB							Bridge has been replaced	
08603735	N.Sembilan	Jelebu	1950	3	SSAL	4.9	2	9.7	SBB	5			5	5		Bridge has collapsed 3 years ago due to abutment failure Bailey bridge is used as a temporary bridge - Construct a new bridge - 134.0sq.m -	
08603990	N.Sembilan	Jelebu	1930	3	P/A	9.6	1	9.6	SBB	1			4	4	2.9	SBPR-REP (66.6sq.m), DSRP-TOR (57.4sq.m) BRP-TOR (S) (12 no), DETOUR (49.6m)	
08604640	N.Sembilan	Jelebu	1950	3	SSAL	9.5	1	9.5	SBB	4			4	4	4.0	SBPR-REP (66.2sq.m), DSRP-TOR (57.1sq.m), APR-PAT (1.4sq.m), SRPR (16.4m), BRP-TOR (S) (12 no), DETOUR (49.5m)	ADD-S (36.8sq.m)

APPENDIX – R

BACKUP DATA FOR COST ESTIMATE

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APPENDIX – R1

UNIT RATE
LABOUR, MATERIAL AND EQUIPMENT

APPENDIX-R1 UNIT RATE OF LABOUR, MATERIAL AND EQUIPMENT

LABOUR UNIT RATE

REF. NO.	SPECIFICATION	UNIT	UNIT RATE	REMARKS
L01	Foreman	Man Per Day	80.00	8.00 hours per day
L02	Charge Hand	Man Per Day	70.00	
L03	Skilled Labour	Man Per Day	60.00	
L04	Common Labour	Man Per Day	30.00	
L05	Steel Labour	Man Per Day	30.00	
L06	Welder	Man Per Day	60.00	
L07	Carpenter	Man Per Day	60.00	
L08	Bar Bender	Man Per Day	60.00	
L09	Concrete Worker	Man Per Day	55.00	
L10	Mason	Man Per Day	60.00	
L11	Rigger	Man Per Day	55.00	
L12	Painter	Man Per Day	60.00	
L13	Mechanic	Man Per Day	60.00	
L14	Electrician	Man Per Day	60.00	
L15	Asphalt Layer	Man Per Day	40.00	
L16	Pavement Worker	Man Per Day	40.00	
L17	Pipe Fitter	Man Per Day	60.00	
L18	Plant Operator	Man Per Day	60.00	
L19	Driver	Man Per Day	45.00	

MATERIAL UNIT RATE

REF. NO.	DESCRIPTION	UNIT	UNIT RATE	REMARKS
M01	Diesel Oil Fuel	Litre	0.65	
M02	Gasoline	Litre	1.13	
M03	Lubricant	Litre	4.40	
M04	Portland Cement	Kg	0.25	
M05	Admixture	Litre	6.50	
M06	Reinforcement Steel	Kg	1.20	
M07	Wire Mesh (100 x 100)	m2	6.50	
M08	PC Strand Wire	Kg	2.80	
M09	PC Anchor 12-RT 15.5	No	400.00	
M10	Shealth Cable 35mm	Lin.m	450.00	
M11	Plywood, t=1/2", marine	m2	15.60	
M12	Plywood, t=1.2", ordinary	m2	13.80	
M13	Timber, Yakal	m3	600.00	
M14	Timber, Apitong	m3	400.00	
M15	Timber Piles (L=5m)	No	90.00	
M16	Bakau Pile	No	48.00	4" DIA, 18' Long
			70.00	5" DIA, 18' Long
M17	PC Pile (350 x 350)	m	60.00	
	PC Pile (400 x 400)	m	68.40	

APPENDIX–R1 UNIT RATE OF LABOUR, MATERIAL AND EQUIPMENT

REF. NO.	DESCRIPTION	UNIT	UNIT RATE	REMARKS
M18	Sand	m3	20.00	
M19	Aggregate	m3	44.00	
M20	Boulders	m3	20.00	
M21	Selected Soil	m3	10.00	
M22	Clayey Soil	m3	30.00	
M23	Sand Bag (20 kg/sack)	No	0.60	
M24	Crusher run	m3	32.00	
M25	H–Shaped Steel	Kg	1.80	
M26	Angle Steel	Kg	1.40	
M27	Steel Plate	Kg	1.50	
M28	Steel Sheet PIle	Kg	1.90	
M29	Acetylene Gas	m3	12.00	
M30	Oxygen Gas	m3	5.10	
M31	Bituminous Material	Ton	428.00	
M32	Asphalt	m2	1.50	
M33	Paint (anti–corrosion)			
	a) Copon 8048 Red Oxide	Litre	19.25	
	b) Copon 8048 Aluminium	Litre	19.25	
	c) Polyurethane Finish	Litre	24.20	
M34	Primer	Litre	13.00	Zine Chrome
M35	Epoxy Resin	Litre	52.00	S40 Bond 101
			96.00	SB, BL Grout
M36	Mortar			
	a) Barra Mortar L	Kg	1.80	
	b) Barrafer	Kg	11.40	
	c) Construction Grout	Kg	1.80	
	d) Barra Emulsion 57	Kg	8.50	
	e) SB 303C	Kg	27.50	
	f) SB 301	Kg	64.00	
M37	Silica Sand	Kg	2.50	
M38	3 S joint	m	2000.00	
M39	Cut Off Joint	m	700.00	
M40	Joint Sealant (Paltox)	Litre	17.00	
M41	BL seal	Kg	31.00	
M42	Dish Sand Paper (150#30)	Piece	10.00	
	Dish Sand Paper (150#16)	Piece	10.00	
M43	Thinner	Litre	5.65	General Purposes Thinner TP 1001
M44	Drill Tip	No	5.00	
M45	Pipe for injection (Aluminium)	No	8.00	Minimum 5000 pieces
M46	Pipe for air release (Aluminium)	No	8.00	Minimum 5000 pieces
M48	Electrode	Kg	3.00	
M49	Diamond Saw	Purchase	1500.00	1 piece

APPENDIX-R1 UNIT RATE OF LABOUR, MATERIAL AND EQUIPMENT

REF. NO.	DESCRIPTION	UNIT	UNIT RATE	REMARKS
M50	Bolts	No	10.00	
M51	Concrete Anchor	No	4.00	
M52	Cobble Stone (150 DIA)	m3	60.00	
M53	Yoke	m3	600.00	
M54	Form tie	No	0.40	
M55	Separator	No	0.20	
M56	Square pipe	m	0.40	
M57	Spacer	No	0.20	
M58	Jack base	No	3.20	
M59	clamp	No	1.40	
M60	Pipe Joint	No	1.20	
M61	Formoil	l	5.00	
M62	Toeboard	No	1.20	
M63	PVC pipe 50 DIA	m	6.00	
	PVC pipe 150 DIA	m	46.00	
	PVC pipe 200 DIA	m	70.00	
M64	Bonding wire	t	2000.00	
M65	Straightrun asphalt	t	360.00	
M66	Asphalt emulsion	t	385.00	

EQUIPMENT UNIT RATE

REF. NO.	EQUIPMENT DESCRIPTION	SPECIFIC	UNIT	UNIT RATE	REMARKS
E01	Bulldozer (D4)	6 Ton	Hour	65.00	
E02	Bulldozer (D6)	15 Ton	Hour	80.00	
E03	Bulldozer (D7)	21 Ton	Hour	90.00	
E04	Bulldozer (D8)	38 Ton	Hour	100.00	
E05	Wheel Loader	1.2 sq.m	Hour	50.00	
E06	Wheel Loader	1.4 sq.m	Hour	50.00	
E07	Wheel Loader	1.7 sq.m	Hour	55.00	
E08	Wheel Loader	2.1 sq.m	Hour	60.00	
E09	Backhoe	0.3 sq.m	Hour	30.00	
E10	Backhoe	0.7 sq.m	Hour	30.00	
E11	Backhoe	1.2 sq.m	Hour	30.00	
E12	Crowler crane	35 Ton	Hour	100.00	
E13	Crowler crane	50 Ton	Hour	130.00	
E14	Crowler crane	100 Ton	Hour	450.00	
E15	Mobile Crane	5 Ton	Hour	45.50	
E16	Mobile Crane	10 Ton	Hour	58.00	
E17	Mobile Crane	15 Ton	Hour	65.00	
E18	Mobile Crane	20 Ton	Hour	71.50	
E19	Mobile Crane	35 Ton	Hour	100.00	
E20	Dump Truck	10 Ton	Hour	40.00	

APPENDIX–R1 UNIT RATE OF LABOUR, MATERIAL AND EQUIPMENT

REF. NO.	EQUIPMENT DESCRIPTION	SPECIFIC	UNIT	UNIT RATE	REMARKS
E21	Cargo Truck	6 Ton	Hour	30.00	
	Cargo Truck	10 Ton	Hour	40.00	
	Trail Truck	30 Ton	Hour	650.00	
E22	Tipper		Hour	40.00	
E23	Bituminous Mixing Plant	50 TPH	Hour	260.00	
E24	Asphalt Plant	100 TPH	Hour	520.00	
E25	Macadam Roller	12 Ton	Hour	50.00	
E26	Steel Wheel Roller	5–9 Ton	Hour	49.00	
E27	Steel Wheel Roller	10–12 Ton	Hour	60.00	
E28	Rubber Tire Roller	12–13 Ton	Hour	55.00	
E29	Vibratory Roller	1 Ton	Hour	50.00	
E30	Vibratory Roller	9 Ton	Hour	60.00	
E31	Vibratory Roller	12 Ton	Hour	65.00	
E32	Portable Compactor		Hour	10.40	
E33	Grader	2.5m blade	Hour	40.00	
E34	Motor Grader	3.7m blade	Hour	75.00	
E35	Agigator Truck	2.0 cu.m/hr	Hour	20.00	
E36	Concrete Truck Mixer	5.0 cu.m	Hour	45.40	
E37	Concrete Mixer	2.0 cu.m/hr	Hour	19.50	
E38	Concrete Mixer	0.3 cu.m/hr	Hour	9.10	
E39	Portable Batcher Plant	30 cu.m/hr	Hour		
E40	Hand Mixer	115 DIA,0.51kw	Piece	550.00	
E41	Concrete Pump	30 cu.m/hr	Hour	150.00	1 set
E42	Generator Set	30 kw	Day	100.00	
E43	Generator Set	50 – 100kw	Day	160.00	
E44	Portable Air Compressor	10m3		140.00	
		5m3		100.00	
E45	Concrete saw	25cm	Day	20.00	
E46	Concrete Cutter	250m DIA	Day	40.00	
E47	Concrete Breaker	30 kg	Day	10.00	
E48	Vibrator	30mm	Day	10.00	
E49	Leg Hammer	30kg	Day	10.00	
E50	Clamshell	0.6 – 0.8cu.m	Hour	250.00	
E51	Diesel Hammer	2.5 Ton	Hour	140.00	
E52	Vibrating Hammer	60 kw	Hour	250.00	
E53	Pick hammer (Jack Hammer)	7 kg	Day	35.00	
	Pile Driver	35 Ton	Day	1680.00	
E54	Reserve Circulting Drill Sets	800 – 1.5mm			
E55	Vibration Drill	14 DIA, 0.4 kw	Purchase	450.00	Depend
E56	Electrical Drill	20 DIA, 0.86kw	Purchase	650.00	1 set
E57	Submersible Pump	150mm DIA	Day	30.00	
E58	Submersible Pump	100mm DIA	Day	15.00	
E59	Welding Machine	200A	Hour	15.00	

APPENDIX–R1 UNIT RATE OF LABOUR, MATERIAL AND EQUIPMENT

REF. NO.	EQUIPMENT DESCRIPTION	SPECIFIC	UNIT	UNIT RATE	REMARKS
E60	Bar Bender	Max. 25mm	Day	35.00	
E61	Bar Cutter		Day	35.00	
E62	Dishsander	150 DIA, 1.1kw	Purchase	450.00	1 piece
E63	Chain Block		Purchase	650.00	1 set
E64	Calibrator		Purchase	300.00	1 piece
E65	Temporary Bolts		Purchase	8.00	1 piece
E66	Winch		Purchase	800.00	1 piece
E67	Torgue Wrench		Purchase	300.00	5 Tonne
E68	Grout Injection Tool		Day	25.00	1 set (Foot Pump)
E69	Vibro Plate	60 kg	Day	35.00	
E70	Tamper	60 – 80 kg	Day	35.00	
E71	Asphalt Finisher		Hour	55.00	
E72	Belt Conveyor		Day	30.00	
E73	Chipping Machine		Day	100.00	
E74	Paver–BK 175 or equivalent (120 TON/HR)		Hour	91.00	
E75	Paver – BK 165 or equivalent (100 TON/HR)		Hour	84.50	
E76	Dish sander (150mm DIA 1.1kW)		Day	25.00	

Remarks : These data are based on market research in K.L., December, 1991

APPENDIX – R2

EXAMPLE CALCULATION SHEETS OF UNIT PRICE ANALYSIS FOR SEVERAL WORK ITEMS

Note: This appendix consist of composition of pay items per one bridge and derivation of unit price for several items of those. Fig. R–1 and Fig. R–2 show composition of pay items for Bridge No. 00341800. While Table R–1 – R–3 indicate unit price derivation from trial calculation with using production rate derived in Japan to calibrated calculation with using modified production rate.

FIGURE R－1 COMPOSITION OF PAY ITEMS FOR BRIDGE NO. 00341800

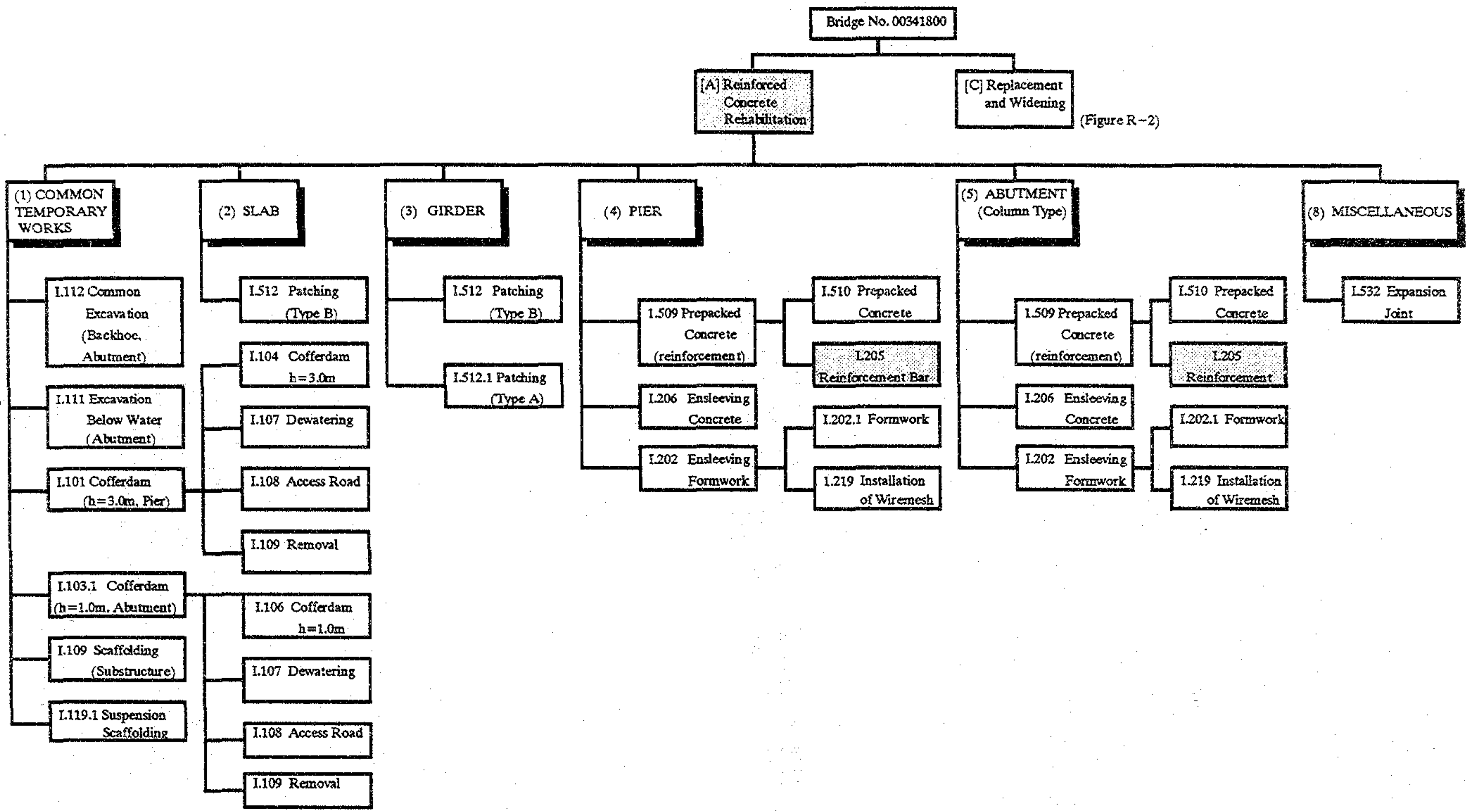

FIGURE R−2 COMPOSITION OF PAY ITEMS FOR BRIDGE NO. 00341800

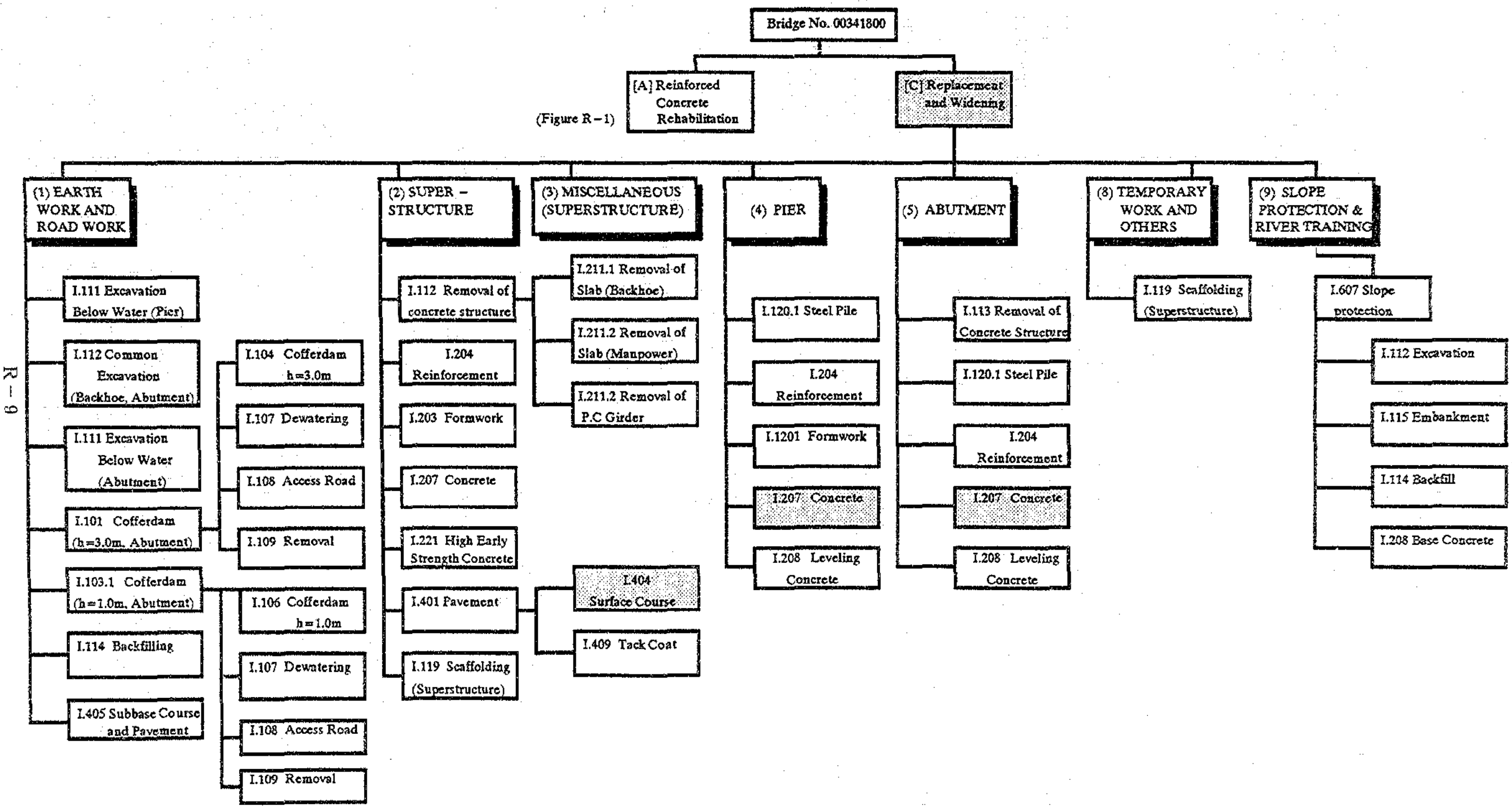

Table R−1 Derivation of Unit Price for Surface Course Work

ITEM No. : L404
WORK ITEM : Surface Course
NOTE : Thickness is 50 mm

Estimated for : 650 m2

	BREAKDOWN OF UNIT PRICE WITH PRODUCTION RATE IN JAPAN						UNIT PRICE WITH CALIBRATED PRODUCTION RATE			
	DISCRIPTION	SPECIFICATION	UNIT	QUANTITY	UNIT PRICE	AMOUNT (M$)	QUANTITY	UNIT	AMOUNT (M$)	REMARKS
1	Material Cost									
	Hot mixed asphalt	2.5x1.08	t	78.49	68.00	5337.32	81.00	68.00	5508.00	1.03
	Timber	50x100x4.000	m3	0.53	600.00	318.00	0.53	600.00	318.00	1.00
	Sub−total					5655.32			5826.00	
2	Labour Cost									
	Foreman		day	0.72	80.00	57.60	1.00	80.00	80.00	1.39
	Pavement worker		day	4.10	40.00	164.00	6.00	40.00	240.00	1.46
	Common labour		day	1.40	30.00	42.00	2.00	30.00	60.00	1.43
	Sub−total					263.60			380.00	
3	Equipment Cost									
	Asphalt finisher		hr	7.13	55.00	392.15	8.00	55.00	440.00	1.12
	Macadam roller		hr	7.13	50.00	356.50	8.00	50.00	400.00	1.12
	Rubber tire roller		hr	7.13	55.00	392.15	8.00	55.00	440.00	1.12
	Dump truck	10t	hr	14.20	40.00	568.00	16.00	40.00	640.00	1.13
	Sub−total					1708.80			1920.00	
4	TOTAL					7627.72			8126.00	
5	UNIT PRICE		M$/m2			11.73			12.50	1.07

Table R−2 Derivation of Unit Price for Concrete Work

ITEM No. : L207
WORK ITEM : Concrete
NOTE : Portable mixer (0.3 m3 batch), carrying and casting by manpower

Estimated for : 1.00 m3

	BREAKDOWN OF UNIT PRICE WITH PRODUCTION RATE IN JAPAN						UNIT PRICE WITH CALIBRATED PRODUCTION RATE			
	DISCRIPTION	SPECIFICATION	UNIT	QUANTITY	UNIT PRICE	AMOUNT (M$)	QUANTITY	UNIT PRICE	AMOUNT (M$)	REMARKS
1	Material Cost									
	Portland cement		t	0.33	250.00	82.50	0.33	250.00	82.50	1.00
	Sand		m3	0.38	20.00	7.60	0.38	20.00	7.60	1.00
	Aggregate		m3	0.69	44.00	30.36	0.69	44.00	30.36	1.00
	Agent		kg	0.75	6.50	4.88	0.75	6.50	4.88	1.00
	Sub−total					125.34			125.34	
2	Labour Cost									
	Foreman		day	0.15	80.00	12.00	0.22	80.00	17.60	1.47
	Concrete worker		day	0.55	55.00	30.25	0.79	55.00	43.45	1.44
	Operator		day	0.06	60.00	3.60	0.08	60.00	4.80	1.33
	Common labour		day	0.52	30.00	15.60	0.72	30.00	21.60	1.38
	Sub−total					61.45			87.45	
3	Equipment Cost									
	Batcher plant		hr	0.27	9.10	2.46	0.33	9.10	3.00	1.22
	Wheel barrow	0.3 m3	hr	0.18	10.00	1.80	0.21	10.00	2.10	1.17
	Vibrator		hr	2.00	1.25	2.50	2.40	1.25	3.00	1.20
	Sub−total					6.76			8.10	
4	TOTAL					193.54			220.89	
5	UNIT PRICE		M$/m3			193.54			220.89	1.14

Table R−3 Derivation of Unit Price for Reinforcement Work

ITEM No. : L205
WORK ITEM : Reinforcement
NOTE : Including Cutting by acetylene gas and welding by engine welder

Estimated for : 100 kg

	BREAKDOWN OF UNIT PRICE WITH PRODUCTION RATE IN JAPAN						UNIT PRICE WITH CALIBRATED PRODUCTION RATE			
	DISCRIPTION	SPECIFICATION	UNIT	QUANTITY	UNIT PRICE	AMOUNT (M$)	QUANTITY	UNIT PRICE	AMOUNT (M$)	REMARKS
1	Material Cost									
	Reinforcement bar	13 − 25mm dia.	t	0.103	1200.00	123.60	0.11	1200.00	132.00	1.07
	Electrode		kg	5.00	3.00	15.00	5.00	3.00	15.00	1.00
	Acetylene gas		m3	0.30	12.00	3.60	0.30	12.00	3.60	1.00
	Oxygen gas		m3	0.60	5.10	3.06	0.60	5.10	3.06	1.00
	Gasoline		L	9.20	1.13	10.40	9.20	1.13	10.40	1.00
	Sub−total					155.66			164.06	
2	Labour Cost									
	Foreman		day	1.15	80.00	92.00	1.50	80.00	120.00	1.30
	Welderman		day	1.50	60.00	90.00	2.00	60.00	120.00	1.33
	Unskilled labour		day	0.75	30.00	22.50	1.00	30.00	30.00	1.33
	Sub−total					204.50			270.00	
3	Equipment Cost									
	Engine welder	200A 10.5ps	day	0.80	120.00	96.00	1.00	120.00	120.00	1.25
	Sub−total					96.00			120.00	
4	TOTAL					456.16			554.06	
5	UNIT PRICE		M$/kg			4.56			5.54	1.21

APPENDIX – R3

COST ESTIMATE
OF EACH STUDY BRIDGE (216 BRIDGES)

APPENDIX–R3 COST ESTIMATE OF EACH STUDY BRIDGE (216 BRIDGES)

No.	Key	State	Year Built	Max. Span (m)	No's of Spans	Span Length (m)	Type of Bridge	Rehabilitation Plans	Unit	Quantity	Unit Price (M$)	Amount (M$)	Total Amount (M$)	Remarks
1	00102590	Johor	1955	1.80	2	3.60	BOX	DCPR–WPL	M2	33.0	75.0	2,475	3,829	
								DCPR–PAT	M2	0.2	270.0	54		
								APR–PAT	M2	0.6	270.0	152		
								APR–INJ	M	1.0	120.0	120		
								APR–PAT	M2	0.7	270.0	189		
								PPR–PAT	M2	0.2	270.0	62		
								SCAFFOLDING	M2	36.0	21.3	767		
2	00108100	Johor	1964	16.90	3	27.40	RCB	CBPR–PAT	M2	1.9	270.0	513	77,104	
								CBPR–SHT	M2	9.2	760.0	6,992		
								CBPR–COT	M2	127.0	32.4	4,115		
								PFPR–RBP	M2	20.0	260.0	5,200		
								APR–INJ	M	5.4	120.0	648		
								CRRF	M	54.6	100.0	5,460		
								EJN	M	16.0	3020.0	48,320		
								SCAFFOLDING	M2	274.0	21.3	5,836		
3	00109990	Johor	1907	2.18	1	2.18	BOX	DCPR–PAT	M2	0.1	270.0	27	3,762	
								APR–PAT	M2	9.0	270.0	2,430		
								SFRS	M2	21.0	41.0	861		
								SCAFFOLDING	M2	21.8	21.3	454		
4	00112630	Johor	1960	6.27	1	6.27	RCS	CBPR–PAT	M2	2.4	270.0	643	26,862	
								WWRP	M3	4.0	600.0	2,400		
								CRRE	M	12.6	176.0	2,207		
								EJN	M	15.0	1190.0	17,850		
								SFRS	M2	21.0	41.0	861		
								DRRF	No	4.0	390.0	1,560		
								SCAFFOLDING	M2	62.7	21.3	1,336		
5	00113760	Johor	1965	6.83	3	20.34	RCB	CBPR–PAT	M2	0.6	270.0	162	142,271	
								DCPR–PAT	M2	1.6	270.0	432		
								APR–PAT	M2	0.5	270.0	135		
								SRRF	M	24.0	105.0	2,520		
								EJN	M	7.0	1190.0	8,330		
								ADD–IS	M2	81.0	1560.0	126,360		
								SCAFFOLDING	M2	203.4	21.3	4,332		
6	00114920	Johor	1965	6.43	2	12.86	RCB					112,917	112,917	INCLUDED IN DETAILED SURVEY
7	00116550	Johor	1947	2.44	2	4.88	BOX	DCPR–PAT	M2	0.1	270.0	27	31,354	
								ARF–PAL	M2	15.2	190.0	2,888		
								COFFERDAM	No	2.0	13700.0	27,400		H=1.0
								SCAFFOLDING	M2	48.6	21.3	1,039		
8	00121260	Johor	1955	2.42	1	2.42	BOX			–	–	–	–	BRIDGE HAS BEEN REPLACED
9	00121280	Johor	1950	2.83	1	2.83	BOX			–	–	–	–	BRIDGE HAS BEEN REPLACED
10	00125250	N.Sembilan	1960	6.70	1	6.70	RCB	CBPR–INJ	M	0.5	120.0	60	3,926	
								DCPR–PAT	M2	0.3	270.0	81		
								SRRE	M	13.4	176.0	2,358		
								SCAFFOLDING	M2	67.0	21.3	1,427		
11	00128254	N.Sembilan	1900	9.58	1	9.58	SBC	SBPR–REP	M2	48.9	58.0	2,836	27,478	
								EJN	M	17.3	1190.0	20,587		
								CRRF	M	19.2	100.0	1,916		
								BPR–REP	No	8.0	12.0	96		
								SCAFFOLDING	M2	95.8	21.3	2,041		
12	00145100	Selangor	1903	1.85	1	1.85	SBE	SFRS	M2	2.3	41.0	93	1,616	
								DCPR–PAT	M2	4.2	270.0	1,129		
								SCAFFOLDING	M2	18.5	21.3	394		
13	00146900	Selangor	1965	12.13	3	25.81	IT	CBPR–INJ	M	0.5	120.0	60	58,263	
								DCPR–WPL	M2	178.0	75.0	13,350		
								APR–INJ	M	2.5	120.0	300		
								AFPR–REV	M2	41.0	140.0	5,740		
								SFRS	M2	2.3	41.0	94		
								EJN	M	11.0	3020.0	33,220		
								SCAFFOLDING	M2	259.1	21.3	5,519		
14	00148900	Perak	1952	2.40	1	2.40	BOX	DCPR–PAT	M2	6.1	270.0	1,647	2,158	
								SCAFFOLDING	M2	24.0	21.3	511		
15	00149920	Perak	1963	12.08	3	36.24	IT	DCPR–WPL	M2	104.0	75.0	7,800	48,659	
								APR–INJ	M	0.6	120.0	72		
								SRRF	M	3.0	105.0	315		
								CRRF	M	72.5	100.0	7,248		
								SFRS	M2	0.1	41.0	4		
								EJN	M	11.0	3020.0	33,220		
16	00151350	Perak	1930	9.08	7	63.56	RCB	SRRF	M	17.0	105.0	1,785	90,341	
								CRRF	M	127.1	100.0	12,712		
								EJN	M	63.7	1190.0	75,803		
								SFRS	M2	1.0	41.0	41		
17	00155590	Perak	1970	1.81	2	3.62	BOX	DCRF–UG	M2	75.0	3160.0	237,000	298,271	
								ARF–PAL	M2	40.0	190.0	7,600		
								PRF–PAL	M2	40.0	190.0	7,600		
								COFFERDAM	No	2.0	13700.0	27,400		
								COFFERDAM	No	1.0	17900.0	17,900		H=1.0
								SCAFFOLDING	M2	36.2	21.3	771		
18	00159100	Perak	1949	11.50	3	31.30	SBS			–	–	–	–	BRIDGE HAS BEEN REPLACED
19	00161140	Perak	1950	9.77	2	19.11	SBB					402,568	402,568	*INCLUDED IN DETAILED SURVEY*
20	00161290	Perak	1955	8.09	2	16.16	SBB	SBPR–REP	M2	273.0	0.0	0	266,226	
								DSRP–TOR	M2	156.0	560.0	87,360		
								AFPR–REV	M2	41.0	140.0	5,740		
								BRP–TOR(6)	No	36.0	0.0	0		
								ADD–IS	M2	67.0	1940.0	129,980		
								DETOUR	M	56.2	590.0	33,146		
21	00165220	Perak	1945	5.67	1	5.67	SBB	SBPR–REP	M2	53.0	0.0	0	87,093	
								DSRP–TOR	M2	54.0	560.0	30,240		
								ARF–TOL	M2	13.2	190.0	2,508		
								BRP–TOR(6)	No	14.0	0.0	0		
								COFFERDAM	No	2.0	13700.0	27,400		H=1.0
								DETOUR	M	45.7	590.0	26,946		
22	00166510	Perak	1935	10.72	1	10.72	SBG					502,038	502,038	INCLUDED IN DETAILED SURVEY
23	00184400	Kedah	1950	2.61	2	12.20	RCB	CBRF–BSP	M2	25.4	930.0	23,622	113,090	
								DCPR–WPL	M2	176.0	75.0	13200.0		
								ARF–TOL	M	16.0	416.0	6,656		380x380
								EJN	M	27.7	1190.0	32,987		
								ASIN	No	2.0	3020.0	6,040		
								SRPR	M	24.4	24.0	565		
								COFFERDAM	No	2.0	13700.0	27,400		H=1.0
								SCAFFOLDING	M2	122.0	21.3	2,599		