8. Superstucture Design

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

The design method and manners of the superstructures such as Reinforced Concrete and Prestressed Concrete shall be based on the provisions prescribed in BS 5400.

9. Substructure Design

The present practices of substructure design in Sri Lanka is based on BS 8004. 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 L-10 and L-11 below.

Table L-10 Classification of Spread Footing and Caisson Foundation

Types of Foundation	Ratio of Df / B
Spread footing	$Df / B \leqq 1/2$
Caisson	$Df / B > 1/2$

Df : Effective embedded depth
B : Shorter width of foundation

Table L-11 Classification of Caisson and Pile Foundation

Type of Foundation	Pile or Caisson Characteristic
Caisson	$\beta \cdot L \leqq 1$
Short Pile	$1 < \beta \cdot L3$
Long Pile	$\beta \cdot L > 3$

where ;

L = embedded length of caisson or pile (m)
β = 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 of pile (kN/m^3)

note:-

1. 'k' for caisson shall be taken as a mean value from ground surface to the point of 1/2 depth.
2. 'k' for pile shall be taken as a mena 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 L-12 and L-13 respectively.

Table L-12 Allowable Bearing Pressure for Spread Footing

Type of Bearing Material	Consistency	Allowable Bearing Pressure kN/m²	
		Ordinary Range	Recommended for Use
Alluvial Soil	Soft	0 - 80	50
	Medium	100 - 200	150
	Very Stiff to Hard	200 - 400	250
Homogeneous Inorganic Clay, Sandy or Silty Clay	Soft	50 - 80	50
	Medium to Stiff	100 - 300	200
	Very Stiff to Hard	300 - 500	300
Fine to Medium Sand	Loose	100 - 200	100
	Medium Dense	200 - 300	200
	Very Dense	300 - 400	300
Gravel, Gravel-sand Mixtures, Boulder-gravel Mixtures	Loose	200 - 300	200
	Medium Dense	400 - 600	400
	Very Dense	600 - 800	700

Table L-13 Angle of Internal Friction for A Broad Basic Soil Type

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 aliding. The sliding resistance at base of footing shall be obtained as follows:-

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

where;

Hu	:	maximum sliding resistance (t)
C	:	cohesion of foundation and ground (t/m²)
β	:	friction angle between foundation and ground (°)
A	:	effective loaded area (m²)
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;

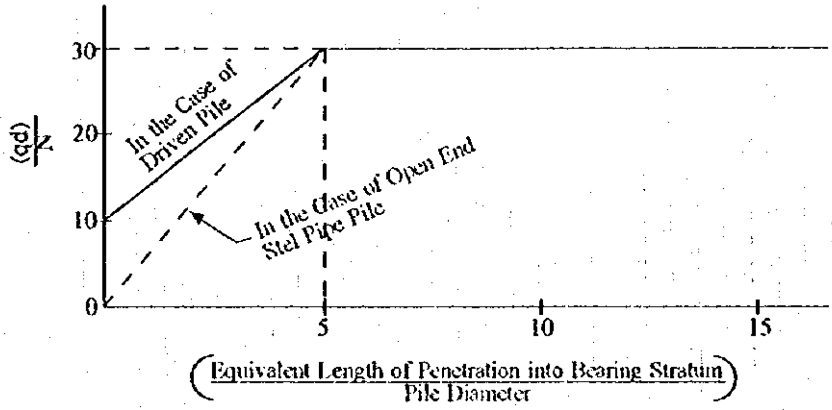
Ra	:	allwable load carrying capacity of pile (t)
n	:	safety factor (refer to Table L-14)
Ws	:	eff. wt of soil replaced by the pile (t)
W	:	eff. wt of pile and earth in it (t)
Ru	:	ultimate bearing capacity of pile (t) = $q_d A + u \Sigma l_i f_i$
A	:	cross-sectional pile tip
q_d	:	ultimate bearing capacity 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/m²)

Table L-14 Pile Safety Factor

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

In case of drivin piles, the ultimate bearing capacity per unit area at the pile tip may be estimated from Figure L-5 below;

Figure L-5 Chart for calculating the Ultimate Bearing Capacity of the Ground at Pile Tip per Unit Area



In Figure L-5 above ' q_d / n ' is given as a function of the ratio of the length 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 N to be used for estimating the bearing capacity of a driven pile (ie. based on Figure L-5 above).

$N = (N_1+N_2) / 2$

where;

N	:	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

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-valu distribution curve and the line of N.

The friction force depends on the type of pile and soil. The maximum friction force in Table L-15 below may be used for preliminary design.

Table L-15 Skin Friction Force

Soil Type	Skin Friction Force (t/m²)	
	Cast in Place	Case in Place Driven
Sandy Soil	N / 5(≦10)	N / 2 (≦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 1/2 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 otuermost row and the dege 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 2.5m 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:-

$$q_a = 1/n \cdot (q_d - \gamma_2 \cdot D_f) + \gamma_2 \cdot D_f$$
$$q_d = \alpha \cdot C \cdot N_C + 1/2 \cdot \beta \cdot \gamma_1 \cdot B \cdot Nr + 2 \cdot D_f \cdot N_q$$

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)
γ_1	:	bulk density of ground at base of caisson (t/cu.m)
γ_2	:	bulk density of earth surrounding the caisson
α ; β	:	shape factor of the base of caisson as in Table L-16
D_f	:	effective embedded length
N_C, N_q, Nr	:	coefficient of bearig capacity (Figure L-6)

Figure L-6 Coefficient of Bearing Capacity

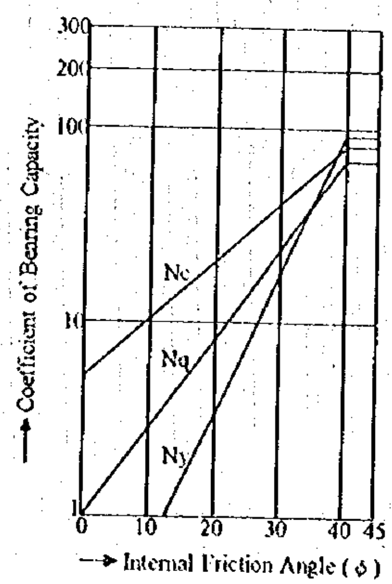


Table L-16 Shape Factor of the Base of Caisson

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 L-17 below:-

Table L-17 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, force 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 L-18 below shall be considered:-

Table L-18 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	-	1.25	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 L-19 below.

Table L-19 The Allowable Compressive and Shear Stress of Concrete

Class of Concrete Denoted by Specified 28-Day Work Curb 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	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

note; L[1] is applicable for the assessment in the study.

Steel Reinforcement

The permissible stresses in steel reinforcement shall be as given in Table L-20 below;

Table L-20 The Permissible Stresses in Steel Reinforcement

Type of Stress	Permissible Stresses in Rebar (N/mm2)		
	Mild Steel Bars		All cold work & hot rolled
	dia.<=40mm L1	dia.>40mm	high yield bar
Tensile stress other than in shear reinforcement	140	125	230
Tensile stres 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; L[1] 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 L-21 below;

Table L-21 The Permissible STresses in Structural Steel

Stress 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	150	142	135	138	85
	245	160	151	144	147	91
	280	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

(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 γ_m, the partial safety factor for material.

- Extreme fibre stress in compression, fc ...... 0.67 fcu/m
- (γ_m shall be taken as 1.5)
- Ultimate bearing stress, fb .... 0.4 fcu
- Ultimate shear stress, Vc shall be as follows:

$$Vc = 0.27 / \gamma_m \{(100 \cdot As)/(b_w \cdot d)\}^{1/3} \cdot fcu^{1/3}$$

where;

As	:	area of longitudinal rebar
b_w	:	breadth of web or rib of member
d	:	effective depth of tension rebar
fcu	:	characteristic concrete cube strength
γ_m	:	1.25

Reinforcing Steel

- The ultimate tensile strength, fs = 0.8fy/m
- (γ_m shall be taken as 1.15)
- Characteristic strength of reinforcement, fy is as follows;
  Mild steel .... 250 N/mm²
  High yield steel .... 425 N/mm²

Structural Steel

Nominal yield stress for steel complying with BS 4360 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 RDA Bridge Design Calculation 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.

13. **Design of Concrete Slab Deck** Source: Specification for Highway Bridges, 1984
Specification for Highway Bridges, 1994
both from Japan Road Association

Note: The word "deck slab" in the Study is defined as "floor slab" in the Specifications for Highway Bridges, 1987.

6.1 REINFORCED CONCRETE FLOOR SLAB

6.1.1 General

(1) Ratio of Young's modulus of reinforcements and concrete used in reinforced concrete floor slab shall be 15 except for the calculation of the action of slab as a main beam in a composited girder.

(2) When a reinforced concrete floor slab is designed in accordance with this section, check for shear force may be omitted.

6.1.2 Span length of floor slab

(1) Span length of a simply supported floor slab or continuous supported floor slab for the T-loading and dead load shall be the distance center to center of supporting girders measured in the direction of main reinforcements. In case of a simple span, if the value of the clear span measured in the direction of main reinforcements plus slab thickness is less than the distance center to center of supporting girders, the former value may be taken as the span length.

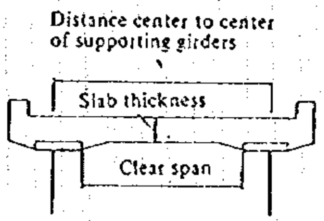


Fig. 6.1.1 Span length of simply supported slab

6.1.3 Design bending moment of floor slab

(1) Design bending moment per unit width (1m) of a slab subject to T-loading (including impact) shall be calculated by the equation given in Table 6.1.1. However, in the design of bridge where large vehicles for one direction per day in the estimated traffic volume are not less than 1,000, bending moment shall be increased 20% over the value calculated by the equation given in Table 6.1.1.

Table 6.1.1 Design bending moment per unit width (1 m) of floor slab due to T-loading (including impact) (kgf·m/m)

Type of slab	Kind of bending moment		Direction of slab span / Direction of bending moment / Applied range	For the span perpendicular to traffic		For the span parallel to traffic	
				Bending moment in direction of main reinforcement	Bending moment in direction of distribution reinforcement	Bending moment in direction of main reinforcement	Bending moment in direction of distribution reinforcement
Simply supported slab	Bending moment through span		$0 < L \leqq 4$	$+(0.12L + 0.07)P$	$+(0.10L + 0.04)P$	$+(0.22L + 0.08)P$	$+(0.06L + 0.06)P$
Continuous slab	Bending moment through span	Intermediate span	$0 < L \leqq 4$	+ (80% of the value for simply supported slab)	+ (80% of the value for simply supported slab)	+ (80% of the value for simply supported slab)	+ (Same value for simply supported slab)
		End span				+ (90% of the value for simply supported slab)	+ (Same value for simply supported slab)
	Bending moment at support	Intermediate support		− (80% of the value for simply supported slab)	−	− (80% of the value for simply supported slab)	−
Cantilever slab	Support		$0 < L \leqq 1.5$	$-\frac{PL}{(1.30L + 0.25)}$	−	$-(0.70L + 0.22)P$	−
	Near free end			−	$+(0.15L + 0.13)P$	−	$+(0.16L + 0.07)P$

where, L: Span length of floor slab for T-loading specified in Art. 6.1.3 (m)
P: One rear wheel load of T-loading specified in Art. 2.1.3, PART I: COMMON (kgf)
For 1st class bridge: P = 8,000 kgf

where, L = span length of floor slab for T-loading specified in Art.6.1.3 (m)
P = one rear wheel load of T-loading specified in Art. 2.1.3, PART I: COMMON (kgf)
for 1st class bridge: P = 8,000kgf

(2) Design bending moment of a floor slab per unit width (1m) due to uniform dead load may be calculated by the equation in Table 6.1.2.

Table 6.1.2 Design bending moment per unit width (1 m) due to uniform dead load (kgf·m/m)

Type of slab	Kind of bending moment		Bending moment in direction of main reinforcement	Bending moment in direction of distribution reinforcement
Simply supported slab	Bending moment through span		$+\omega L^2/8$	Negligible
Cantilever slab	Bending moment at support		$-\omega L^2/2$	
Continuous slab	Bending moment through span	End span	$+\omega L^2/10$	
		Intermediate	$+\omega L^2/14$	
	Bending moment at support	2 spans	$-\omega L^2/8$	
		More than 3 spans	$-\omega L^2/10$	

where, L: Span length of floor slab for dead load as specified in Art. 6.1.3 (m)
ω: Uniform dead load (kgf/m^2)

(3) When stiffness of girders which support a floor slab differ remarkably from each other, Table 6.1.1 and 6.1.2 shall not be applied to the design of the floor slab. In this case, design bending moment shall be calculated considering the difference of stiffness of girders which support the floor slab.

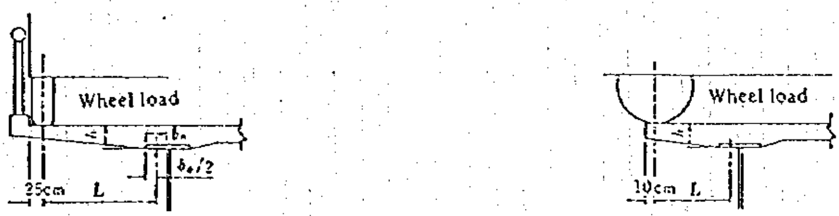
6.1.4 Minimum thickness of floor slab

(1) Minimum thickness of a floor slab in the roadway portion shall be the value given in Table 6.1.3, but not less than 16cm in any case. Minimum thickness of a cantilever slab shall be the value for the thickness h shown in Fig. 6.1.3.

Table 6.1.3 Minimum thickness of floor slab in the roadway portion (cm)

Type of slab		Direction of slab span		
		Perpendicular to traffic		Parallel to traffic
1st class bridge	Simply supported slab	4L + 11		6.5L + 13
	Continuous slab	3L + 11		5L + 13
	Cantilever-slab	$0 < L \leq 0.25$	28L + 16	24L + 13
		$L > 0.25$	8L + 21	

where, L: Span length of a floor slab for T-loading specified in Art. 6.1.3.



(a) For main reinforcement perpendicular to traffic

(b) For main reinforcement parallel to traffic

Fig. 6.1.3 Minimum thickness h of cantilever slab

(2) Thickness of floor slab shall be given by equation:-

d = k1 * k2 * do .... (6.1.2)

where; d : thickness of floor slab (cm)

do : minimum thickness of floor slab defined in Table 6.1.3 (round off two decimal place do>= 16.0cm)

k1 : coefficient depend on traffic volume of large vehicles and difficulty of rehabilitation works as shown in Table 6.1.3 A

k2 : coefficient of additional moment due to deference of beams which support floor slab given by equation:

$$k2 = 0.9 \sqrt{M/M0} >= 1.00$$

In this study 1.00 is taken because outer beams and inner beams are the same in the bridges in Sri Lanka.

<table>
<tr><th rowspan="2">Design traffic volume of large vehicle per 1 way (vpd)</th><th rowspan="2">Difficulty of rehabilitation works</th><th colspan="2">Coefficient</th></tr>
<tr><th>Non-composite beam</th><th>Composite beam</th></tr>
<tr><td rowspan="2">vpd < 500</td><td>Easy</td><td>1.00</td><td>1.05</td></tr>
<tr><td>Difficult</td><td rowspan="2">1.05</td><td rowspan="2">1.10</td></tr>
<tr><td rowspan="2">500 <= vpd < 1,000</td><td>Easy</td></tr>
<tr><td>Difficult</td><td rowspan="2">1.10</td><td rowspan="2">1.15</td></tr>
<tr><td rowspan="2">1,000 <= vpd < 2,000</td><td>Easy</td></tr>
<tr><td>Difficult</td><td rowspan="2">1.15</td><td rowspan="2">1.20</td></tr>
<tr><td rowspan="2">2,000 <= vpd</td><td>Easy</td></tr>
<tr><td>Difficult</td><td>1.20</td><td>1.25</td></tr>
</table>

Note: Difficulty of traffic safety control at rehabilitation works of floor slab.

(3) Minimum thickness of a floor slab in the sidewalk portion shall be 14cm.

6.1.6 Kind and arrangement of reinforcement

(1) Deformed bars shall be used as reinforcement and their diameters shall generally be 13, 16 and 19mm.

(2) Cover of reinforcement shall not be less than 3cm.

(3) Spacing of reinforcements shall not be less than 10cm and not more than 30cm. However, spacing of main tension reinforcements shall not exceed the thickness of a floor slab.

(4) Amount of reinforcements in compression area of the section shall generally be at least one half the amount of reinforcements in tension area.

(5) When main reinforcements are bent in a continuous slab, they shall be bent at the point of L/6 from the support as shown in Fig. 6.1.4. However, not less than 80% of tension reinforcements of a floor slab around the midpoint of span and not less than 50% of tension reinforcements around the support shall not be bent and shall be placed continuously. Here, L is the center to center distance of supporting girders.

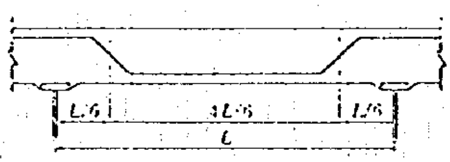
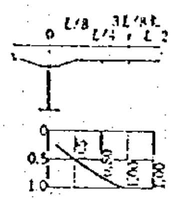
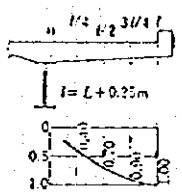
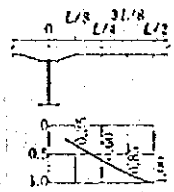
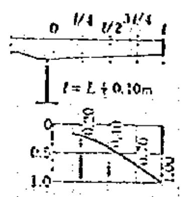


Fig. 6.1.4 Position of bent of main reinforcement for continuous slab

(6) The amount of distribution reinforcements in a floor slab may e changed along the direction of span. In this case, amount of reinforcements can be calculated as the product of the amount of distribution reinforcements specified in Art. 6.1.4 and the factors in Table 6.1.4.

Table 6.1.4 Factors for calculating the amount of distribution reinforcement in floor slab

For floor slab whose span is perpendicular to traffic		For floor slab whose span is parallel to traffic	
Continuous or simply supported slab	Cantilever slab without sidewalk	Continuous or simply supported slab	Cantilever slab
			

L : (m)

6.1.5 Allowable stress of reinforcement

Allowable stress of reinforcements for a floor slab shall be given in Table 6.1.5.

Table 6.1.5 Allowable stress of reinforcement (kgf/cm2)

Grade of reinforcement	Allowable tensile stress	Allowable compressive stress
425 / 460	1,400	1,400

6.1.6 Specified compressive strength of concrete

Specified compressive strength σck of concrete for a floor slab shall conform to the following provisions.

(1) Not less than Grade 30 shall be taken when composed action of concrete with steel girders is not considered.

6.1.7 Allowable stress of concrete

(1) Allowable bending compressive stress of concrete for a floor slab shall be 1/3 of the specified compressive strength σck for design when composed action of concrete with steel girders is not considered. However, it shall not exceed 100kgf/cm2.

(2) Allowable stress of concrete for a floor slab shall conform to the provisions in Art. 9.3.1 when composed action of concrete with steel girders is considered.

6.1.8 Impact coefficient shall be as follows:

$i = 20 / (50+L)$

where; L : span length

6.1.9 The effective width of floor slab

The effective width λ of floor slab on each side of web plates for the calculation of stresses and deformation shall be as given in equations. The application of these equations shall be as given in Table 6.1.9.

$\lambda = b$	$(b/l \le 0.05)$
$= \{1.1 - 2(b/l)\}\, b$	$(0.05 < b/l < 0.30)$
$= 0.15\, l$	$(0.30 \le b/l)$

where; λ : effective width of floor slab on each side of web plate (cm) (Fig. 6.1.9)
b : 1/2 of the distance between web plates or outstanding length of flange at cantilever (cm) (Fig. 6.1.9)
l : equivalent span length (cm) (Table 6.1.9)

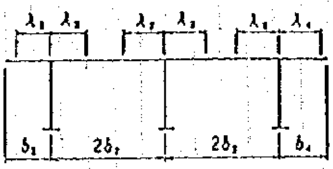


Fig. 6.1.9 Effective width of floor slab

Appendix - M

DATA OF PRELIMINARY REHABILITATION DESIGN FOR STEEL BRIDGES

LIST OF CONTENTS

M - 1.	General	M - 1
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M—1 General

This section presents back-up data for preliminary rehabilitation design of steel bridges and is composed as follows:-

M-2 Change of allowable stress of steel material as time passing

M-3 Stress check on Truss bridges, SER No. 77

M-4 Stress check on bridges selected for the loading test, SER No. 211

M-5 Calculation on representative beams

(1) Calculation on the assumption of composite beam

1) I-305
2) I-400

(2) Calculation on the assumption of non-composite beam

1) I-305
2) I-400

(3) Allowable flexural compressive stress

M-6 Study of new additional beam on RSJ

M-7 Study of covering of RSJ with RC

(1) General

(2) I-400

(3) I-305

M-8 Results of stress check for 54 nos. of RSJ bridges which the preliminary inspection was carried out.

M-9 Relaxation of restriction for tractor and trailer

M-10 Correspondent to increase of heavy vehicles in size (Interim Report)

M－2 Change of Allowable Stress of Steel Material as Time Passing

Maintenance and Rehabilitation Method for Railway Bridges

Dr. Kazuo Tomonaga

Source: Textbook of Summer Seminar,

Japan Society of Civil Engineer, 1951

Table-2 Allowable stress for new beam

German Standard for Design of Railway Bridge

Steel	Average stress of high and low yeild stress	Tensile and flexural stress kg/cm²		Tensile and flexural stress due to longitudinal load on lateral brace and bracking brace (kg/cm²)	Rivet		Pin
	kg/cm2	Primary load	Primary load + secondary load		Shear kg/cm²	Bearing kg/cm²	Bearing kg/cm²
St37	2 400	δzul 1 400	1 600	1 000	0.8 σzul	5 σzul	1.3 σzul
St52	3 600	δzul $1\ 400\times\frac{3\ 600}{2\ 400}$ ≒2 100	$1\ 600\times\frac{3\ 600}{2\ 400}$ ≒2 400	$1\ 000\times\frac{3\ 600}{2\ 400}$ ≒1 500	0.8 σzul	2 σzul	1.3 σzul

Note: 1) Coefficient of ω shall be considered for allowable compressive stress.

2) Primary load : Dead load, live load, impact, temperature change, centrifugal force, etc.

Secodary load: Wind, braking, collision, nonemiform, settlement, etc.

3) Material of rivet shall be St34 for St37, St44 for St52.

4) Allowable bearing stress of rivet for St37 was σc=2.5 σzul in 1933.

Allowable stress for old beam (existing beam)

Steel	Average stress of high and low yield stress kg/cm²	Modulous of elasticity kg/cm²	Modulous of rigidity kg/cm²	Tensile and flexural stress kg/cm²		Rivet and Bolt kg/cm²	
				Primary load	Secondary load	Shear	Bearing
Wrought iron and mild steel before 1894	2 200	2 000 000	770 000	σzul 1 400	1 600	0.8 σzul	3 σzul
Mild steel after 1895	2 400	2 100 000	810 000	σzul 1 500	1 700	0.8 σzul	3 σzul
St48	3 120	2 100 000	810 000	δzul $1\ 400\times\frac{3\ 120}{2\ 400}$ ≒1 820	$1\ 650\times\frac{3\ 120}{2\ 400}$ ≒2 030	0.8 σzul	3 σzul

Note: 1) Allowable bearing stress of pin is 10% above of the new beam.

2) Schaper said characteristics of the wrought iron are:

Braking stress ＝ 3.300 to 4.000 kg/cm2

E ＝ 2.000.000kg/cm2

Elongation ＝ 12 to 15%

3) According to the paper, Die Bautech. Heft 7/15 Feb 1929. Roloff, St37 replaced wrought iron.

St48 1924 (St44 for rivet)
StSi Sep. 1925 (St44 for rivet)
St52 Jan. 1929 (St44 for rivet)
Breaking stress for St37 is 3,700 to 4,500 kg/cm2.
Breaking stress for St34 is 3,400 to 4,200 kg/cm2.

Source: Japan Society of Civil Engineer

Table-3
from Rules for Rating Existing Iron and Steel Bridges(1636. A. R. E. A)(unit: lbs/in^2)

		Steel		Wrought iron
		Open hearth steel	Bessemer steel	
Axial tensile (net section)		24 000	21 000	20 000
Flexural tensile(do)		1 680 kg/cm^2	1 480 kg/cm^2	1 410 kg/cm^2
Axial compressive gross Section	for t/r<140 Rivet connection	$\frac{4}{3}(15\ 000-\frac{1}{4}(\frac{1}{r})^2)$	$\frac{7}{6}(15\ 000-\frac{1}{4}(\frac{1}{r})^2)$	$\frac{4}{3}(12\ 500-0.21(\frac{1}{r})^2)$
	for t/r<140 Pin connection	$\frac{4}{3}(15\ 000-\frac{1}{3}(\frac{1}{r})^2)$	$\frac{7}{6}(15\ 000-\frac{1}{3}(\frac{1}{r})^2)$	$\frac{4}{3}(12\ 500-0.28(\frac{1}{r})^2)$
Edge subject to Compressive stress		$\frac{4}{3}(18\ 000-5(\frac{1}{b})^2)$	$\frac{7}{6}(18\ 000-5(\frac{1}{b})^2)$	$\frac{4}{3}(18\ 000-5(\frac{1}{b})^2)$
Pin		48 000	42 000	4 000
Shear stress	Web	18 000	15 750	15 000
	Rivet (general)	21 600	18 900	18 000
	Rivet Others	17 300	15 120	14 400
Bearing strength		Allowable unless any formation changes		
Yield stress assumed		30 000	30 000	25 000
Increasing coefficient for σs		$\frac{\sigma s}{30\ 000}$	$\frac{\sigma s}{30\ 000}$	$\frac{\sigma s}{30\ 000}$

Table-5 Characteristics of wrought iron from railway bridge

Bridge	Item	Yield point kg/mm^2	Breaking strength kg/mm^2	Elongation %	Specimen
1886	Diagonal	27.5	35.9	8.5	
	Diagonal	26.4	36.4	9.0	
UK made	Upp. chrd	22.8	30.8	7.0	No. 1
Portal	Upp. chrd	20.9	30.2	7.0	specimen
Cross beam (200 Jp. ft.)	Lwr. chrd	27.7	36.5	9.0	
	Lwr. chrd	29.0	36.3	8.0	
Plate girder before 1896			32.2	5.5	
Plate girder A	Flange	26.8	38.1	17.4	No. 5 specimen
	Angle	31.0	34.7	15.4	
	Web	27.5	33.8	14.0	
Plate girder B	Flange	21.6	35.7	12.6	No. 5 specimen
	Angle	23.6	35.1	11.0	
	Web	23.8	31.8	9.4	

Note: Tensile stress and durability for wrought iron is 80% of that of mild steel according to Transaction of the A.S.C.E. 1899 Vol. 41. P468.
The Determination of the Scale Working Stress for Railway Bridges of wrought iron and steel, by E. Herbert Stone, in U.S.A.

Allowable stress for railway bridge

1. Wrougt iron period

Source: Shin-Nihon Seitetsu Colomn (No. 37)
Dr. Jiro Tajima

Table-2 Design standard for railway in China by Sir Benjamin Baker (about 1893)

(1) Allowable tensile stress

Span range applicable		Allowable stress(kg/mm²)
Main beam, cross beam & stringer for plate girder		
under 20' (6.10m)		709
20' to 25' (7.62m)		747
25' to 30' (9.14m)		787
30' to 50' (15.24m)		827
50' to 80' (24.38m)		866
Truss and lattice truss		
80' to 160' (48.77m)	Lower chord	866
	Diagonal	709 ~ 866
160' to 200' (60.96m)	Lower chord	906
	Diagonal	709 ~ 906
200' to 400' (121.92m)	Lower chord	945 ~ 1 102
	Diagonal	709 ~ 1 102
For all span range	Wind bracing	1 339
	Suspension	394

Note: 709 for central diagonal, high value for end diagonal and average value for intermediate members.

(2) Allowable compressive stress

Plate girder

The same as area of tensile flange, of 85% of allowable tensile stress, or less than tensile of 1.0 - 0.006l/b

Truss and lattice girder

0.95-0.003 l/b of allowable tensile stress of tube or box section (rivet end)

0.95-0.0045 l/b of allowable tensile stress of tube or box section (pin end)

0.85-0.003 l/b of allowable tensile stress of I or T-section (rivet end)

(3) Alternating stress

A half can be added whichever smaller where tensile and compressive occur alternaterly.

(4) Shop rivet

$\sigma : \sigma_t : \tau = 1 : 1.5 : 0.75$ (15% of rivet members shall be increased or field rivets)

Note: The allowable stress is set without coefficient of impact due to train load.

2 Steel girder period — before 1909

Table-3 Specification for Theodore Cooper(1901)

(1) Allowable tensile stress (kg/cm²)

For Medium Steel	
Subsuspension and members against severe loading	422
Wind bracing	1 266
Lateral bracing for live load	844
Rolled I for cross beam and stringer	703
Flanges of cross beam for rivet connection	703
Stringer and L-flange of main beam for rivet connection	703
Lower chord, main diagonal and long vertical member	
for live load	703
for dead load	1 406
3/4 of above can be taken for stress due to dead load where movable bridge is operating.	
10% shall be reduced for soft steel	

(2) Allowable compressive stress (kg/cm²)

For Medium Steeel	
Chord	
for live load	703—3.16 l/r
for dead load	1 406—6.33 l/r
Beam of through bridge	
for live load	597—3.16 l/r
for dead load	1 194—6.33 l/r
Beam of deck bridge and trestle	
for live load	633—2.81 l/r
for dead load	1 266—5.62 l/r
Bracing	
for wind load	914—4.22 l/r
for live load	2/3 above
3/4 of above can be taken for stress due to dead load where movable bridge is operating.	
10% shall be reduced for soft steel.	

(3)Alternating stress

8/10 can be added to smaller where tensile and compressive occur alternaterly.

Note: The allowable stress is set without coefficient of impact due to train load.

The Medium steel and soft steel specified in the standard have its characteristics as follows:

Tensile strength	42.2 ~ 47.8kg/mm²
	38.0 ~ 43.6kg/mm²
Elasticity limit	1/2 of tensile strength
	- do -
Elongation	22%(8 in. distance)
	25%(8 in. distance)

Table-5 Comparison for allowable tensile stress (Unit : kg/cm²)

Specification	Steel: Tensile strength σ_B	Steel: Yeild point σ_Y	Allowable tensile stress σ_{ta}	σ_B/σ_{ta}	σ_Y/σ_{ta}
AREA (1910)	4218	----	1125	3.76	----
Railway bridge (1912)			1125		
Railway bridge (1928)	3900	----	1200	3.25	----
Railway bridge (1940)	4100	----	1200	3.42	----
UK Civil Society(1949)	(BS15)		1420		
〃	(BS548)		1965		
AREA (1950)		2320	1265		1.83
		3164	1687		1.88
		3867	2109		1.83
Germany (1951)	3700	2400	1400	2.65	1.72
Railway bridge BE	5200	3600	2100	2.43	1.72
Germany (1955)		2400	1600		1.50
Railway bridge BE		3600	2400		1.50
Railway bridge (1956)	4100	2300	1300	3.15	1.77
Railway bridge (1959)	5000	3200	1800	2.78	1.78
〃	5500	3600	2000	2.75	1.80
BS (1958)	(BS15)	t≤ 19 2520	1500		1.68
		t> 19 2360	1420		1.66
	(BS968)	t≤ 13 3620	2130		1.70
		13<t≤ 25 3460	2030		1.70
		t> 25 3310	1940		1.71
Germany (1959) Railway bridge BE	(St37)	t≤ 16 2400	1600		1.50
		16<t≤ 40 2300	〃		1.44
		t> 40 2200	〃		1.38
	(St52)	t≤ 16 3600	2400		1.50
		16<t≤ 40 3500	〃		1.46
		40<t≤ 50 3400	〃		1.42
		50<t≤ 75 3200	〃		1.33
AREA (1965)	(A36)4070	2351	1406	2.90	1.80
	(A 6)	t≤ 25 3515	1898		1.85
		25<t≤ 38 3304	1758		1.88
		38<t≤102 3164	1758		1.80
Railway bridge (1970)	4100	t≤ 16 2500	1400	2.94	1.79
		16<t≤ 40 2400	〃		1.71
		t> 40 2200	〃		1.57
	5000	t≤ 16 3300	1900	2.64	1.74
		16<t≤ 40 3200	〃		1.68
		t> 40 3000	〃		1.58
	5000 or 5300	t≤ 16 3700	2100	2.38 or 2.53	1.76
		16<t≤ 40 3600	〃		1.71
		t> 40 3400	〃		1.62

Table-6 Allowable axial compressive stress

Specification	Axial compressive stress (kg/cm^2) for transverse direction	l/r=0 Ratio σ_{ta}	Ratio σ_Y	Safety factor (Euler stl)
AREA (1910)	1125—4.92 l/r under984 以下	0.875	—	—
Railway bridge (1912)	- do -	0.875	—	—
Railway bridge (1928)	l/r< 40 1000 40≦l/r<100 1200— 5 l/r 100≦l/r $7000000(r/l)^2$	0.833	1/2.3	2.96
Railway bridge (1940)	0≦l/r≦100 $1100— 0.04(l/r)^2$ 100<l/r $7000000(r/l)^2$	0.917	1/2.09	2.96
Railway bridge (1956)	0≦l/r≦110 $1200— 0.05(l/r)^2$ 110<l/r $7200000(r/l)^2$.	0.924	1/1.92	2.88
Railway bridge (1959)	0≦l/r< 90 $1700— 0.1 (l/r)^2$ 但し 1600 以下 90≦l/r $7200000(r/l)^2$	0.945	1/2.0	2.88
Railway bridge (1970)	0<l/r≦ 28 1250 28<l/r≦130 1250— 8.0 (l/r—28) 130<l/r $7400000(r/l)^2$	0.893	1/1.92	2.80
	0<l/r≦ 24 1700 24<l/r≦115 1700—12.5 (l/r—24) 115<l/r $7400000(r/l)^2$	0.895	1/1.88	2.80
	0<l/r≦ 22 1900 22<l/r≦105 1900—14.8 (l/r—22) 105<l/r $7400000(r/l)^2$	0.905	1/1.92	2.80

M－3 Stress Check on Truss bridge, SER No.77

This bridge was constructed in 1869. Allowable stress of the steel is determined as 80% of the allowable stress of SS400.

1. Section Properties

1-1 Upper Code

t (mm)	ΣA (m²)	W (tf/m)	I (cm⁴)	r (cm)
8.5	0.0121	0.097	6110	7.11
14.7	0.0149	0.119	6850	6.78
17.3	0.0161	0.129	7572	6.86

Allowable stress can be calculated by the formula:-

$\sigma ca' = \sigma cag \times \sigma cal / \sigma cao$

l/r: $(20 < l/r \leq 93)$

$\sigma cag = 1400 - 8.4(l/r - 20) = 1344 kgf/cm^2$

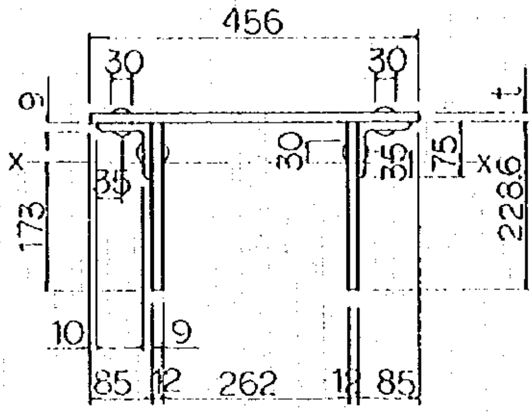
b/t: $(b/16 \leq t < b/13.1)$

$\sigma cal = 240000 \times (t/b)^2 = 661 kgf/cm^2$

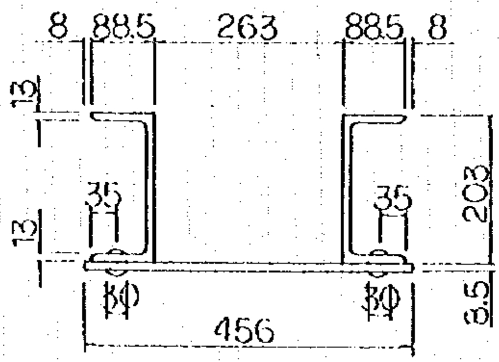
$\sigma ca' = 1344 \times 661 / 1400 = 635 kgf/cm^2$

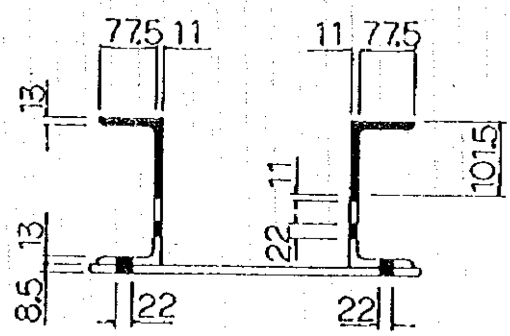
$\sigma ca = \sigma ca' \times 0.8 \times 1.5$

$= 635 \times 0.8 \times 1.5 = 762 kgf/cm^2$



1-2 Lower Code





$A_G = 0.0124 m^2$ (Full section area)

$I = 8260 cm^4$

$W = 0.099 tf/m$

Effective section area, A_N, can be obtained by reduction of holes and non-effective area:-

$A_N = A_G - A_0$

U.Flg	13×77.5×2	=2015
Web	101.5×11×2	=2233
Web	(22×11+11×11)×2	= 726
L.Flg	(13+8.5)×22×2	= 946
	A_0	=5920(mm²)
		=0.00592(m²)

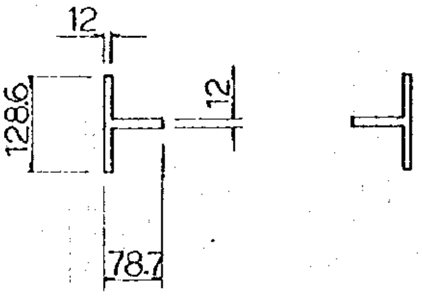
$A_N = 0.0124 - 0.00592 = 0.00648 (m^2)$

Calculation of allowable stress

$\sigma t = 1400 \times 0.8 \times 1.5 = 1680 kgf/cm^2$

1-3 Diagonal Member

1) Type a



$A = 0.0047 m^2$
$I = 213 cm^4$
$W = 0.038 tf/m$

Calculation of allowable stress

$\sigma ca = \sigma cag \times \sigma cal / \sigma cao$

l/r: $(93 < l/r)$

$\sigma cag = 12000000/\{6700 + (l/r)^2\} = 561$

b/t: $(b/13.1 \leq t)$

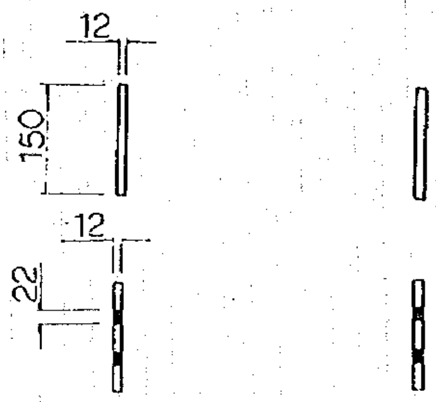
$\sigma cal = 1400$

$\sigma ca' = 561 \times 1400/1400 = 561$

$\sigma ca = \sigma ca' \times 0.8 \times 1.5$

$= 561 \times 0.8 \times 1.5 = 673 kgf/cm^2$

2) Type b

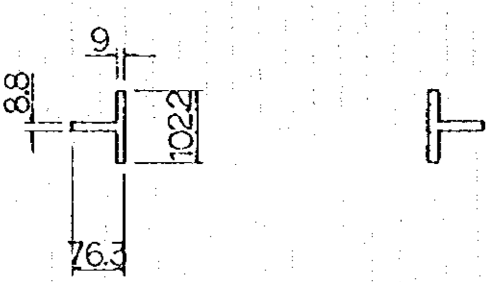


$A_G = 0.0036 m^2$ (Full section area)
$W = 0.029 tf/m$
$A_N = A_G - (22 \times 12 \times 2 \times 2/10^6)$
$= 0.0025 m^2$ (Effective section area)

Calculation of allowable stress

$\sigma t = 1400 \times 0.8 \times 1.5 = 1680 kgf/cm^2$

3) Type c

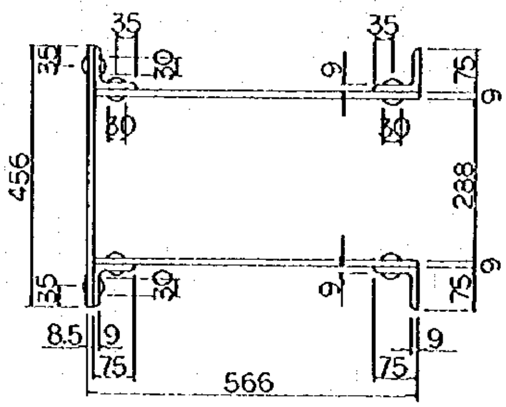


$A = 0.0030 m^2$
$W = 0.024 tf/m$

Calculation of allowable stress

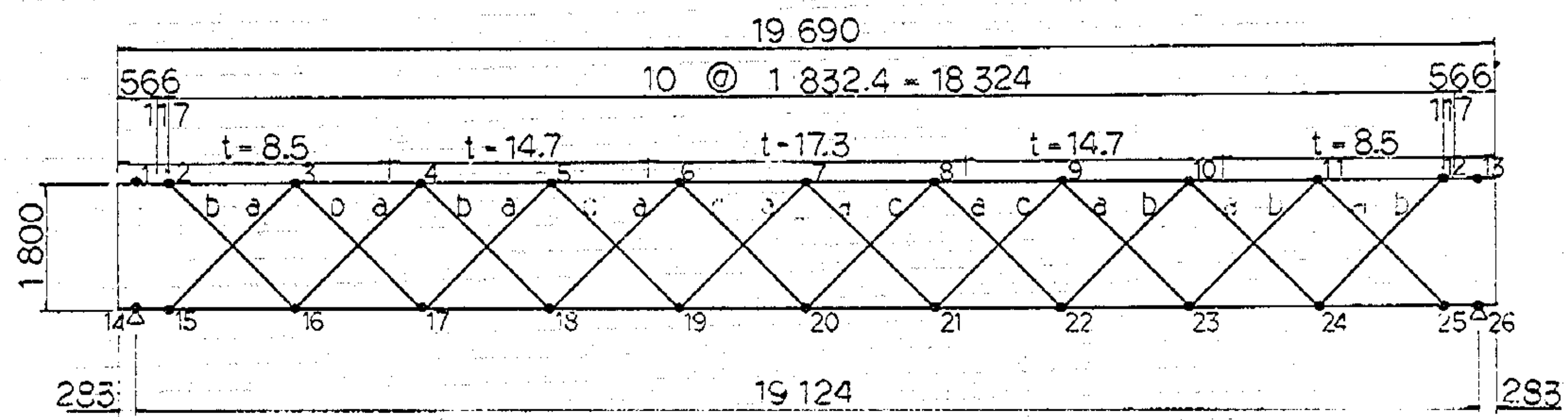
$\sigma t = 1400 \times 0.8 \times 1.5 = 1680 kgf/cm^2$

1-4 End Post



$A = 0.0200 m^2$
$W = 0.160 tf/m$

2. Analysis Model and Panel Point Numbers



3 . Loading

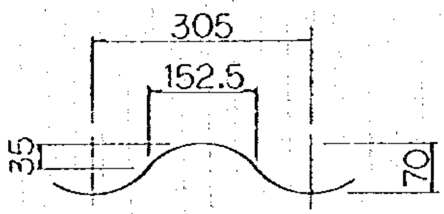
3-1 Dead Load

Pavement	0.050×5.410×2.3	=0.622
R.C. Concrete	0.180×5.660×2.5	=2.547
Steel Plate	0.011×5.660×7.85	=0.489
Kerb	0.155×0.125×2.5×2	=0.097
		ΣW=3.755tf/m
		1.878tf/m (One main frame only)

Cross Beam	0.090×6.572	=0.591tf
		0.296tf (One main frame only)

Calculation of steel plate

The corrugated steel plate with t =8mm thickness is converted to flat steel plate with t' thickness.



$R\sin\theta = 76.25 \cdots ①$

$R - R\cos\theta = 35 \cdots ②$

①② $R = 100.5580$

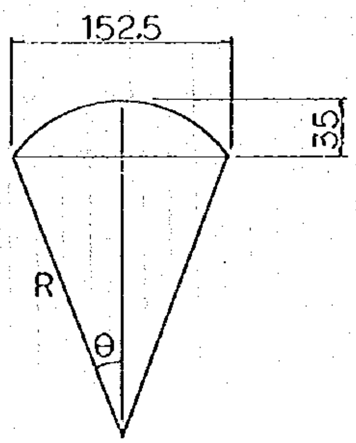
$\theta = 49.3118$

$l = 2\pi R \times 2\theta / 360 = 173.091$mm

$t' = 173.091 \times 8 / 152.5 = 9.08$mm

$t'' = 9.08 \times 3.0 / 2.5 = 10.896 \fallingdotseq 11.0$mm

(rap length)



Loading of Dead Load

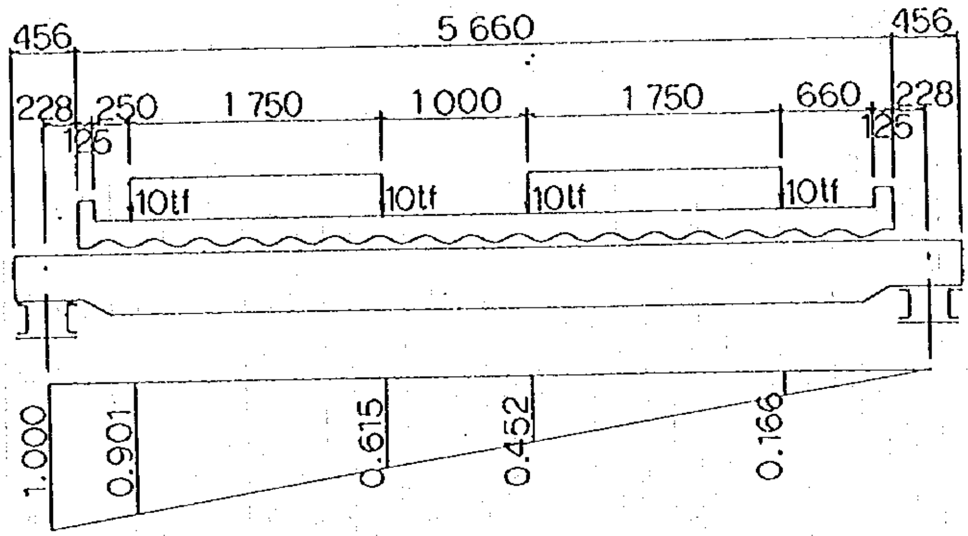
Unit:tf

	Panel Points	1	2	3	4	5	6	7	8	9	10	11	12	13
Upper Code	Code	-	0.100	0.178	0.208	0.218	0.232	0.236	0.232	0.218	0.208	0.178	0.100	-
	Diagonal	-	0.037	0.086	0.086	0.080	0.080	0.098	0.080	0.080	0.086	0.086	0.037	-
	Total	-	0.137	0.264	0.294	0.298	0.312	0.334	0.312	0.298	0.294	0.264	0.137	-
	Panel Points	14	15	16	17	18	19	20	21	22	23	24	25	26
Lower Code	Diagonal	-	0.049	0.086	0.086	0.086	0.080	0.062	0.080	0.086	0.086	0.086	0.049	-
	Code	-	0.102	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.102	-
	Slab Concrete etc.	-	2.472	3.441	3.441	3.441	3.441	3.441	3.441	3.441	3.441	3.441	2.472	-
	Cross Beam	-	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	-
	End Post	0.309	-	-	-	-	-	-	-	-	-	-	-	0.309
	Total	0.309	2.919	4.004	4.004	4.004	3.998	3.980	3.998	4.004	4.004	4.004	2.919	0.309

3-2 Live Loading

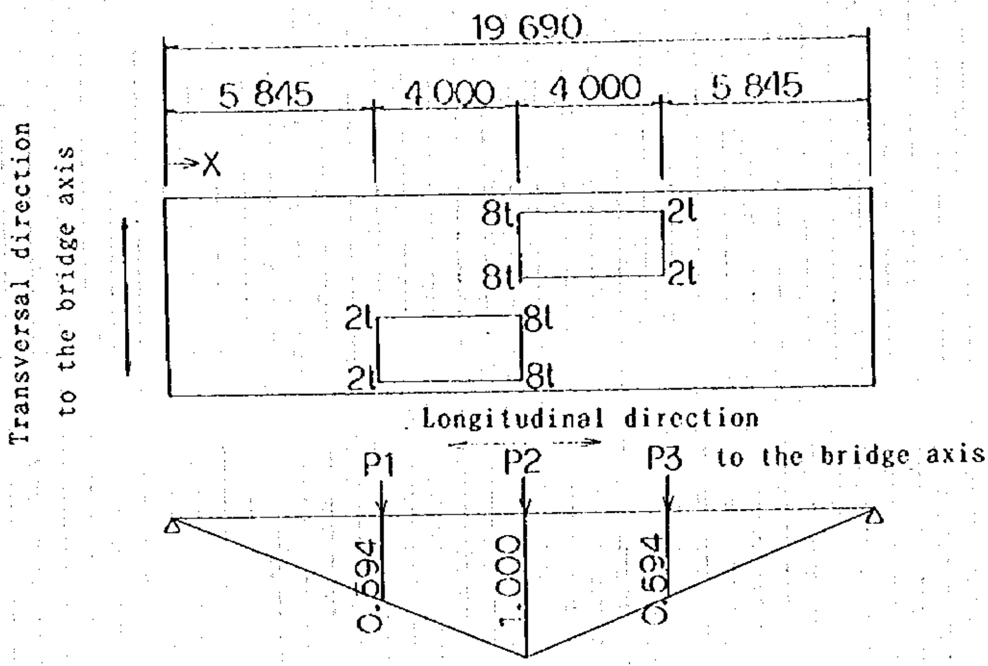
1) T - 20

Transversal direction to the bridge axis



X 1 = 5.845m P 1 = 2 × (0.901 + 0.615) = 3.032tf
X 2 = 9.845m P 2 = 8 × (0.901 + 0.615 + 0.452 + 0.166) = 17.072tf
X 3 = 13.845m P 3 = 2 × (0.452 + 0.166) = 1.236tf

Longitudinal direction to the bridge axis



Σ P = 3.032 × 0.594 + 17.072 × 1.000 + 1.236 × 0.594 = 19.607tf

Coefficient of impact can be obtained by the formula:-

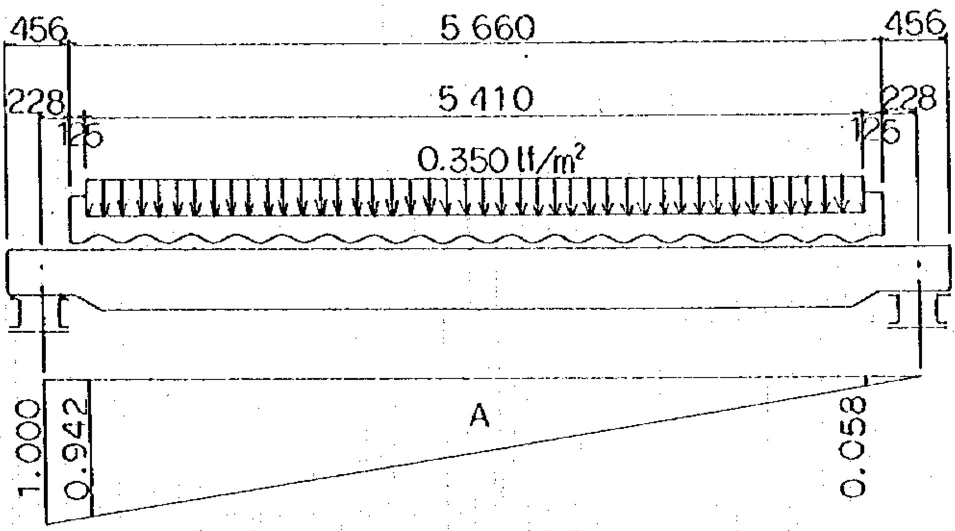
i = 20/(50 + L)

Code (L = 19.124m) i = 0.289

Diagonal (L = 6.116m) i = 0.356

2) L - 20

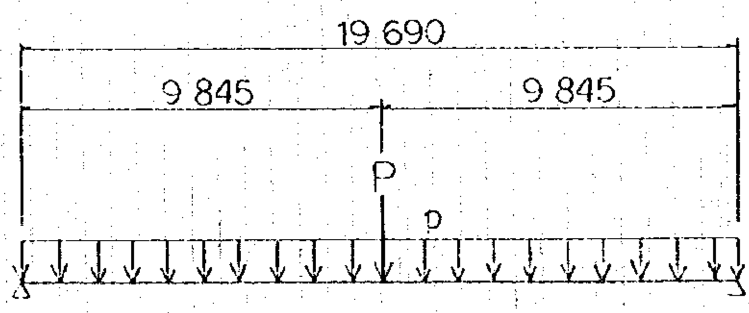
Transversal direction to the bridge axis



A =(0.058+0.942)×5.410/2=2.705m

Knife edge load　　P =5.000× A =13.525tf
Uniform load　　p =0.350× A = 0.947tf/m

Longitudinal direction to the bridge axis



Σ P =13.525+0.947×19.690=32.171tf

4. Structural Analysis

The frame analysis method was used for analysis for sectional forces. This calculation was done with computer owned by JBSI.

- Computer: FACOM.
- Softwear: TMATS (Optional 2 - Dimension Frame Analysis)

5. Stress Check

Stress check was carried out on the compressive and tensile members with application of N_{max} obtained from the out of put of computer analysis.

5-1 Stress Check under Live Loading T-20

Code Pt. 6 -Pt. 7 (A =0.0161m²)

N_D = -59.569t

N_L = -67.053t $\sigma c = N/A = 126.622 \times 10^3/(0.0161 \times 10^4)$

ΣN =-126.622t =786kgf/cm² > σca=762kgf/cm²

【1.03】

Pt. 19-Pt. 20(A_N=0.0065m²)

N_D = 57.713t

N_L = 56.330t $\sigma t = N/A = 114.044 \times 10^3/(0.0065 \times 10^4)$

ΣN =114.044t =1755kgf/cm² > σt=1680kgf/cm²

【1.04】

Diagonal Pt. 4 -Pt. 16(A =0.0047m²)

N_D = -9.418t

N_L =-19.442t $\sigma c = N/A = 28.860 \times 10^3/(0.0047 \times 10^4)$

ΣN =-28.860t =614kgf/cm² < σca=673kgf/cm²

Pt. 2 -Pt. 16(A_N=0.0025m²)

N_D=15.132t

N_L=19.442t $\sigma t = N/A = 34.574 \times 10^3/(0.0025 \times 10^4)$

ΣN =34.574t =1383kgf/cm² < σt=1680kgf/cm²

5-2 Stress Check under Live Loading L-20

Code Pt. 6 -Pt. 7 (A =0.0161m²)

Pt. 7 -Pt. 8 (A =0.0161m²)

N_D = -59.569t

N_L = -77.249t $\sigma c = N/A = 136.818 \times 10^3/(0.0161 \times 10^4)$

ΣN = -136.818 =850kgf/cm² > σca=762kgf/cm²

【1.12】

Pt. 19-Pt. 20(A_N=0.0065m²)

Pt. 20-Pt. 21(A_N=0.0065m²)

N_D = 57.713t

N_L = 67.237t $\sigma t = N/A = 124.950 \times 10^3/(0.0065 \times 10^4)$

ΣN =124.950t =1922kgf/cm² > σt=1680kgf/cm²

【1.14】

Diagonal Pt. 10-Pt. 24(A =0.0047m²)

Pt. 4 -Pt. 16(A =0.0047m²)

N_D = -9.418t

N_L =-17.226t $\sigma c = N/A = 26.644 \times 10^3/(0.0047 \times 10^4)$

ΣN =-26.644t =567kgf/cm² < σca=673kgf/cm²

Pt. 2 -Pt. 16(A_N=0.0025m²)

Pt. 12-Pt. 24(A_N=0.0025m²)

N_D=15.132t

N_L=20.417t $\sigma t = N/A = 35.549 \times 10^3/(0.0025 \times 10^4)$

ΣN =35.549t =1422kgf/cm² < σt=1680kgf/cm²

5-3 Stress Check under Live Loading T-18

Code Pt. 6 -Pt. 7 (A =0.0161m²)

N_D = -59.569t
N_L = -67.053×18/20=-60.348t
ΣN =-119.917t

$\sigma c = N/A$
=119.917×10³/(0.0161×10⁴)
=745kgf/cm² < σca=762kgf/cm²

Pt. 19-Pt. 20(A_N=0.0065m²)

N_D= 57.713t
N_L= 56.330×18/20=50.697t
ΣN =108.410t

$\sigma t = N/A$
=108.410×10³/(0.0065×10⁴)
=1668kgf/cm² < σt=1680kgf/cm²

Diagonal Pt. 4 -Pt. 16(A =0.0047m²)

N_D= -9.418t
N_L=-19.442×18/20=-17.498t
ΣN =-26.916t

$\sigma c = N/A$
=26.916×10³/(0.0047×10⁴)
=573kgf/cm² < σca=673kgf/cm²

Pt. 2 -Pt. 16(A_N=0.0025m²)

N_D=15.132t
N_L=19.442×18/20=17.498t
ΣN =32.630t

$\sigma t = N/A$
=32.630×10³/(0.0025×10⁴)
=1305kgf/cm² < σt=1680kgf/cm²

5-4 Stress Check under Live Loading T-16

Code Pt. 6 -Pt. 7 (A =0.0161m²)

N_D= -59.569t
N_L= -67.053×16/20=-53.642t
ΣN =-113.211t

$\sigma c = N/A$
=113.211×10³/(0.0161×10⁴)
=703kgf/cm² < σca=762kgf/cm²

Pt. 19-Pt. 20(A_N=0.0065m²)

N_D= 57.713t
N_L= 56.330×16/20=45.064t
ΣN =102.777t

$\sigma t = N/A$
=102.777×10³/(0.0065×10⁴)
=1581kgf/cm² < σt=1680kgf/cm²

Diagonal Pt. 4 -Pt. 16(A =0.0047m²)

N_D= -9.418t
N_L=-19.442×16/20=-15.554t
ΣN =-24.972t

$\sigma c = N/A$
=24.972×10³/(0.0047×10⁴)
=531kgf/cm² < σca=673kgf/cm²

Pt. 2 -Pt. 16(A_N=0.0025m²)

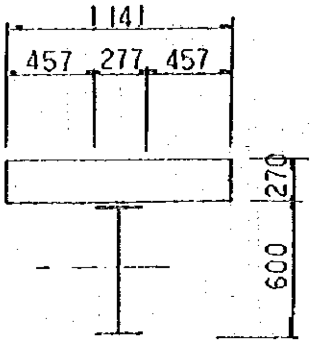
N_D=15.132t
N_L=19.442×16/20=15.554t
ΣN =34.686t

$\sigma t = N/A$
=34.686×10³/(0.0025×10⁴)
=1387kgf/cm² < σt=1680kgf/cm²

M—4 Stress check on Bridges Selected for the Loading Tests

SER No.211 L=6.68m (using T20 live load)

a. Stress assuming Composite Beam $\sigma ck=330kgf/cm^2$ n=7



↓

Assuming $\sigma ck=300kgf/cm^2$

$E=2.8\times10^5$

Effective Width b =(1.18-0.227)/2 =0.477

b/L=0.477/6.68 =0.071 > 0.05, < 0.30

λ = {1.1-2(b/l)} *b =0.457

			$A cm^2$	y cm	$Ay cm^3$	$Ay^2+I cm^4$
1-conc	1141×270	×1/7	440.1	43.5	19 144	859 500
1-Flg PL	227× 9		20.43	29.55	604	17 800
2-L Flg	2× 80	×11	17.60	28.55	503	14 300
2-L Web	2× 64	×11	14.08	24.80	349	8 700
1- Web PL	580× 8.5		49.30	----	----	13 800
2-L Web	2× 64	×11	14.08	-24.80	-349	8 700
2-L Flg	2× 80	×11	17.60	-28.55	-503	14 300
1-Flg PL	227× 9		20.43	-29.55	-604	17 800
			593.62		19 144	954 900

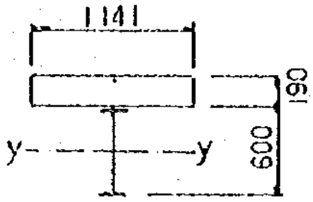
$$e = \frac{Ay}{A} = \frac{19\ 144}{593.62} = 32.25\ cm$$

Lower part of slab concrete becomes tensional area because the neutral axis is in the slab concrete. (Many cracks occurs on the bottom surface of slab concrete.) Slab thickness required for rehabilitation can be determined in accordance with JS.

$d = k_1\times k_2\times do$ $k_1=1.20$ $k_2=1.0$ $do= 3l+11 = 3\times1.18+11 = 14.5cm$

$d = 1.20\times1.00\times14.5 = 17.4 \rightarrow 17cm$

Haunches are not to be provided for bridges inspected except where splice connection is on the top of main beam, considering the current condition for its production, practice and standard. Instead, slab thickness is to be increased up to height of rivet head in this Study.



Slab thickness (assuming $\sigma ck=300kgf/cm^2$)

$d' = d + \alpha = 17.4 + 1.5 = 18.9 \rightarrow 19cm$

↑

Ribet Head

			Acm^2	ycm	$Aycm^3$	Ay^2+Icm^4
1-conc. Slab	1141×190	×1/7	309.7	39.50	12 233	492 500
1-U. Flg PL	227× 9		20.43	29.55	604	17 800
2-U. L Flg	2× 80	×11	17.60	28.55	503	14 300
2-U. L Web	2× 64	×11	14.08	24.80	349	8 700
1- Web PL	580× 8.5		49.30	——	——	13 800
2-L. L Web	2× 64	×11	14.08	-24.80	- 349	8 700
2-L. L Flg	2× 80	×11	17.60	-28.55	- 503	14 300
1-L. Flg PL	227× 9		20.43	-29.55	- 604	17 800
			463.22		12 233	587 900
						-323 100
						264 800

$$e = \frac{Ay}{A} = \frac{12\ 233}{463.22} = 26.41cm$$

yc = 30.0+19.0 -26.41 = 22.59cm Is = 95 500cm^4

dc = 30.0-26.41+ 9.50 = 13.09cm yul = 30.0cm

yus = 30.0-26.41 = 3.59cm

yls = 30.0+26.41 = 56.41cm

Preliminary stress check (creep and shrinkage of concrete are not considered)

Wd As 0.05×2.3×1.18 = 0.136tf/m (Md_2)

Slab 0.19×2.5×1.18 = 0.561tf/m (Md_1)

Metal = 0.127tf/m (Md_1)

0.824tf/m

$$Md = \frac{Wl^2}{8}$$

$$Md_1 = \frac{0.688\times 6.68^2}{8} = 3.838tf\cdot m \qquad Md_2 = \frac{0.136\times 6.68^2}{8} = 0.759tf\cdot m$$

$$M_{l+i} = \frac{Pl}{4}(1+i)\times\alpha = \frac{10\times 6.68}{4}(1+0.353)\times 0.90 = 20.336\,tf\cdot m$$

$$i = \frac{20}{50+L} = \frac{20}{50+6.68} = 0.353$$

α : Coefficient of load distribution rate by slab
(taken 0.90 from result of FEM analysis)

$$\Sigma M_1 = M_{d1} = 3.838 = 3.84\,tf\cdot m$$
$$\Sigma M_2 = M_{d2}+M_{l+i} = 0.759+20.336 = 21.10\,tf\cdot m$$

$$\sigma c = \frac{M_2}{Ic}\times yc\times\frac{1}{n} = \frac{21.10\times 10^5}{264\ 800}\times 22.59\times\frac{1}{7}$$

$$= 25.70\,kgf/cm^2 < \sigma ca = 300/3.5 = 85.7\,kgf/cm^2$$

$$\sigma s = \frac{M_1}{Is}\times ys + \frac{M_2}{Ic}yl = \frac{3.84\times 10^5}{95\ 500}\times 30.0 + \frac{21.10\times 10^5}{264\ 800}\times 56.41$$

$$= 121+449 = 570\,kgf/cm^2 < \sigma sa = 1400\,kgf/cm^2 \text{ (mild steel)}$$

b. Stress assuming non-composite beam

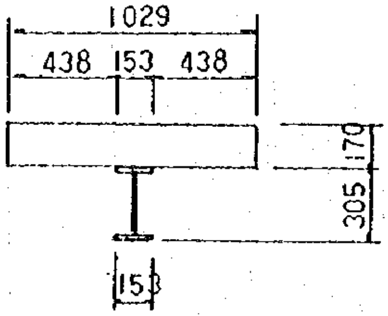
$$\Sigma M = M_{d1}+M_{d2}+M_{l+i} = 3.838+0.759+20.336 = 24.933\,tf\cdot m$$

$$\sigma s = \frac{\Sigma M}{Is}\times ys = \frac{24.933\times 10^5}{95\ 500}\times 30.0 = 783\,kgf/cm^2 < \sigma sa = 1400\,kgf/cm^2$$

M—5 Calculation on Representative Beams

(1) Calculation on the assumption of composite beam

1) I-305



I-305 L=6.5m a=1.067m(3 1/2feet)

Effective Width

b =(1.067-0.153)/2 =0.457m

b/L= 0.457/6.50 =0.070 > 0.05, < 0.30

λ = {1.1-2(b/l)} b =0.438m

Slab thickness required for redecking

$d \doteqdot k_1 \times k_2 \times do = 1.20 \times 1.00 \times (3 \times 1.067 + 11) = 17.04 \rightarrow 17cm$

Innertia of composite section

				Acm^2	ycm	$Aycm^3$	Ay^2+Icm^4
1-conc	1029	×170	×1/7	249.9	23.75	5935.1	146 980
1-U.Flg PL	152.4×	18.5		28.19	14.325	403.8	3 730
1- Web PL	268	× 10.3		27.60	——	——	1 650
1-L.Flg PL	152.4×	18.5		28.19	-14.325	-403.8	3 730
				333.88		5935.1	156 090
							-105 550
							50 540

$$e = \frac{5935.1}{333.88} = 17.78cm$$

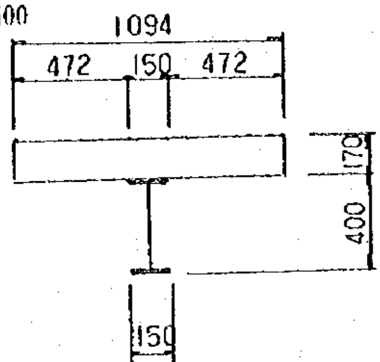
yc = 30.5/2+17.0-17.78 = 14.47cm The neutral axis is in the slab concrete, at 2.53cm from bottom of soab.

Then the calculation is continued by increacing the haunch height.

Haunch	Position of neutral axis from bottom of slab
0cm	2.53cm
5cm	1.3cm
8cm	0.5 cm
9cm	0.3 cm
10cm	0.01cm

The neutral axis is still in the slab concrete. Therefore, this beam can not be composite in case of redecking with RCS.

2) I-400



I-400 L=9.0m a=1.1m

Effective Width

b =(1.100-0.150)/2 =0.475m

b/L= 0.475/9.00 =0.053 > 0.05, < 0.30

λ = {1.1-2(b/1)} *b =0.472m

Slab thickness required for redecking

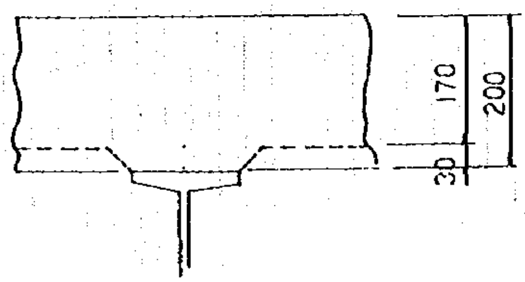
$d = k_1 \times k_2 \times do = 1.20 \times 1.00 \times (3 \times 1.1 + 11) = 17.2 \rightarrow 17cm$

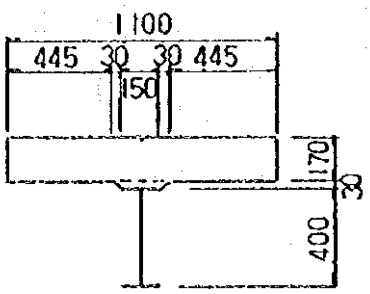
Innertia of composite section

		Acm^2	ycm	$Aycm^3$	Ay^2+Icm^4
I-conc	1094×170×1/7	265.69	28.5	7572	222 200
I-Flg PL	150× 23	34.50	18.85	650	12 300
I-Web PL	354× 13	46.02	—	—	4 800
I-Flg PL	150× 23	34.50	-18.85	-650	12 300
		380.71		7572	251 600
					-150 600
					101 000

$$e = \frac{7\ 572}{380.71} = 19.89cm$$

The neutral axis is in the slab. Height of 3cm haunch is considered to shift the neutral axis out of the slab concrete. Considering the defficulty of setting of haunches, thickness of slab concrete is to be increased up to the height of haunches assumed. The inertia of the additional concrete is ignored but the dead load is considered.





Effective Width

$b = (1.1 - 0.150 - 0.030\times 2)/2 = 0.445m$

$b/L = 0.445/9.00 = 0.049 \leq 0.05$

$\lambda = b = 0.445m$

Innertia of composite section

	Acm^2	ycm	$Aycm^3$	Ay^2+Icm^4
1-conc 1100×170×1/7	267.14	31.5	8423	271 500
1-Flg PL 150× 23	34.50	18.85	650	12 300
1-Web PL 354× 13	46.02	----	—	4 800
1-Flg PL 150× 23	34.50	-18.85	-650	12 300
	382.16		8423	300 900
				-185 600
				115 300

$$e = \frac{8\ 423}{382.16} = 22.04cm$$

$yc = 20.0+3.0+17.0-22.04 = 17.96cm$ $\qquad Is = 29\ 400cm^4$

$yL = 20.0 + 22.04 = 42.04cm$ $\qquad yul = 20.0cm$

Preliminary stress check (creep and shrinkage of concrete are not considered)

Wd			
As	0.05×2.3×1.10	= 0.127tf/m (Wd_2)	
Slab	0.20×2.5×1.10	= 0.550tf/m (Wd_1)	(include weight of haunch and additional slab)
Beam		= 0.090tf/m (Wd_1)	
		0.767tf/m	

$$M_1 = \frac{Wd_1\times l^2}{8} = \frac{0.640\times 9.0^2}{8} = 6.480tf\cdot m$$

i; Coefficient of impact

$$M_2 = Md_2+Ml+i = \frac{Wl^2}{8} + \frac{Pl}{4}(1+i)\times\alpha \qquad i = \frac{20}{50+l} = \frac{20}{50+9} = 0.339$$

α : Load distribution rate by deck slab (taken 0.90 from result of FEM analysis)

$$= \frac{0.127\times 9.0^2}{8} + \frac{10.0\times 9.0}{4}(1+0.339)\times 0.9 = 28.400tf\cdot m$$

$$\sigma c = \frac{M_2}{Ic} \times yc \times \frac{1}{n} = \frac{28.40 \times 10^5}{115\ 300} \times 17.96 \times \frac{1}{7}$$

$$= 63.2 kgf/cm^2 < \sigma ca = 260/3.5 = 74.3 kgf/cm^2$$

$$\sigma s = \frac{M_1}{Is} \times yl_1 + \frac{M_2}{Ic} yl_2 = \frac{6.48 \times 10^5}{29\ 400} \times 20.0 + \frac{28.40 \times 10^5}{115\ 300} \times 42.04$$

$= 441 + 1\ 036 = 1\ 477 kgf/cm^2 > \sigma sa = 1\ 400 kgf/cm^2$ (1.06) mild steel

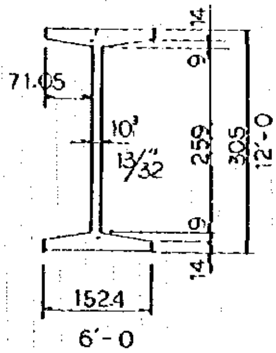
$> \sigma sa = 1\ 120 kgf/cm^2$ (1.32) wrought iron /low quality mild steel

(1 400×0.8=1 120)

(2) Calculation on the assumption of non-composite beam

1) I= 305

H = 305mm, B = 153mm, I = 13 200cm⁴, y = 15.25cm



$A = 152.4\times305-2\times(259+277)/2\times71.05 = 8399.2mm^2 = 84.0cm^2$

$W = 0.0084\times7.850 = 65.94kgf/m$

$$I = \frac{bd^3-\dfrac{a}{4(m-n)}(c^4-e^4)}{12}$$

$$= \frac{15.24\times30.5^3-\dfrac{7.105}{4(2.3-1.4)}(27.7^4-25.9^4)}{12} = 13\ 214cm^4$$

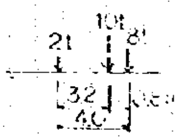
$r = \sqrt{(I/A)} = 12.5$ $\quad l = 3'0" \sim 3'1/2 \rightarrow 3'1/2 = 1067mm$

As = 5.0cm

Rc = 17.0cm ($d = k_1\times k_2\times do$ $k_1=1.20$, $k_2=1.00$, $do=3l+11=14.2cm$, $d = 17cm$)

Wd	As	$0.05\times2.3\times1.067$	= 0.123tf/m
	Rc	$0.17\times2.5\times1.067$	= 0.454tf/m
	Gd		= 0.066tf/m
			0.643tf/m

T20 LOADING(P=10tf/Girder)



	P
T20	10
T18	9
T16	8
T14	7
T12	6

$Md = \frac{WdL^2}{8}$, $Ml+i = \frac{PL}{4}(1+i)$, $i = \frac{20}{50+L}$; $\Sigma M = Md+(Ml+i)\cdot\alpha$ $\quad \alpha$;0.9 (Load distribution rate by slab)

$\sigma = \frac{\Sigma M}{I}y$,

Allowable stress of mild steel
(wrought iron, low quality mild steel: * 0.8)

$\sigma a = 1400kgf/cm^2\times1.5 = 2100kgf/cm^2$
$\sigma max = 1400kgf/cm^2\times1.7 = 2380kgf/cm^2$

Table M-5.1

L (m)	7.5	7.0	6.5	6.0	5.5	5.0
Md (tf·m)	4.521	3.938	3.396	2.894	2.431	2.009
i	0.348	0.351	0.354	0.357	0.360	0.364
Ml+i(T20)(tf·m)	25.275	23.643	22.003	20.355	18.700	17.050
ΣM (T20)(tf·m)	27.269	25.217	23.199	21.214	19.261	17.354
T20 σ(kgf/cm²)	3 150	2 913	2 680	2 451	2 225	2 005
T18 σ(〃)	2 888	2 667	2 451	2 239	2 030	1 828
T16 σ(〃)	2 625	2 422	2 223	2 028	1 836	1 650
T14 σ(〃)	2 362	2 176	1 994	1 816	1 642	1 473
T12 σ(〃)	2 118	1 930	1 765	1 604	1 447	1 296

2) I= 400

H = 400mm, B = 150mm, I = 29 300cm^4, l = 1.1m, As = 50mm, Rc = 170mm

W = 90.3kg/m, y = 20.0cm, A = 115cm^2

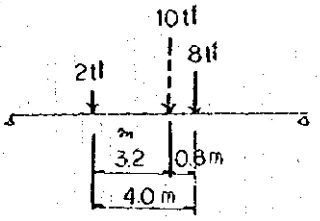
r = $\sqrt{(I/A)}$ = 15.96 = 16.0 ≤ 20 σca = 1400kgf/cm^2

d = $k_1 \times k_2 \times do$ k_1=1.20 non-composite k_2=1.00 same rigidity do=3×L+11=14.32

d = 1.2×1.0×14.3cm = 17.16 → 17cm

Wd	As	0.05×2.3×1.1	= 0.127tf/m
	Rc	0.17×2.5×1.1	= 0.468tf/m
	Gd		= 0.090tf/m
	Wd		0.685tf/m

T20 LOADING P=10tf/Girder



	P
T20	10
T18	9
T16	8
T14	7
T12	6

$Md = \frac{WdL^2}{8}$ $Ml+i = \frac{PL}{4}(1+i)$ $i = \frac{20}{50+L}$ $\Sigma M = Md + (Ml+i) \cdot \alpha$

$\sigma = \frac{\Sigma M}{I} \times y$ α ;0.9 (load distribution by deck slab)

Allowable stress of mild steel (taken 0.8 for wrought iron/low quality mild steel)

σa = 1400kgf/cm^2×1.5 = 2100kgf/cm^2, σmax = 1400kgf/cm^2×1.7 = 2380kgf/cm^2

Table M-5.2

L (m)	10.5	10.0	9.5	9.0	8.5	8.0	7.5	7.0
Md (tf·m)	9.440	8.563	7.728	6.936	6.186	5.480	4.816	4.196
i	0.331	0.333	0.336	0.339	0.342	0.345	0.348	0.351
Ml+i(T20)(tf·m)	34.939	33.325	31.730	30.128	28.518	26.900	25.275	23.643
ΣM (T20)(tf·m)	40.885	38.556	36.285	34.051	31.852	29.690	27.564	25.475
T20 σ(kgf/cm^2)	2 791	2 632	2 477	2 324	2 174	2 027	1 881	1 739
T18 σ(〃)	2 576	2 427	2 282	2 139	1 999	1 861	1 726	1 594
T16 σ(〃)	2 362	2 222	2 087	1 954	1 824	1 696	1 571	1 448
T14 σ(〃)	2 147	2 018	1 892	1 796	1 649	1 531	1 416	1 303
T12 σ(〃)	1 932	1 813	1 697	1 584	1 473	1 366	1 260	1 158

(3) Allowable flexual compressive stress

According to JS, the allowable flexural compressive stress is taken 1400 kgf/cm2 (SS400) when compressive flanges are directly fixed with slab concrete, etc., and shall be reduced using the ratio of l/b (distance between fixed points of compressive flange/width of compressive flange) for others such as non-composite beams.

Though the RSJ is non-composite, the upper flanges of I-beams are directly touched the deck slab because of simply supported beams and behave like a composite beam. Furthermore, average thickness of flange including taper is thick (t=20) for width of flange.

Threrfore, upper limit of allowable flexural compressive stress is taken considering that l/b can be ignored and reduction of the stress due to local backling is not necessary.

M—6 Study of Additional New Cross Beam on RSJ

This study is carried out in order to determine the applicability of the additional new cross beams as a rehabilitation method for RSJ.

1. Load Distribution Rate

Load distribution rate can be obtained by comparison with the ratio of the area of influence line of Leonhardt-Homberg and I-0 method in case of adding new cross beam. In addition, load distribution rate of existing deck slab only can be calculated by comparison with the ratio of reaction force based on the results of FEM analysis and I-0 method.

(1) L - H Method/I-0 Method

Main beam I-400×150 $I_o = 29\ 300 cm^4$ Cross beam $I_Q = 7\ 410 cm^4$

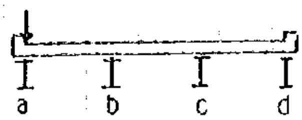
Ratio of rigidity of outer and inner beams $J = \frac{I_{in}}{I_{out}} = 1.0$

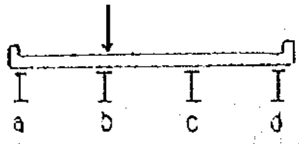
Rigidity of grid $Z = \frac{I_Q}{I_o}\left(\frac{1}{2a}\right)^3 = \frac{7\ 410}{29\ 300}\left(\frac{8.5}{2\times 1.175}\right)^3 = 11.97 \doteq 12$

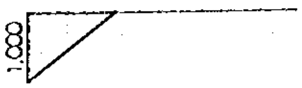
$N_1 = 10J/Z+(2j+2) = 4.833 \doteq 4.8$

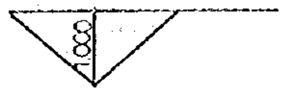
$N_2 = 6J/Z+(18j+2) = 20.500 \doteq 20.5$

Kaa-1	$= -\frac{1}{N_1}+\left(-\frac{1}{N_2}\right)$	$= -\frac{1}{4.8} - \frac{1}{20.5}$	= -0.208-0.049	= -0.257	Kaa = 0.743
Kab	$= \frac{1}{N_1}+\frac{3}{N_2}$	$= \frac{1}{4.8}+\frac{3}{20.5}$	= 0.208+0.146	= 0.357	Kab = 0.357
Kac	= 〃 - 〃	= 〃 - 〃	= 〃 - 〃	= 0.062	Kac = 0.062
Kad	$= -\frac{1}{N_1}-\left(-\frac{1}{N_2}\right)$	$= -\frac{1}{4.8}+\frac{1}{20.5}$	= -0.208+0.049	= -0.159	Kaa = 0.159
Kba	= Kab/j = 0.357/1.0			= 0.357	Kba = 0.357
Kbb-1	$= -\frac{1}{N_1}+\left(-\frac{9}{N_2}\right)$	$= -\frac{1}{4.8} - \frac{9}{20.5}$	= -0.208-0.439	= -0.647	Kbb = 0.353
Kbc	= 〃 - 〃	= 〃 + 〃	= 0.208+0.439	= 0.231	Kbc = 0.231
Kbd	= Kac/J = 0.062/1.0			= 0.062	Kbd = 0.062

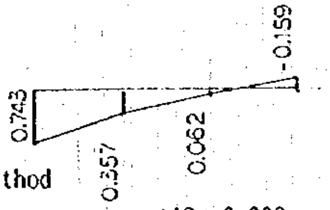


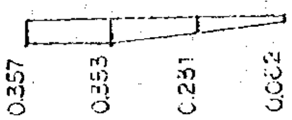






1-0 method A1=0.588 A1=1.175





Leonhardt -Homberg method

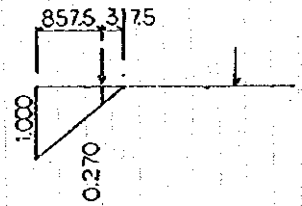
+A2= 0.902
-A2=-0.067
A2= 0.835

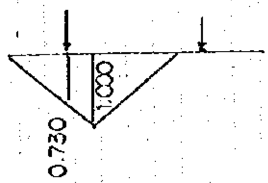
A2=0.932

$\frac{\text{L-H m.}}{\text{1-0 m.}} = \frac{A2}{A1}$ $\frac{0.835}{0.588} = 1.42$ $\frac{0.932}{1.175} = 0.79$

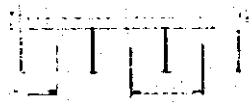
(2) FEM / 1-0 Method

Load distribution rate can be calculated by comparing the ratio of reaction and the result of FEM analysis on SER No. 59 and by 1-0 method.





Reaction due to dead load G_1, G_4 = 0.447 +0.512/2+1.395 = 2.098tf (2.098/5.081=0.41)
G_2, G_3 = 0.512/2+0.455/2+2.499 = 2.983tf (2.983/ 〃 =0.59)



0.567t/m 0.852t/m

G_1, G_4 = 0.567/(0.567+0.852) = 0.400] Dead load is
G_2, G_3 = 0.852/(〃) = 0.600] is not distributed.

Reaction due to live load G_1, G_4 = -0.027 +1.343/2+0.451 = 1.096tf (1.096/3.458=0.32)
G_2, G_3 = 1.343/2-0.123/2+1.752 = 2.362tf (2.362/ 〃 =0.68)

FEM/1-0 method G_1, G_4 = 0.32/0.27 = 1.19 The load distribution ratio can be
G_2, G_3 = 0.68/0.73 = 0.93 expected as 0.90 at the inner beams which mainly resist the live load.

2. Conclusion

The load distribution rate of inner beams is about 0.80 according to the calculation (1) above in case of the adding new cross beams.

The load distribution rate of deck slab is about 0.90 according to the calculation (2) above.

Therefore, 10% of distribution against live load can be expected in case of the adding new cross beams.

The stress of main beam of I-305, l=5m (refer table M-5.1) is σ=2005kgf/cm2 in case of without the adding cross beams. Where the additional cross beam is provided, the stress is reduced about 177kgf/cm2, σ=1828kgf/cm2.
Assuming the increase rate of allowable stress up to 50% (1400 X 1.5 = 2100kgf/cm2) and applying T20 live load, the main beam can be used up to the span of 5.2m length (derived by the calculation of stress between 5.5m and 5.0m) where the load distrubution is deck slab only, the span of it can be extended to 5.7m length if the additional cross beam is provided. Since the extention of span length is limited, 0.6m only, it can be said that the adding new cross beam is not so effective.

M—7 Study of Covering of RSJ with RC

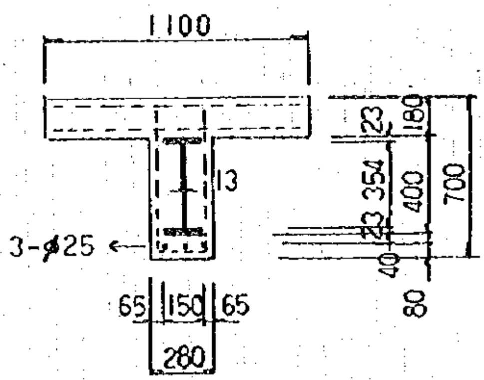
(1) General

This rehabilitation method shall be done on bridges which do not have enough durability against the live loading adopted in the rehabilitation plan although redecking from existing BUC or COR to RCS has been taken. This section presents the results of Stress Check carried out on I-400 and I-305 which are commonly used in Sri Lanka.

(2) Stress Check

1) I-400

a) Span l = 9.5m, a = 1.1m, n = 7, I-400, Is = 29 300cm⁴, Yu,l = 20.0cm



Assuming that:-
- Steel beams resist dead load of before composite
- Compsite section resists dead load of after composite and live load.
- Cross beam (RC structure) is provided in the center of span for load distribution.
- Bending moment of main beams reduce by 20% due to the effect of load distribution.

$$Md_1 = \frac{Wd_1 \times l^2}{8} = \frac{0.922 \times 9.5^2}{8} = 10.41 tf \cdot m$$

RC Slab	0.17×2.5 ×1.10	= 0.468tf/m
RC Beam	0.28×0.52×2.50	= 0.364tf/m
Steel		= 0.090tf/m
	Wd₁	= 0.922tf/m

$$\sigma s_1 = \frac{Md_1}{Is} \times Y = \frac{10.40 \times 10^5}{29\ 300} \times 20 = 710 kgf/cm^2$$

Calculation of neutral axil after covering of main beam with RC (concrete of tensile area are ignored.) n=7

Temporary neutral axia is on the bottom of upper flange		Acm²	ycm	Aycm³	Ay²+Icm⁴
1-Slab conc	1100× 170×1/7	267.14	10.8	2 885	37 593
1-U.Flg PL	150× 23	34.50	1.15	40	61
1-Web PL	354× 13	46.02	-17.70	- 815	19 223
1-L.Flg PL	150× 23	34.50	-36.55	-1 261	46 104
3-Round Bar	3×ϕ25	14.73	-41.70	- 614	25 614
		396.79		235	128 595
					- 139
					128 456
					128 000cm⁴

$e = \frac{Ay}{A} = \frac{235}{396.79} = 0.59cm$ $\quad Ycu = 17.0+2.3-0.59 = 18.71cm$

Dead load of after composite (asphalt) $Wd_2 = 0.05 \times 1.10 \times 2.30 = 0.127tf/m$
Live load $P = 10.0tf$ (T20)
Impact $i = 20/(50+l) = 20/(50+9.5) = 0.336$

Maximum bending moment due to dead load (after) and live load

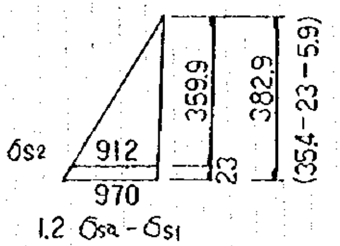
$$M_2 = \frac{Wd_2 \cdot l^2}{8} + \frac{Pl}{4}(1+i)\times\alpha \qquad \alpha: \text{load distribution ratio} = 0.80$$

$$= \frac{0.127\times 9.5^2}{8} + \frac{10.0\times 9.5}{4}(1+0.336)\times 0.8 = 1.43+25.38 = 26.81tf\cdot m$$

Calculation of resistant moment

Although the allowable stress can be increased by 30% based on the bridge rehabilitation guideline in Japan, which states that 20% for compressive and 30% for tensile stress can be increased for rehabilitation, 20% of increase is to be taken considering the reduction of innertia by 10% due to corosion.

$Ms_1 = \{(\sigma sa\times 1.20-\sigma s_1)+\sigma s_2\}\times 1/2\times Af\times yf$
$= \{(1400\times 1.20-710)+912\}\times 1/2\times(15.0\times 2.3)\times(35.99+2.3/2)$
$= (970+912)/2\times 34.50\times 37.14 = 1,205,000kgfcm = 12.05tf\cdot m$
$Ms_2 = (\sigma s_2+0)\times 1/2\times Aw\times yw/2$
$= (912+0)\times 1/2\times(35.99\times 1.3)\times 35.99/2$
$= 384,000kgf/cm = 3.84tf\cdot m$



where: Ms_1 = Resistant moment of flange
Af = Sectional area of flange
yf = Distance between neutral axis and center of flange
Ms_2 = Resistant moment of web
Aw = Sectional area of web
yw = Distance between neutral axis and center of web

Bending moment which is received by the reinforcements, 3 nos. of dia. 25. for strengthening the beam. ($\sigma sa = 1800kgf/cm^2$)

$Ms_3 = \sigma sa\times n\times Asa\times Ysa$
$= 1800\times 3\times 4.908\times(41.70+0.59) = 1,120,000kgfcm = 11.20tf\cdot m$

Total bending moment which is received by the steel and reinforcements

$Ms = Ms_1+Ms_2+Ms_3 = 12.05+3.84+11.20 = 27.09tf\cdot m > 26.81tf\cdot m$ O.K.

Compressive stress at the top of slab concrete

$$\sigma c = \frac{M}{I} \times yc \times \frac{1}{n} = \frac{26.81\times10^5}{128\ 000} \times 18.71 \times \frac{1}{7}$$

$$= 56.0\text{kgf/cm}^2 < \frac{\sigma ck}{3.5} = \frac{260}{3.5} = 74.3\text{kgf/cm}^2$$

Grade 30N/mm^2(Qubic strength) → (Cylinder strength) 260kgf/cm^2

b) Other spans

Stress check was carried out on other type of spans. The results of calculations are summarized and shown hereunder.

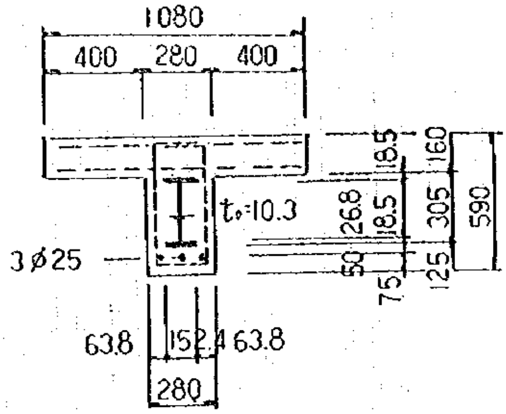
① $l = 9.6\text{m}$ I-400 $a = 1.1\text{m}$ $\sigma sa = 1400\text{kgf/cm}^2 \times 1.2$ (mild steel)
$Md_1 = 10.93\text{tf}\cdot\text{m}$ $\sigma s_1 = 746\text{kgf/cm}^2$ $i = 0.336$
$Ms_1 = 11.84\text{tf}\cdot\text{m}$ $Ms_2 = 3.85\text{tf}\cdot\text{m}$ $Ms_3 = 11.40\text{tf}\cdot\text{m}$
$Ms = 27.09\text{tf}\cdot\text{m} = M_2 = 27.11\text{tf}\cdot\text{m}$

② $l = 8.5\text{m}$ I-400 $a = 1.1\text{m}$ $\sigma sa = 1120\text{kgf/cm}^2 \times 1.2$ [wrought iron / low quality mild steel]
$Md_1 = 8.57\text{tf}\cdot\text{m}$ $\sigma s_1 = 585\text{kgf/cm}^2$ $i = 0.342$
$Ms_1 = 9.62\text{tf}\cdot\text{m}$ $Ms_2 = 3.13\text{tf}\cdot\text{m}$ $Ms_3 = 11.40\text{tf}\cdot\text{m}$
$Ms = 24.15\text{tf}\cdot\text{m} > M_2 = 23.96\text{tf}\cdot\text{m}$

2) I-305

a) span l = 7.0m, a = 1.1m, I-305, Is = 13 200cm^4, Yu.1 = 15.25cm, n = 7

(n=7 is taken for composite structure)



Effective width of slab concrete

$b = (1.10-0.28)/2 = 0.41$

$\frac{b}{l} = \frac{0.41}{7.00} = 0.059 \begin{smallmatrix} > \\ < \end{smallmatrix} \begin{smallmatrix} 0.05 \\ 0.30 \end{smallmatrix}$

$\lambda = \{1.1-2(\frac{b}{l})\} * b = 0.40m$

Slab thickness

$d = k_1 \cdot k_2 \cdot do$

$do = 3\times0.82+11$

$= 13.46 = 13.5cm$

$d = 1.20\times1.00\times13.5$

$= 16.2 \rightarrow 16cm$

k_1:1.20(nos. of heavy vehicles>2000)

k_2:1.00 do=3l+11 l:1.1-0.28=0.82

Assuming that: steel beams resist dead load of before composite, compsite section resists dead load of after composite and live load, cross beam (RC structure) is provided in the center of span for load distribution, beanding moment of main beams reduce by 20% due to the effect of load distribution.

Maximum bending moment due to dead load of before composite

$$Md_1 = \frac{Wd_1 \times l^2}{8} = \frac{0.807\times7.0^2}{8} = 4.94tf\cdot m$$

RC Slab 0.16×2.5 ×1.10	= 0.440tf/m
RC Beam 0.28×0.43×2.50	= 0.301tf/m
Steel	= 0.066tf/m
Wd_1	= 0.807tf/m

Stress of steel (σsa = 1400kgf/cm2 for mild steel)

$$\sigma s_1 = \frac{Md_1}{Is}\times y = \frac{4.94\times10^5}{13\ 200}\times15.25 = 570kgf/cm^2$$

Calculation of neutral axis after covering of main beam with RC (concrete of tensile area are ignored). n=7

Temporary neutral axis is on the bottom of slab concete				Acm^2	ycm	$Aycm^3$	Ay^2+Icm^4
1-Slab conc	1080	×160	×1/7	286.86	8.0	1 974	21 100
1-U.Flg PL	152.4×	18.5		28.19	-0.925	- 26	30
1- Web PL	268	× 10.3		27.61	-15.25	- 421	8 100
1-L.Flg PL	152.4×	18.5		28.19	-29.575	- 834	24 700
3-RoundBar	3	×φ25		14.73	-35.5	- 523	18 600
				345.58		170	72 530
							- 80
							$72\ 450cm^4$

$$e = \frac{170}{345.58} = 0.49cm$$

The neutral axis is assumed on the bottom of slab concrete because the eccentric value "e" is small.

Dead load of after composite (asphalt) $Wd_2 = 0.05\times1.10\times2.30 = 0.127tf/m$
Live load $P = 10.0tf$ (T20)
Impact $i = 20/(50+l) = 20/(50+7) = 0.351$

Maximum bending moment due to dead load (after) and live load

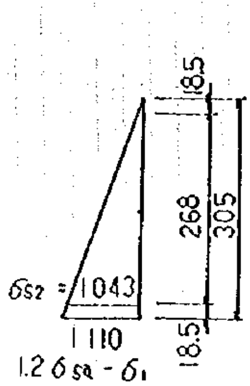
$$M_2 = \frac{Wl^2\cdot l^2}{8} + \frac{Pl}{4}(1+i)\times\alpha \qquad \alpha:\ \text{load distribution ratio} = 0.80$$

$$= \frac{0.127\times7.0^2}{8} + \frac{10.0\times7.0}{4}(1+0.351)\times0.8 = 0.78+18.91 = 19.69tf\cdot m$$

Calculation of resistant moment

Although the allowable stress can be increased by 30% based on the bridge rehabilitation guideline in Japan, which states that 20% for compressive and 30% for tensile stress can be increased for rehabilitation, 20% of increase is to be taken considering the reduction of innertia by 10% due to corosion.

$Ms_1=\{(\sigma sa\times1.20-\sigma s_1)+\sigma s_2\}\times1/2\times Af\times Yf$
$=\{(1400\times1.20-570)+1043\}\times1/2\times15.24\times18.5\times(30.5-0.925)$
$=(1110+1043)/2\times28.194\times29.575=898000kgfcm = 8.98tf\cdot m$
$Ms_2=(\sigma s_2+0)/2\times Aw\times Yw$
$=(1043+0)/2\times28.65\times1.03\times28.65/2$
$= 220\ 000kgfcm = 2.20tf\cdot m$



Bending moment which is received by the reinforcements for strengthening the beam
$\sigma sa = 1800 kgf/cm^2$

$$Ms_3 = \sigma sa \times n \times Asa \times ysa$$
$$= 1800 \times 3 \times 2.5^2 \pi / 4 \times 35.5 = 941000 kgfcm = 9.41 tf \cdot m$$

Total bending moment which is received by the steel and reinforcements

$$Ms = Ms_1 + Ms_2 + Ms_3 = 8.98 + 2.20 + 9.41 = 20.59 tf \cdot m > 19.69 tf \cdot m$$

Compressive stress at the top of slab concrete

$$\sigma c = \frac{M}{I} \times y \times \frac{1}{n} = \frac{19.69 \times 10^5}{72400} \times 16.0 \times \frac{1}{7}$$
$$= 62.2 kgf/cm^2 < \frac{\sigma ck}{3.5} = \frac{260}{3.5} = 74.3 kgf/cm^2$$

b) Other spans

Stress check was carried out on other type of spans. The results of calculations are summarized and shown hereunder.

① $l = 7.2m$, I-305, $a = 1.1m$, $\sigma sa = 1400 kgf/cm^2 \times 1.2$ (mild steel)
$\lambda = 0.40m$ $Md_1 = 5.23 tf \cdot m$ $\sigma s_1 = 604 kgf/cm^2$ $i = 0.350$
$Ms_1 = 8.70 tf \cdot m$ $Ms_2 = 2.14 tf \cdot m$ $Ms_3 = 9.41 tf \cdot m$
$Ms = 20.25 tf \cdot m \leq M_2 = 20.26 tf \cdot m$ $\sigma c = 64.0 kgf/cm^2$

② $l = 6.45m$, I-305, $a = 1.1m$, $\sigma sa = 1120 kgf/cm^2 \times 1.2$ (wrought iron / low quality mild steel)
$\lambda = 0.40m$ $Md_1 = 4.20 tf \cdot m$ $\sigma s_1 = 485 kgf/cm^2$ $i = 0.354$
$Ms_1 = 6.95 tf \cdot m$ $Ms_2 = 1.71 tf \cdot m$ $Ms_3 = 9.41 tf \cdot m$
$Ms = 18.07 tf \cdot m < M_2 = 18.13 tf \cdot m$ $\sigma c = 57.2 kgf/cm^2$

M—8 Results of stress check for 54 nos. of RSJ bridge which the preliminary inspection was carried out

Table M-8.1 shows the results of stress check for 54 nos. of JSJ bridges which preliminary inspection was carried out.

Explanation of the items shown in the table are as follows:-

BEAM LENGTH: Taken average length of beams

PROPOSED WIDTH: Standard width was taken for reconstruction.
Substandard width was taken for rehabilitation.

PROP WIDEN: O means widening should be done with additional beams.
RCB means widening should be done with rececking by RCB.

REDEC T=(cm): Thickness of deck slab concrete for redecking

T20 X 1.5: Results of stress check using T20 live load and increase rate of allowable stress of 1.5. O means safe. X means excessive stress.

T18 X 1.5: Results of stress check using T18 live load and increase rate of allowable stress of 1.5. O means safe. X means excessive stress.

T16 X 1.5: Results of stress check using T16 live load and increase rate of allowable stress of 1.5. O means safe. X means excessive stress.

Non-comp. A18, B16 a,;
Flexural stress of main beams in case of non-composite beam using T18 live load for bridges on A-class road and T16 live load for bridges on B-class road.

Comp. A18, B16 b;
Flexural stress of main beams in case of composite beam using T18 live load for bridges on A-class road and T16 live load for bridges on B-class road.

(Non + Comp.)/2 (a + b)/2;
Flexural stress of main beams in case of half composite beam.

Stress X 1.5; Increase rate of allowable stress 1.5 was considered.

OK means safe, X means excessive stress.

R/F cover conc. : In case of rehabilitation is to be taken by covering of main beam with reinforced concrete. In crease rate of allowable stress 1.2 is taken. T18 live load for bridges on A-class road and T16 live load for bridges on B-class road are used.
O means safe and T20 means load capacity. X means excessive stress.

RECONSTRUCTION REC 2:
O means that excessive stress occur in the main beam although the rehabilitation is taken.

RECONSTRUCTION REC 1:
O means that reconstruction is needed due to significant damages.

Rehab. Type: Type of rehabilitation or reconstruction to be taken is shown.

PSC : Reconstruction by PSC/PRE

COV : Covering of main beam with reinforced concrete

RED : Redecking with reinforced concrete slab

WID : Widening

Allowable stress without considering of increase rate

σsa=1400X0.8=1120 kg/cm2 for construction year before 1930 or unknown

σsa=1400 kg/cm2 for construction year after 1930

Table M - 8.1 STRESS CHECK ON RSJ

SER No	ROUTE No	BRIDGE No	TRAFFIC VOLUME (vpd)/year	YEAR OF CONST	TYPE OF BRIDGE	YEAR OF REPAIR	TYPE OF REPAIR	LENGTH EXST. (m)	NOS. OF SPAN	BEAM LENGTH (m)	DEPTH OF GIRDER(mm)	EXIST. WIDTH CARR. (m)	EXIST. WIDTH OVRAL (m)	PROPOSED WIDTH CARR. (m)	PROPOSED WIDTH OVRAL (m)	SLAB SPAN(m)	SLAB RAILING	Beam RAILING	PROP WIDEN	DEFECT I+ (CM)	T20 XL5	T18 XL5	T16 XL5	Non-comp A1R,B16a	Comp. A1R,B16b	(Non./Comp.)? (a/b)?	STRESS XL5	RF Cover conc	RECONST REC 2	RECONST REC 1	Rehabilitation Type
44	AA004	19/7K	210 /93		RSJ/DUC			31.15	3	10.40	400	4.50	4.90	4.00	5.00	1.09	4	2	O	17	X	X	-	2337	1456	1096	X	X	O	-	PSC
89	AA004	16/9K	940 /93		RSJ/COR			4.80	1	4.80	270	4.22	4.22	6.50	7.50	1.02	3	2	RCD	17	X	X	-	-	X	-	X	O 20	-	-	COV+RCD(WID)
2	AA010	25/1K	1110 /94		RSJ/COR			122.60	12	10.20	460	5.19	5.55	6.50	7.50	1.52	2	2	O	19	X	X	-	2066	1301	1729	X	O 20	-	-	COV+WID
36	AA010	48/1K	3119 /94		RSJ/COR		(Red)RCS(A1-P1)	31.12	3	10.40	370	5.22	5.52	6.50	7.50	1.01	2	2	O	17	X	X	-	2470	1501	1986	X	X	O	-	PSC
102	AA010	25/2K	3450 /94	1920	RSJ/COR	1979	(Wdn)Substructure	17.20	2	8.60	300*2	5.54	5.54	6.50	7.50	1.31	3	3	O	17	O		-				X		-	-	RED+WID
65	AA011	24/3K	1500 /93	1967	RSJ/RCS			9.70	1	9.70	400	5.30	5.65	6.50	7.50	1.15	2	3	O	17	X	O	-						-	-	RED+WID
52	AA017	2/2K	1250 /93		RSJ/COR			10.50	1	10.50	410	4.30	4.30	6.50	7.50	1.04	3	3	O	17	X	X	-	2298	1420	1859		X	O	-	PSC
77	AA019	3/2K	1992 /94	1960	ST.TR/T/COR RSJ/DUC			39.22 79.66	2 8	10.50	400	5.36 5.36	5.66 5.66	6.50	7.50	1.10	3 3	3 3	O	-	-	-	-	-	-	-	X	-	-	O	PSC
106	AA026	69/1K	1780 /94		RSJ/RCS			16.30	2	8.10	400	4.70	4.70	6.50	7.50	1.18	2	3	O	17	X	O	-				-		-	-	RED+WID
108	AA033	3/3K	3247 /94		RSJ/DUC			5.70	1	5.70	300	3.70	3.70	6.50	7.50	0.89	3	3	RCD	16	X	X	-	-	X	-		O 20	-	-	COV+RCD(WID)
119	AB026	3/1K	-		ARCH/DR		(Wdn)RSJ/RCS	10.87	1	10.80	(400)	5.00	7.05	6.05	7.05	(1.20)	4 -	2 2	-	18	X	X	-	2459	1538	1999	X	X	O	-	PSC
175	AB027	1/2M	4750 /94		RSJ/COR			4.40	1	4.40	250	3.70	9.70	7.40	9.80		3	4	-	-	-	-	-	-	-	-	X	-	-	O	RCD
120	AB029	17/2K	2019 /94		RSJ/RCS	1994	(Red)COR→RCS (Rep)Con.Cov(MD) (Wdn)	4.25	1	4.20	300	7.03	7.03	6.50	7.50	1.05	3	3	-	-	O						-		-	-	
30	B014	8/1K	1390 /93		RSJ/COR			20.70	2	10.40	610	5.50	5.60	6.00	7.00	1.33	3	3	O	18	O								-	-	RED+WID
33	B093	8/10K	670 /89		RSJ/DUC			20.90	2	10.50	400	4.50	4.50	4.00	5.00	1.09	4	2	-	17	X	X	X	2172	1373	1773		O 20	-	-	COV
34	B093	3/7K	670 /89		RSJ/DUC			10.10	1	10.10	400	4.57	4.57	4.00	5.00	1.10	4	2	-	17	X	X	X	2058	1294	1676	X		-	-	RED
127	B093	12/2K	670 /89		RSJ/COR			10.20	1	10.20	400	4.25	4.25	4.00	5.00	1.02	4	2	-	17	X	X	X	2087	1314	1680	OK		-	-	RED
31	B114	3/36	480 /91		RSJ/RCS			12.38	2	6.20	300	3.03	3.45	4.00	5.00	0.95	2	4	-	-	-	-	-	-	-	-	OK	-	-	O	PSC
57	B116	2/2K	1126 /93		RSJ/DUC	1991	(Wdn)Footway	9.20	1	9.20	400	4.50	5.65	5.50	7.10	1.09	3	3	O	17	X	X	X	1810	1123	1467	-			-	RED+WID
131	B127	1/2K	1054 /94	1900	RSJ/COR		(Rep)Con.Cov(MD) outside beam only, (Rep)Pro.Con.foundn., (Rep)Abutment	4.73	1	4.70	300	4.27	4.27	6.00	7.00	0.83	2	3	RCD	16	O						OK		-	-	RED+RCD(WID)
209	B146	21/1K	2620 /94	1861	ARCH/DR		(Wdn)RSJ/COR	4.40	1	4.40	340	6.26	7.26	6.00	7.00	1.10	- 3	2 3	-	17	O								-	-	RED
210	B146	6/1K	2620 /94		RSJ/RCS			23.70	3	7.90	600	3.54	4.20	6.00	7.00	1.18	1	2	O	-	O								-	-	WID
211	B146	8/1K	2620 /94	1942	RSJ/RCS			23.60	3	7.90	600	3.55	3.33	6.00	7.00	1.18	2	2	O	-	O								-	-	WID
33	B157	12/1K	750 /91	1945	ST.TR/T/RCS RSJ/RCS			51.00 17.85	1 2	8.90	380	3.30	3.64	6.10	9.20	0.68	3	4	-	-	-	-	-	-	-	-		-	-	O	PSC
58	B157	44/3K	750 /91	1930	RSJ/RCS		(Rep)Con.Cov(MD) Abn.Steel Piers(P1-4)	10.35	1	10.30	400	3.68	3.96	4.00	5.00	1.18	2	2	O	17	X	X	O				-		-	-	RED
99	B157	4/4K	750 /91	1924	RSJ/DUC			51.00	5	9.00	400	3.20	3.50	4.00	5.00	1.18	2	2	O	17	X	X	O						-	-	RED+WID
67	B157	2/2K	554 /94	1960	RSJ/DUC		Abandoned Steel Piers	19.10	4	2*(6.0+3.6)	410	3.34	3.34	4.00	5.00	1.06	2	2	O	17	O								-	-	RED+WID
18	B158	16/7K	940 /90	1935	RSJ/RCS		(Red)DUC→RCS	31.20	3	10.40	360	3.40	3.70	4.00	5.00	1.18	2	4	-	-	-	-	-	-	-	-		-	-	O	PSC
68	B164	1/5K	620 /92		RSJ/DUC (ext)		(Ext)PSC/PRE	46.9 50.6	4 5	10.80	420	4.55 4.90	4.55 6.14	4.00	5.00	1.10	3 1	3 1	-	17	X	X	X	1943	900	1425	-		-	-	RED
133	B188	3/2M	873 /93		RSJ/DUC			9.00	1	9.00	370	3.60	3.60	4.00	5.00	1.14	4	3	O	17	X	X	X	1907	1172	1540	OK		-	-	RED+WID
78	B199	9/5K	1829 /94	1918	RSJ/DUC	1995	(Wdn)Footway	124.40	12	10.40	410	4.52	4.52	5.50	7.50	1.09	4	3	O	17	X	X	X	1993	1328	1663	OK		-	-	RED+WID
135	B249	5/9K	320 /92		RSJ/DUC			9.30	1	9.30	400	4.60	4.60	4.00	5.00	1.11	3	3	-	17	X	X	X	1837	1142	1490	OK		-	-	RED
20	B264	25/7K	1601 /94		RSJ/COR			14.35	2	7.20	305	3.97	4.29	6.00	7.00	1.03	3	4	-	17	X	X	X	-	X	-	OK	O 20	-	-	COV+WID
38	B265	8/1K	-		RSJ/T			17.02	3	5.60	305	3.19	3.49	4.00	5.00	1.15	4	4	-	-	-	-	-	-	-	-	X	-	-	O	PSC
136	B272	15/2K	1270 /89		RSJ/DUC			30.50	5	6.10	305	4.28	4.28	6.00	7.00	1.03	3	2	O	17	X	X	X	-	X	-	-	O 20		-	COV+WID
195	B288	10/2K	8480 /94		RSJ/COR			5.50	1	5.50	470	6.06	6.06	6.50	7.50	1.96	-	2	RCD	20	O						X		-	-	RED+RCD(WID)
70	B295	3/6K	8818 /94	1960	RSJ/RCS			43.23	5	8.50	400	5.46	5.93	6.50	7.50	1.22	2	2	O	-	O								-	-	WID
134	B304	25/3K	2000 /91		RSJ/DUC			10.30	1	10.30	450	5.47	5.47	6.00	7.00	1.33	3	2	O	18	X	X	O						-	-	RED+WID
173	B304	17/1K	2000 /91	1940	RSJ/DUC			6.80	1	6.80	350	5.55	5.70	6.00	7.00	1.08	2	3	O	17	O								-	-	RED+WID
39	B309	30/2K	1410 /95	1927	RSJ/COR			23.10	3	7.70	480	3.87	3.87	6.00	7.00	1.23	2	3	-	18	O								-	-	RED+WID
144	B379	3/5K	-		RSJ/RCS			3.10	1	3.10	280	5.50	6.38	6.80	9.20	1.30	4	4	-	-	-	-	-	-	-	-		-	-	O	RCD
147	B419	6/2K	2260 /94		RSJ/DUC			9.84	1	9.80	400	4.35	4.68	6.00	7.00	1.06	2	3	O	17	X	X	X	1974	1236	1605	-		-	-	RED+WID
148	B419	24/2K	2260 /94		RSJ/DUC			8.40	1	8.40	300	3.60	3.60	6.00	7.00	1.15	3	3	O	17	X	X	X	-	X	-	OK	X	O	-	PSC
21	B421	8/5K	875 /94	1930	ST/DT/T/COR RSJ/DUC			26.22 10.50	3 1	10.00	410	4.22	4.22	4.00	5.00	1.01	4	2	-	17	X	O					X		-	-	RED
40	B421	66/2K	1452 /94	1930	RSJ/DUC			21.00	2	10.50	460	4.60	4.70	6.00	7.00	1.11	4	3	O	17	O								-	-	RED+WID
17	B437	3/1K	-		RSJ/DUC			10.35	1	10.30	400	3.42	3.42	4.00	5.00	1.09	3	2	O	17	X	X	X	2144	1354	1749		O 10		-	COV+WID
32	B437	2/1K	-		RSJ/COR			10.20	1	10.20	450	3.70	3.70	4.00	5.00	1.18	3	2	-	-	-	-	-	-	-	-	X	-	-	O	PSC
150	B444	4/5K	1231 /95		RSJ/COR			7.90	1	7.90	340	4.00	4.31	6.00	7.00	1.37	4	4	O	17	X	O							-	-	RED+WID
151	B445	14/2K	3912 /94		RSJ/DUC			10.10	1	10.10	410	4.66	4.66	6.50	7.50	1.11	3	3	O	17	X	X	X	1917	1261	1589			-	-	RED+WID
154	B445	14/3K	3912 /94		RSJ/DUC			10.35	1	10.30	410	4.60	4.60	4.00	5.00	1.11	3	3	-	17	X	X	X	1997	1324	1663	OK		-	-	RED
24	B450	19/2K	370 /91	1937	RSJ/T			13.60	2	6.80	305	2.75	3.06	4.00	5.00	0.92	4	2	O	17	X	X	X	-	X	-	OK	O 20	-	-	COV+WID
23	B454	6/6K	370 /91		RSJ/RCS		(Rep)Con.Cov(MD)	24.20	4	4.40 + 7.40	300	3.78	3.28	4.00	5.00	1.06	2	2	O	17	X	X	X	-	X	-	X	X	O	-	PSC
35	B454	3/1K	370 /91	1945	RSJ/RCS		(Rep)Con.Cov(MD)	22.30	5	2.80 + 5.30	300	3.30	3.30	4.00	5.00	1.03	2	2	-	-	-	-	-	-	-	-	X	-	-	O	PSC
74	B466	6/5K	580 /91	1940	RSJ/DUC			10.30	1	10.30	410	5.60	5.60	5.50	6.50	1.35	4	2	-	18	X	X	O				-		-	-	RED

M - 9 Relaxation of restriction for tractor and trailer

Source: Ministry of construction, Japan, 1993

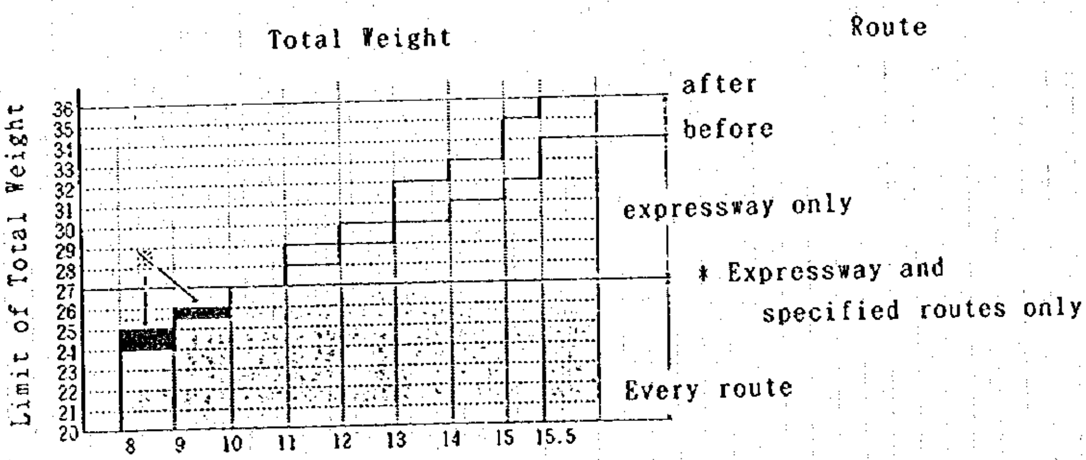
Composition of [special low for tractor and trailer]

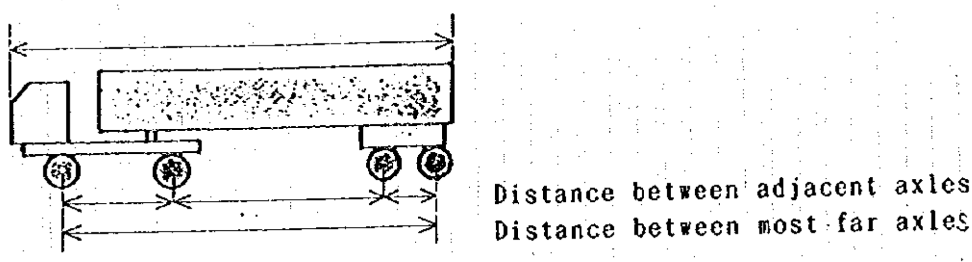
= [Total weight] x [Length] x [Vehicle type] x [Route]

+ [Permission] + [special total weight/length for trailer (maintenance regulation)]

Total weight for tractor and trailer

■ Total weight for tractor and trailer has relaxed.





M－10 Correspondent to increase of heavy vehicles in size (Interim Report)
Source:Ministry of construction, Japan, 1993

1. Back ground

The relaxation of restriction for total weight of heavy vehicles is coming up in order to promote smooth traffic flow, rationalization of goods transportation and correspondence to international interchange. New design live load which corresponds to increase of heavy vehicles in size has been studied by relevant organizations now.

Summary of the study at present is shown have under:-

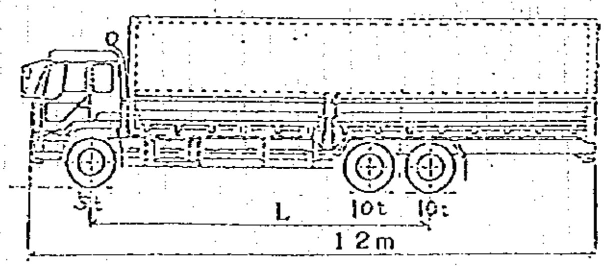
2. New design live load

1) Assumptions for the study

① Axle load : 10t which is the same as limits at present should be considered.

② Vehicles to be considered : A truck which has total weight of 25t is considered.

In case of 3 axles, the total weight of the truck will be 25t (5t + 10t + 10t) where the axle load is limited within 10t.



③ Outline of live load : For L-load, 2 degrees of live loads will be established in place of classification of 1st class bridge and 2nd class bridge.

: The load shall be established as goods as other countries' are.

: TT-43 shall be considered.

: Consideration shall be made on existing bridges.

[At present]

- T load
  - 1st class bridge (20t)
  - 2nd class bridge (14t)
- L load
  - 1st class bridge
  - 2nd class bridge

[Proposal]

- T load ···· The same as present load or more (Design load for deck slab etc.)
- L load
  - LA load ···· 3 nos. of 25 truck train loadings TT-43 considered (Design load for main beam)
  - LB load ···· 1 nos. of 25 truck loading (Design load for main beam)

Appendix - N

DATA OF RECONSTRUCTION DESIGN

LIST OF CONTENTS

1. Standard PSC Beams of RDA .... N - 1

2. Summary of Reaction (Nominal, for stability check) .... N - 2

3. Reaction .... N - 3

Table N. 1 Standard PSC Beam of RDA

Type of PSC Beam	PRE or POS	Feet / Inch				Metric (mm)			Remark
		Length			Depth	Length		Depth	
		Finished	Cast	End		Finished	End		
23'- 00" LONG	PRE	23'- 3"	23'- 0"	9"	9"	7 090	230	230	
27'- 0", 32'-0" & 35'- 0" LONG	PRE	27'- 3"	27'- 0"	9"	14 ½"	8 310	230	370	
		32'- 3"	32'- 0"	9"		9 830	230		
		35'- 3"	35'- 0"	9"		10 750	230		
40'- 0" & 44'- 0" LONG	PRE	40'- 3"	40'- 0"	9"	2' - 0"	12 260	230	610	
		44'- 3"	44'- 0"	9"		13 490	230		
53'- 0" LONG	PRE	53'- 3"	53'- 0"	9"	2' - 0 ½"	16 230	230	630	
62'- 6" LONG (53'- 0" + POS)	PRE + POS	62'- 6"	(53'- 0")	9"	2 - 1 ½"	19 050	230	650	
75'-11" LONG	POS	75'-11"	-	17 ½"	4' - 6 ½"	23 140	450	1 390	
92'- 6" LONG	POS	92'- 6"	-	1' - 9"	6' - 0"	28 200	540	1 830	

Table N. 2 Summary of Reaction (Nominal, for stability check)

(Unit : ton)

SER No.			212		77		53		211		33		59		20		70		7		Remark
Width (m)				9.8		9.8		9.2		9.8		9.2		9.2		9.2		11.0		9.2	
Case 1	RD	D	A1	123.4	A1	61.7	A1	90.5	A1	99.6	A1	115.6	A1	115.6	A1	52.7	A1	139.0	A1	115.6	
		SD	F	22.2	A2	14.7	F	30.8	F	18.4	F	21.6	F	21.6	F	13.1	F	29.0	F	21.6	
		D+SD		145.6	F	76.4		121.3		118.0		137.2		137.2		65.8		168.0		137.2	
	RI	HA		79.2		60.7		102.4		69.9		79.2		79.2		57.6		81.7		79.2	
		HB		128.7		100.3		152.1		116.3		128.7		128.7		93.6		131.2		128.7	
	Rh	HA		33.7		29.2		39.3		31.4		33.7		33.7		28.4		33.7		33.7	
		HB		30.6		30.6		30.6		30.6		30.0		30.6		30.6		30.6		30.6	
Case 2	RD	D	A2	123.4	P1	123.4	A2	90.5	A2	99.6	A2	57.6	A2	115.6	A2	52.7	A2	139.0	A2	115.6	
		SD	M	22.2	P2	29.4	M	30.8	M	18.4	M	14.3	M	21.6	M	13.1	M	29.0	M	21.6	
		D+SD		145.6	P3	152.8		121.3		118.0		71.9		137.2		65.8		168.0		137.2	
	RI	HA		79.2	MF	96.9		102.4		69.9		60.7		79.2		57.6		81.7		79.2	
		HB		128.7		120.1		152.1		116.3		100.3		128.7		93.6		131.2		128.7	
	Rh	HA		0.0		29.2		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
		HB		0.0		30.6		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Case 3	RD	D	P1	246.8	P4	156.2	P1	181.0	P1	199.2	P1	201.1	P1	231.2	P1	105.4	P1	278.0	P1	231.2	
		SD	P2	44.4	MF	46.3	MF	61.6	P2	36.8	MF	88.2	P2	43.2	MF	26.2	P2	58.0	-	43.2	
		D+SD	MF	291.2		202.5		242.6	MF	236.0		289.3	MF	274.4		131.6	MF	336.0	P8	274.4	
	RI	HA		133.8		138.6		180.4		115.4		211.1		133.8		90.7		138.8	MF	133.8	
		HB		158.4		171.9		194.6		141.2		217.4		158.4		111.6		163.4		158.4	
	Rh	HA		33.7		39.3		39.3		31.4		61.2		33.7		28.4		33.7		33.7	
		HB		30.6		30.6		30.6		30.6		30.6		30.6		30.6		30.6		30.6	
Case 4	RD	D			P5	189.0					P2	152.1									
		SD			MM	63.2					MF	80.9									
		D+SD				252.2						233.0									
	RI	HA				180.4						192.6									
		HB				194.6						207.4									
	Rh	HA				0.0						29.2									
		HB				0.0						30.6									

Reaction PSC/PRE

Beam Length(m)		16.23	16.23	16.23	13.49	13.49	13.49
Width W (m)		11.0	9.8	9.2	11.0	9.8	9.2
Carriageway Wc (m)		7.4	7.4	6.8	7.4	7.4	6.8
Footway Wf (m)		1.8	1.2	1.2	1.8	1.2	1.2
Beam	Height(m)	0.63	0.63	0.63	0.61	0.61	0.61
	Nos.	16	15	14	16	15	14
Dia of voids		0.325	0.325	0.325	0.325	0.325	0.325
	Beam	157.3	140.2	131.6	127.1	113.2	106.3
	Voids	-22.9	-21.4	-19.9	-18.6	-17.4	-16.2
	Adj. con.	4.6	4.6	3.9	3.8	3.8	3.2
	Total (t)	139.0	123.4	115.6	112.3	99.6	93.4
	Curb	20.4	13.6	13.6	17.0	11.3	11.3
	Handrail	1.6	1.6	1.6	1.3	1.3	1.3
	Pavement	6.9	6.9	6.3	5.7	5.7	5.3
	Total (t)	29.0	22.2	21.6	24.1	18.4	18.0
D+SD (Abut) (t)		168.0	145.6	137.2	136.3	118.1	111.3
D+SD Pier (t)		336.1	291.1	274.5	272.7	236.1	222.6
Live Load	HB a (t)	123.7	123.7	123.7	112.2	112.2	112.2
	HB p (t)	148.5	148.5	148.5	132.9	132.9	132.9
	HA a (t)	74.2	74.2	74.2	65.8	65.8	65.8
	HA p (t)	123.9	123.9	123.9	107.1	107.1	107.1
	Footway LLa	7.5	5.0	5.0	6.2	4.1	4.1
	Footway LLp	14.9	9.9	9.9	12.4	8.3	8.3
Longitudinal	HB (t)	30.6	30.6	30.6	30.6	30.6	30.6
Load	HA (t)	33.7	33.7	33.7	31.4	31.4	31.4

Beam	Rd = 1/2 * W * (Bh + 0.075) * BL * 2.5
Voids	Rd = 1/2 * (Bn -1) * (BL-1.5) * 1/4 * π * Dv^2 *2.5
Adj. con.	Rd = 1/2 * 1/2*Wc/60 * 1/2*Wc * BL * 2.5
Curb	Rd = 1/2 * Wf*0.28 * BL *2.5 *2
Handrail	Rd = 1/2 * 0.1t/m * BL * 2
Pavement	Rd = 1/2 * 0.05 * Wc * BL * 2.3

Live Load	HBa = (1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HBp = (2 * 1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HAa = (1/2 * 30*2*BL +120*2)/9.8
	HAp = (2*1/2 * 30*2*BL +120*2)/9.8
	Footway a = (1/2 * BL * 5 * Wf * 2)/9.8 *0.5
	Footway p = (2 * 1/2 * BL * 5 * Wf * 2)/9.8 *0.5
Longitudinal	HBa = HBp = 10 * 30 * 4 *0.25/9.8
Load	HAa = HBp = (8 * BL + 200)/9.8

Reaction PSC/PRE

Beam Length(m)		10.75	10.75	10.75	9.83	9.83	9.83
Width W (m)		11.0	9.8	9.2	11.0	9.8	9.2
Carriageway Wc (m)		7.4	7.4	6.8	7.4	7.4	6.8
Footway Wf (m)		1.8	1.2	1.2	1.8	1.2	1.2
Beam	Height(m)	0.37	0.37	0.37	0.37	0.37	0.37
	Nos.	16	15	14	16	15	14
Dia of voids		0	0	0	0	0	0
Dead load	Beam	65.8	58.6	55.0	60.1	53.6	50.3
	Voids	0.0	0.0	0.0	0.0	0.0	0.0
	Adj. con.	3.1	3.1	2.6	2.8	2.8	2.4
	Total (t)	68.8	61.7	57.6	63.0	56.4	52.7
Superimposed	Curb	13.5	9.0	9.0	12.4	8.3	8.3
dead load	Handrail	1.1	1.1	1.1	1.0	1.0	1.0
	Pavement	4.6	4.6	4.2	4.2	4.2	3.8
	Total (t)	19.2	14.7	14.3	17.6	13.4	13.1
D+SD (Abut) (t)		88.0	76.3	71.9	80.5	69.8	65.8
D+SD Pier (t)		176.1	152.7	143.8	161.0	139.6	131.5
Live Load	HB a (t)	97.0	97.0	97.0	90.6	90.6	90.6
	HB p (t)	113.5	113.5	113.5	105.6	105.6	105.6
	HA a (t)	57.4	57.4	57.4	54.6	54.6	54.6
	HA p (t)	90.3	90.3	90.3	84.7	84.7	84.7
	Footway LLa	4.9	3.3	3.3	4.5	3.0	3.0
	Footway LLp	9.9	6.6	6.6	9.0	6.0	6.0
Longitudinal	HB (t)	30.6	30.6	30.6	30.6	30.6	30.6
Load	HA (t)	29.2	29.2	29.2	28.4	28.4	28.4

Beam	Rd = 1/2 * W * (Bh + 0.075) * BL * 2.5
Voids	Rd = 1/2 * (Bn -1) * (BL-1.5) * 1/4 * π * Dv^2 *2.5
Adj. con.	Rd = 1/2 * 1/2*Wc/60 * 1/2*Wc * BL * 2.5
Curb	Rd = 1/2 * Wf*0.28 * BL *2.5 *2
Handrail	Rd = 1/2 * 0.1t/m * BL * 2
Pavement	Rd = 1/2 * 0.05 * Wc * BL * 2.3

Live Load	HBa = (1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HBp = (2 * 1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HAa = (1/2 * 30*2*BL +120*2)/9.8
	HAp = (2*1/2 * 30*2*BL +120*2)/9.8
	Footway a = (1/2 * BL * 5 * Wf * 2)/9.8 *0.5
	Footway p = (2 * 1/2 * BL * 5 * Wf * 2)/9.8 *0.5
Longitudinal	HBa = HBp = 10 * 30 * 4 *0.25/9.8
Load	HAa = HBp = (8 * BL + 200)/9.8

Reaction PSC/PRE+POS

Beam Length(m)		19.05	19.05	19.05
Width W (m)		11.0	9.8	9.2
Carriageway Wc (m)		7.4	7.4	6.8
Footway Wf (m)		1.8	1.2	1.2
Beam	Height(m)	0.65	0.65	0.65
	Nos.	16	15	14
Dia of voids		0.325	0.325	0.325
Dead load	Beam	189.9	169.2	158.8
	Voids	-27.3	-25.5	-23.7
	Adj. con.	5.4	5.4	4.6
	Total (t)	168.0	149.1	139.8
Superimposed	Curb	24.0	16.0	16.0
dead load	Handrail	1.9	1.9	1.9
	Pavement	8.1	8.1	7.4
	Total (t)	34.0	26.0	25.4
D+SD (Abut) (t)		202.1	175.2	165.1
D+SD Pier (t)		404.1	350.3	330.2
Live Load	HB a (t)	133.3	133.3	133.3
	HB p (t)	162.5	162.5	162.5
	HA a (t)	82.8	82.8	82.8
	HA p (t)	141.1	141.1	141.1
	Footway LLa	8.7	5.8	5.8
	Footway LLp	17.5	11.7	11.7
Longitudinal	HB (t)	30.6	30.6	30.6
Load	HA (t)	36.0	36.0	36.0

Beam	Rd = 1/2 * W * (Bh + 0.075) * BL * 2.5
Voids	Rd = 1/2 * (Bn -1) * (BL-1.5) * 1/4 * π * Dv^2 *2.5
Adj. con.	Rd = 1/2 * 1/2*Wc/60 * 1/2*Wc * BL * 2.5
Curb	Rd = 1/2 * Wf*0.28 * BL *2.5 *2
Handrail	Rd = 1/2 * 0.1t/m * BL * 2
Pavement	Rd = 1/2 * 0.05 * Wc * BL * 2.3

Live Load	HBa = (1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HBp = (2 * 1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HAa = (1/2 * 30*2*BL +120*2)/9.8
	HAp = (2*1/2 * 30*2*BL +120*2)/9.8
	Footway a = (1/2 * BL * 5 * Wf * 2)/9.8 *0.5
	Footway p = (2 * 1/2 * BL * 5 * Wf * 2)/9.8 *0.5
Longitudinal	HBa = HBp = 10 * 30 * 4 *0.25/9.8
Load	HAa = HBp = (8 * BL + 200)/9.8

Reaction PSC/POS

Beam Length(m)		28.2	28.2	28.2	23.14	23.14	23.14
Width W (m)		11.0	9.8	9.2	11.0	9.8	9.2
Carriageway Wc (m)		7.4	7.4	6.8	7.4	7.4	6.8
Footway Wf (m)		1.8	1.2	1.2	1.8	1.2	1.2
Beam	Area (m^2)	0.432	0.432	0.432	0.371	0.371	0.371
	Height (m)	1.83	1.83	1.83	1.39	1.39	1.39
	Nos.	5	5	5	5	5	5
	Pitch (m)	2.10	2.00	1.85	2.10	2.00	1.85
Dead load	Beam	76.1	76.1	76.1	53.7	53.7	53.7
	In-situ slab	39.2	33.3	30.4	32.2	27.3	24.9
	Adj. con.	47.8	40.7	39.4	33.4	6.6	5.6
	End cross beam	4.2	4.0	3.7	2.9	2.8	2.6
	Int. cross beam	6.3	6.0	5.5	4.4	4.2	3.8
	Total (t)	173.7	160.1	155.1	126.5	94.5	90.5
Superimposed dead load	Curb	35.5	23.7	23.7	29.2	19.4	19.4
	Handrail	2.8	2.8	2.8	2.3	2.3	2.3
	Pavement	12.0	12.0	11.0	9.8	9.8	9.0
	Total (t)	50.4	38.5	37.5	41.3	31.6	30.8
D+SD (Abut) (t)		224.1	198.6	192.6	167.9	126.1	121.3
D+SD Pier (t)		448.1	397.2	385.2	335.7	252.2	242.6
Live Load	HB a (t)	157.2	157.2	157.2	145.0	145.0	145.0
	HB p (t)	200.4	200.4	200.4	180.4	180.4	180.4
	HA a (t)	110.8	110.8	110.8	95.3	95.3	95.3
	HA p (t)	197.1	197.1	197.1	166.2	166.2	166.2
	Footway LLa	12.9	8.6	8.6	10.6	7.1	7.1
	Footway LLp	25.9	17.3	17.3	21.3	14.2	14.2
Longitudinal Load	HB (t)	30.6	30.6	30.6	30.6	30.6	30.6
	HA (t)	43.4	43.4	43.4	39.3	39.3	39.3

Beam	Rd = 1/2 * Ba * Bn * BL * 2.5
In-situ slab	Rd = 1/2 * (W - Bn*0.61) * 0.14* BL *2.5
Adj. con.	Rd = 1/2 * (1/2*Wc/60 * 1/2*Wc + 0.04 * Wc) * BL * 2.5
End cross beam	Rd = (Bp-0.15) * (Bh-0.14-0.25) *0.15*(Bn-1) *2.5
Int. cross beam	Rd = 1/2 * 3 * (Bp-0.15) * (Bh-0.14-0.25) *0.15*(Bn-1) *2.5
Curb	Rd = 1/2 * Wf*0.28 * BL *2.5 *2
Handrail	Rd = 1/2 * 0.1t/m * BL * 2
Pavement	Rd = 1/2 * 0.05 * Wc * BL * 2.3
Live Load	HBa = (1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HBp = (2 * 1/2 * 30*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HAa = (1/2 * 30*2*BL +120*2)/9.8
	HAp = (2*1/2 * 30*2*BL +120*2)/9.8
	Footway a = (1/2 * BL * 5 * Wf * 2)/9.8 *0.5
	Footway p = (2 * 1/2 * BL * 5 * Wf * 2)/9.8 *0.5
Longitudinal Load	HBa = HBp = 10 * 30 * 4 *0.25/9.8
	HAa = HBp = (8 * BL + 200)/9.8

Reaction Steel Bridge

Beam Length(m)		50
Width W (m)		9.2
Carriageway Wc (m)		6.8
Footway Wf (m)		1.2
Beam	Height(m)	2.00
	Nos.	2
Insitu slab	Thickness (m)	0.325
Hunch	Height (m)	0.08
Dead load	Steel	62.1
	Insitu slab	20.3
	Adj. con.	12.0
	Total (t)	94.5
Superimposed dead load	Curb	42.0
	Handrail	5.0
	Pavement	19.6
	Total (t)	66.6
D+SD (Abut) (t)		161.0
D+SD Pier (t)		322.0
Live Load	HB a (t)	175.6
	HB p (t)	252.1
	HA a (t)	144.4
	HA p (t)	264.3
	Footway LLa	12.0
	Footway LLp	24.0
Longitudinal Load	HB (t)	30.6
	HA (t)	61.2

Steel	Rd = 1/2 * W * BL * 0.270
In-situ slab	Rd = 1/2 * W * Ist *2.5
Hunch	Rd = 1/2 * Hh * 1/2*(1.970+3.47)*2 * 2.5
Adj. con.	Rd = 1/2 * 1/2*Wc/60 * 1/2*Wc * BL * 2.5
Curb	Rd = 1/2 * Wf*0.28 * BL *2.5 *2
Handrail	Rd = 1/2 * 0.1t/m * BL * 2
Pavement	Rd = 1/2 * 0.05 * Wc * BL * 2.3

Live Load	HBa = (1/2 * 23.530*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HBp = (2 * 1/2 * 23.5*BL + 120 + 10*30*(4*BL-1.8-7.8-9.4)/BL)/9.8
	HAa = (1/2 * 23.5*2*BL +120*2)/9.8
	HAp = (2*1/2 * 23.5*2*BL +120*2)/9.8
	Footway a = (1/2 * BL * 23.5/30 * 5 * Wf * 2)/9.8 *0.5
	Footway p = (2 * 1/2 * BL * 23.5/30 * 5 * Wf * 2)/9.8 * 0.5
Longitudinal Load	HBa = HBp = 10 * 30 * 4 *0.25/9.8
	HAa = HBp = (8 * BL + 200)/9.8

Appendix - O

SUMMARY OF BRIDGE REHABILITATION PLAN FOR 100 BRIDGES

Table O.1 SUMMARY OF BRIDGE REHABILITATION PLAN FOR 100 BRIDGES (1/2)

SER No	ROUTE No	BRIDGE No	TRAFFIC VOLUME (vpd)/year	YEAR OF CONST	TYPE OF BRIDGE	YEAR OF REPAIR	TYPE OF REPAIR	LENGTH EXST. (m)	NOS. OF SPAN	EXIST. WIDTH CARR. (m)	EXIST. WIDTH OVRAL (m)	PROP. WIDTH (RDA) CARR. (m)	PROP. WIDTH (RDA) OVRAL (m)	GEOM DEFECT Narrow (RDA)	GEOM DEFECT Poor align	STRUCTURAL DEFECTS(RATING) Deck	Main Frame	Abut	Pier	Wing wall	Super-structure	Sub-structure	Overall Rating	REHABILITATION PLAN Widen	Repair	Re deck	Repl. superst	Re const
84	AA001	110/2K	16050/95	1933	ARCH/S			68.30	3	5.50	7.80	7.40	12.00	O	O	3	1	1	1	1	2.4	1.0	2.4			O		
35	AA001	91/2K	7060/95	1894	ARCH/BK			68.90	4	6.30	7.50	7.40	10.00	O	O	-	2	2	2	1	2.0	2.0	2.0	O				
1	AA002	98/1K	5850/94		RCB			30.00	3	7.80	9.30	7.40	10.40	O	-	4	4	2	2	2	4.0	2.0	4.0					O
27	AA002	87/1K	5560/94	1898	ARCH/ST			35.20	3	6.80	7.60	7.40	9.80	O	Δ	•	1	2	3	3	1.0	3.0	3.0					O
75	AA002	62/2K	8230/94	1903	ST.TR/T/RCS		(Red)RCS	49.50	1	5.34	5.68			O	-	3	3	2	-	3	3.0	2.0	3.0		O	O		
76	AA002	62/1K	8230/94	1902	ST.TR/T/RCS		(Red)RCS	90.90	2	5.88	6.25	7.40	12.00	O	O	2	2	2	2	2	2.0	2.0	2.0		O			
86	AA002	199/3K	3170/94		PSC/PRE			7.40	1	7.20	9.80			-	•	2	3	4	•	2	3.0	4.0	4.0		O			
87	AA002	256/1K	1480/94		PSC/PRE			4.85	1	4.95	5.60			O	•	4	2	3	-	2	3.2	3.0	3.2		O			
212	AA002	138/1K	4120/94	1975	PSC/PRE			62.48	3	10.40	11.90			O	•	2	4	3	2	2	4.0	3.0	4.0		O			
79	AA003	43/1K	12620/94	1918	ST.TR/T/COR	1995	(Wdn)Footway, under con	69.20	3	4.88	5.18	7.40	10.40	O	•	2	2	2	1	3	2.0	2.0	2.0		O			
80	AA003	96/7K	2530/94	1898	ST.TR/T/COK			104.03	4	3.94	4.24	7.40	9.80	O	•	4	3	2	2	2	3.2	2.0	3.2		O	O		
43	AA004	206/9K	270/93		ARCH/BR			39.40	3	4.25	4.70	7.40	9.80	O	-	-	2	2	1	2	2.0	2.0	2.0		O			
44	AA004	196/7K	210/93		RSJ/BUC			31.35	3	4.50	4.50	7.40	9.80	O	•	4	2	2	3	3	3.2	3.0	3.2					O
45	AA004	209/1K	270/93		ARCH/CO			28.40	2	4.00	4.25	7.40	9.80	O	•	•	2	1	1	2	2.0	1.6	2.0		O			
59	AA004	16/9K	940/93		RSJ/COR			4.80	1	4.22	4.22			O	•	3	2	3	•	3	2.4	3.0	3.0	O		O		
91	AA004	169/9K	940/93		RC/BOX			13.80	3	6.70	7.30	7.40	9.80	O	•	•	4	4	3	-	4.0	3.0	4.0		O			
178	AA004	192/2K	295/93		ST.TR/D/COR			43.60	4	4.60	4.60	7.40	9.80	O	•	4	2	2	2	2	3.2	2.0	3.2		O	O		
93	AA005	21/4K	4700/94	1926	ST.TR/T/BUC			98.30	2	4.85	9.01	7.40	12.00	O	-	2	2	2	3	2	2.0	3.0	3.0		O			
46	AA007	73/5K	1380/94		ARCH/ST			11.70	1	5.20	5.80	6.80	9.20	O	-	•	1	1	-	1	1.0	1.0	1.0	O				
47	AA007	70/8K	1380/94	1918	ARCH/ST			14.57	1	5.30	6.30	6.80	9.20	O	-	•	2	3	•	1	2.0	3.0	3.0	O	O			
99	AA009	5/1K	16240/94	1860	ST.TR/D/COR	1979	(Wdn)Footway	124.80	6	6.70	10.30	7.40	12.00	O	O	3	2	2	2	3	2.4	2.0	2.4		O	O		
2	AA010	75/1K	1110/94		RSJ/COR			122.60	12	5.19	5.55	7.40	9.89	O	Δ	2	2	1	1	2	2.0	1.9	2.0	O		O		
36	AA010	48/1K	3119/94		RSJ/COR		(Red)RCS(A1→P1)	31.12	3	5.22	5.52	7.40	10.40	O	Δ	2	2	2	1	2	2.0	2.0	2.0					O
102	AA010	25/2K	3450/94	1920	RSJ/COR	1979	(Wdn)Substructure	17.20	2	5.54	5.54	7.40	9.80	O	-	3	3	2	2	2	3.0	2.0	3.0	O		O		
65	AA011	24/3K	1500/93	1967	RSJ/RCS			9.70	1	5.30	5.65	7.40	9.80	O	O	2	3	2	•	2	3.0	2.0	3.0	O		O		
103	AA012	16/1K	670/94	1970	RCS			6.64	1	5.50	6.64			O	-			2	-	2	•	2.0	2.0					
32	AA017	2/2K	1250/93		RSJ/COR			10.50	1	4.30	4.30	6.80	9.20	O	-	3	3	1	-	1	3.0	1.0	3.0	•				O
77	AA019	3/2K	1992/94	1869	ST.TR/T/COR RSJ/BUC			39.22 79.66	2 8	5.36 5.36	5.66 5.66	7.40	9.80	•	-	3 3	3 3	- 2	2 2	- 3	3.0 3.0	2.0 2.0	3.0					O
53	AA021	36/3K	644/94	1899	ST.TR/T/RCS		(Red)RCS	39.95	1	3.37	3.65	7.40	9.80	O	O	1	2	1	-	1	2.0	1.0	2.0		O			
106	AA026	69/1K	1700/94		RSJ/RCS			16.30	2	4.70	4.70	7.40	9.40	O	•	2	1	1	1	1	1.6	1.0	1.6	O		O		
108	AA033	5/3K	3247/94		RSJ/BUC			5.70	1	3.70	3.70	6.80	9.20	O	-	3	3	2	-	2	3.0	2.0	3.0	O		O		
119	AB026	3/1K	-		ARCH/BR		(Wdn)RSJ/RCS	10.87	1	5.00	7.05	6.80	9.20	O	-	4 -	2 2	2 1	- -	2 -	3.2 2.0	2.0 1.0	3.2					O
175	AB027	1/2M	4750/94		RSJ/COR			4.40	1	5.70	9.70			O	•	3	4	3	-	3	4.0	3.0	4.0					O
120	AB029	12/2K	2059/94		RSJ/RCS	1994	(Red)COR→RCS (Rep)Con.Cov(MB) (Wdn)	4.25	1	7.03	7.03	7.40			-	3	3	2	•	2	3.0	2.0	3.0		O			
30	B014	8/1K	1390/91		RSJ/COR			20.70	2	5.50	5.60			O	-	3	3	2	3	3	3.0	3.0	3.0		O	O		
122	B045	19/1K	540/92	1992	ST.TR/T/RCS	Reuse	(Rep)Prot.Con. Foundation	18.50	1	3.40	3.68			O	O	2	4	1	-	1	4.0	1.0	4.0					O
123	B079	23/2M	1999/94		RCB		(Reuse)RCB	12.02	2	3.67	4.28	7.40	11.00	O	Δ	3	1	3	1	3	2.4	3.0	3.0	O				
45	B093	8/10K	670/89		RSJ/BUC			20.90	2	4.50	4.50	6.80	9.20	O	•	4	2	1	1	1	3.2	1.0	3.2	O		O		
56	B093	3/7K	670/89		RSJ/BUC			10.10	1	4.57	4.57	6.80	9.20	O	•	4	2	1	•	1	3.2	1.0	3.2	O		O		
127	B093	12/2K	670/89		RSJ/COR			10.20	1	4.25	4.25	6.80	9.20	O	•	4	2	3	-	1	3.2	3.0	3.2	O		O		
128	B097	13/4K	120/93	1915	ST.TR/T/RCS			14.67	1	3.09	3.09	7.40	9.80	O	O	4	3	4	-	3	3.2	4.0	4.0		O	O		
66	B111	7/1K	6125/94	1930	ST.TR/T/COR			36.80	2	5.50	5.50	7.40	11.00	O	Δ	2	3	2	2	1	3.0	2.0	3.0		O			
31	B114	3/3M	480/91		RSJ/RCS			12.38	2	3.03	3.45			O	•	2	4	2	4	3	4.0	4.0	4.0					O
57	B116	2/2K	1126/93		RSJ/BUC	1991	(Wdn)Footway	9.20	1	4.50	5.65	6.80	9.20	O	•	3	3	2	•	2	3.0	2.0	3.0	O		O		
129	B127	2/7K	1054/94	1900	ARCH/BR			4.60	1	4.45	5.25	6.80	9.20	O	O(ver)	-	4	3	•	3	4.0	3.0	4.0					O
130	B127	7/1K	1054/94	1917	ST.TR/T/COR			24.73	1	4.16	4.54	7.40	9.80	O	•	1	2	1	•	2	2.0	1.0	2.0		O			
131	B127	1/2K	1054/94	1900	RSJ/COR		(Rep)Con.Cov(MB) outside beam only, (Rep)Pro.Con.founda., (Rep)Abutment	4.73	1	4.27	4.27	7.40	9.80	O	-	2	3	2	•	2	3.0	2.0	3.0					O
209	B146	21/1K	2620/94	1861	ARCH/BR		(Wdn)RSJ/COR	4.40	1	6.26	7.26				•	- 3	2 3	- 2	-	2	3.0	2.0	3.0			O		
210	B146	6/3K	2620/94		RSJ/RCS			23.70	3	3.54	4.20			O	Δ	1	2	1	1	2	2.0	1.0	2.0	O		O		
211	B146	8/3K	2620/94	1942	RSJ/RCS			23.60	3	3.55	3.83			O	•	2	2	2	1	1	2.0	2.0	2.0	O		O		

Table O.2 SUMMARY OF BRIDGE REHABILITATION PLAN FOR 100 BRIDGES (2/2)

SER. No	ROUTE No.	BRIDGE No.	TRAFFIC VOLUME (vpd)/year	YEAR OF CONST.	TYPE OF BRIDGE	YEAR OF REPAIR	TYPE OF REPAIR	LENGTH EXST. (m)	NOS. OF SPAN	EXIST. WIDTH CARR. (m)	EXIST. WIDTH OVRAL (m)	PROP. WIDTH (RDA) CARR. (m)	PROP. WIDTH (RDA) OVRAL (m)	GEOM. DEFECT Narrow (RDA)	GEOM. DEFECT Poor align	STRUCTURAL DEFECTS (RATING) Deck	Main Frame	Abut.	Pier	Wing wall	Super-structure	Sub-structure	Overall Rating	REHABILITATION PLAN Widen	Repair	Re deck	Repl. superst.	Re const.
33	B157	12/3K	750 /91	1945	ST.TR/T/RCS			51.00	1	3.30	3.64	6.80	9.20	O	-	3	4	2	2	1	4.0	2.0	4.0					O
58	B157	44/3K	750 /91	1930	RSJ/RCS		(Rep)Con.Cov(MB)	10.35	1	3.68	3.96	6.80	9.20	O	-	2	2	2	(4)	-	2.0	2.0	2.0					O
59	B157	43/4K	750 /91	1924	RSJ/BUC			31.00	5	3.20	3.36	6.80	9.20	O	-	2	2	2	2	2	2.0	2.0	2.0	O		O		
67	B157	23/2K	554 /94	1960	RSJ/BUC		Abandoned Steel Piers	19.10	4	3.34	3.34	6.80	9.20	O	-	2	2	3	2	2	2.0	3.0	3.0	O		O		
18	B158	16/7K	940 /90	1935	RSJ/RCS		(Red)BUC⇒RCS	31.20	3	3.40	3.70	6.80	9.20	O	-	2	4	2	2	2	4.0	2.0	4.0					O
48	B164	1/5K	670 /92		RSJ/BUC (ext)		(Ext)PSC/PRE	46.9 50.6	4 5	4.55 4.90	4.55 6.14	 6.00		O O		3 1	3 1	4 1	3 1	3 3	3.0 1.0	4.0 1.5	 4.0	O	O	O		
208	B172	10/4K	300 /93		BAILEY			18.30	1	4.12	4.12			-		(3)	(1)	-	-	-	(2.4)	-	(2.4)		O	O		
69	B188	5/4K	873 /95		ST.TR/T/RCS		(Red)COR⇒RCS	12.60	1	3.06	3.06	6.80	9.20	O	-	1	3	2	-	-	3.0	2.0	3.0		O			
133	B188	5/2M	873 /95		RSJ/BUC			9.00	1	3.60	3.60	6.80	9.20	O	O	4	1	1	-	1	3.2	1.0	3.2	O		O		
78	B199	5/5K	1829 /94	1918	RSJ/BUC	1995	(Wdn)Footway	124.40	12	4.52	4.52	7.40	10.00	O	-	4	3	2	1	2	3.2	2.0	3.2	O		O		
19	B207	10/3K	1098 /94	1890	ST.TR/T/COR	1987	(Rep)COR, Cross Beam	32.30	1	4.28	4.28	6.80	9.20			2	3	3	-	3	3.0	3.0	3.0		O			
71	B227	1/3M	320 /95	1994	PSC/PRE		(Restriper)	16.20	1	4.50	5.98	6.80	9.80	O	Δ	1	1	1	-	1	1.0	1.0	1.0					
72	B248	9/4K	2210 /92		ST.TR/T/COR			12.10	1	4.30	4.30	6.80	9.20	O	-	2	4	2	-	2	4.0	2.0	4.0					O
135	B249	5/9K	320 /92		RSJ/BUC			9.30	1	4.60	4.60	6.80	9.20	O	O	3	3	3	-	3	3.0	3.0	3.0	O		O		
20	B264	25/7K	1601 /94		RSJ/COR			14.35	2	3.97	4.29	7.40	9.80	O	O	3	4	2	1	2	4.0	2.0	4.0	O	O	O	O	
34	B264	7/1K	1601 /94		ST.TR/T/COR			27.23	2	4.33	4.33	6.80	9.20	O	Δ	4	2	2	2	2	3.2	2.0	3.2		O	O		
38	B265	8/1K	-		RSJ/T			17.02	3	3.19	3.49	6.80	9.20	O	-	4	4	4	4	4	4.0	4.0	4.0					O
136	B272	15/2K	1270 /89		RSJ/DEC			30.50	5	4.25	4.25	7.40	9.80	O	-	1	2	3	2	3	2.0	3.0	3.0	O				
195	B288	10/2K	8480 /94		RSJ/COR			5.50	1	6.06	6.06			O	-	-	2	1	-	1	2.0	1.0	2.0	O		O		
197	B288	10/3K	8480 /94	1918	ST.TR/T/DEC			52.80	2	5.48	5.48			O	-	2	3	2	2	2	3.0	2.0	3.0		O			
201	B288	10/5K	8480 /94		ARCH/CO			7.20	2	6.00	8.06			O	-	-	1	2	-	2	1.0	2.0	2.0		O			
70	B295	3/6K	8818 /94	1960	RSJ/RCS			43.23	5	5.46	5.93	7.40	11.00	O	-	2	2	3	2	2	2.0	3.0	3.0	O		O		
60	B300	15/6K	610 /89	1933	CAUSEWAY			7.87	3	4.60	4.60	6.80	9.20	O	-	-	2	1	1	2	2.0	1.0	2.0					O
138	B304	25/3K	2000 /91		RSJ/BUC			10.30	1	5.47	5.47	6.80	9.20	O	-	3	2	2	-	2	2.4	2.0	2.4	O		O		
173	B304	17/1K	2000 /91	1960	RSJ/BUC			6.80	1	5.55	5.70			O	-	2	3	3	-	2	3.0	3.0	3.0	O		O		
202	B304	14/5K	2600 /91	1993	BAILEY			9.15	1	4.42	4.60			-	-	-	-	(4)	-	(4)	-	(4.0)	(4.0)		O			
139	B312	25/1K	310 /91	1890	CAUSEWAY	Sch 1995		67.50	20	3.30	4.01	6.80	9.20	O	-	-	4	4	4	-	4.0	4.0	4.0					
39	B349	30/2K	1410 /95	1927	RSJ/COR			23.10	3	3.87	3.87	6.80	9.20	O	O	2	3	2	2	2	3.0	2.0	3.0	O		O		
61	B379	7/6K	-		BAILEY			33.50	1	4.11	4.75	6.80	9.20	-	-	(4)	(1)	-	-	-	(3.2)	-	(3.2)			O		
144	B379	1/1K	-		RSJ/RCS			3.10	1	5.50	6.38			O	-	4	4	2	-	2	4.0	2.0	4.0					O
147	B419	6/2K	2260 /94		RSJ/BUC			9.84	1	4.35	4.68			O	-	2	3	3	-	2	3.0	3.0	3.0	O		O		
148	B419	24/2K	2260 /94		RSJ/BUC			8.40	1	3.60	3.60			O	-	3	3	3	-	2	3.0	3.0	3.0					O
21	B421	3/1K	875 /94	1930	ST.TR/T/COR RSJ/BUC			26.22 10.50	1 1	4.22	4.22	6.80	9.20	O	-	4	2	2	2	2	3.2	2.0	3.2		O	O		
40	B421	66/2K	1452 /94	1930	RSJ/BUC			21.00	2	4.60	4.70	6.80	9.20			4	3	2	2	2	3.2	2.0	3.2	O		O		
62	B423	29/3K	351 /94		CAUSEWAY			15.02	4	3.00	3.66	6.80	9.20	O	-	-	4	3	2	-	4.0	3.0	4.0					O
63	B423	27/2K	351 /94		CAUSEWAY			7.00	3	3.30	3.30	6.80	9.20	O	-	-	4	4	3	2	4.0	3.0	4.0					O
73	B423	44/3K	351 /94		RCS			7.60	2	4.00	4.00	6.80	9.20	O	-	1	-	1	1	3	1.0	1.5	1.5		O			
7	B425	20/4K	1380 /93		PSC/PRE,RCB			139.18	18	5.85	6.85	7.40	11.00	O	-	1	4	3	1	4	4.0	3.0	4.0		O			
22	B431	2/3K	460 /92	1978	BAILEY			162.30	5	4.17	4.17	7.40	9.80	-	-	(2)	(1)	(1)	(1)	-	(1.6)	(1.0)	(1.6)					
17	B437	3/1K	-		RSJ/BUC			10.35	1	3.42	3.42	6.80	9.20	O	-	3	2	3	-	2	2.4	3.0	3.0	O		O		
32	B437	2/1K	-		RSJ/COR			10.20	1	3.70	3.70	6.80	9.20	O	-	3	2	4	-	2	2.4	4.0	4.0					O
150	B444	4/5K	1231 /95		RSJ/COR			7.90	1	4.00	4.31	6.80		O	-	4	4	3	-	3	4.0	3.0	4.0	O		O		
151	B445	14/2K	3912 /94		RSJ/BUC			16.10	1	4.66	4.66	6.80		O	-	3	3	3	-	2	3.0	3.0	3.0	O		O		
154	B445	14/3K	3912 /94		RSJ/BUC			10.35	1	4.60	4.60	6.80		O	-	3	3	3	-	2	3.0	3.0	3.0	O		O		
24	B454	19/2K	370 /91	1937	RSJ/T			13.60	2	2.75	3.06	6.80	9.20	O	-	4	2	2	3	2	3.2	3.0	3.2	O		O		
25	B454	4/6K	370 /91		RSJ/RCS		(Rep)Con.Cov(MB)	24.20	4	3.28	3.28	6.80	9.20	O	-	2	2	2	3	2	2.0	3.0	3.0					O
35	B454	3/1K	370 /91	1945	RSJ/RCS		(Rep)Con.Cov(MB)	22.30	5	3.30	3.30	6.80	9.20	O	-	2	2	4	4	4	2.0	4.0	4.0					O
41	B454	15/3K	370 /91	1924	RCS			10.30	2	3.63	3.63	6.80	9.20	O	-	-	2	3	2	3	2.0	3.0	3.0		O			
26	B462	10/1K	820 /93		ST.TR/T/COR			19.00	1	4.00	4.26	7.40	9.80	O	-	3	2	2	-	1	3.0	2.0	3.0		O	O		
42	B464	5/1K	1140 /90	1906	ST.TR/T/COR			39.20	3	4.29	4.29	7.40	9.80	O	-	4	2	2	2	2	3.2	2.0	3.2		O	O		
74	B466	6/5K	580 /91	1940	RSJ/BUC			10.30	1	5.60	5.60	6.80	9.20	O	-	4	2	2	-	3	3.2	2.0	3.2	O		O		

Appendix - P

DETERMINATION OF REHABILITATION METHOD FOR 100 BRIDGES

Table P.1 DETERMINATION OF REHABILITATION METHOD FOR 100 BRIDGES (1/2)

SER No.	ROUTE No.	BRIDGE No	TRAFFIC VOLUME (vnd)/year	YEAR OF CONST.	TYPE OF BRIDGE	YEAR OF REPAIR	TYPE OF REPAIR	LENGTH EXST. (m)	NOS. OF SPAN	EXIST WIDTH CARR (m)	EXIST WIDTH OVRAL (m)	PROP. WIDTH (RDA) CARR. (m)	PROP. WIDTH (RDA) OVRAL (m)	GEOM DEFECT Narrow (RDA)	GEOM DEFECT Poor align	FOR CONCRETE Crack Injection	FOR CONCRETE Patching	FOR CONCRETE Prepacked Concrete	FOR CONCRETE Grouting	FOR CONCRETE Clemming	Hand rail	FOR STEEL Re Paint	FOR STEEL Patching	FOR STEEL Re deck	FOR STEEL Weep Hole	FOR STEEL Add. Main B	RECONSTRUCTION RC	RECONSTRUCTION PSC	RECONSTRUCTION ST/BOX	Others
84	AA001	110/2K	16050 /95	1933	ARCH/S			68.30	3	5.50	7.80	7.40	12.00	O	O									O						
85	AA001	91/2K	7060 /95	1894	ARCH/BR			68.90	4	6.30	7.50	7.40	10.00	O	O						O									O
1	AA002	99/1K	5850 /94		RCB			30.00	3	7.80	9.30	7.40	10.40	O	-													O		
27	AA002	87/1K	5560 /94	1898	ARCH/ST			35.20	3	6.80	7.60	7.40	9.80	O	A													O		
75	AA002	62/2K	8230 /94	1903	ST TR/T/RCS		(Red)RCS	40.50	1	5.34	5.68			O	•							O	O	O	O					
76	AA002	62/1K	8230 /94	1902	ST TR/T/RCS		(Red)RCS	90.50	2	5.88	6.25	7.40	12.00	O	O							O	O		O					
86	AA002	199/3K	3170/94		PSC/PRE			7.40	1	7.20	9.80			-	-		O													
87	AA002	256/1K	1480 /94		PSC/PRE			4.85	1	4.95	5.60			O	•				O											
212	AA002	138/1K	4120 /94	1975	PSC/PRE			62.45	3	10.40	11.90			O	•	O	O													
79	AA003	43/1K	12620 /94	1918	ST TR/T/COR	1995	(Wdn)Footway, under con	69.20	3	4.88	5.18	7.40	10.40	O	•							O	O		O					
80	AA003	96/7K	2530 /94	1898	ST TR/T/COR			104.03	4	3.94	4.24	7.40	9.80	O	-							O	O	O	O					
43	AA004	206/9K	270 /93		ARCH/BR			39.40	3	4.25	4.70	7.40	9.80	O	•				O											
44	AA004	196/7K	210 /93		RSJ/BUC			31.15	3	4.50	4.50	7.40	9.30	O	-													O		
45	AA004	209/1K	270 /93		ARCH/CO			28.40	2	4.00	4.25	7.40	9.30	O	-				O											
39	AA004	163/9K	940 /93		RSJ/COR			4.80	1	4.22	4.22			O	•						O	O		O		O				
91	AA004	169/9K	940 /93		RC/BOX			13.80	3	6.70	7.30	7.40	9.80	O	•	O														
178	AA004	192/2K	295 /93		ST TR/D/COR			43.60	4	4.60	4.60	7.40	9.80	O	-							O	O	O	O					
93	AA005	21/4K	4700 /94	1926	ST TR/T/BUC			98.30	2	4.85	9.01	7.40	12.00	O	•							O	O		O					
46	AA007	73/3K	1380 /94		ARCH/ST			11.70	1	5.20	5.80	6.80	9.20	O	•															O
47	AA007	70/8K	1380 /94	1918	ARCH/ST			14.57	1	5.30	6.30	6.80	9.20	O	-				O	O										
99	AA009	3/1K	16240 /94	1860	ST TR/D/COR	1939	(Wdn)Footway	124.80	6	6.70	10.30	7.40	12.00	O	O							O	O	O	O					
2	AA010	25/1K	1110 /94		RSJ/COR			122.60	12	5.19	5.55	7.40	9.80	O	A						O	O		O		O				
36	AA010	48/1K	3119 /94		RSJ/COR		(Red)RCS(A1-P1)	31.12	3	5.22	5.52	7.40	10.40	O	A													O		
102	AA010	25/2K	3450 /94	1920	RSJ/COR	1979	(Wdn)Substructure	17.20	2	5.54	5.54	7.40	9.80	O	•						O	O		O		O				
63	AA011	24/3K	1500 /93	1967	RSJ/RCS			9.70	1	5.30	5.65	7.40	9.80	O	O						O	O		O		O				
103	AA012	16/1K	670 /94	1970	RCS			6.64	1	5.50	6.64			O	-															
52	AA017	2/2K	1250 /93		RSJ/COR			10.50	1	4.30	4.30	6.80	9.20	O	•													O		
77	AA019	3/2K	1992 /94	1869	ST.TR/T/COR, RSJ/BUC			39.22 79.66	2 8	5.36 5.36	5.66 5.66	7.40	9.80	-	•													O		
53	AA021	36/3K	444 /94	1899	ST TR/T/RCS		(Red)RCS	39.95	1	3.37	3.65	7.40	9.80	O	O							O	O		O					
106	AA026	69/1K	1700 /94		RSJ/RCS			16.30	2	4.70	4.70	7.40	9.40	O	•						O	O		O	O					
108	AA033	5/3K	3247 /94		RSJ/BUC			5.70	1	3.70	3.70	6.80	9.20	O	•						O	O		O		O				
119	AB026	3/1K	-		ARCH/BR		(Wdn)RSJ/RCS	10.87	1	5.00	7.05	6.80	9.20	O	•													O		
175	AB027	1/2M	4750 /94		RSJ/COR			4.40	1	5.70	9.70			O	•												O			
120	AB029	12/2K	2959 /94		RSJ/RCS	1994	(Red)COR→RCS (Rep)Con.Cov(MB) (Wdn)	4.25	1	7.03	7.03	7.40			•						O			O						
30	B014	8/1K	1390 /91		RSJ/COR			20.70	2	5.50	5.60			O	•	O					O	O		O						
122	B045	1W1K	540 /92	1992	ST TR/T/RCS	Renew	(Rep)Prot.Con. Foundatio	18.50	1	3.40	3.65			O	O													O		
123	B079	23/2M	1999 /94		RCB		(Renuer)RCB	12.02	2	3.67	4.25	7.40	11.00	O	A						O	O		O						
55	B093	9/10K	670 /89		RSJ/BUC			20.90	2	4.50	4.50	6.80	9.20	O	•						O	O		O						
56	B093	3/7K	670 /89		RSJ/BUC			10.10	1	4.57	4.57	6.80	9.20	O	-						O	O		O						
127	B093	12/2K	670 /89		RSJ/COR			10.20	1	4.25	4.25	6.80	9.20	O	•						O	O		O						
128	B097	15/4K	120 /93	1915	ST.TR/T/RCS			14.67	1	3.09	3.09	7.40	9.80	O	O						O	O	O	O	O					
66	B111	7/1K	6125 /94	1930	ST TR/T/COR			36.80	2	5.50	5.50	7.40	11.00	O	A							O	O		O					
31	B114	3/3M	480 /93		RSJ/RCS			12.38	2	3.03	3.45			O	•													O		
57	B116	2/2K	1126 /93		RSJ/BUC	1991	(Wdn)Footway	9.20	1	4.50	5.65	6.80	9.20	O	•						O	O		O		O				
129	B127	2/7K	1054 /94	1900	ARCH/BR			4.60	1	4.45	5.25	6.80	9.20	O	O(ver)												O			
130	B127	7/1K	1054 /94	1917	ST TR/T/COR			24.73	1	4.16	4.54	7.40	9.80	O	-							O	O		O					
131	B127	1/2K	1054 /94	1900	RSJ/COR		(Rep)Con.Cov(MB) outside beam only. (Rep)Pro.Con.founda.. (Rep)Abutment	4.73	1	4.27	4.27	7.40	9.80	O	-												O			
209	B146	21/1K	2620 /94	1861	ARCH/BR		(Wdn)RSJ/COR	4.40	1	6.26	7.26				•						O	O		O						
210	B146	6/3K	2620 /94		RSJ/RCS			23.70	3	3.54	4.20			O	A						O	O				O				
211	B146	8/3K	2620 /94	1942	RSJ/RCS			23.60	3	3.55	3.83			O	-						O	O				O				

Table P.2 DETERMINATION OF REHABILITATION METHOD FOR 100 BRIDGES (2/2)

SER	ROUTE	BRIDGE	TRAFFIC VOLUME	YEAR OF	TYPE OF	YEAR OF	TYPE OF	LENGTH EXST.	NOS. OF	EXIST WIDTH		PROP WIDTH (RDA)		GEOM.DEFECT		FOR CONCRETE					-	FOR STEEL					RECONSTRUCTION			Others
No	No	No.	(vpd)/year	CONST	BRIDGE	REPAIR	REPAIR	(m)	SPAN	CARR. (m)	OVRAL (m)	CARR. (m)	OVRAL (m)	Narrow (RDA)	Poor Align	Crack Injection	Patching	Prepacked Concrete	Grouting	Cleaning	Hand rail	Re Paint	Patching	Re deck	Weep Hole	Add. Main B	RC	PSC	ST/BOX	
33	B157	12/3K	750/91	1945	ST.TR/T/RCS RSJ/RCS			51.00 17.85	1 2	3.30	3.64	6.80	9.20	O	-													O	O	
58	B157	44/3K	750/91	1930	RSJ/RCS		(Rep)Con.Cov(MB) Abn.Steel Piers(P1-4)	10.35	1	3.68	3.96	6.80	9.20	O	-													O		
59	B157	43/4K	750/91	1924	RSJ/BUC			51.00	5	3.20	3.56	6.80	9.20	O	-						O	O		O		O				
67	B157	23/2K	556/94	1960	RSJ/BUC		Abandoned Steel Piers	19.10	4	3.34	3.34	6.80	9.20	O	-						O	O		O		O				
18	B158	16/7K	940/90	1935	RSJ/RCS		(Red)BUC⇒RCS	31.29	3	3.40	3.70	6.80	9.20	O	-													O		
68	B164	1/5K	670/92		RSJ/BUC (ext)		(Ext)PSC/PRE	46.9 50.6	4 5	4.35 4.90	4.55 6.14	6.00		O O					O		O	O		O		O				
208	B172	10/4K	300/93		BAILEY			18.30	1	4.12	4.12			-										O						O
69	B188	5/4K	873/95		ST TR/T/RCS		(Red)COR⇒RCS	12.60	1	3.06	3.06	6.80	9.20	O	-							O	O		O					
133	B188	5/2M	873/95		RSJ/BUC			9.00	1	3.60	3.60	6.80	9.20	O	O						O	O		O		O				
78	B199	5/3K	1829/94	1918	RSJ/BUC	1995	(Wdn)Footway	124.40	12	4.52	4.52	7.40	10.06	O	-						O	O		O						
19	B207	10/3K	1088/94	1890	ST TR/T/COR	1992	(Rep)COR, Cross Beam	32.38	1	4.28	4.28	6.80	9.20									O	O		O					
71	B227	1/5M	320/95	1994	PSC/PRE		(Remper)	16.20	1	4.50	5.98	6.80	9.80	O	A															
72	B248	9/4K	2210/92		ST TR/T/COR			12.10	1	4.30	4.30	6.80	9.20	O	-													O		
135	B249	5/9K	320/92		RSJ/BUC			9.30	1	4.60	4.60	6.80	9.20	O	O						O	O		O						
20	B264	25/7K	1601/94		RSJ/COR			14.35	2	3.97	4.29	7.40	9.80	O	O						O	O		O		O				
34	B264	7/1K	1601/94		ST TR/T/COR			27.23	2	4.33	4.33	6.80	9.20	O	A							O	O	O	O					
38	B265	8/1K	-		RSJ/T			17.02	3	3.19	3.49	6.80	9.20	O	-													O		
136	B272	15/2K	1270/89		RSJ/DEC			30.50	5	4.28	4.28	7.40	9.80	O	-						O	O				O				
195	B288	10/2K	8480/94		RSJ/COR			5.50	1	6.06	6.06			O	-						O	O		O		O				
197	B289	10/3K	8480/94	1918	ST TR/T/DEC			52.80	2	5.48	5.48			O	-							O	O		O					
201	B289	10/5K	8480/94		ARCH/CO			7.20	2	6.00	8.06			O	-				O											
70	B295	3/6K	8818/94	1960	RSJ/RCS			43.23	5	5.46	5.93	7.40	11.00	O	-						O	O		O		O				
60	B300	15/6K	610/89	1933	CAUSEWAY			7.87	3	4.60	4.60	6.80	9.20	O	-													O		
130	B304	25/3K	2000/91		RSJ/BUC			10.30	1	5.47	5.47	6.80	9.20	O	-						O	O		O		O				
173	B304	17/1K	2090/91	1940	RSJ/BUC			6.50	1	5.55	5.70			O	-						O	O		O		O				
202	B304	14/5K	2600/91	1993	BAILEY			9.15	1	4.42	4.80			-	-															O
139	B312	2/1K	310/91	1980	CAUSEWAY	Sch 1995		67.50	20	3.30	4.01	6.80	9.20	O	-															
39	B349	30/2K	1410/95	1927	RSJ/COR			23.10	3	3.87	3.87	6.80	9.20	O	O						O	O		O		O				
61	B379	7/6K	-		BAILEY			33.50	1	4.11	4.75	6.80	9.20	-	-									O						
144	B379	1/1K	-		RSJ/RCS			3.10	1	5.50	6.35			O	-												O			
147	B419	6/2K	2260/94		RSJ/BUC			9.84	1	4.35	4.68			O	-						O	O		O		O				
148	B419	24/2K	2260/94		RSJ/BUC			5.40	1	3.60	3.60			O	-													O		
21	B421	8/1K	875/94	1930	ST.TR/T/COR RSJ/BUC			26.22 10.50	1 1	4.22	4.22	6.80	9.20	O	-							O	O	O	O					
40	B421	66/2K	1452/94	1930	RSJ/BUC			21.00	2	4.60	4.70	6.80	9.20								O	O		O		O				
62	B423	29/3K	351/94		CAUSEWAY			15.02	4	3.00	3.66	6.80	9.20	O	-													O		
63	B423	27/2K	351/94		CAUSEWAY			7.00	3	3.30	3.30	6.80	9.20	O	-													O		
73	B423	44/3K	351/94		RCS			7.60	2	4.00	4.00	6.80	9.20	O	-				O											
7	B425	20/4K	1380/93		PSC/PRE,RCB			139.18	18	5.85	6.85	7.40	11.00	O	-	O	O	O												O
22	B431	2/3K	460/92	1978	BAILEY			162.30	5	4.17	4.17	7.40	9.80	-	-															
17	B437	3/1K	-		RSJ/BUC	-		10.35	1	3.42	3.42	6.80	9.20	O	-						O	O		O		O				
32	B437	3/1K	-		RSJ/COR			10.20	1	3.70	3.70	6.80	9.20	O	-													O		
150	B444	4/5K	1231/95		RSJ/COR			7.90	1	4.00	4.31	6.80		O	-						O	O		O		O				
151	B445	14/2K	3912/94		RSJ/BUC			10.10	1	4.66	4.66	6.80		O	-						O	O		O		O				
154	B445	14/3K	3912/94		RSJ/BUC			10.35	1	4.60	4.60	6.80		O	-						O	O		O		O				
24	B454	19/2K	370/91	1937	RSJ/T			13.60	2	2.75	3.06	6.80	9.20	O	-						O	O		O		O				
25	B454	6/6K	370/91		RSJ/RCS		(Rep)Con.Cov(MB)	24.20	4	3.28	3.28	6.80	9.20	O	-													O		
35	B454	3/1K	370/91	1945	RSJ/RCS		(Rep)Con.Cov(MB)	22.30	5	3.30	3.30	6.80	9.20	O	-													O		
41	B456	15/3K	370/91	1924	RCS			10.30	2	3.63	3.63	6.80	9.20	O	-						O									
26	B462	10/1K	820/93		ST.TR/T/COR			19.00	1	4.00	4.26	7.40	9.80	O	-							O	O	O	O					
42	B464	3/1K	1140/90	1904	ST TR/T/COR			59.20	3	4.29	4.29	7.40	9.80	O	-							O	O	O	O					
74	B466	6/5K	530/91	1940	RSJ/BUC			10.30	1	5.60	5.60	6.80	9.20	O	-						O	O		O						

DATA OF ENVIRONMENTAL EXAMINATION

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Table Q.1 Preliminary Environmental Examination Form (Sheet 1)

NAME OF BRIDGE	CLASS OF ROAD	CROSSING UNDER THE BRIDGE		DATE OF EXAMINATION	NAME OF EXAMINER

Item	Present condition	Potential environmental impact	Information to be gathered	Remarks	Sketch of bridge and surroundings
Resettlement	-Distribution of dwellings (near bridge and approach roads) ☐ Dense distribution ☐ Thin distribution ☐ No dwellings (please sketch in blank space on right) -Distribution of schools, hospitals, religious facilities (other important facilities) ☐ Exist (please show the position and name of the facilities in sketch on right) ☐ Do not exist	-Relocation of dwellings schools, hospitals, religious facilities, or other important facilities (due to bridge rehabilitation/construction) ☐ Likely ☐ Likely in some cases ☐ Unlikely ☐ Not clear -Effect of relocation on residents /community ☐ Major ☐ Small ☐ None ☐ Not clear	-Distribution map of dwellings, important facilities (e.g. large scale topographic map, town map) ☐ Available (please attach the map) ☐ Not available -Regional records of relocation in previous projects ☐ Have the records (please attach the details, e.g. project, number of resettled people, compensation) ☐ Have no record		
Remains and cultural assets	-Distribution of remains and cultural assets ☐ Exist (please show position in sketch on right) ☐ Do not exist ☐ Unknown -(If any,) Name, value, state of preservation:	-Effect of rehabilitation/construction of bridge on remains and cultural assets ☐ Remains and cultural assets in the rehabilitation/construction area ☐ Remains and cultural assets in surrounding area (some will have to be destroyed) ☐ No effect	-Distribution map of remains and cultural assets ☐ Available (please attach the map) ☐ Not available -Number of visitors (average annual visitors)		

Table Q.1 Preliminary Environmental Examination Form (Sheet 2)

NAME OF BRIDGE	CLASS OF ROAD	CROSSING UNDER THE BRIDGE	DATE OF EXAMINATION	NAME OF EXAMINER

Item	Present condition	Potential environmental impact	Information to be gathered	Remarks
Water rights and right of common	-Water rights (for river crossing under the bridge) ☐ Exist (please attach details) ☐ Do not exist ☐ Unknown -Right of common (for lands adjacent to bridge/approach roads) ☐ Exist (please attach details) ☐ Do not exist ☐ Unknown	-Effect on water rights, river use, right of common (due to bridge rehabilitation and construction) ☐ Major ☐ Small ☐ None ☐ Not clear	-River-use (for river crossing under bridge) ☐ Fishery (please attach detail, e.g. fishery right, species of fish) ☐ Mining (please attach details, e.g. mining right, types of minerals) ☐ Navigation (please attach details) ☐ Use of river water, i.e. water supply, agricultural, industrial (please attach details) ☐ Other use, e.g. washing, bathing, etc. (please attach details)	
Land-scape	-Distribution of scenic places/religious sites ☐ Exist (please show position and name in sketch on sheet 1) ☐ Do not exist ☐ Unknown -(If any,) name, value:	-Effect of bridge rehabilitation/construction on scenic places/religious sites ☐ Scenic places in rehabilitation/construction area ☐ Scenic places in surrounding areas ☐ No effect	-Distribution map of scenic places/religious sites ☐ Available (please attach map) ☐ Not available -Number of visitors (average annual visitors)	
Others (traffic condi-tions)	-Traffic volume: -Traffic congestion: -Traffic accidents:	-Traffic disturbance (associated with rehabilitation/construction work) ☐ Likely ☐ Likely in some cases ☐ Unlikely ☐ Not clear -Obstruction to public safety and lifestyle due to rehabilitation/construction work) ☐ Likely ☐ Likely in some cases ☐ Unlikely ☐ Not clear	-Traffic volume data ☐ Available (please attach data) ☐ Not available -Traffic accident data ☐ Available (please attach data) ☐ Not available -Pedestrian traffic data ☐ Available (please attach data) ☐ Not available	

Surrounding Conditions
-Densely populated/inner-city area ☐ Yes ☐ No -Tourist area ☐ Yes ☐ No -Historical (or religious) area ☐ Yes ☐ No -National park (or any other area restricted for development) ☐ Yes ☐ No

Table Q. 1 Preliminary Environmental Examination Form (Sheet 3)

NAME OF BRIDGE	CLASS OF ROAD	CROSSING UNDER THE BRIDGE	DATE OF EXAMINATION	NAME OF EXAMINER

Photographs

Photo 4

Photo 1

Location of photographs taken

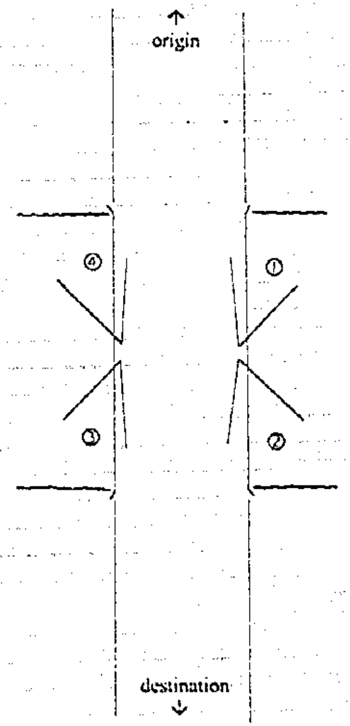

Photo 3

Photo 2

(If location is changed, please plot location of photographs taken)

Table Q.2 List of Bridges for Preliminary Environmental Examination (1/2)

SER No	ROUTE No	BRIDGE No	TRAFFIC VOLUME (vdt/year)	SURROUNDING CONDITIONS: Densely populated/ inner-city area	Tourist area	Historical (or religious) area	National park (or any other area for development)	Remark	Effects During Construction: Relocation of residents	School, hospitals, religious facilities	River-use	Traffic disturbance	Obstruction to public safety	Landscaping: Cultural remains	*1 Scenic places	Considera-tion on Natural Resources	Evaluation on Environ-mental Considera-tion	Comments (Environmental consideration shall especially be given to the items shown below)	Page
34	AA001	110/2K	16050 /95	Yes	Yes	Yes	No	Botanical Garden, Peradenia Univ. Scenic bridge	○	◎	○	◎	◎	×	◎	×	◎	Relocation, Traffic disturbance, Scenic place/bridge	1
85	AA001	91/2K	7060 /95	Yes	No	No	No	Scenic bridge	○	×	○	◎	◎	×	◎	×	◎	Traffic disturbance, Scenic Bridge	4
1	AA002	95/1K	5880 /94	Yes	Yes	No	No		○	×	○	◎	◎	×	◎	×	◎	Traffic disturbance, Scenic place	7
27	AA002	87/1K	5560 /94	Yes	Yes	No	No		×	×	○	◎	◎	×	○	×	◎	Traffic disturbance, Scenic place	10
75	AA002	62/2K	8230 /94	Yes	Yes	No	No	Bo-tree, Boat-house, Fishery	◎	○	◎	○	○	×	◎	×	◎	Relocation, Fishery, Traffic disturbance, Scenic place	13
76	AA002	62/1K	8230 /94					Railway crossing											
86	AA002	199/3K	3170/94	No	No	No	No		×	×	×	×	×	×	×	×	×		16
87	AA002	256/1K	1480 /94	No	No	No	No		×	×	○	×	×	×	×	×	○	River-use	19
212	AA002	138/1K	4120 /94	No	No	No	No		×	×	○	○	×	×	○	×	○	River-use, Traffic disturbance	22
79	AA003	4/1K	12620 /94	No	No	No	No	Fishery, Big river landscape	△	×	△	○	○	×	△	×	○	River-use, Big river landscape	25
80	AA003	96/7K	2530 /94	No	Yes	No	No		○	×	△	○	○	×	×	×	○	Traffic disturbance, Relocation	28
43	AA004	296/9K	270 /93	No	Yes	No	No	DIYALUWA WATER FALL	×	×	△	○	×	×	◎	×	◎	Traffic disturbance, Scenic place	31
44	AA004	196/7K	210 /93	No	No	No	No		×	×	○	○	○	×	×	×	○	River use, Traffic disturbance	34
45	AA004	209/1K	270 /93	No	No	No	No		×	×	△	○	○	×	×	×	○	Traffic disturbance	37
89	AA004	163/9K	940 /93	No	No	No	No		×	×	△	◎	◎	×	×	○	◎	Traffic disturbance, Natural resources	40
91	AA004	166/9K	940 /93	No	No	No	No		×	×	×	○	○	×	×	○	○	Traffic disturbance, Natural resources	43
178	AA004	192/2K	295 /93	No	No	No	No		×	×	△	○	○	×	×	×	○	Traffic disturbance	46
93	AA005	2/14K	4700 /94	Yes or No	No	No	No	Bo-tree, Free Medical Center	○	○	○	◎	◎	○	△	×	◎	Traffic disturbance, Relocation, Remains, River	49
46	AA007	73/3K	1350 /94	No	No	No	No		×	×	○	○	○	×	×	×	○	Traffic disturbance, River use	52
47	AA007	70/8K	1350 /94	No	No	No	No		×	×	○	○	○	×	×	×	○	Traffic disturbance, River use	55
99	AA009	5/1K	16240 /94	Yes or No	Yes	Yes	No	Church, School, Buddhist temple, Scenic bridge	◎	◎	△	◎	◎	×	◎	×	◎	Relocation, Traffic disturbance, Scenic place/bridge	58
2	AA010	75/1K	1110 /94	No	No	No	No	Buddhist temple	×	×	△	○	○	×	×	×	○	Traffic disturbance	61
36	AA010	48/1K	3119 /94	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	64
102	AA010	25/2K	3450 /94	No	No	No	No		○	×	×	×	×	×	×	×	○	Relocation of residents	67
65	AA011	24/3K	1500 /93	No	No	No	No	Elephant bathing	×	×	○	×	○	×	×	×	○	River-use	70
103	AA012	16/1K	670 /94	No	No	No	No	Wewa(Lake)	×	×	△	○	○	×	×	×	○	Traffic disturbance	73
52	AA017	2/2K	1250 /93	No	No	No	No		○	×	×	×	×	×	×	×	○	Relocation of residents	76
77	AA019	3/2K	1992 /94	No	No	No	No		○	×	○	◎	◎	×	△	×	◎	Traffic disturbance, River use, Relocation	79
53	AA021	36/3K	644 /94	No	No	No	No	Pupils of the school walk	×	×	×	○	○	×	×	×	○	Traffic disturbance	82
106	AA026	69/1K	1700 /94	Yes	No	No	No	Cinema hall, Police station	○	×	◎	◎	◎	×	×	○	◎	Traffic disturbance, River, Natural resources	85
108	AA033	9/3K	3247 /94	No	No	No	No	Roman catholic church nearby	×	×	×	×	×	×	×	×	×		88
119	AB026	3/1K	-	Yes	No	Yes	No	Temple	◎	◎	◎	◎	◎	×	×	×	◎	Relocation, River, Traffic disturbance	91
175	AB027	1/2M	4750 /94	Yes	No	No	No	Fishery	◎	×	△	○	○	×	×	×	◎	Relocation, Traffic disturbance	94
120	AB029	12/2K	2059 /94	No	No	No	No		×	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	97
30	B014	8/1K	1390 /91	No	No	No	No		×	×	△	×	×	×	×	×	△	River-use	100
122	B065	19/1K	540 /92	No	No	No	No		×	×	×	×	×	×	×	×	×		103
123	B079	23/2M	1999 /94	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	106
55	B093	8/10K	670 /89	No	No	No	No		○	×	△	○	○	×	×	×	○	Relocation of residents, Traffic disturbance	109
56	B093	3/7K	670 /89	No	No	No	No		○	×	○	○	○	×	×	×	○	Relocation, River, Traffic disturbance	112
127	B093	12/2K	670 /89	No	No	No	No		×	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	115
128	B097	15/4K	120 /93	No	No	No	No		×	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	118
66	B111	7/6K	6125 /94	No	No	No	No	Well	○	×	△	○	○	×	×	×	○	Relocation, River, Traffic disturbance	121
31	B114	3/3M	450 /91	No	No	No	No		×	×	×	×	×	×	×	×	×		124
57	B116	2/2K	1126 /93	No	No	No	No		×	×	×	×	×	×	×	×	×		127
129	B127	2/7K	1054 /94	No	No	No	No		◎	×	×	○	○	×	×	×	◎	Relocation of residents, Traffic disturbance	130
130	B127	7/1K	1054 /94	No	No	No	No	Bank, Post office	×	×	×	○	○	×	×	×	○	Traffic disturbance	133
131	B127	1/2K	1054 /94	No	No	No	No		○	×	△	○	○	×	×	×	○	Relocation of residents, Traffic disturbance	136
209	B146	21/1K	2620 /94	No	No	No	No		×	×	△	×	×	×	×	×	△	River-use	139
210	B146	6/3K	2620 /94	No	No	No	No		×	×	△	○	○	×	×	×	○	Traffic disturbance	142
211	B146	8/3K	2620 /94	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	145

Legends
◎ Environmental consideration shall be given
○ Better to be considered
△ A few consideration shall be given
× No need to be considered

Note *1 include potential to become scenic resource

Table Q.2 List of Bridges for Preliminary Environmental Examination (2/2)

SER No.	ROUTE No	BRIDGE No	TRAFFIC VOLUME (vdt)/year	SURROUNDING CONDITIONS: Densely populated/ inner-city area	Tourist area	Historical (or religious) area	National park (or any other area for development)	Remark	Effects During Construction: Relocation of residents	School, hospitals, religious facilities	River-use	Traffic disturbance	Obstruction to public safety	Landscaping: Cultural remains	*1 Scenic places	Consideration on Natural Resources	Evaluation on Environmental Consideration	Comments (Environmental consideration shall especially be given to the items shown below.)	Page
33	B157	12/3K	750 /91	No	No	No	No		○	×	△	○	○	×	△	×	○	Relocation of residents, Traffic disturbance	148
58	B157	44/3K	750 /91	No	No	No	No	Pagoda(200m)	×	△	×	×	×	×	×	×	△	River-use	151
59	B157	43/4K	750 /91	No	No	No	No		×	×	○	×	×	×	×	×	×	River-use	154
67	B157	23/2K	554 /94	No	No	No	No	Mosque	○	○	○	×	×	×	×	×	○	Relocation of residents, River-use	157
18	B158	16/7K	940 /90	No	No	No	No		△	×	×	×	×	×	×	×	△	Relocation of residents	160
68	B164	1/5K	670 /92	No	Yes	Yes	No		×	×	○	○	○	○	×	×	○	Remains, Traffic disturbance, River-use	163
208	B172	10/4K	300 /93	No	No	No	No		×	×	○	○	○	×	×	×	○	Traffic disturbance, River-use	166
69	B188	3/4K	873 /95	No	No	No	No	Range water pipe 3-nos.	×	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	169
133	B188	3/2M	873 /95	No	No	No	No	Range water pipe 4-nos	×	×	×	○	○	×	×	×	○	Traffic disturbance	172
78	B199	3/3K	1829 /94	No	No	No	No	Intake tower (Water supply)	○	×	◎	○	○	×	○	×	◎	River-use, Traffic disturbance, Relocation	175
19	B207	10/3K	1088 /94	No	No	No	No		×	×	△	×	×	×	×	×	△	River-use	178
71	B227	1/5M	320 /95	No	No	No	No		×	×	×	×	×	×	×	×	×		181
72	B248	9/4K	2210 /92	No	No	No	No		○	○	×	○	○	×	×	×	○	Relocation, Traffic disturbance	184
135	B249	5/9K	320 /92	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	187
20	B264	25/7K	1601 /94	No	No	No	No	Well (abandoned)	○	×	○	○	○	×	×	×	○	Relocation, River, Traffic disturbance	190
34	B264	7/1K	1601 /94	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	193
38	B265	8/1K	-	No	No	No	No	Buddhist temple, Access road to Adams Peak	×	×	×	○	○	×	×	×	○	Traffic disturbance	196
136	B272	15/2K	1270 /89	No	No	No	No		×	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	199
195	B288	10/2K	8480 /94																
197	B288	10/3K	8480 /94	No	No	No	No	Temple	×	○	△	○	○	×	×	×	○	Relocation of Temple, Traffic disturbance	202
201	B288	10/5K	8480 /94																
76	B295	3/6K	8518 /94	Yes	No	No	No	Fishery	◎	×	◎	◎	◎	×	×	×	◎	Relocation of residents, Fishery, Traffic disturb	207
60	B300	15/6K	610 /89	No	No	No	No		○	×	×	×	×	×	×	×	○	Relocation of residents	210
138	B304	25/3K	2000 /91	No	No	No	No		×	×	×	×	×	×	×	×	×		213
173	B304	17/1K	2900 /91	No	No	No	No		×	×	△	×	×	×	×	×	△	River-use	216
202	B304	14/5K	2600 /91	No	No	No	No		○	×	×	○	×	×	×	×	○	Relocation of residents, Traffic disturbance	219
139	B312	23/1K	310 /91	No	No	No	No		×	×	×	△	△	×	×	×	△	Traffic disturbance	222
39	B349	30/2K	1410 /95	No	No	No	No		×	×	×	×	×	×	×	×	×		225
61	B379	7/6K	-	No	No	No	No		×	×	×	×	×	×	×	×	×		228
144	B379	1/1K	-	Yes	No	No	No	Relocation completed	×	×	×	○	○	×	×	×	○	Traffic disturbance	231
147	B419	6/2K	2260 /94	No	No	No	No		×	×	△	○	○	×	×	×	○	Traffic disturbance	234
148	B419	24/2K	2260 /94	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	237
21	B421	8/1K	875 /94	No	No	No	No	Temple Pagoda	○	○	○	○	×	×	×	×	○	Relocation, River, Traffic disturbance	240
40	B421	66/2K	1452 /94	No	No	No	No		×	×	△	×	×	×	×	×	△	River-use	243
62	B423	29/3K	351 /94	No	No	No	No		×	×	×	×	×	×	×	×	×		246
63	B423	27/2K	351 /94	No	No	No	No		×	×	×	×	×	×	×	×	×		249
73	B423	44/3K	351 /94	No	No	No	No		×	×	×	×	×	×	×	×	×		252
7	B425	20/4K	1380 /93	Yes	No	No	No	Fishery, Boat-house, Junior School	○	○	◎	○	○	×	△	×	◎	Fishery, Traffic disturbance, Relocation	255
22	B431	2/3K	460 /92	No	No	No	No		×	×	○	○	○	×	×	×	○	Traffic disturbance	258
17	B437	3/1K	-	No	No	No	No		×	×	×	○	○	×	×	×	○	Traffic disturbance	261
32	B437	2/1K	-	No	No	No	No		×	×	△	○	○	×	×	×	○	Traffic disturbance	264
150	B444	4/5K	1231 /95	No	No	No	No	Bo-tree	×	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	267
151	B445	14/2K	3912 /94	No	No	No	No		○	×	○	○	○	×	×	×	○	River-use, Traffic disturbance	
154	B445	14/3K	3912 /94																270
24	B454	19/2K	370 /91	No	No	No	No		×	×	○	×	×	×	×	×	○	River-use	273
25	B454	6/6K	370 /91	No	No	No	No		○	×	×	×	×	×	×	×	○	Relocation of residents	276
35	B454	3/1K	370 /91	No	No	No	No		×	×	×	×	×	×	×	×	×		279
41	B454	15/3K	370 /91	No	No	No	No		×	×	×	×	×	×	○	×	○	Scenic place in surrounding area	282
26	B462	10/1K	820 /93	No	No	No	No		×	×	×	×	×	×	×	×	×		285
42	B464	5/1K	1140 /90	No	Yes	No	No		×	×	×	×	×	×	◎	×	◎	Scenic place	288
74	B466	6/5K	580 /91	No	No	No	No		×	×	○	×	×	×	×	×	○	River-use	291

Legends
◎ Environmental consideration shall be given
○ Better to be considered
△ A few consideration shall be given
× No need to be considered

Note *1: include potential to become scenic resource

Table Q.3 (1) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 85

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Widening	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
	Additional footways are provided at both sides. One lane traffic is used during construction. Construction road is required. Construction period: 12 months	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	No plan	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

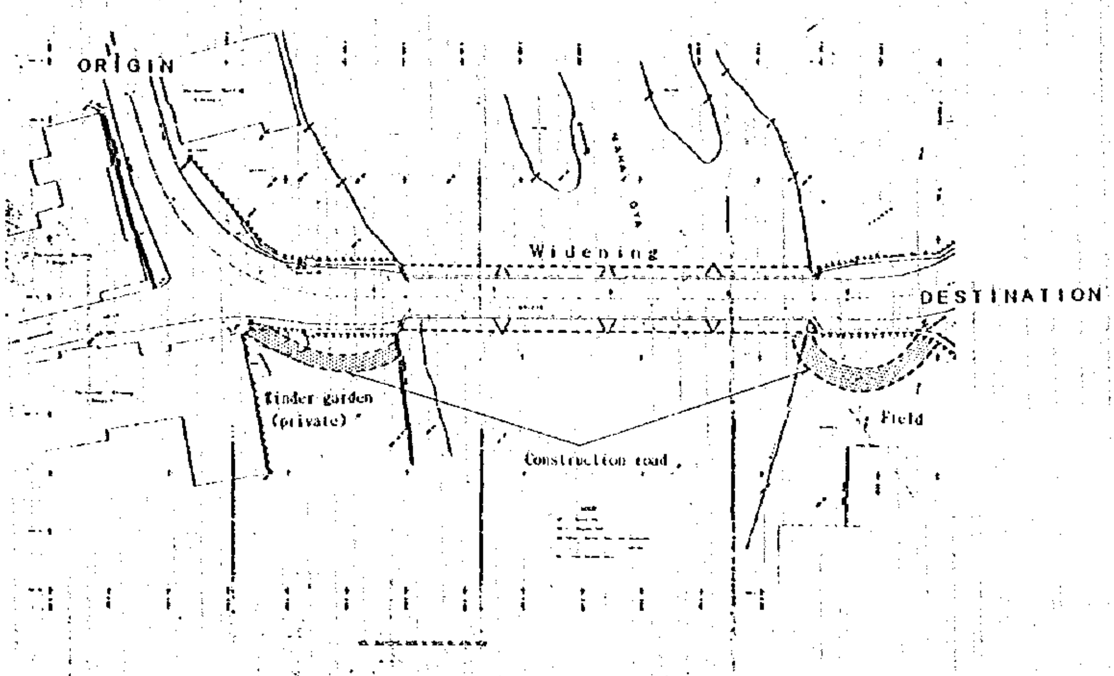

Table Q.3 (1) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 85

Outline of environment	Geography: This bridge is located at Route A1 between Colombo and Kandy over the Maha Oya river. Many crossing of traffic and tourists. Located close to Mawanella. Housing density near the bridge is high.			
	Use of land: Agricultural land (homesteads and paddy)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	A kindergarten is present at the origin of the bridge. Vegetable field is present at the destination of the bridge.	No relocation is required. The field or land (garden) before the kindergarten is used for construction road.	Private lands are occupied, but it is temporary and the area is limited. Residents are not much affected.	Careful planning should be made for minimal use of private lands in construction. Meetings should be held with parties concerned before use of lands. Safety for kindergarten infants during construction must be ensured.
(ii) Use of river and water rights	The Maha Oya river at the bridge is used for residents' washing and bathing.	Impact on bathing and washing around the bridge	Since construction is not carried out at the bathing and washing points, impacts may be small.	Construction must be processed to prevent flowing of large amount of soil.
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 7,060/day. This number is considered large. Since no footway is provided on the bridge, pedestrians are disturbing smooth flow of vehicles.	One lane due to construction can disturb smooth flow of vehicles.	Traffic jam may occur during construction. Additional footways after construction will result in smooth flow of vehicles.	Traffic signs and traffic supervisor can control vehicles during construction.
(iv) Others (remains, cultural assets and sceneries)	There are no remains and cultural assets The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks	The current bridge is an old attractive arc shaped bridge and may be used as a tourist attraction spot in the future. It is recommended to reserve the current bridge (by building a by-pass road) or bridge design.			

Table Q.3 (2) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 212

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction The proposed bridge is built at the same location of the existing bridge. Two lane traffic is ensured during reconstruction.	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
		b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	Repair No traffic is suspended during construction. Two lane traffic is ensured during repair.	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

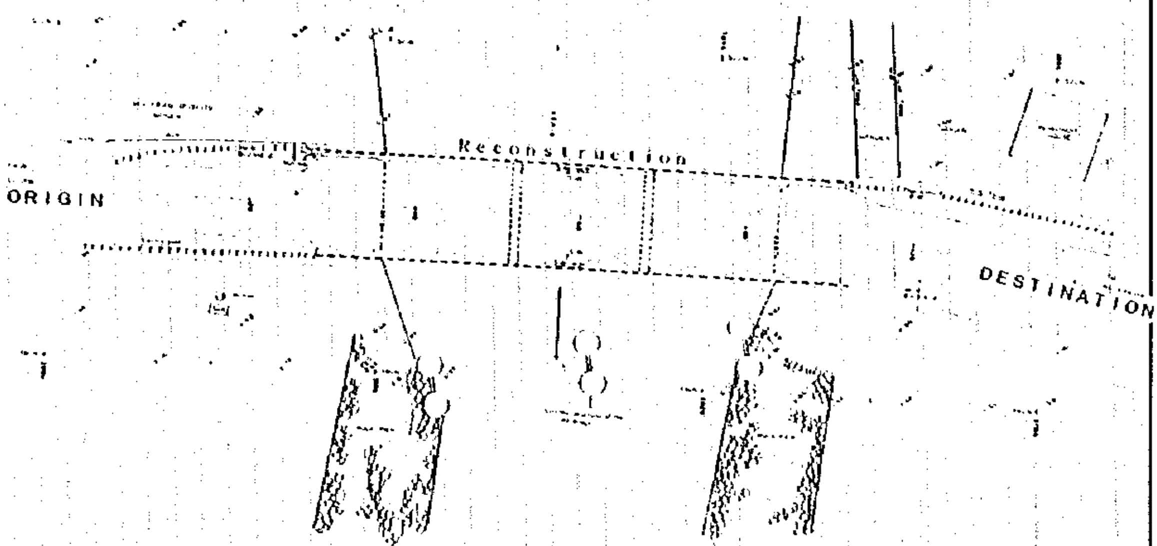

Table Q.3 (2) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 212

Outline of environ-ment	Geography: This bridge is located at Route A1 between Galle and Matara over the Goviyapana Era river. The river is located close to the coast line. Housing density near the bridge is low.			
	Use of land: Agricultural land (Homesteads)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	No house is present alongside the road.	Since the road width is sufficient, no land acquisition is required for reconstruction or repair of the bridge.	None	Not necessary
(ii) Use of river and water rights	There is no river-use near the bridge.	None	None	Not necessary
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 4,120/day. This number is considered large. However, since the bridge width is sufficient for 4 lanes and a footway is provided, traffic jam does not occur.	Since double lane traffic can be secured during construction, no impact will be given.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks				

Table Q.3 (3) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 77

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction The proposed bridge is built at the same location of the existing bridge. Embankment work is carried out to widen the approach road. The Bailey bridge is required during construction. Construction period: 30 months	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
		b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	No plan	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

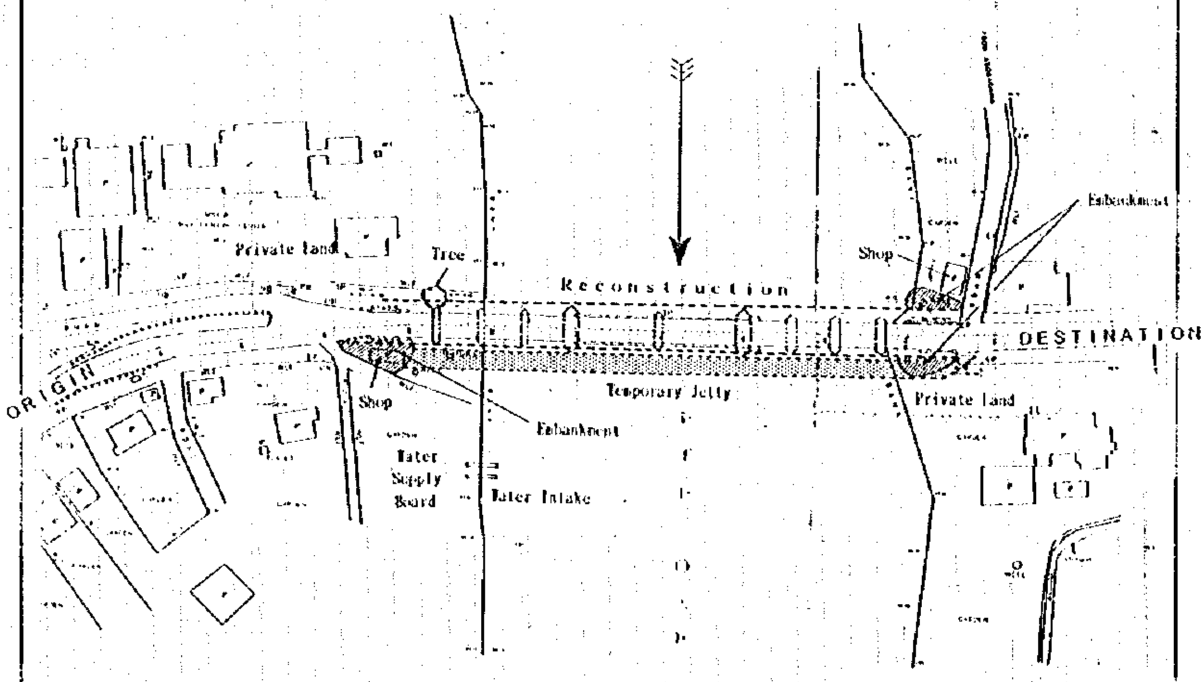

Table Q.3 (3) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 77

Outline of environ-ment	Geography: This bridge is located at Route A19 over the Maha Oya river. The river is close to Polgahawela city, but the housing density near the bridge is low.			
	Use of land: Agricultural land (Homesteads, coconut plantation, paddy)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	A milk factory and a shop are present at the origin of the bridge. A shop, well, and private land (garden) are present at the destination of the bridge.	(Origin) Impact on the shop due to construction of the Bailey bridge and due to banking of approach road. (Destination) Impact on private lands due to construction of the Bailey bridge and due to banking of approach road of the new bridge. Impact on the well due to banking of approach road of the new bridge.	(Origin) Relocation of the shop is required, but no serious problem will occur at relocation because the shop is built on a public land. (Destination) Acquisition of private lands is required, but the area is limited and no serious impact will be given to the residents.	Careful planning should be made for minimal use or acquisition of private lands in construction. Meetings should be held with parties concerned before relocation of shops or use of lands. The well at the destination of the bridge must be relocated, or water service system should be installed.
(ii) Use of river and water rights	River water from the downstream of the bridge is used for water service. The Maha Oya river at the bridge is used for residents' washing and bathing. Sand mining is carried out around the bridge	Impact on intake for water service Impacts on washing, bathing, and sand mining around the bridge during construction	Since the construction site is far from the water intake point, no direct impact will be given. However, careful consideration should be given to water intake because it is an important facility for local residents' lives. Since construction is not carried out at the bathing, washing, and sand mining points, impacts will be small.	A large amount of soil should not run off into the river during construction. If a large amount of soil may run off to bury the water intake, the water intake should be relocated.
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 1,990/day. This number is considered small. Since the bridge is narrow, one lane traffic is used for large vehicles.	Smooth flow of vehicles during construction can be achieved by constructing the Bailey bridge. After construction, the new bridge will be wide enough to facilitate smooth flow of vehicles.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks				

Table Q.3 (4) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No.53

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction	a. Construction of new bridge and approach road necessitates new space.	Yes/ ~~No~~
	The proposed bridge is built at a different location from the existing bridge.	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	~~Yes/~~ No
	The approach road is required during construction.	c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	~~Yes/~~ No
Repair & Reinforcement	Repair	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	~~Yes/~~ No
	Painting is partially repaired. Traffic is suspended for a short period of time.(The width of the existing bridge is 3.65 m.) Construction period: Approx. 3.5 months	c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ ~~No~~

Out Line of Plan

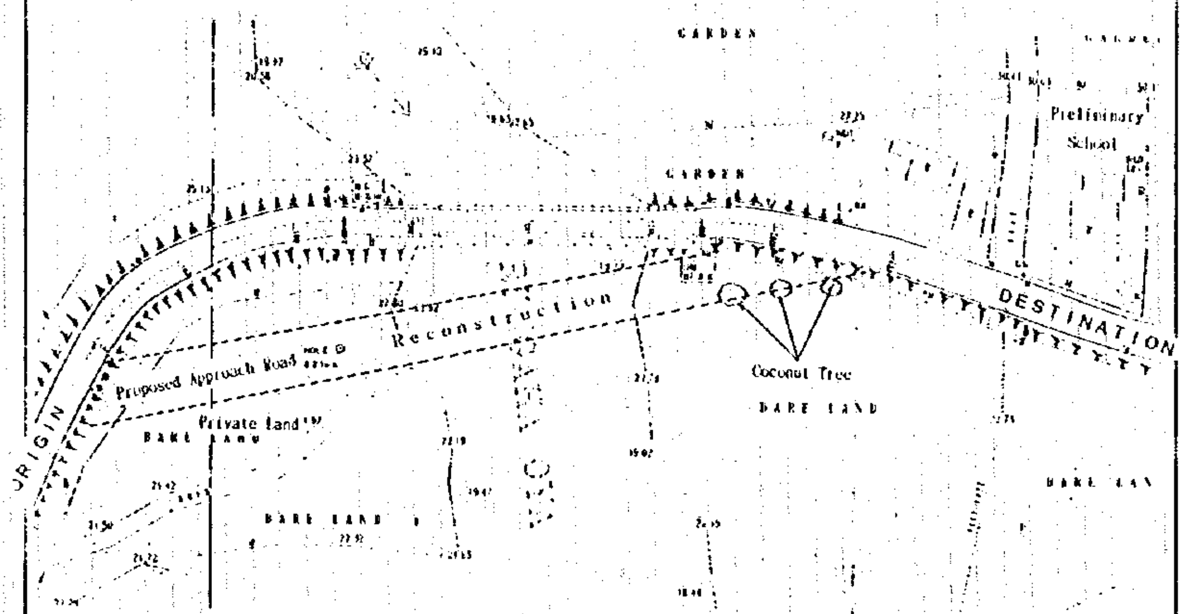

Table Q.3 (4) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 53

Outline of environment	Geography: This bridge is located at Route A21 over the Ritigaha Oya river. Housing density near the bridge is low. Use of land: Agricultural land (Homestead, Rubber plantation)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	Houses and a primary school are present at the destination of the bridge. Private lands are present at both sides of the bridge. Coconut trees are present at the destination of the bridge.	(Reconstruction) Impacts on private lands and coconut trees for constriction of approach road. (Repair) None	(Reconstruction) Acquisition of private land and cutting three coconut trees are required, but no serious impact will be given to the local residents because the construction is minor and the measures in the next column will be implemented. (Repair) None	(Reconstruction) Careful planning should be made for minimal use of private lands in construction. Meetings should be held with parties concerned before relocation of shops or use or acquisition of private lands. Compensation should be made for damaged coconut trees. (Repair) Not necessary
(ii) Use of river and water rights	The Ritigaha Oya river at the bridge is used for residents' washing and bathing. Sand mining is conducted around the bridge.	(Reconstruction) Impacts on washing, bathing, and sand mining around the bridge (Repair) None	(Reconstruction) Since the area to be occupied by piers and abutments of the new bridge is limited, impact on these river-use is small. (Repair) None	(Reconstruction) A large amount of soil should not run off into the river during construction. (Repair) None
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 640/day. This number is considered small. Since the bridge is narrow, one lane traffic is used for vehicles. Primary school students cross the bridge	(Reconstruction) Since the current bridge is available, no impact will be given during construction. After the construction, the bridge will become wider to improve flow of vehicles. (Repair) Impact of short-term traffic suspension of the bridge Impact on students crossing the bridge to/from the primary school	(Reconstruction) None (Repair) Since traffic volume is small, impact of traffic suspension is considered minor. Primary school students can be protected by implementing the safety measures in the rights column.	(Reconstruction) Not necessary (Repair) Traffic supervisor or policeman should protect traffic safety of primary school students during construction.
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not located at a scenic site.	None	None	Not necessary
Remarks				

Table Q.3 (5) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 211

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Widening The bridge is widened both sides. The Bailey bridge is built during construction. (The position is not determined.) Construction period: Approx. 9 months.	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
		b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	Reconstruction The proposed bridge is built at the same location of the existing bridge The Bailey bridge is built during construction. (The position is not determined.)	c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge)	Yes/ No
Repair & Reinforcement	No plan	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

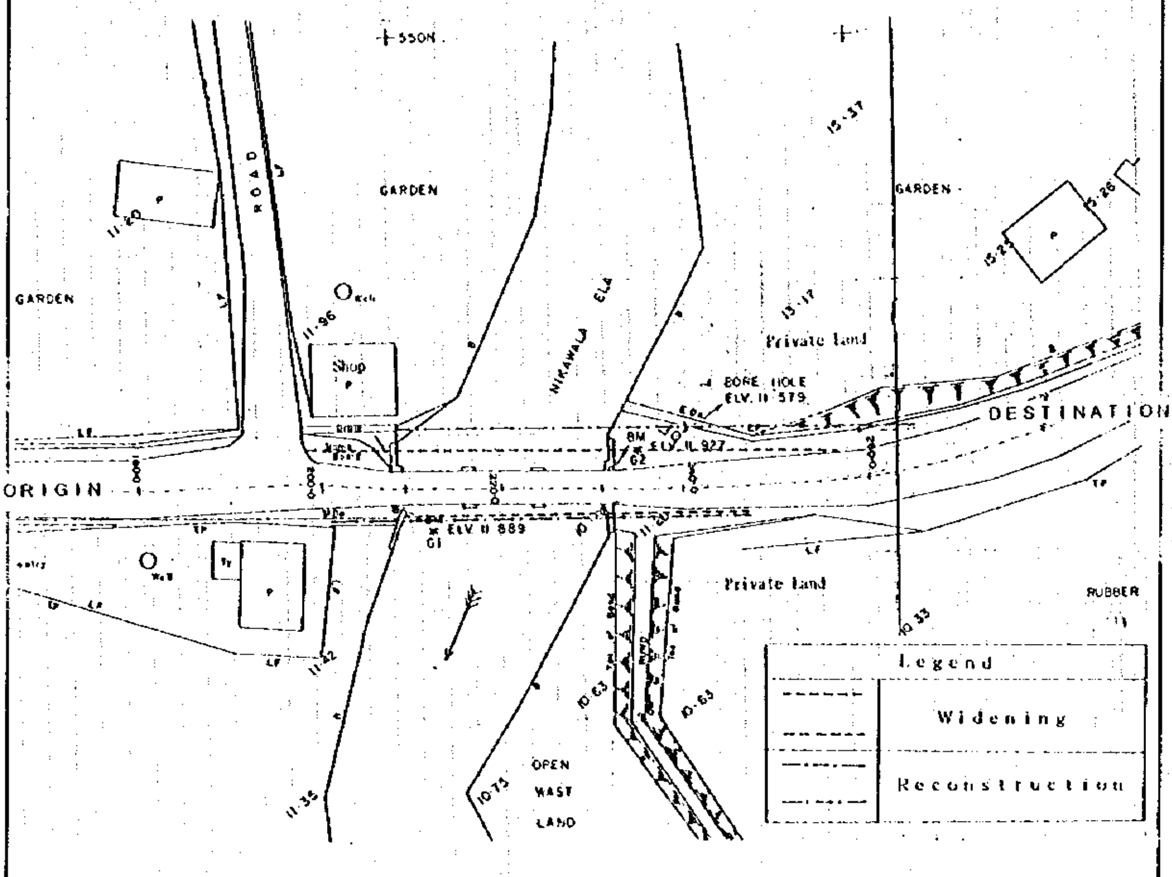

Table Q.3 (5) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 211

Outline of environ-ment	Geography: This bridge is located at Route A146 over the Nikawala Ela. The Nikawala Ela is a small river. Housing density near the bridge is low.			
	Use of land: Agricultural land (Paddy, Homesteads)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	Houses and shops are present at the origin of the bridge.	(Widening and reconstruction) Relocation of residents of houses and shops and impact on private land due to construction of Bailey bridge	No relocation of residents will be carried out by implementing the measures in the right column. Acquisition of private land is required, but since it is temporary, no serious impact will be given.	Careful planning should be made to construct the approach road and Bailey bridge behind the houses and shops. Careful planning should be made for minimal use of private lands in construction. Meetings should be held with parties concerned before use or acquisition of private lands.
(ii) Use of river and water rights	The Nikawala Era at the bridge is used for residents' washing and bathing.	Impact on washing and bathing	Since the area occupied by structures of the Bailey bridge and bridge in the river is small, impact on river-use will be minor.	A large amount of soil should not run off into the river during construction.
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 2,620/day. This number is considered small.	Traffic around the bridge can be secured by construction of the Bailey bridge.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not located at a scenic site.	None	None	Not necessary
Remarks	If traffic volume increases in the future, residents' safety may be affected and noise problem may occur because the shops at the origin of the bridge are excessively close to the widened road. In these cases, shops should be relocated further off the road.			

Table Q.3 (6) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 33

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
	The proposed bridge is built at a different location from the existing bridge.	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	Construction period: Approx. 28 months	c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	No plan	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

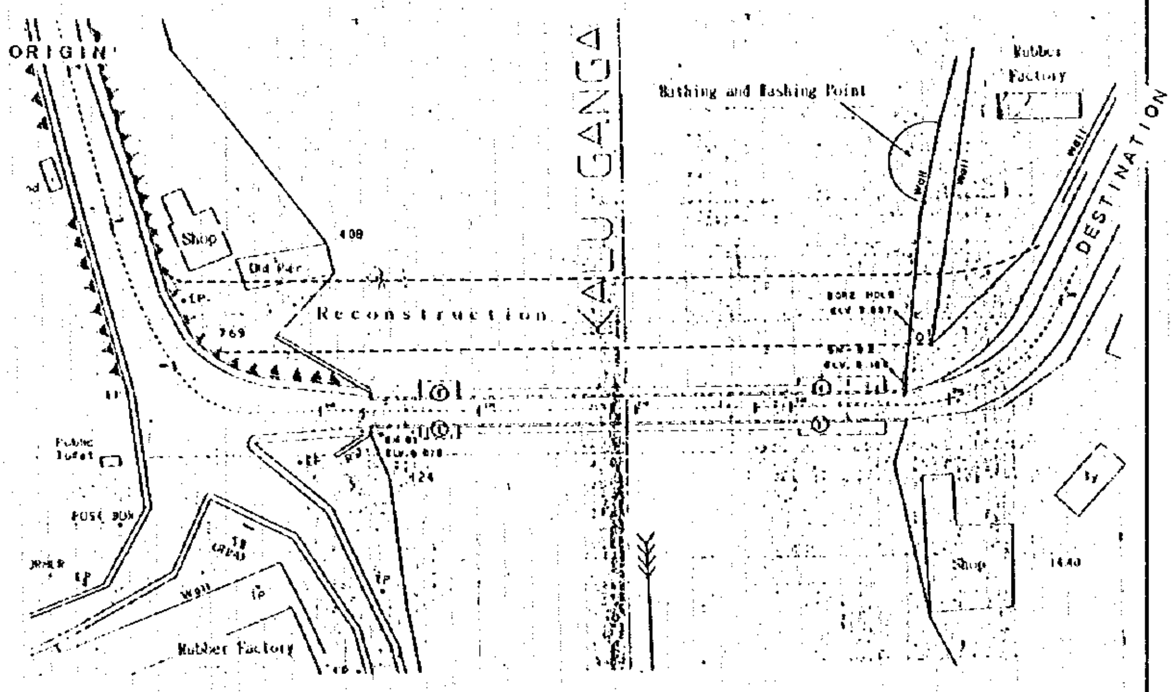

Table Q.3 (6) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 33

Outline of environment	Geography: This bridge is located at Route B157 over the Kalu Ganga river. A rubber factory is present near the bridge. Housing density near the bridge is very low.			
	Use of land: Agricultural land (Rubber plantation, homesteads, paddy)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	Shops and a rubber factory are present near the bridge.	Impact on private lands due to construction of approach road	Acquisition of land in the rubber factory at the destination of the bridge is required, but no impact will be given because the required site is at the corner of the factory ground where no building is present.	Meetings should be held with parties concerned before acquisition of land.
(ii) Use of river and water rights	River water from the downstream of the bridge (at the origin) is used at the rubber factory. The Kalu Ganga river at the bridge is used for residents' washing and bathing. Sand mining is conducted in the upper stream of the bridge.	Impact on water-use at rubber factory, washing, and bathing during construction Since the sand mining point is far from the construction site, no problem will occur.	Since construction is not carried out at water-use, washing or bathing points, impact may be small.	A large amount of soil and muddy water should not run off into the river during construction.
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 750/day. This number is considered small. Since the bridge is narrow, traffic flow is disturbed and pedestrians are exposed to danger.	Since the current bridge is available, no problem occurs. After construction, sufficient width will be achieved on the new bridge to facilitate smooth flow of vehicles.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks	If traffic volume increases, intersection at the origin of the bridge should be improved. For instance, the shops should be relocated further off the road.			

Table Q.3 (7) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 59

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction The proposed bridge is built at the same location of the existing bridge.	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
	The approach road needs to be widened.	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	The Bailey bridge is required during construction.	c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	Repair and widening	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	Demolition of deck slab and widening The Bailey bridge is built during construction. Construction period: 9 months	c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

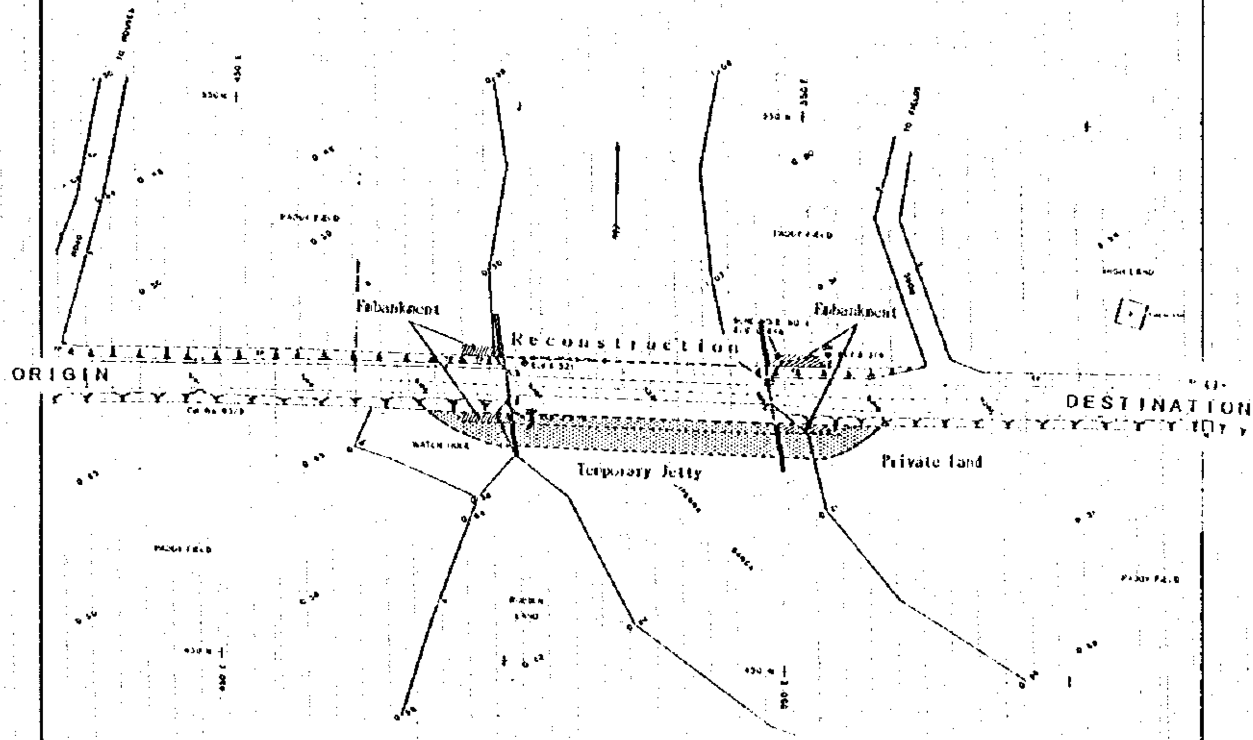

Table Q.3 (7) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 59

Outline of environ-ment	Geography: This bridge is located at Route B157 over the Muhunumalwatte Ela river. The ground near the bridge is low and used as paddy field. Housing density near the bridge is very low.			
	Use of land: Agricultural land (Paddy, homesteads, rubber plantation)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	No house is present near the bridge. Private land (paddy) is present.	(Reconstruction) Impact on private land (paddy) due to construction of the Bailey bridge and widening of the approach road. Impact on the water hole at the origin of the bridge (Repair and widening) Impact on private land (paddy) due to construction of the Bailey bridge. Impact on water hole at the origin of the bridge	(Reconstruction) Banking on the paddy is carried out to construct the approach road. Since the area used for banking is limited, impact may be small. Water hole may be filled with banking of the road resulting in poor drainage for the paddy near the water hole. Measures in the next column will mitigate these problems. (Repair and widening) Ditto	(Reconstruction) Careful planning should be made for minimal acquisition of private lands in construction. Meetings should be held with parties concerned before acquisition of private lands. Allow better drainage of water hole by building a drain at the toe of slope at the fill. (Repair and widening) Ditto
(ii) Use of river and water rights	No river-use. If flood occurs, wastes may cling to the piers of the bridge and disturb river flow.	Disturbance of water flow due to wastes clinging to the piers	Since wastes are usually cleaned by residents, no serious impact will be given.	If piers and abutments are newly constructed, consideration should be given not to disturb the river flow.
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 750/day. This number is considered small. The river is narrow, but no traffic jam occurs because the traffic volume is small.	Traffic flow is smoothed during construction by the Bailey bridge.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks	If the approach road is narrow and traffic volume increases due to the scheduled construction of express high way which will intersect the approach road, the approach road should be widened.			

Table Q.3 (8) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 20

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
	The proposed bridge is built at the same location of the existing bridge.	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	The approach road needs to be widened. The Bailey bridge is required during construction.	c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	Repair and widening Redecking and widening The Bailey bridge is built during construction. Construction period: 9 months	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
		c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

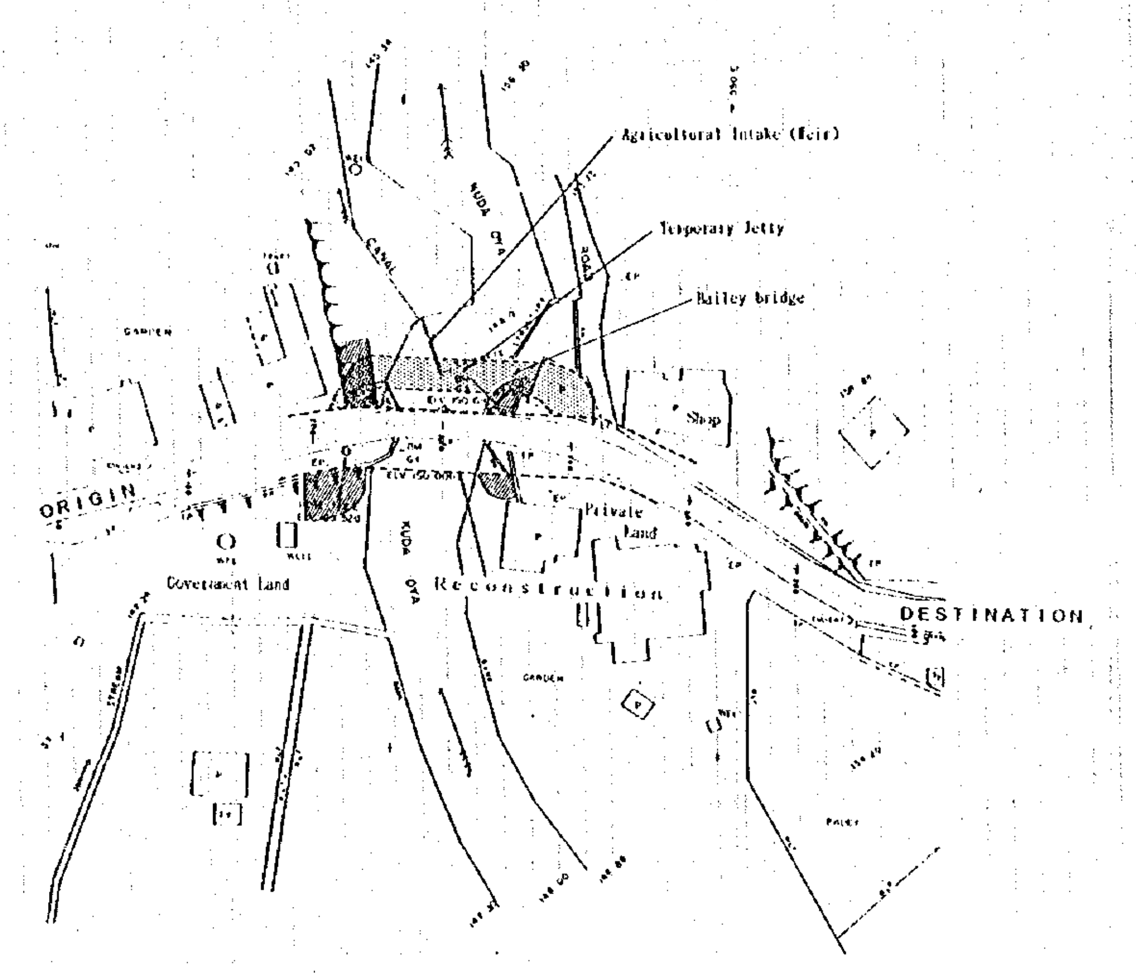

Table Q.3 (8) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 20

Outline of environ-ment	Geography: This bridge is located at Route B264 over the Ogodapola Era river. This river is small. This bridge is located in mountains and housing density near the bridge is very low. Use of land: Agricultural land (Homesteads, paddy)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	Houses and shops are present near the bridge.	(Reconstruction) Relocation of residents of the houses and shops due to construction of the Bailey bridge Impact on private land due to widening of the approach road (Repair and widening) Relocation of residents of the houses and shop	(Reconstruction) Relocation of the shop (seemingly unauthorized building) is required for construction of the Bailey bridge. Measures in the next column will mitigate this problem. To widen the approach road, acquisition of lands in front of the shops at the destination of the bridge is required. Measures in the next column will mitigate this problem. (Repair and widening) Ditto	(Reconstruction) To relocate the shop, an alternative place or other consideration should be provided. Careful planning should be made for minimal use of private lands in construction. Meetings should be held with parties concerned before relocation of shops or use of lands. (Repair and widening) Ditto
(ii) Use of river and water rights	A weir for agricultural use (paddy) is present in the downstream, close to the bridge. The Ogodapola Era river at the bridge is used for residents' washing and bathing. Sand mining is carried out around the bridge.	Impact on agricultural water intake due to construction of the Bailey bridge Impact on washing, bathing, and sand mining around the bridge	By implementing measures in the next column to construct the Bailey bridge, no impact will be given to agricultural water intake. Since the area in the river occupied by structures of the Bailey bridge and new bridge is limited, impact on river-use will be minor.	Construction of piers for the Bailey bridge should not affect the function of the weir for agriculture. A large amount of soil should not run off into the river during construction.
(iii) Traffic problem and safety for pedestrians	No. of vehicles crossing the bridge is 1,600/day. This number is considered small. No traffic jam has occurred.	Smooth flow of vehicles can be secured by construction of the Bailey bridge.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks				

Table Q.3 (9) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 70

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction The proposed bridge is built at the same location of the existing bridge. The approach road needs to be widened.	a. Construction of new bridge and approach road necessitates new space.	Yes/ No
	The construction procedures are as follows:* 1. Half side of the new bridge is built. (The existing bridge is used for traffic.)	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	2. The existing bridge is destroyed. The remaining half of the new bridge is built. (Half of the new bridge is used for traffic.).	c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	Yes/ No
Repair & Reinforcement	Repair and widening Piers are reinforced and the bridge is widened both sides.	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ No
	One lane traffic is used during construction. Construction period: Approx. 10 months	c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	Yes/ No

Out Line of Plan

*Construction image
1 The new bridge is built here.
2 After completion of the new bridge, the old bridge is destroyed for building the remaining part of the new bridge.

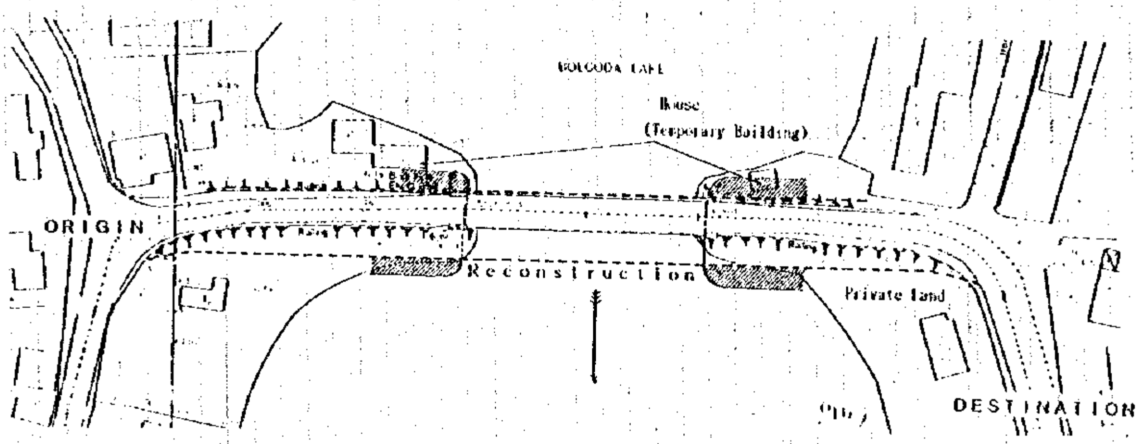

Table Q.3 (9) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 70

Outline of environ-ment	Geography: This bridge is located at Route B295 over the Bolgoda lake. This bridge is approx. 15 km away from Colombo city. Housing density near the bridge is high. Fishing is carried out in the Bolgoda lake. Use of land: Urban land (built-up land) and agricultural land (Homesteads)			
Item	Current environment	Expected environmental impact	Anticipation/ evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	Houses are present near the bridge.	(Reconstruction) Impact on houses and private lands due to widening of the approach road (Reinforcement and widening) None	(Reconstruction) Relocation of residents of a house (temporary building, unauthorized) is required for banking of the approach road. Measures in the next column will mitigate this problem. Acquisition of private land is required. Measures in the next column will mitigate this problem. (Reinforcement and widening) None	(Reconstruction) Meetings should be held with parties concerned before relocation of residents or use of lands. Careful planning should be made for minimal use of private lands in construction. Meetings should be held with parties concerned before acquisition of private lands. (Reinforcement and widening) None
(ii) Use of river and water rights	Fishing canoes are passing under the bridge. Water plants clung to the piers may disturb canoe traffic.	River flow and fishing canoe traffic are disturbed due to water plants clung to the piers.	Since canoeists and the residents around the bridge usually remove water plants, no serious problem has occurred.	If piers and abutments are newly constructed, consideration should be given not to disturb the river flow.
(iii)Traffic problem and safety for pedestrians	The bridge is close to Colombo city. No. of vehicles crossing the bridge is 3,300/day and is considered large. Although a large number of pedestrians cross the bridge, no footway is provided.	Disturbance of traffic flow during construction After construction, traffic flow on the bridge will be improved.	(Reconstruction) Since the current bridge is available during construction, no serious impact will be given to traffic flow. (Reinforcement and widening) Traffic disturbance will be worse due to one lane traffic around the bridge during construction, but measures in the next column will mitigate this impact.	Traffic flow should be secured and pedestrian should not be exposed to danger by sign boards and a traffic supervisor.
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object.	None	None	Not necessary
Remarks	Crank-shaped intersections on both sides of the bridge are causing traffic jam and require improvement.			

Table Q.3 (10) IEE Results (Form 1 / Bridge Rehabilitation Plan)

Bridge SER. No. 7

Bridge Rehabilitation Plan		Factors of Possible Environmental Impacts	
Reconstruction & Widening	Reconstruction The proposed bridge is built at the same location of the existing bridge.	a. Construction of new bridge and approach road necessitates new space.	~~Yes~~/ No
	The Bailey bridge is built during construction. (The position is not determined.)	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	Yes/ ~~No~~
		c. Traffic jam occurs due to one lane traffic during construction (excluding construction of the Bailey bridge).	~~Yes~~/ No
Repair & Reinforcement	Repair Repair of main beams abutments and piers	b. Construction of the Bailey bridge, approach road and access road necessitates new space.	~~Yes~~/ No
	Suspension of traffic is not required. (The work is carried out from a boat.) Construction period: Approx. 6 months	c. Traffic jam occurs due to one lane traffic and a suspension of traffic during construction (excluding construction of the Bailey bridge).	~~Yes~~/ No

Out Line of Plan

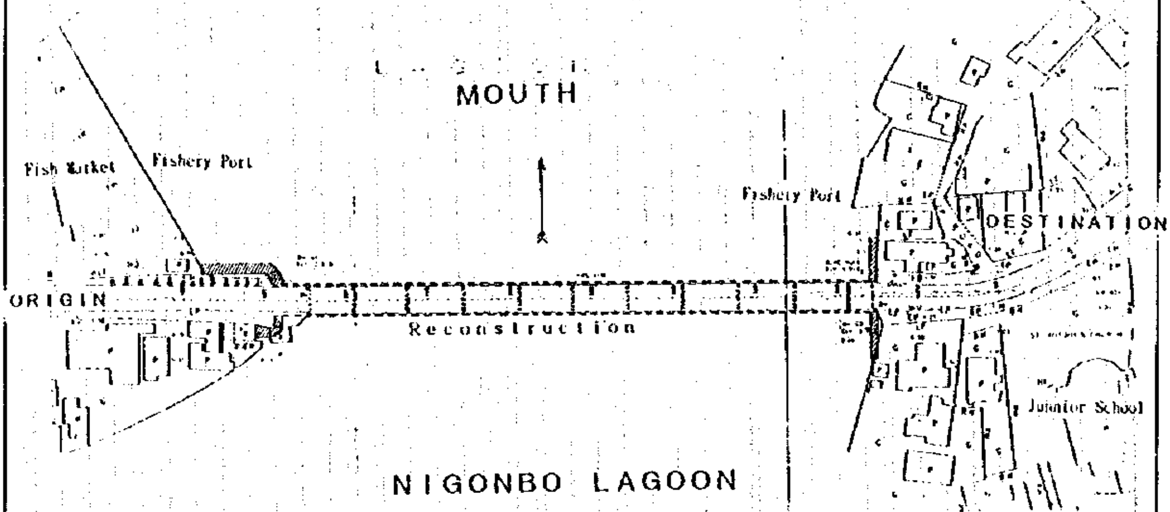

Table Q.3 (10) IEE Results (Form 2 / Environmental Impact Examination)

Bridge SER. No. 7

Outline of environment	Geography: This bridge is located at Route B425 over the Negombo Lagoon. The bridge is located at the fishing area of Negombo town. Housing density near the bridge is high.			
	Use of land: Urban land (built-up land) and agricultural land (homesteads)			
Item	Current environment	Expected environmental impact	Anticipation/evaluation of environmental impact	Maintenance of environment
(i) Relocation of residents (rights of common)	A fishery port is present in the Negombo Lagoon. A fish market is present at the origin of the bridge. Houses and shops are densely located along the approach road.	(Reconstruction) Relocation of houses and shops for construction of Bailey bridge (Repair) None	Construction of the Bailey bridge on the coastal side (closer to the estuary) of the bridge will seriously affect the fishing port. Therefore, the Bailey bridge should be constructed on the opposite side. To do so, relocation of the temporary building at the origin of the bridge is required. Although this building is unauthorized, measures in the next column can prevent serious problems.	Careful planning should be made to avoid relocation of residents in permanent buildings. Meetings should be held with parties concerned before relocation of residents.
(ii) Use of river and water rights	Fishing boats pass under the bridge frequently. Net fishing is carried out near the bridge.	Disturbance for fishing boats Since the area occupied by the Bailey bridge and piers of the new bridge are small, no impact will be given to fishing operations near the bridge.	Although the situation will not be worsened by construction, measures in the next column can mitigate the effect.	Consideration for construction of the Bailey bridge and piers of the new bridge should be given not to disturb traffic flow of fishing boats. If repair work is carried out, consideration should be given to ensure safe traffic of fishing boats.
(iii) Traffic problem and safety for pedestrians	Since many lorries and buses cross the bridge in the morning and evening, traffic jam has occurred. Traffic volume between the rush hours is small.	(Reconstruction) Smooth traffic flow around the bridge can be ensured by the Bailey bridge. (Repair) Since no traffic suspension is implemented, no impact will be given.	None	Not necessary
(iv) Others (remains, cultural assets and sceneries)	There are no remains or cultural assets. The bridge is not considered as a scenic object. (There is no traffic of pleasure boats.)	None	None	Not necessary
Remarks	Considering that larger fishing boats may pass under the bridge in the future, a larger free board will be required for the new bridge. Since this bridge is located close to a tourist area in Negombo town, it may be improved as a tourist attraction spot.			