FIG DRILLING LOG

Project No. K03-16 **Project** REHABILITATION OF BRIDGE SG. JERAM, SIMPANG TIGA, KUALA SELANGOR. **Type of Drilling** ROTARY

Hole Number BH-1 **Elevation** RL +2.2 m **Date** 27th September to 1st October 1991

Water Table GL-1.55 m. Bridge No 546560 **Driller** Lim (Leong)

Remarks
P : Standard Penetration Test
UD : Undisturbed Soil Sampling

Elevation in m	Depth in m	Thickness in m	Type of Soil	Colour	Relative Density or Consistency	General Remarks
2.20	0.00					
0.80	1.40	1.40	Clayey SAND	Brownish Grey		Fill. Sand is fine to medium grained. With lateritic gravel.
-16.30	18.50	17.10	Silty CLAY	Bluish Grey; Bluish Grey to Grey	Very Soft	With tiny organic fragments throughout. Slightly oxidized up to 2m. Traces of shell fragments up to 8m. With decayed woods at 8m. With lots of decayed woods at 10.5m. Trace of shell fragments at 15m. Below 14m, with a lot of organic matter and decayed woods.
-18.80	21.00	2.50	Silty CLAY	Whitish Grey Mottled Red	Soft	With decomposed vegetation and organic matter. With pocket of fine sand at bottom.
-21.85	24.05	3.05	Silty CLAY	Bluish Grey	Very Soft to Soft	With very fine sand seams. Becomes stiffer with depth. Traces of organic matter at bottom.
-28.80	31.00	6.95	SAND	Grey	Loose; Medium	Well-graded fine to coarse sand. Trace of silt throughout. With fine gravel at 27m. Trace of organic fragments at 28m.

Depth in m	Sample No.	N-Value Blows/45cm	Blows per each 7.5cm (15 cm)	(15 cm)	(15 cm)	Standard Penetration Test remarks
1.65 / 1.95 / 2.20	P-1	1	1 / 0	1 / 0	0 / 0	
3.00	UD-1	77/80				
3.35 / 3.65	P-2	0/30				SELF PENETRATION BY HAMMER
4.65 / 4.95 / 5.20	P-3	0/30				SELF PENETRATION BY HAMMER
6.00	UD-2	76/80				
6.35 / 6.65	P-4	0/30				SELF PENETRATION BY HAMMER
7.65 / 7.95 / 8.20	P-5	0/30				SELF PENETRATION BY HAMMER
9.00	UD-3	80/80				
9.35 / 9.65	P-6	0/30				SELF PENETRATION BY HAMMER
10.65 / 10.95 / 11.20	P-7	0/30				SELF PENETRATION BY HAMMER
11.95	UD-4	75/75				
12.35 / 12.65	P-8	0/30				SELF PENETRATION BY HAMMER
13.65 / 13.95 / 14.20	P-9	0/30				SELF PENETRATION BY HAMMER
15.00	UD-5	77/80				
15.15 / 15.65	P-10	0/30				SELF PENETRATION BY HAMMER
16.65 / 16.95 / 17.20	P-11	0/30				SELF PENETRATION BY HAMMER
18.00	UD-6	80/80				
18.35 / 18.65	P-12	2	0 / 0	0 / 0	1 / 1	
19.65 / 19.95 / 20.20	P-13	4	1 / 1	1 / 0	2 / 1	
21.00	UD-7	80/80				
21.35 / 21.65	P-14	0/30				SELF PENETRATION BY HAMMER
22.65 / 22.95 / 23.20	P-15	0/30				SELF PENETRATION BY HAMMER
24.00	UD-8	76/80				
24.35 / 24.65	P-16	9	1 / 0	2 / 2	2 / 3	
25.65 / 25.95	P-17	8	0 / 1	1 / 2	2 / 3	
27.15 / 27.45	P-18	11	1 / 2	2 / 2	3 / 4	
28.65 / 28.95	P-19	13	2 / 2	2 / 3	3 / 5	
30.15 / 30.45	P-20	16	4 / 4	7 / 3	3 / 3	

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Drilling Log - Bridge No. 00546560, Selangor (1)

FIG DRILLING LOG

Project No.	K03-16
Project	REHABILITATION OF BRIDGE SG. JERAM SIMPANG TIGA, KUALA SELANGOR.
Type of Drilling	ROTARY
Hole Number	BH-1
Elevation	RL +2.20 m m.
Date	27th September to 1st October 1991
Water Table	GL-1.55 m.
Bridge No.	546560
Driller	Lim (Leong)

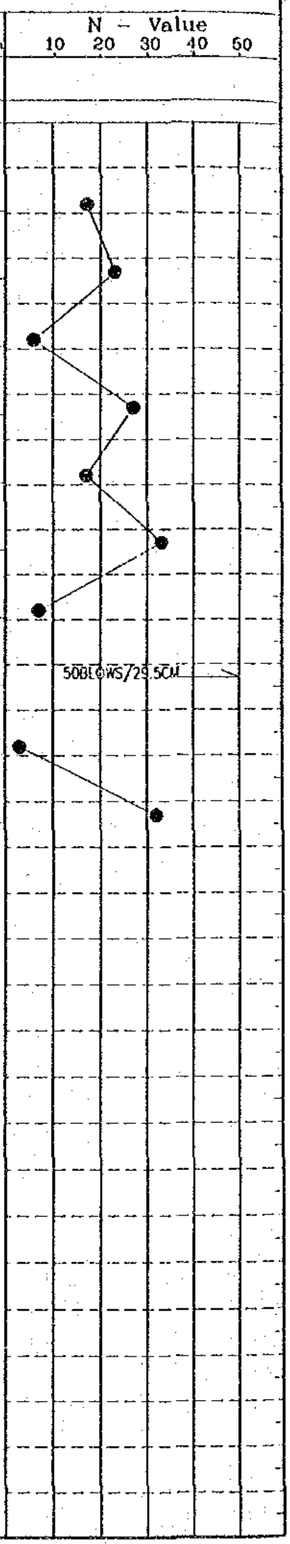
Remarks
P : Standard Penetration Test

Elevation in m	Depth in m	Thickness in m	Type of Soil	Colour	Relative Density or Consistency	General Remarks
-29.80	32.00	3.00	SAND	Grey	Medium	Sand is medium to coarse. with seams of decayed woods and trace of fine gravel at bottom.
-33.10	35.30	3.30	Organic Clayey SAND	Dark Brown to Dark Grey	Medium to Loose	With a lot of organic matter and decayed woods. With sandy clay lense at bottom.
-35.10	37.30	2.00	SAND	Light Grey	Medium	Poorly-graded very fine sand.
-35.55	37.75	0.45	Silty CLAY	Grey	Very Stiff	Trace of decayed vegetation and organic matter.
-36.40	38.60	0.85	Sandy SILT	Whitish Grey	Very Stiff	Sand is very fine grained
-37.15	39.35	0.75	Silty CLAY	Light Grey	Very Stiff	Trace of very fine sand.
-38.20	40.40	1.05	Silty SAND	Light Grey	Dense	Very fine sand.
-38.50	40.70	0.30	SAND	Light Brown		With fine sand and slightly clayey at top.
-38.70	40.90	0.20	Silty CLAY	Light Brownish Grey	Soft	Traces of fine sand
-39.40	41.60	0.70	Clayey SAND	Light Brown	Loose	With fine sand and traces of decayed wood
-41.30	43.50	1.90	Silty SAND	Light Grey	Very Dense	Sand is very fine grained
-41.55	43.75	0.25	Silty CLAY	Dark Brown	Soft	With lots of decayed wood
-42.70	44.90	1.15	Sandy SILT	Light Grey	Soft	Sand is very fine grained
-43.25	45.45	0.55	SAND	Light Brown	Dense	Fine to medium sand Traces of decayed wood

-END OF DRILLING-

Sampling / Standard Penetration Test

Depth in m	Sample No.	N-Value Blows/45cm	Blows Per Each 7.5cm (15 cm)	(15 cm)	(15 cm)
31.65–31.95	P=21	17	4 / 5	5 / 4	4 / 4
33.15–33.45	P=22	23	1 / 2	4 / 6	6 / 7
34.65–34.95	P=23	6	1 / 0	1 / 1	2 / 2
36.15–36.45	P=24	27	8 / 7	7 / 6	7 / 7
37.65–37.95	P=25	17	1 / 1	2 / 3	5 / 7
39.15–39.45	P=26	33	1 / 2	2 / 3	5 / 23
40.65–40.95	P=27	7	8 / 5	1 / 1	1 / 4
42.15–42.45	P=28	50/29.5	10 / 14	15 / 12	11 / 12
43.65–43.95	P=29	3	3 / 1	1 / 0	1 / 1
45.15–45.45	P=30	32	7 / 9	8 / 7	7 / 10



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Drilling Log - Bridge No. 00546560, Selangor (2)

FIG DRILLING LOG

Project No.	K03-16
Project	REHABILITATION OF BRIDGE AT SG. BULOH, KUALA SELANGOR.
Type of Drilling	ROTARY
Hole Number	BH-1
Elevation	RL +3.70m m.
Date	2nd October to 7th October 1991
Water Table	GL-2.5 m m.
Bridge No.	546980
Driller	Lim (Leong)

Remarks
P : Standard Penetration Test
UD: Undisturbed Soil Sampling

Elevation in m	Depth in m	Thickness in m	Type of Soil	Colour	Relative Density or Consistency	General Remarks
3.70	0.00					
0.30	3.40	3.40	Clayey SILT	Reddish Brown	Medium	Fill. With fine sand and fine to coarse gravel. Pieces of wood below 2m
-17.30	21.00	17.60	Silty CLAY	Bluish Grey	Very soft	Homogeneous. With tiny organic fragments, throughout. Trace of shell fragments between 6 and 8m. Becomes stiffer below 8m. With silt seams 8 to 9m. With silt and fine sand seams, 14 to 15m. Trace of shell fragments at 16m. Less moisture content at bottom.
-23.00	26.70	5.70	Silty CLAY	Light Grey (to 24m); Bluish Grey (below 24m)	Very soft to Soft	Homogeneous. With tiny organic fragments at top.
-26.70	30.40	3.70	Silty CLAY	Greenish Grey	Stiff	Trace of organic matter throughout. Limonite nodule at top. Higher silt content at bottom.

Sampling and Standard Penetration Test

Depth in m	Sample No.	N-Value Blows/45cm	Blows per Each 7.5cm (15 cm)	Blows per Each 7.5cm (15 cm)	Blows per Each 7.5cm (15 cm)	N-Value remark
1.65 – 1.95	P-1	6	1 / 2	1 / 2	2 / 1	
3.15 – 3.45	P-2	10	3 / 4	4 / 4	1 / 1	
3.80 – 4.60	UD-1	70/60				
5.40 – 6.15	UD-2	75/75				
6.65 – 6.95	P-3	0/30				SELF PENETRATION BY HAMMER
7.35 – 7.65	P-4	0/30				SELF PENETRATION BY HAMMER
8.20 – 8.95	UD-3	74/75				
10.50 – 11.25	UD-4	74/75				
12.15 – 12.45	P-5	0/30				SELF PENETRATION BY HAMMER
13.50 – 14.25	UD-5	72/75				
14.65 – 14.95	P-6	0/30				SELF PENETRATION BY HAMMER
16.15 – 16.45	P-7	0/30				SELF PENETRATION BY HAMMER
18.20 – 18.95	UD-6	70/75				
19.65 – 19.95	P-8	0/30				SELF PENETRATION BY HAMMER
21.15 – 21.45	P-9	0/30				SELF PENETRATION BY HAMMER
22.50 – 23.30	UD-7	78/80				
24.15 – 24.45	P-10	0/30				SELF PENETRATION BY HAMMER
25.65 – 25.95	P-11	2	0 / 0	0 / 0	1 / 1	
27.15 – 27.45	P-12	12	2 / 2	3 / 3	3 / 3	
28.65 – 28.95	P-13	11	1 / 2	3 / 2	3 / 3	
30.00 – 30.45	UD-8	45/45				

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Drilling Log - Bridge No. 00546980, Selangor (1)

FIG DRILLING LOG

Remarks
P : Standard Penetration Test

Project No. K03-16 Project REHABILITATION OF BRIDGE AT SG.BULOH KUALA SELANGOR. Type of Drilling ROTARY

Hole Number BH-1 Elevation RL +3.70m m. Date 2nd October to 7th October 1991

Water Table GL-2.5 m. Bridge No. 546980 Driller Lim (Leong)

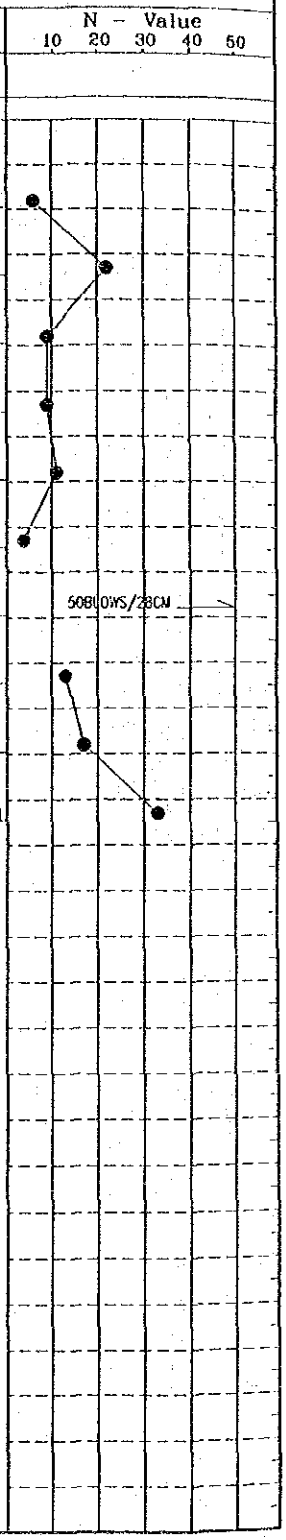
Elevation in m	Depth in m	Thickness in m	Legend	Type of Soil	Colour	Relative Density or Consistency	General Remarks
-26.70	30.40						
-27.90	31.60	1.20		SAND	Grey	Loose	Fine to coarse sand. Alternating beds of sand and sandy clay with organic fragments at bottom.
-32.10	35.80	4.20		SAND	Light Grey	Loose to Medium	Fine to coarse sand. Silty at top. With fine gravel at bottom. Lense of clay silt with decayed wood at bottom.
-36.40	40.10	4.30		Silty CLAY	Whitish Grey Mottled Brown	Stiff / Medium	Residual Soil. With decomposed calcite veins. Fine sand lense at 37.70 to 37.85m.
-38.10	41.80	1.70		Sandy SILT	Light Grey	Very Dense	Residual Soil. Sand is very fine grained.
-41.75	45.45	3.65		Clayey SILT	Yellowish Light Grey / Reddish Brown	Stiff / Very Stiff to Hard	Residual Soil. Trace of fine sand. With decomposed calcite veins at top.

-END OF DRILLING-

Scale in m: 31 to 61

Sampling Depth in m	Sample No.	N-Value Blows/45cm	Blows Per Each 7.5cm: 15 cm	15 cm	15 cm
31.65 – 31.95	P=14	6	4 / 3	2 / 2	1 / 1
33.15 – 33.45	P=15	22	2 / 3	3 / 5	6 / 8
34.65 – 34.95	P=16	9	4 / 5	4 / 2	2 / 1
36.15 – 36.45	P=17	9	1 / 2	1 / 2	3 / 3
37.65 – 37.95	P=18	11	2 / 2	2 / 2	3 / 4
39.15 – 39.45	P=19	4	1 / 0	1 / 0	2 / 1
40.65 – 40.95	P=20	50/28	4 / 5	10 / 10	14 / 16
42.15 – 42.45	P=21	13	1 / 2	2 / 3	4 / 4
43.65 – 43.95	P=22	17	1 / 2	3 / 4	4 / 6
45.15 – 45.45	P=23	33	2 / 5	5 / 9	8 / 11

Standard Penetration Test



KISO-JIBAN CONSULTANTS (M) SDN.,BHD Page......

Drilling Log - Bridge No. 00546980, Selangor (2)

FIG DRILLING LOG

Project No. K03-16 Project BRIDGE REHABILITATION PROJECT AT SG.SELINSING, PERAK

Type of Drilling Rotary

Hole Number BH-1(A) Elevation RL +20.90m m. Date 28th September 1991

Water Table - m. Bridge No. 567840 Driller Ho (Zulkefli)

Remarks

Due to presence of Boulder, the Borehole location was shifted to BH-1(B).

Scale in m	Elevation in m	Depth in m	Thickness in m	Legend	Type of Soil	Colour	Relative Density or Consistency	General Remarks	Sampling: Depth in m	Sampling: Sample No.	Standard Penetration Test: N-Value Blows/45cm	Blows Per Each 7.6cm: 15 cm	15 cm	15 cm	N - Value 10 20 30 40 50
	20.90	0.00													
	20.40	0.50	0.50		Silty SAND	Grey	Loose	Fill. Sand is medium to coarse grained.							
1					BOULDER										
2															
3															
4															
5															
6															
7															
8															
9															
10															
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Drilling Log - Bridge No. 00567840, Perak (1)

FIG DRILLING LOG

Project No.	K03-16	Project	BRIDGE REHABILITATION PROJECT AT SG.SELINSING,PERAK
Hole Number	BH-1(B)	Elevation	RL +20.90m m.
Water Table	GL-0.65 m.	Bridge No.	567840
Type of Drilling	Rotary	Date	28th September 1991
Driller	Ho (Zulkelli)		

Remarks

C : Coring

Due to presence of boulder, the borehole location was shifted to BH-1(C)

Scale in m	Elevation in m	Depth in m	Thickness in m	Legend	Type of Soil	Colour	Relative Density or Consistency	General Remarks	Sampling: Depth in m	Sampling: Sample No.	N-Value Blows/45cm	Blows Per Each 7.5cm: 15 cm	15 cm	15 cm	N - Value (10 20 30 40 50) / RQD, CR (20 40 60 80 100%)
	20.90	0.00													
1	19.70	1.20	1.20		Silty SAND	Grey	Loose	Fill. With roots at top.	1.20						
2	18.70	2.20	1.00		BOULDER	Mottled White Black	Moderately Strong	Granite boulder.	2.20	C-1					RQD 58, CR 85
					-END OF DRILLING-										

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Drilling Log - Bridge No. 00567840, Perak (2)

FIG DRILLING LOG

Project No. K03-16 Project BRIDGE REHABILITATION PROJECT AT SG SELINSING, PERAK Type of Drilling ROTARY

Hole Number BH-1(C) Elevation RL +20.90m m. Date 29th September to 2nd October 1991

Water Table GL-1.85m m. Bridge No. 567840 Driller Mo (Zulkefli)

Remarks
P : Standard Penetration Test
C : Coring
-

Elevation in m	Depth in m	Thickness in m	Type of Soil	Colour	Relative Density or Consistency	General Remarks
20.90	0.00					
19.40	1.50	1.50	Silty SAND	Grey	Loose	Fill. Sand is medium to coarse grained.
18.20	2.70	1.20	BOULDER	Mottled with White and Black	Hard	Fill. Granite boulders.
16.90	4.00	1.30	Silty SAND	Light Grey	Very loose	Medium to coarse sand at top. Very fine sand at bottom. Contains sub-angular gravel.
14.10	6.80	2.80	SAND	Grey	Loose to Medium	Sand is fine to medium grained. With some organic matter at GL-6.40m.
9.40	11.50	4.70	Sandy SILT	Whitish Grey to Greenish Light Grey	Medium to Stiff	Sand is fine to medium grained quartz particle.
7.90	13.00	1.50	Sandy SILT	Greenish Grey	Soft	Sand is very fine to fine grained. Trace of medium gravel.
6.35	14.55	1.55	GRANITE	Light Grey	Weak to Moderately Strong	Highly Weathered Granite.

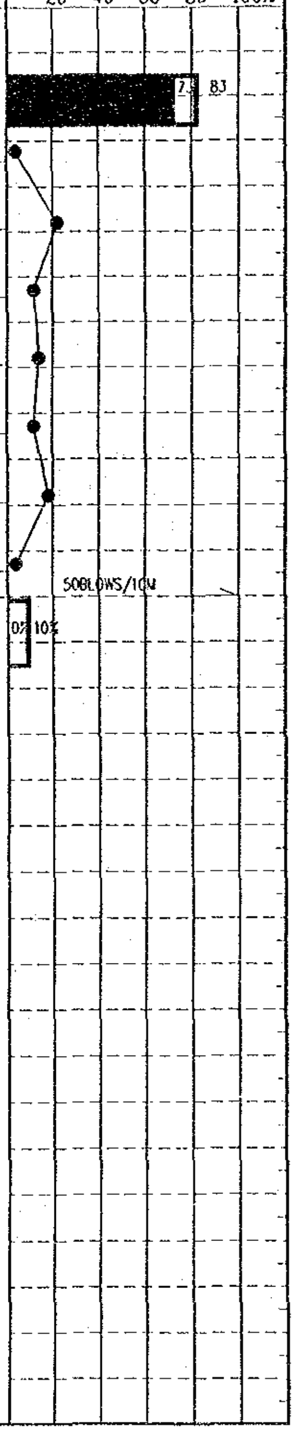
-END OF DRILLING-

Sampling / Standard Penetration Test & Core Recovery (CR)

Depth in m	Sample No.	N-Value Blows/45cm	Blows Per Each 7.5cm: 15 cm	15 cm	15 cm
1.50–2.70	C-1				
3.00–3.45	P-1	2/45			
4.65–4.95	P-2	11	2 / 3	3 / 4	3 / 1
6.15–6.45	P-3	6	2 / 2	2 / 1	2 / 1
7.65–7.95	P-4	7	1 / 1	1 / 1	2 / 3
9.15–9.45	P-5	6	1 / 1	1 / 1	3 / 1
10.65–10.95	P-6	9	1 / 1	2 / 2	2 / 3
12.15–12.45	P-7	2	1 / 1	0 / 1	0 / 1
13.00–13.01	P-8	50/1			
13.05–14.55	C-2				

N - Value 10 20 30 40 50

RQD CR 20 40 60 80 100%



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Drilling Log - Bridge No. 00567840, Perak (3)

Append-J

Plot of Index Properties Versus Depth at Bridge No. 00546980

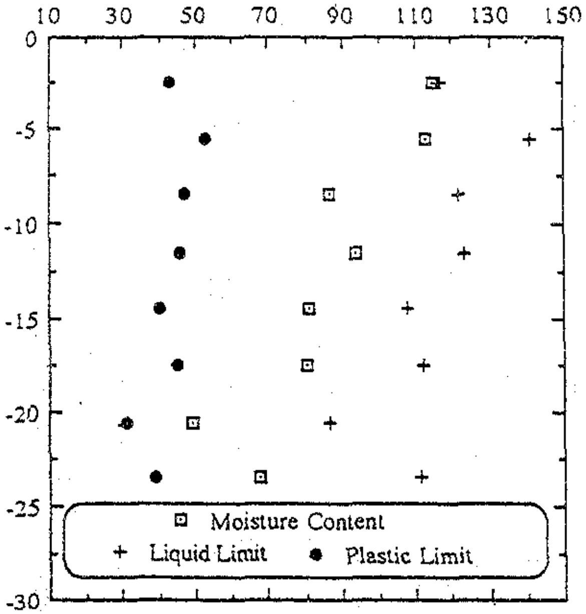


Fig. J-1 - Plot of Moisture Content and Atterberg Limits Versus Depth for Marine Clay Stratum at Bridge No.00546560

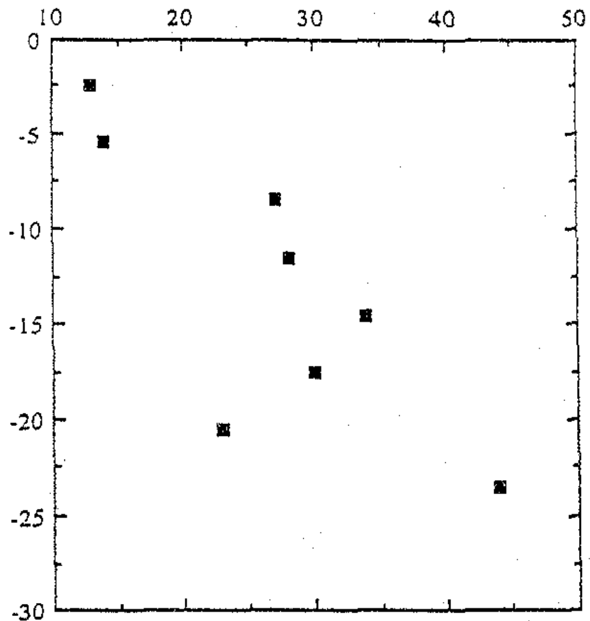


Fig. J-2 - Plot of Undrained Shear Strength (UIU Test) Versus Depth for Marine Clay Stratum at Bridge No.00546560

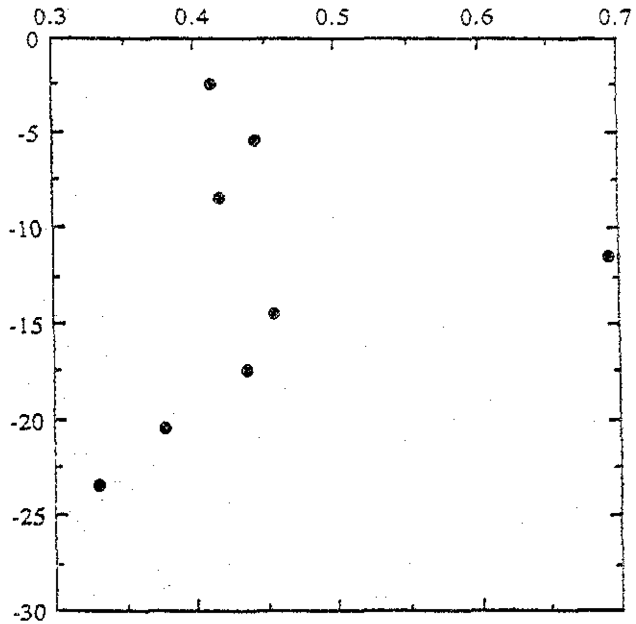


Fig. J-3 - Plot of Cc/(1+e) Versus Depth for Marine Clay Stratum at Bridge No.00546560

Plot of Index Properties Versus Depth at Bridge No. 00546980

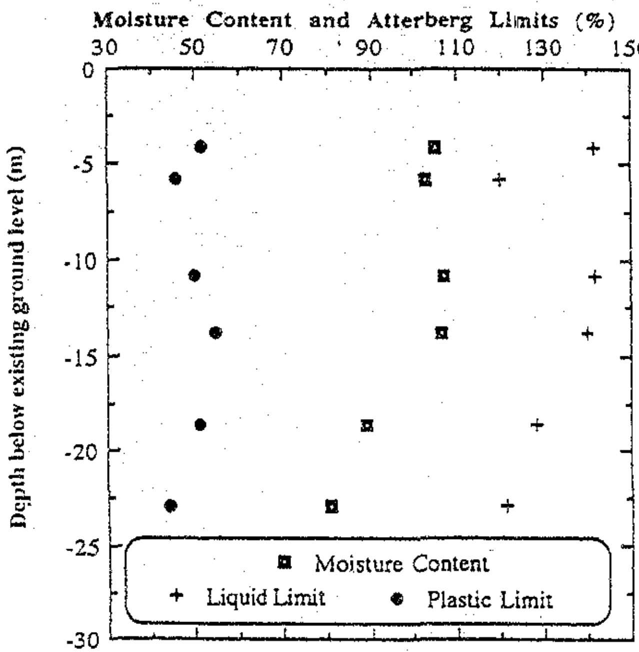


Fig. J-4 - Plot of Moisture Content and Atterberg Limits Versus Depth for Marine Clay Stratum at Bridge No.00546980

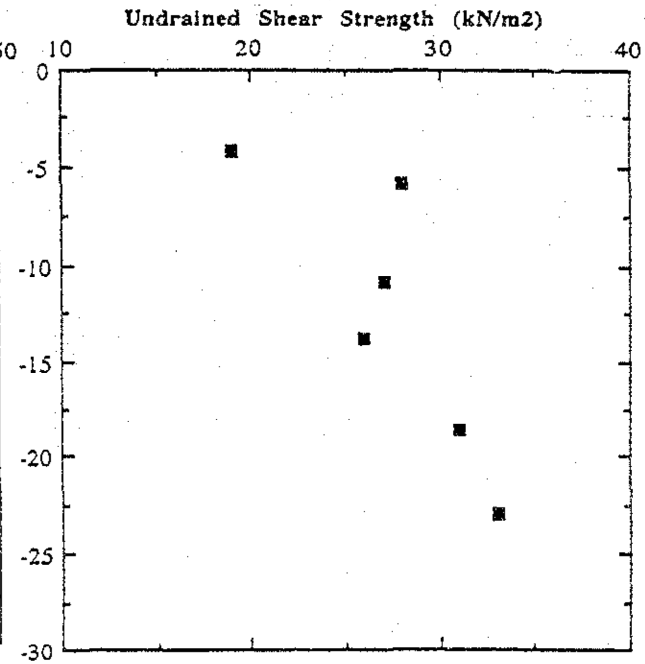


Fig. J-5 - Plot of Undrained Shear Strength (UU Test) Versus Depth for Marine Clay Stratum at Bridge No.00546980

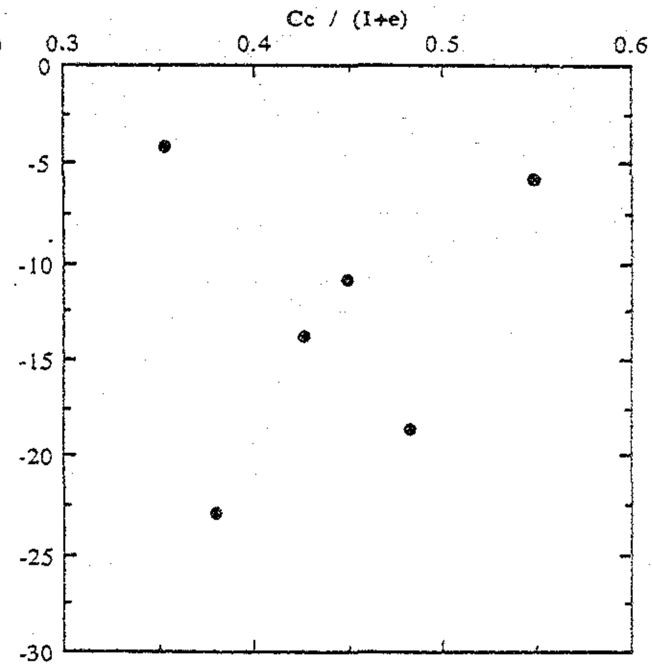
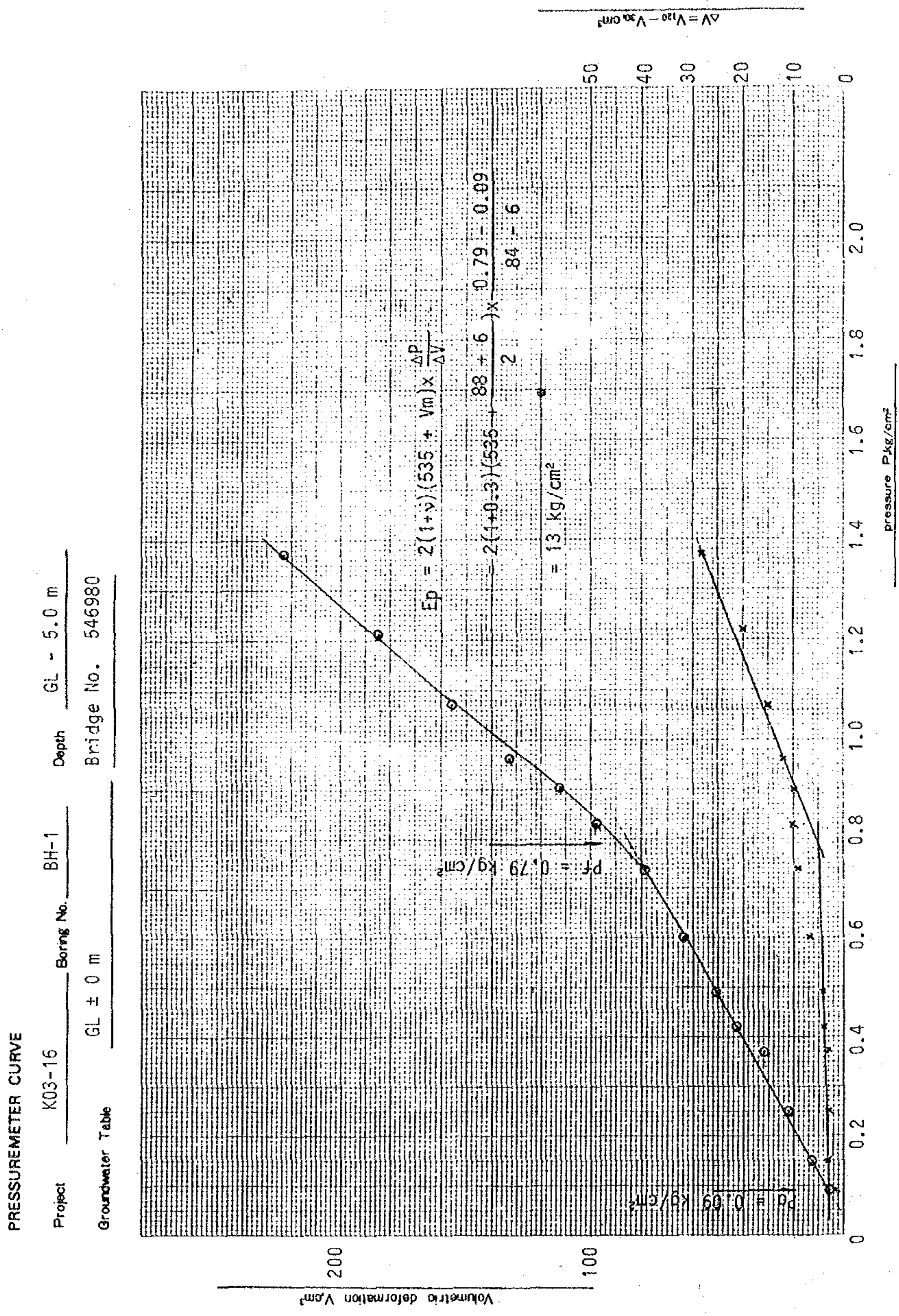


Fig. J-6 - Plot of Cc/(1+e) Versus Depth for Marine Clay Stratum at Bridge No.00546980

Pressuremeter Curve at 5 meters depth for Bridge No. 00546980



Pressuremeter Curve at 10 meters depth for Bridge No. 00546980

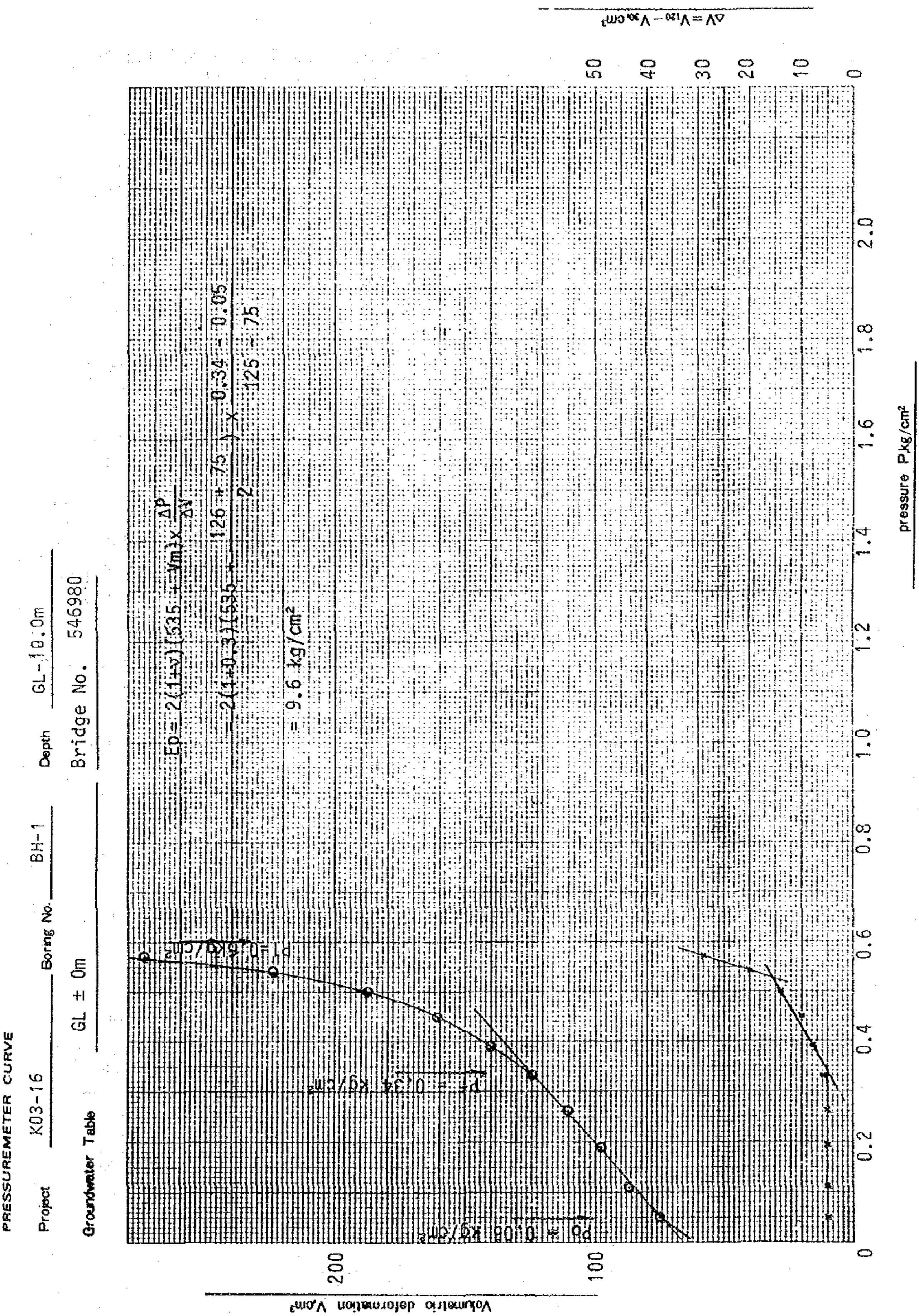


Table J-1 Results of Chemical Tests on Water Samples

Bridge No.	Bridge Location	Location of Sampling *	pH – Value	Sulphate Content (as SO3, g/1)
161140	Sg. Chemor, Kinta Perak	Borehole	6.9	< 0.01
		River	6.4	< 0.01
346740	Sg. Dungun, Dungun Trengganu	Borehole	5.5	< 0.01
		River	5.3	< 0.01
546560	Sg. Jeram, Kuala Selangor, Selangor	Borehole	5.7	0.82
		River	6.2	0.12
546980	Sg. Buluh, Kuala Selangor, Selangor	Borehole	6.8	0.15
		River	5.4	0.20
567840	Sg. Selinsing, Kinta, Perak	Borehole	7.0	0.04
		River	6.8	0.02
108100	Sg. Machap, Johor	W-2	5.7	< 0.01
		W-1 (Upstream)	5.6	< 0.01
114920	Sg. Karas, Johor	W-1	6.3	< 0.01
		W-2 (Upstream)	6.1	< 0.01
303220	Johor	W-1	5.5	< 0.01
		W-2 (Upstream)	5.4	< 0.01
303430	Johor	W-1	6.0	< 0.01
		W-2 (Upstream)	6.1	< 0.01
303890	Sg. Tembioh, Johor	W-1	5.7	< 0.01
		W-2 (Upstream)	5.7	< 0.01
316745	Sg. Air Tawar, Johor	W-1	4.4	< 0.01
		W-2 (Upstream)	4.3	< 0.01
361490	Trengganu	W-1	5.3	< 0.01
		W-2	5.4	< 0.01
366660	Kelantan	W-2	6.0	< 0.01
		W-1 (Upstream)	5.9	< 0.01
366890	Kelantan	W-1	5.1	< 0.01
		W-2	5.0	< 0.01
368300	Kelantan	W-1	5.4	< 0.01
		W-2	5.3	< 0.01

* Note : Please refer to pages B4 to B8 for the exact locations where the river water samples were collected.

Table J-2 Results of Chemical Analysis on Soil Samples from Boreholes

Bridge No.	Bridge Location	Sample No.	pH Value	Total Sulphate (as SO3, %)	Water Soluble Sulphate (as SO3, g/l)
161140	Sg. Chemor, Kinta, Perak	P-1	6.2	< 0.01	< 0.01
346740	Sg. Dungun, Dungun District Terengganu	P-1	6.0	< 0.01	< 0.01
		P-2	6.6	< 0.01	< 0.01
		P-5	6.6	0.04	0.15
		P-7	7.6	< 0.01	< 0.01
		P-9	8.5	< 0.01	< 0.01
		P-10	7.9	0.03	< 0.01
546560	Sg. Jeram, Kuala Selangor, Selangor	UD-1	7.7	0.68	1.2
		UD-2	5.5	1.12	3.6
		P-5	5.7	0.10	0.35
		UD-5	4.5	1.52	4.3
		P-10	6.2	0.14	0.40
		P-13	7.9	< 0.01	0.01
		UD-7	7.9	0.01	< 0.01
		P-24	7.2	< 0.01	0.01
546980	Sg. Buluh, Kuala Selangor, Selangor	UD-1	7.5	1.10	2.80
		UD-2	7.7	0.96	2.50
		P-3	7.8	0.74	1.31
		P-6	7.5	0.88	2.24
		P-10	7.3	0.66	1.04
		P-13	7.1	0.08	< 0.01
		P-15	7.6	0.08	0.25
		P-18	5.5	< 0.01	< 0.01
		P-20	6.8	0.04	< 0.01
567840	Sg. Selinsing, Kinta, Perak	P-3	4.9	< 0.01	< 0.01
		P-5	7.5	< 0.01	< 0.01
		P-7	6.5	< 0.01	< 0.01

Table J-3 Results of Chemical Analysis on Soil Samples from Hand Auger Holes

Bridge No.	Location	Point No.	Sample No.	pH Value	Total Sulphate (as SO3, %)	Water Soluble Sulphate (as SO3, g/l)
108100	Sg. Machap, Johor	1	A-4	5.4	< 0.01	< 0.01
		2	A-4	4.1	< 0.01	< 0.01
		3	A-1	6.6	< 0.01	< 0.01
		3	A-3	4.3	< 0.01	< 0.01
114920	Sg. Karas, Johor	1	A-6	5.0	< 0.01	< 0.01
		1	A-2	4.9	< 0.01	< 0.01
		2	A-3	4.1	< 0.01	< 0.01
		2	A-2	4.4	< 0.01	< 0.01
		3	A-1	4.8	< 0.01	< 0.01
303220	Johor	1	A-5	4.0	< 0.01	< 0.01
		1	A-6	4.3	< 0.01	< 0.01
		2	A-2	4.1	< 0.01	< 0.01
		2	A-3	4.1	< 0.01	< 0.01
		3	A-5	4.3	< 0.01	< 0.01
		3	A-6	4.4	< 0.01	< 0.01
303430	Johor	1	A-4	5.0	< 0.01	< 0.01
		1	A-3	4.6	< 0.01	< 0.01
		2	A-6	4.9	< 0.01	< 0.01
		3	A-3	4.2	< 0.01	< 0.01
		3	A-5	4.2	< 0.01	0.01
303890	Sg. Tembioh, Johor	1	A-5	4.9	< 0.01	< 0.01
		2	A-3	4.2	< 0.01	< 0.01
		2	A-4	4.7	< 0.01	< 0.01
		3	A-5	4.9	< 0.01	< 0.01
		3	A-4	4.8	< 0.01	< 0.01
316745	Sg. Air Tawar, Johor	1	A-3	3.7	0.88	0.30
		1	A-4	3.4	0.06	0.20
		2	A-2	4.5	< 0.01	< 0.01
		3	A-4	3.2	-	-
		3	A-5	3.3	1.47	3.2
361490	Terengganu	1	A-1	4.6	0.02	< 0.01
		2	A-2	5.3	< 0.01	< 0.01
		3	A-4	5.0	0.04	0.10
366660	Kelantan	1	A-1	4.0	< 0.01	< 0.01
		2	A-4	6.0	< 0.01	< 0.01
		3	A-2	6.2	< 0.01	< 0.01
366890	Kelantan	1	A-3	4.7	< 0.01	< 0.01
		1	A-3	4.7	< 0.01	< 0.01
		2	A-3	5.1	< 0.01	< 0.01
		3	A-5	4.8	< 0.01	< 0.01
368300	Kelantan	1	A-4	5.0	< 0.01	< 0.01
		2	A-4	5.1	< 0.01	< 0.01
		3	A-3	4.8	< 0.01	< 0.01

Table J-4 Recommendations for Concrete Exposed to Sulphate Attack (Source : BS 8004:1986)

Concrete exposed to sulphate attack

NOTE. The recommendations are for concrete in a near-neutral groundwater; for acid conditions see Gutt and Harrison (1977).

Class	Concentration of sulphates expressed as SO_3: In soil: Total SO_3	Concentration of sulphates expressed as SO_3: In soil: SO_3 in 2:1 water:soil extract	Concentration of sulphates expressed as SO_3: In groundwater	Type of cement	Dense fully compacted concrete made with aggregates complying with BS 882 or BS 1047: Minimum cement content*	Dense fully compacted concrete made with aggregates complying with BS 882 or BS 1047: Maximum free water/cement* ratio
	%	g/L	g/L		kg/m^3	
1	Less than 0.2	Less than 1.0	Less than 0.3	Ordinary Portland cement (OPC) Rapid hardening Portland cement (RHPC), or combinations of either cement with slag‡ or p.f.a.§ Portland blastfurnace cement (PBFC) — Plain concrete†	250	0.70
				(as above) — Reinforced concrete	300	0.60
2	0.2 to 0.5	1.0 to 1.9	0.3 to 1.2	OPC or RHPC or combinations of either cement with slag or p.f.a. PBFC	330	0.50
				OPC or RHPC combined with minimum 70 % or maximum 90 % slag‖ OPC or RHPC combined with minimum 25 % or maximum 40 % p.f.a.¶	310	0.55
				Sulphate resisting Portland cement (SRPC)	290	0.55
3	0.5 to 1.0	1.9 to 3.1	1.2 to 2.5	OPC or RHPC combined with minimum 70 % or maximum 90 % slag OPC or RHPC combined with minimum 25 % or maximum 40 % p.f.a.	380	0.45
				SRPC	330	0.50
4	1.0 to 2.0	3.1 to 5.6	2.5 to 5.0	SRPC	370	0.45
5	Over 2	Over 5.6	Over 5.0	SRPC plus protective coating**	370	0.45

*Inclusive of content of p.f.a. or slag. These cement contents relate to 20 mm nominal maximum size aggregate. In order to maintain the cement content of the mortar fraction at similar values, the minimum cement contents given should be increased by 50 kg/m^3 for 10 mm nominal maximum size aggregate and may be decreased by 40 kg/m^3 for 40 mm nominal maximum size aggregate.

†When using strip foundations and trench fill for low rise buildings in class 1 sulphate conditions, further relaxation in the cement content and water/cement ratio is permissible.

‡Ground granulated blastfurnace slag (see BS 6699).

§Selected or classified pulverized-fuel ash complying with BS 3892.

‖Per cent by mass of slag/cement mixture.

¶Per cent by mass of p.f.a./cement mixture.

**See CP 102.

NOTE 1. Different aggregates require different water contents to produce concrete of the same workability and therefore a range of free water/cement ratios is applicable to each cement content. In order to achieve satisfactory workability at the specified maximum free-water/cement ratio it may be necessary to increase the cement content above the minimum specified.

NOTE 2. Within the limits specified in this table, the use of p.f.a or slag in combination with sulphate resisting Portland cement (SRPC) will not give lower sulphate resistance than combination with cements complying with BS 12.

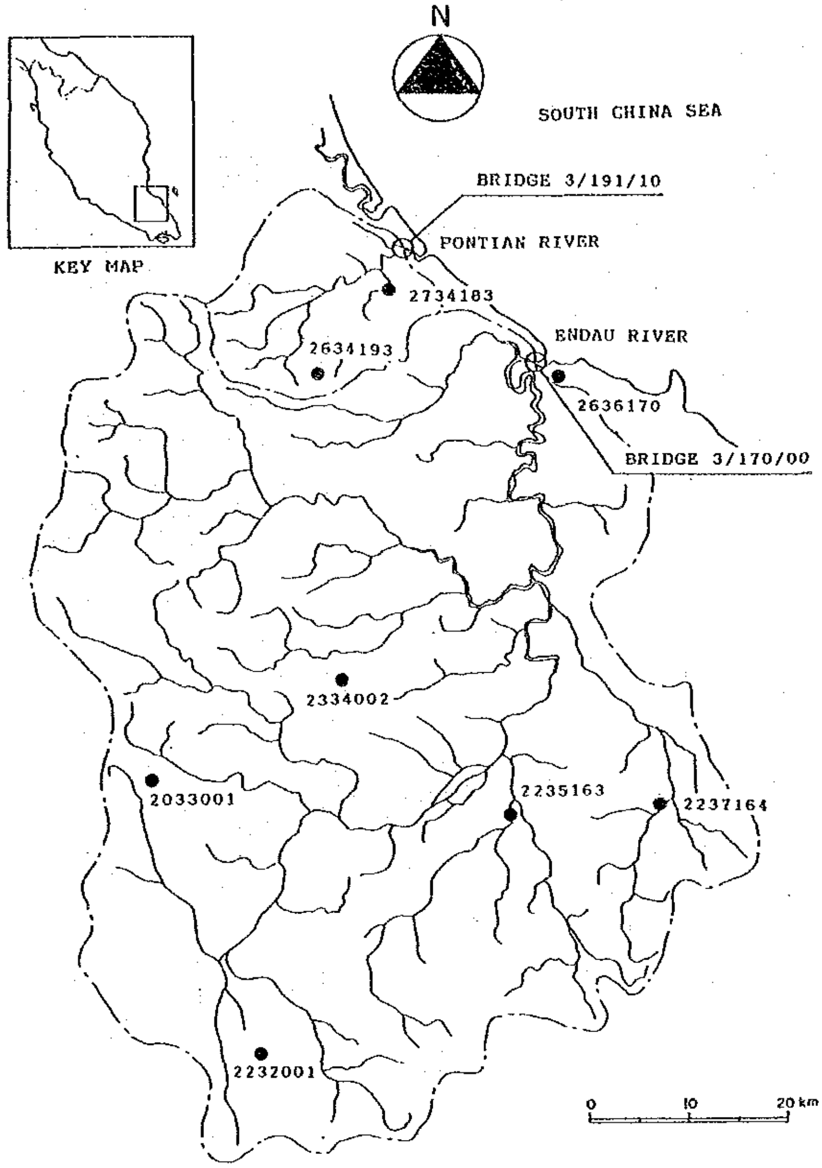
NOTE 3. If much of the sulphate is present as low solubility calcium sulphate, analysis on the basis of a 2:1 water extract may permit a lower site classification than that obtained from the extraction of total SO_3. Reference should be made to BRE Current Paper 2/79 for methods of analysis and to BRE Digests 250, 275 and 276 for interpretation in relation to natural soils, fill and hardcore.

APPENDIX – K

BACKUP DATA FOR HYDROLOGICAL ANALYSIS

TABLE OF CONTENTS

Location of Rainfall Gauging Station (Endau/Pontian River Basin)



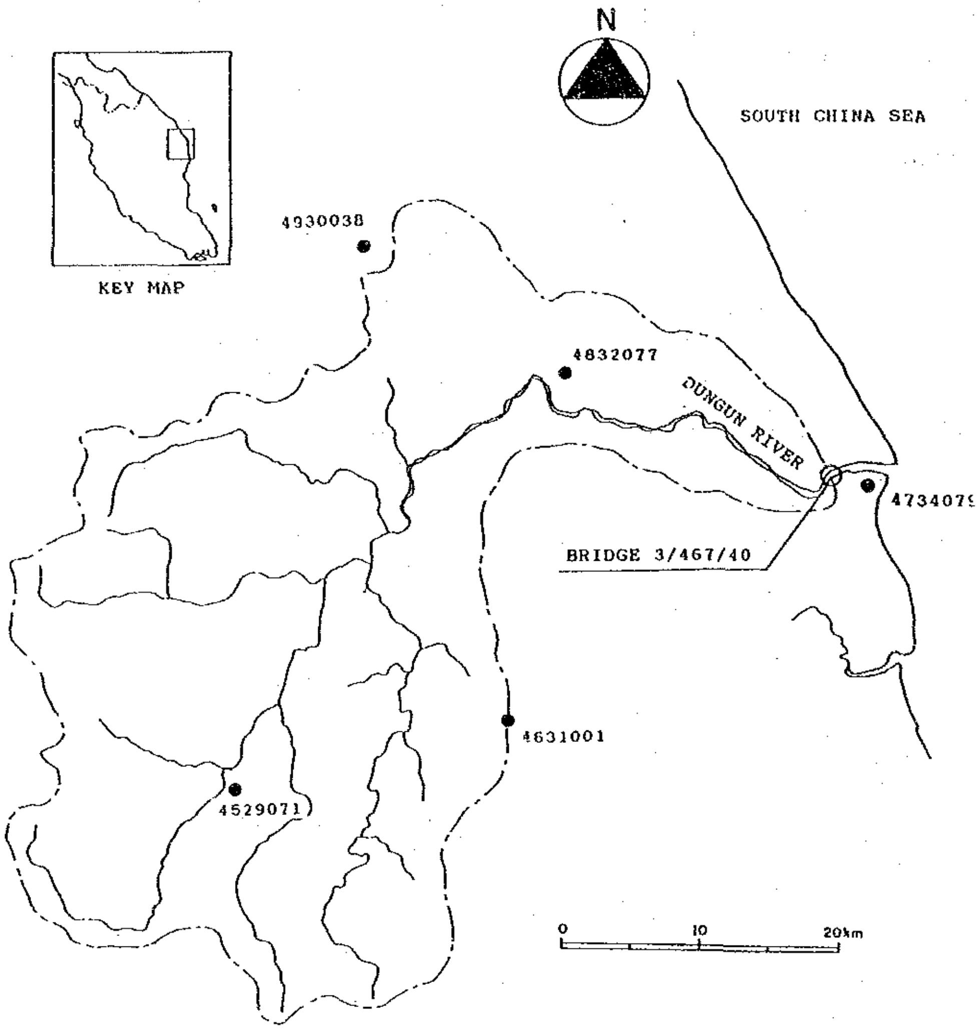
Source: Study on Kelantan River Basinwide Flood Mitigation, JICA, 1989

Endau/Pontian River Basin (Unit : mm)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1 2033001	162	123	206	195	139	120	137	120	179	181	217	221	2,001
2 2232001	227	112	212	143	138	126	96	105	176	157	203	278	1,973
3 2235163	208	98	227	219	218	119	173	157	253	195	263	515	2,643
4 2237164	312	159	190	178	225	159	180	159	261	247	329	562	2,960
5 2334002	277	152	180	157	195	107	126	153	198	239	392	435	2,610
6 2634193	343	291	384	195	183	153	164	234	186	276	225	660	3,293
7 2636170	307	139	160	132	127	114	127	136	173	216	396	784	2,811
8 2734183	299	202	172	169	152	176	154	195	185	209	370	757	3,039

Monthly Mean Rainfall of Endau/Pontian River Basin

Location of Rainfall Gauging Station (Dungun River Basin)



Source: Study on Kelantan River Basinwide Flood Mitigation, JICA, 1989

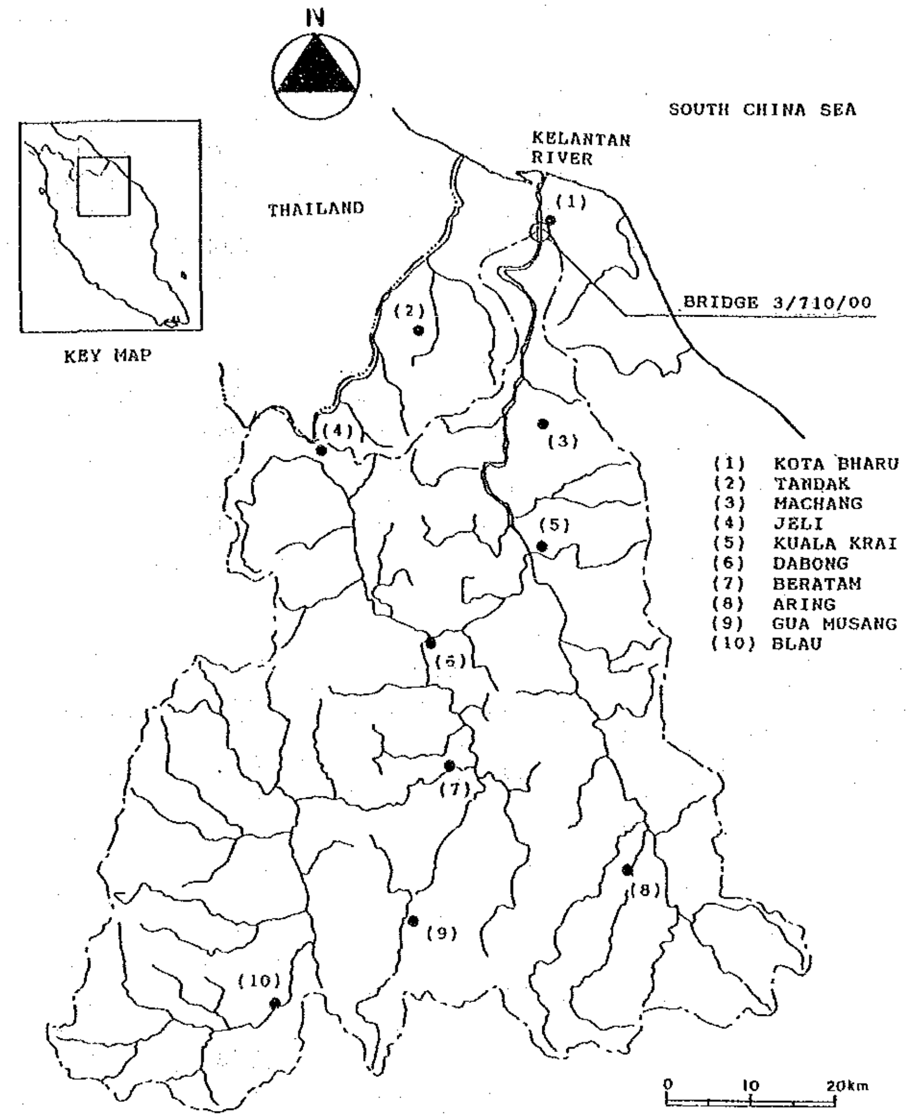
Dungun River Basin

(Unit : mm)

Station	JAN	fEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1 4529071	289	146	160	192	248	170	217	255	253	335	291	708	3,263
2 4631001	197	106	195	177	220	167	201	207	280	281	624	697	3,352
3 4734079	140	80	110	119	134	107	140	172	173	240	533	561	2,510
4 4832077	178	96	136	135	207	199	252	248	349	279	514	580	3,171
5 4930038	195	139	163	170	224	208	217	217	305	353	661	833	3,684

Monthly Mean Rainfall of Dungun River Basin

Location of Rainfall Gauging Station (Kelantan River Basin)



Source: Study on Kelantan River Basinwide Flood Mitigation, JICA, 1989

Kelantan River Basin (Unit : mm)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1 Kota Bharu	79	36	66	55	106	101	177	142	209	257	702	743	2,673
2 Tandak	161	71	74	95	201	193	265	277	352	368	456	583	3,096
3 Machang	170	60	128	91	190	175	187	216	307	253	451	533	2,761
4 Jeli	152	133	115	184	252	187	199	229	294	332	433	682	3,192
5 Kuala Krai	106	166	153	108	160	121	124	168	231	175	188	761	2,461
6 Dabong	93	78	72	171	158	138	200	203	193	247	315	311	2,179
7 Beratam	59	96	69	136	206	90	197	178	242	266	137	280	1,956
8 Aring	93	78	51	114	270	158	205	232	289	328	228	378	2,424
9 Gua Musang	85	107	100	140	238	183	181	209	297	272	233	207	2,252
10 Blau	69	103	169	138	270	151	230	68	204	267	236	157	2,062

Monthly Mean Rainfall of Kelantan River Basin

Annual Maximum Rainfall - Endau/Pontian River Basin Station (1)

STATION NO. 2033001

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1978	77	97	129	156	178	205	205
1979	107	139	142	191	194	215	218
1980	70	108	110	117	127	129	168
1981	75	117	168	189	203	213	222
1982	142	165	165	202	214	236	260
1983	175	202	211	214	214	214	214
1984	110	181	255	261	268	268	268
1985	121	121	122	135	161	161	165
1986	132	184	221	253	264	272	339
1987	151	202	252	280	324	375	422
1988	130	170	170	179	190	191	196
1989	155	179	208	214	219	222	222
1990	144	179	182	188	196	204	232

STATION NO. 2232001

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1980	82	118	146	174	177	193	223
1981	89	166	219	235	238	240	261
1982	77	104	140	172	190	210	215
1983	226	244	253	255	255	255	268
1984	114	181	207	232	259	268	278
1985	75	80	87	98	102	115	123
1986	140	204	233	269	285	292	313
1987	96	170	242	268	321	394	419
1988	69	96	107	145	156	174	183
1989	203	296	339	353	364	367	367
1990	179	243	243	244	266	272	290

STATION NO. 2235163

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1980	105	158	196	196	197	198	201
1981	144	232	305	361	405	435	449
1982	206	284	410	539	572	694	722
1983	185	344	379	407	408	424	451
1984	110	171	223	241	286	331	382
1985	186	204	205	205	205	208	233
1986	101	181	192	212	229	283	318
1987	175	269	316	346	420	468	509
1988	210	220	229	230	233	243	247
1989	372	470	506	538	566	575	575
1990	116	144	155	171	185	227	243

Annual Maximum Rainfall - Endau/Pontian River Basin Station (2)

STATION NO. 2237164

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1978	204	283	299	344	403	419	463
1979	169	234	277	329	394	394	394
1980	125	152	180	212	220	252	272
1981	203	323	421	493	546	580	590
1982	359	507	616	803	827	1,007	1,035
1983	239	400	451	482	492	498	526
1984	199	227	322	322	337	365	564
1985	274	321	321	321	321	322	330
1986	106	128	179	204	210	238	286
1987	250	309	344	389	416	475	534
1988	241	281	327	367	370	395	419
1989	199	279	350	381	414	435	435
1990	189	224	311	379	433	455	493

STATION NO. 2334002

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1978	368	491	604	678	791	811	819
1979	156	221	256	274	289	299	305
1980	180	225	248	268	268	268	268
1981	250	382	462	522	537	562	578
1982	193	314	340	478	516	543	569
1983	149	206	221	231	231	231	251
1984	175	255	300	341	386	413	450
1985	140	165	165	165	165	165	165
1986	174	217	321	428	478	478	478
1987	139	247	285	308	397	436	473
1988	107	123	147	167	197	201	245
1989	276	543	676	696	714	723	723
1990	158	209	221	221	230	265	285

STATION NO. 2634193

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1981	135	233	293	340	400	433	469
1982	181	266	343	460	545	622	683
1983	165	309	442	479	485	508	531
1984	187	257	300	309	327	389	512
1985	195	247	266	280	290	292	295
1986	159	269	344	379	402	416	416
1987	350	632	644	668	687	799	811
1988	147	241	309	451	494	503	604
1989	114	157	204	250	282	310	337
1990	286	341	370	372	381	387	388

Annual Maximum Rainfall - Endau/Pontian River Basin Station (3)

STATION NO. 2636170

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1978	195	388	450	476	489	518	543
1979	122	166	187	192	193	193	264
1980	144	180	265	283	283	283	293
1981	340	574	620	670	707	738	763
1982	278	391	521	747	856	967	1,070
1983	186	315	459	598	604	608	673
1984	205	313	423	437	440	448	574
1985	134	163	168	178	214	215	243
1986	330	346	348	350	368	371	371
1987	269	378	444	457	461	510	519
1988	291	426	469	512	530	549	579
1989	185	227	279	328	348	360	370
1990	261	340	384	410	410	425	441

STATION NO. 2734183

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1978	368	491	604	678	791	811	819
1979	254	327	430	438	440	459	574
1980	178	243	303	328	328	328	329
1981	191	322	392	438	508	531	562
1982	266	377	473	634	745	841	911
1983	246	422	450	482	485	497	527
1984	197	335	445	492	526	537	632
1985	123	140	153	164	165	174	175

Annual Maximum Rainfall - Dungun River Basin Station (1)

STATION NO. 4529071

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1974	138	196	241	272	298	341	384
1975	148	187	225	267	321	353	383
1976	151	219	238	254	284	354	354
1977	147	147	152	165	180	180	186
1978	202	247	277	303	374	404	429
1979	114	208	251	292	335	374	402
1980	124	203	236	266	269	277	280
1981	92	117	127	175	217	248	279
1982	285	400	455	487	491	511	519
1983	265	528	700	869	988	1,075	1,165
1984	325	406	465	541	560	569	569
1985	119	213	329	362	380	405	456

STATION NO. 4631001

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1977	154	154	158	178	201	223	239
1978	112	176	209	237	268	287	306
1979	180	323	374	421	472	516	539
1980	143	242	307	351	373	385	387
1981	132	150	152	184	231	260	288
1982	266	479	480	489	489	529	564
1983	339	674	934	1,249	1,390	1,528	1,649
1984	308	456	480	552	568	577	595
1985	108	163	233	293	326	333	341
1986	569	768	847	1,055	1,126	1,169	1,194
1987	279	330	379	532	584	659	710
1988	281	452	502	528	548	564	614
1989	94	130	150	186	218	225	227
1990	254	411	558	700	716	717	720

STATION NO. 4734079

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1974	215	367	447	499	579	610	629
1975	228	349	397	429	488	538	648
1976	207	281	347	378	379	458	524
1977	99	107	143	151	158	161	169
1978	120	127	160	189	193	204	210
1979	120	239	295	336	380	428	459
1980	118	180	240	350	397	406	406
1981	130	183	237	267	275	305	356
1982	197	296	429	445	448	449	466
1983	265	354	516	625	720	797	829
1984	186	244	280	286	298	306	312
1985	159	265	341	418	482	499	499
1986	319	594	762	937	1,099	1,238	1,320
1987	131	226	249	294	311	371	436
1988	572	766	858	895	903	940	940
1989	99	130	130	130	148	148	156
1990	128	182	202	218	226	230	231

Annual Maximum Rainfall - Dungun River Basin Station (2)

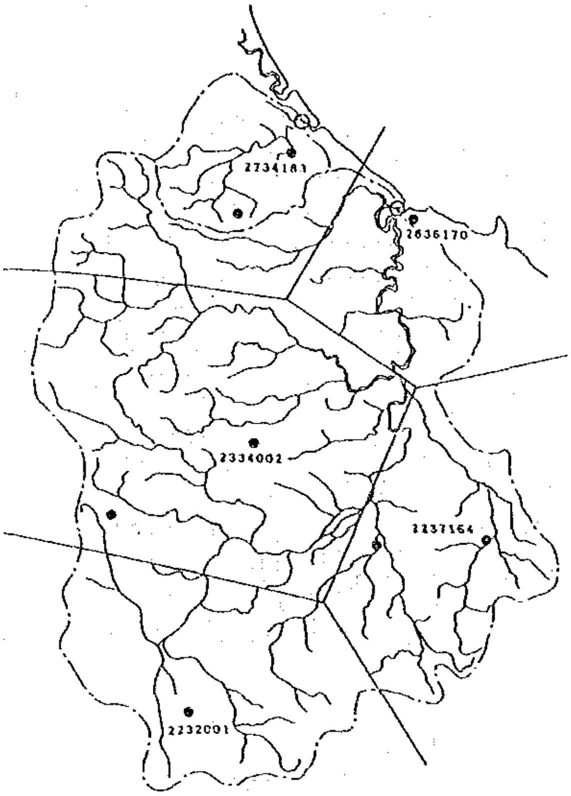
STATION NO. 4832077

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1974	159	253	355	455	567	621	693
1975	204	346	403	468	569	602	630
1976	305	539	570	598	604	609	772
1977	86	119	152	195	196	198	209
1978	103	146	160	175	195	213	241
1979	203	405	476	515	562	618	632
1980	140	269	317	428	464	471	476
1981	80	147	181	230	286	309	324
1982	217	336	400	428	440	444	446
1983	92	137	188	245	260	268	307
1984	195	275	300	370	395	406	418
1985	164	295	392	449	491	498	519

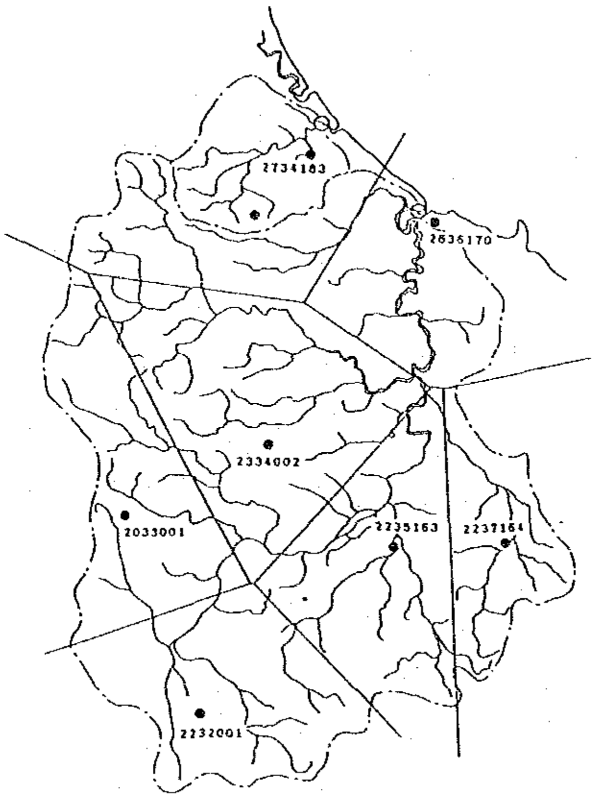
STATION NO. 4930038

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1974	254	383	487	601	685	786	822
1975	257	361	403	466	552	580	605
1976	300	483	522	544	579	582	647
1977	98	152	163	215	226	231	245
1978	144	170	191	198	216	237	247
1979	235	420	477	529	586	634	651
1980	165	231	350	409	444	448	461
1981	85	121	135	172	210	246	263
1982	225	409	464	484	489	508	518
1983	273	509	774	884	1,087	1,200	1,249
1984	170	330	371	452	493	505	526
1985	153	246	319	362	399	402	425
1986	651	807	955	1,207	1,355	1,425	1,523
1987	145	237	243	283	330	365	397
1988	300	512	679	711	727	758	769
1989	87	94	101	131	175	185	189
1990	292	523	630	690	705	718	725

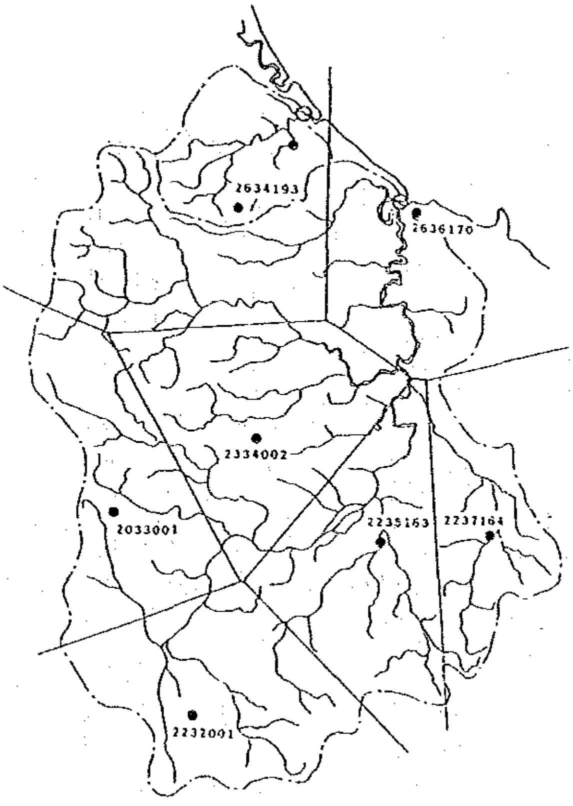
Period 1978 - 1979



Period 1980 - 1984

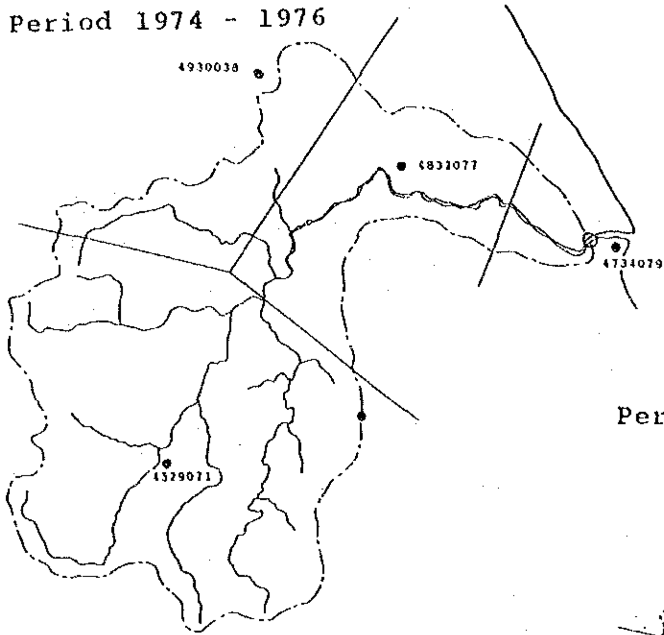


Period 1985 - 1990

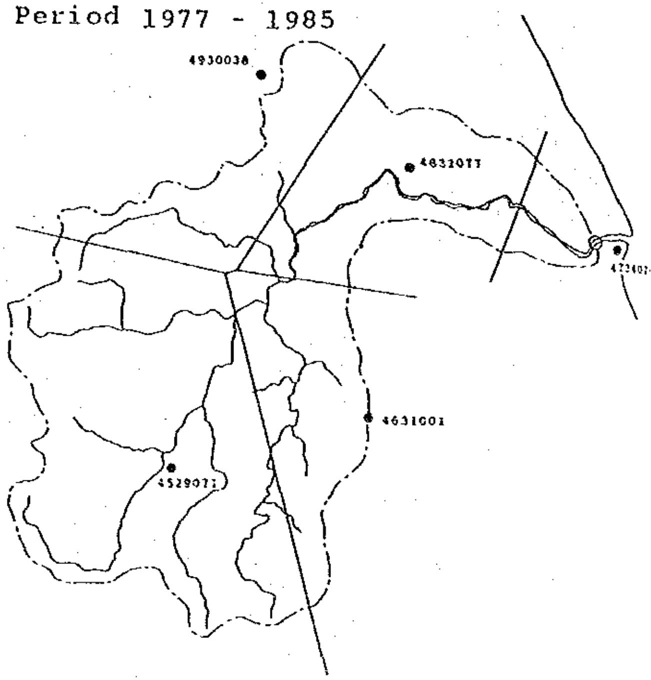


THIESSEN POLYGON
(ENDAU RIVER BASIN)

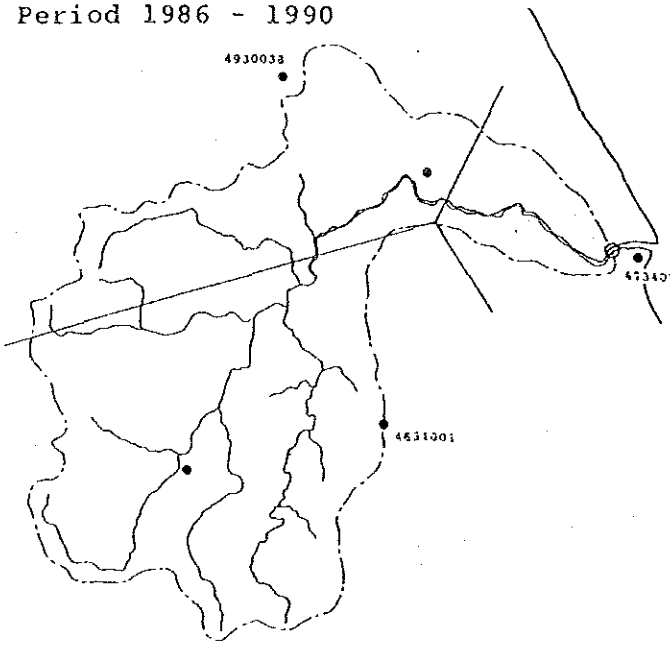
Period 1974 - 1976



Period 1977 - 1985



Period 1986 - 1990



THIESSEN POLYGON (DUNGUN RIVER BASIN)

Subjected Area by Rainfall Gauging Station - Endau River Basin

Endau River Basin

Period	1978 - 1979		1980 - 1984		1985 - 1990	
Station Number	Area (km2)	Weight	Area (km2)	Weight	Area (km2)	Weight
2033001	1079	0.23	750	0.16	750	0.16
2232001	–	–	750	0.16	704	0.15
2235163	–	–	797	0.17	797	0.17
2237164	844	0.18	422	0.09	422	0.09
2334002	1829	0.39	1032	0.22	844	0.18
2634193	–	–	–	–	704	0.15
2636170	469	0.10	469	0.10	469	0.10
2734183	469	0.10	469	0.10	–	–
(Total)	4690	1.00	4690	1.00	4690	1.00

Annual Maximum Rainfall - Basin Mean of Endau River Basin

ENDAU RIVER – BASIN MEAN

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1978	246	342	416	461	527	545	556
1979	104	179	211	240	247	275	279
1980	97	146	180	195	196	197	201
1981	165	283	353	388	418	446	461
1982	172	271	325	459	501	571	605
1983	160	226	266	305	312	320	345
1984	123	192	212	224	242	291	327
1985	128	148	148	148	150	151	151
1986	82	110	148	194	210	248	291
1987	162	217	250	287	329	399	452
1988	112	150	186	246	258	270	318
1989	216	320	378	408	424	440	445
1990	116	161	174	185	190	209	253

Subjected Area by Rainfall Gauging Station - Dungun River Basin

Dungun River Basin

Period	1974 - 1976		1977 - 1984		1985 - 1990	
Station Number	Area (km2)	Weight	Area (km2)	Weight	Area (km2)	Weight
4529071	1,014	0.60	811	0.48	–	–
4631001	–	–	254	0.15	1,014	0.60
4734079	68	0.04	68	0.04	152	0.09
4832077	372	0.22	321	0.19	–	–
4930038	237	0.14	237	0.14	524	0.31
(Total)	1690	1.00	1690	1.00	1690	1.00

Annual Maximum Rainfall - Basin Mean of Dungun River Basin

DUNGUN RIVER – BASIN MEAN

YEAR	1-DAY	2-DAY	3-DAY	4-DAY	5-DAY	6-DAY	7-DAY
1974	144	231	291	344	408	462	505
1975	170	251	294	345	415	447	478
1976	149	270	286	300	311	312	373
1977	105	106	122	143	162	163	165
1978	131	200	225	246	273	297	319
1979	158	294	346	384	435	480	502
1980	133	207	270	333	351	357	363
1981	69	116	140	180	227	256	281
1982	245	366	448	474	479	492	500
1983	238	436	606	774	897	977	1,056
1984	268	368	409	482	504	513	522
1985	103	181	267	289	312	324	366
1986	558	754	873	1,088	1,192	1,240	1,287
1987	189	231	266	386	464	514	556
1988	271	407	529	557	572	600	608
1989	65	109	113	149	189	194	199
1990	254	415	547	653	667	673	676

Outline of Runoff Calculation

1. Runoff Calculation for Sub-basin

Flood runoff from sub-basin is calculated by the following equations.

$$S = K Q^P$$

$$dS/dt = (1/3.6)\ f\ r\ A - Q$$

where,
- S : storage volume in sub-basin (m3)
- Q : runoff from sub basin (m3/sec)
- K : constant
- P : constant
- t : time (sec)
- f : runoff coefficient
- r : basin mean rainfall (mm/hr)
- A : catchment area (km2)

in which, the constants of K and P are estimated by the following equation.

$$K = 119\ I^{0.3}$$
$$P = 0.175\ I^{-0.235}$$

where, I : average gradient along stream in sub-basin

The constants K and P above were obtained from the Tone river basin in Japan. In this Study, the constants for the respective river basins are estimated based on the observed flood records.

$$K' = a\ K$$
$$P' = b\ P$$

where,
- K', P' : constants estimated in this Study
- a , b : conversion factors

Finally, flood runoff is adjusted taking lag time into considerations. The lag time is roughly estimated by following equation.

$$T_l = 0.047\ L - 0.56 \quad (\ L > 11.9\ km\ )$$
$$= 0.0 \quad (\ L < 11.9\ km\ )$$

where,
- T_l : lag time (hours)
- L : stream length (km)

2. Flood Routing through River Channel

In case that riverbed gradient is rather gentle or water level is affected by backwater level in main stream, flood runoff generally retards through river channel. The storage function of river channel is estimated by river cross section, riverbed gradient and river length.

Flood runoff through river channel is calculated by the following equation.

$$S = K\,O^{P} - T_{l}\,O$$

$$dS/dt = I - O$$

where, S : storage volume along river channel (m^3)
K : constant
P : constant
T_l: lag time (hours)
I : inflow (m^3/sec)
O : outflow (m^3/sec)

The lag time is estimated by the following equation.

$$T_l = 7.36 \times 10-4\ L\ I\ -0.5$$

where, T_l : lag time (hours)
L : length of river channel
I : average riverbed gradient

3. River Basin Model

The basin division and the river basin model for the Dungun river and the Endau river basins are shown below.

Endau River Basin

Sub-basin	Catchment Area (km^2)	Stream Length (km)	Slope
1	433	38	1/ 70
2	283	28	1/ 150
3	202	29	1/ 220
4	476	61	1/ 80
5	220	36	1/ 250
6	612	56	1/ 70
7	296	42	1/ 100
8	491	57	1/ 120
9	438	34	1/ 50
10	560	54	1/ 60
11	427	68	1/ 200
12	140	22	1/ 260
13	112	33	1/ 500
	4,690		

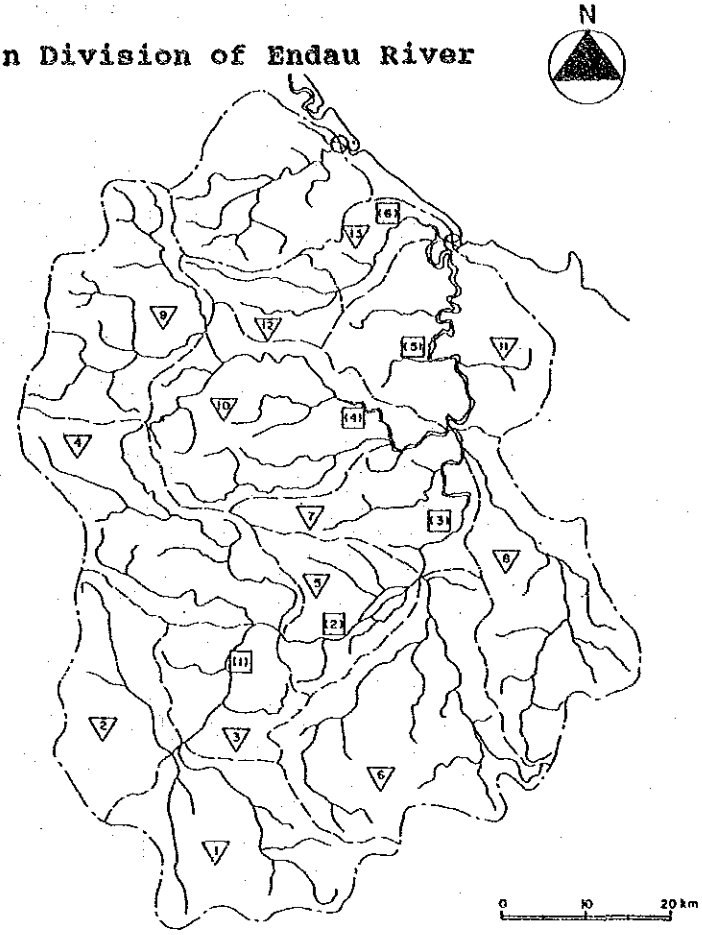
Stretch	Length (km)	Slope
1	25	1/ 2,000
2	23	1/ 2,500
3	32	1/ 3,300
4	52	1/ 3,500
5	63	1/ 5,500
6	26	1/ 2,500

Dungun River Basin

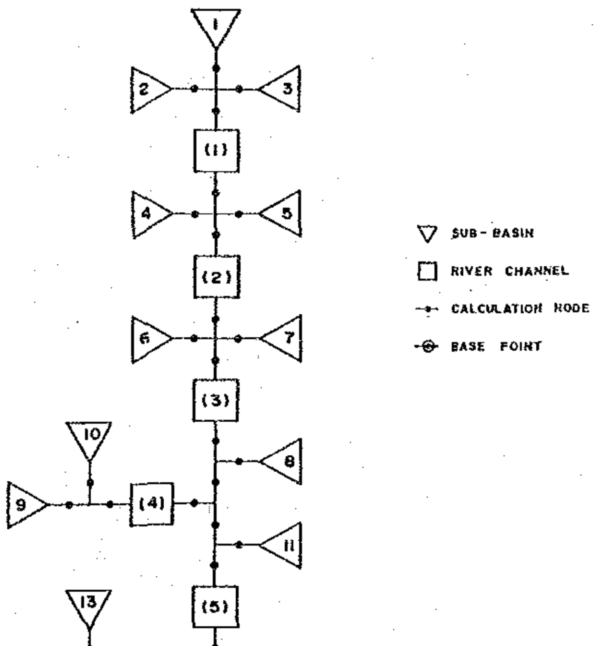
Sub-basin	Catchment Area (km^2)	Stream Length (km)	Slope
1	489	38	1/ 40
2	235	28	1/ 20
3	294	29	1/ 100
4	166	61	1/ 25
5	302	36	1/ 65
6	205	56	1/ 200
	1,690		

Stretch	Length (km)	Slope
1	8	1/ 1,000
2	23	1/ 3,000
3	31	1/ 3,500

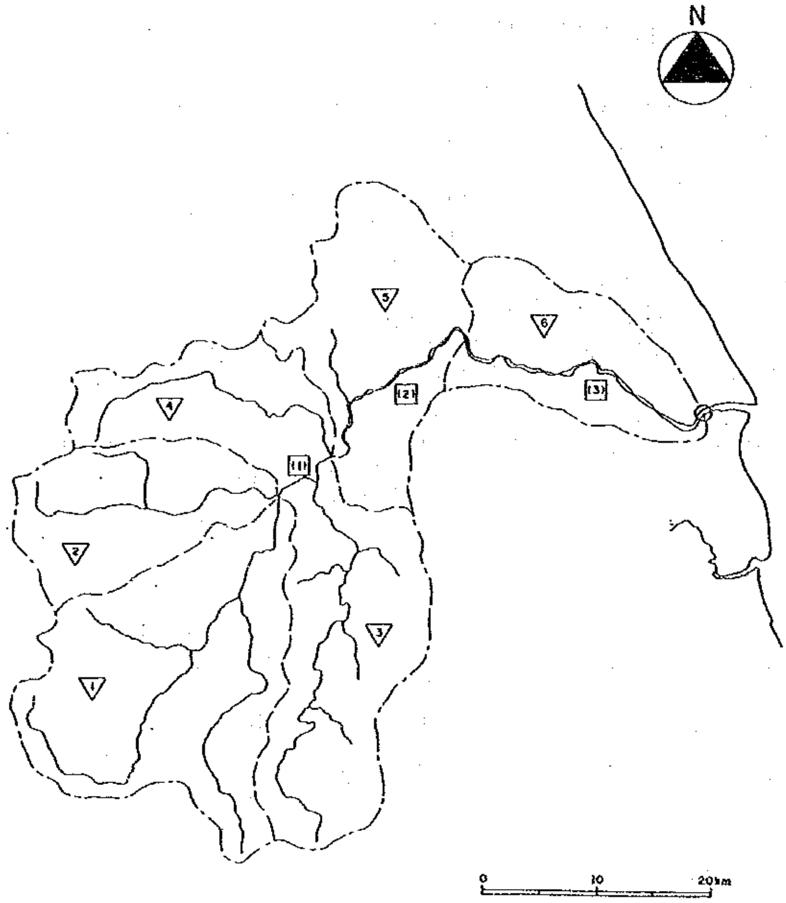
The Basin Division of Endau River



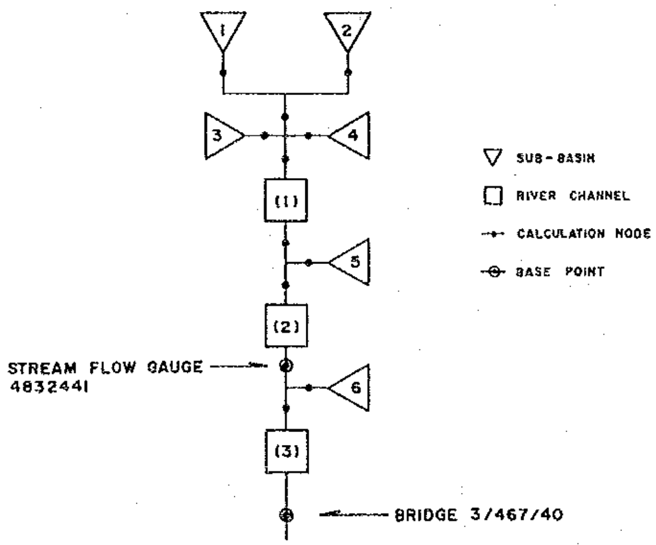
The River Basin Model of Endau River



The Basin Division of Dungun River



The River Basin Model of Dungun River



4. Water Level Calculation

(1) Non-uniform Calculation

The flood level is converted from the flood runoff by using the non-uniform calculation as described below. The Ida method which is developed to solve the non-uniform calculation of the compound channel section is applied.

(Ida's Equation)

$$\left\{H_2+\frac{D_2}{2g}\left(\frac{Q_2}{A_2}\right)^2\right\}-\left\{H_1+\frac{D_1}{2g}\left(\frac{Q_1}{A_1}\right)^2\right\}=h_e$$

$$h_e=\frac{1}{2}\left\{\frac{N_1{}^2Q_1{}^2}{A_1{}^2R_1{}^{4/3}}+\frac{N_2{}^2Q_2{}^2}{A_2{}^2R_2{}^{4/3}}\right\}\Delta X$$

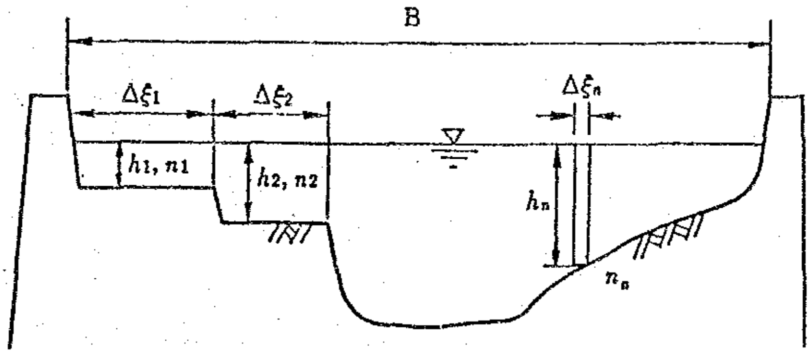
where,
- A : area of river cross section (m2)
- H_1 : water depth at section 1
- H_2 : water depth at section 2
- D : energy correction factor
- He : loss of energy head (m)
- N : composite channel roughness
- R : composite channel hydraulic radius
- X : distance between the sections
- g : acceleration of gravity (= 9.8 m/sec)
- Q : flood runoff (m3/sec)

The subscripts 1 and 2 denote the values at lower and upper sections under consideration, respectively.

According to the Ida method, the energy correction factor, composite channel roughness and composite hydraulic radius of the compound section are a function of depth, roughness and width of each river sub-section as shown below.

River Cross Section

Width	:	B
Water Level	:	H
Sectional Area	:	A



Append-K

$$D = \alpha \frac{A^2 \int_0^B \frac{h^3}{n^3} d\xi}{\left(\int_0^B \frac{h}{n}^{5/3} d\xi \right)^3}$$

$$N = \frac{\int_0^B h^{5/3} d\xi}{\int_0^B \frac{h^{5/3}}{n} d\xi}$$

$$R = \left(\frac{1}{A} \int_0^B h^{5/3} d\xi \right)^{3/2}$$

where, B : surface width
: width of each vertical strip
h : depth of each vertical strip
n : roughness of each vertical strip
: velocity distribution coefficient (0.95 - 1.1)

2) Calculation Condition

The calculation condition of the non-uniform calculation was set at as follows.

(1) Several number of river cross sections were assumed between river month and bridge by using the available topographic information.

(2) Water level at river mouth where the calculation is started were set at the annual mean highest high water level of the sea.

(3) Runoff through river channel was set at the flood runoff peak estimated by the flood runoff analysis.

APPENDIX – L

LOADING POSITIONS AND MEASUREMENT POINTS

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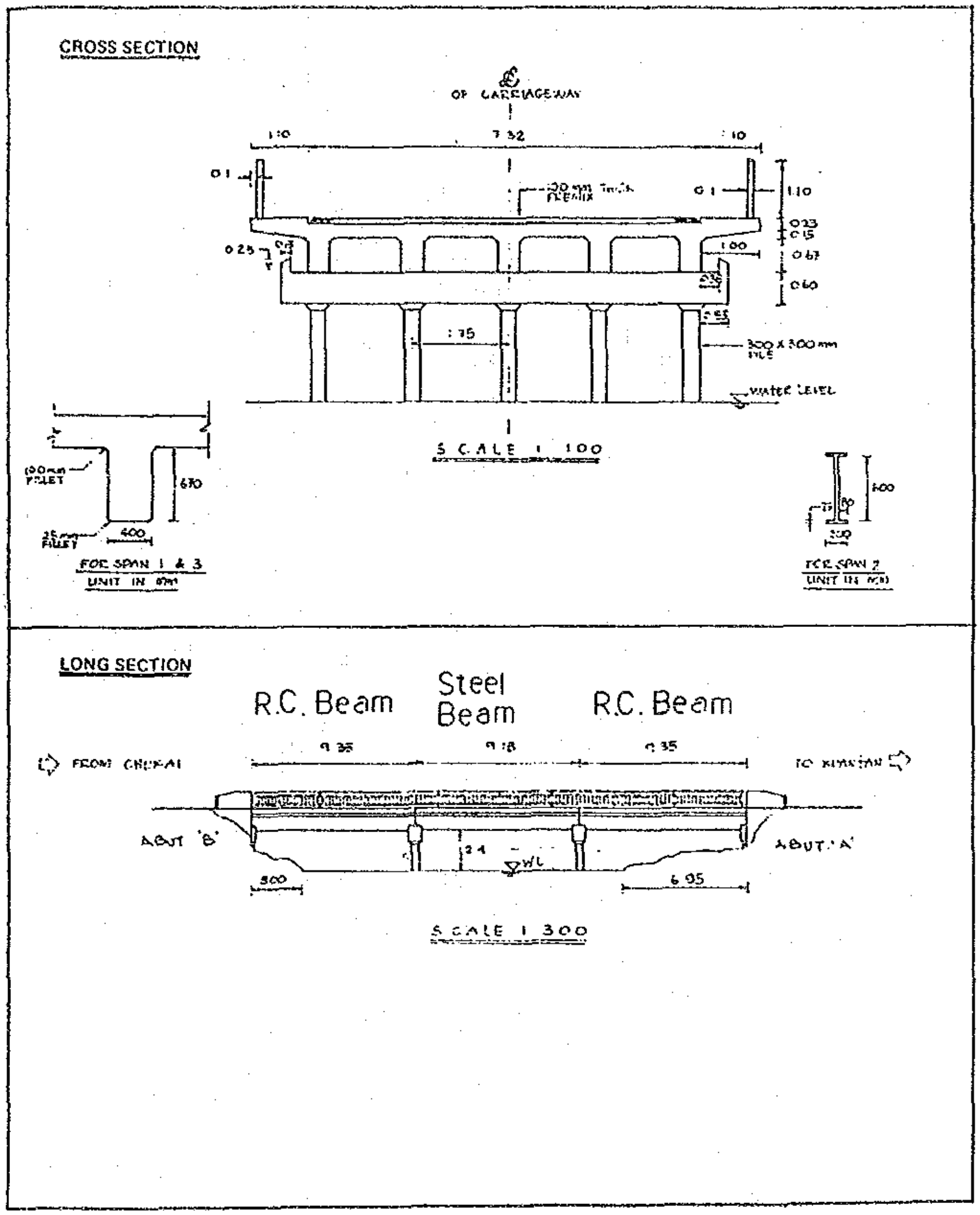
<Bridge No. 00237200>

1. General View

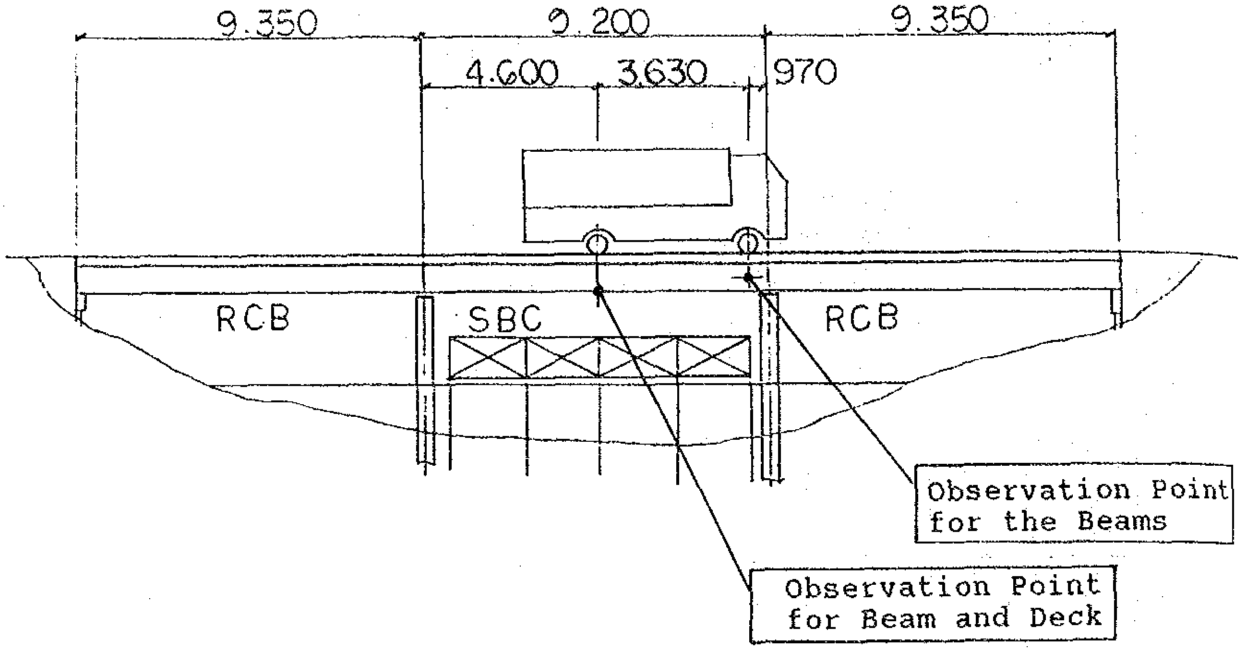


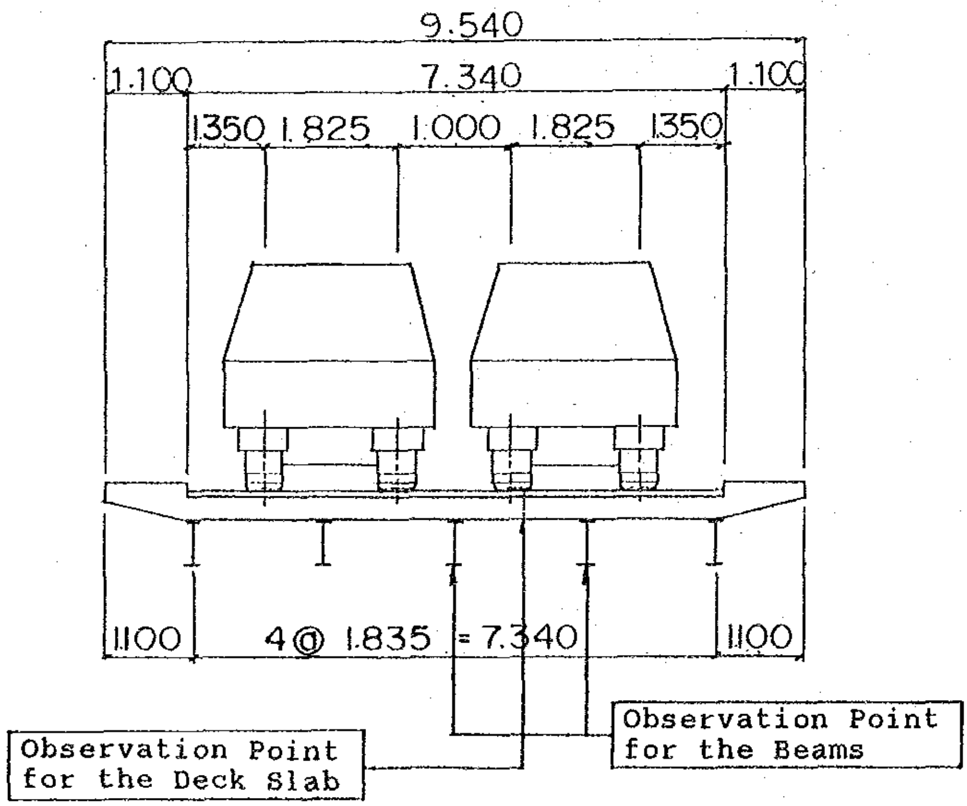
Append-L

2. Measurement of Strain and Displacement

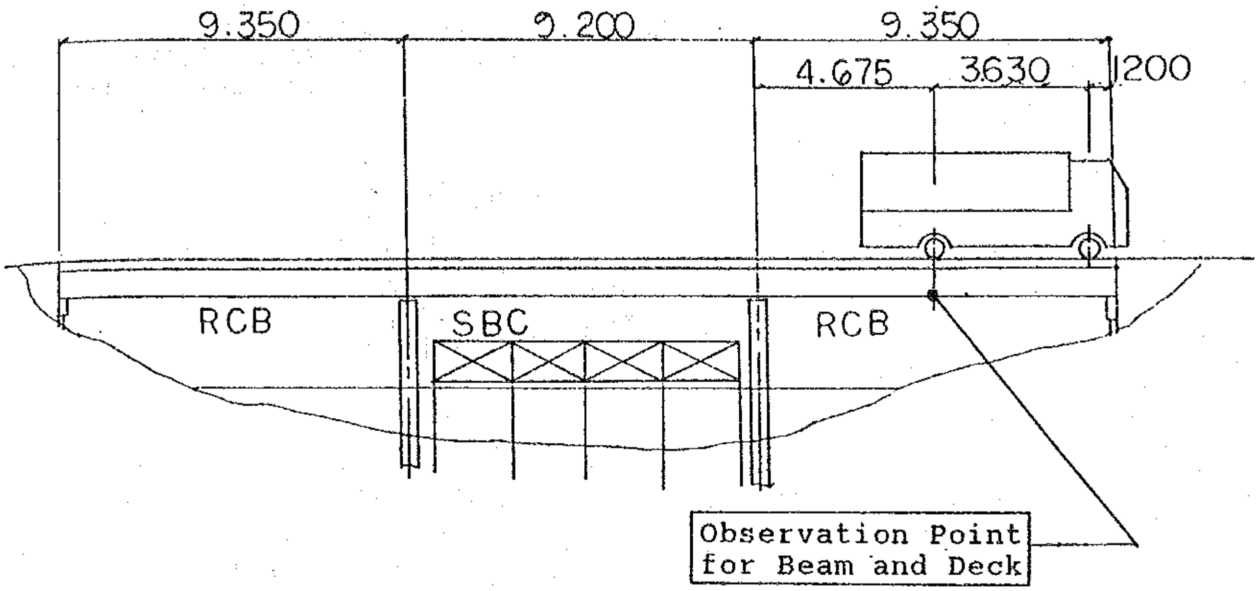
1) Observation Point of Strain and Displacement

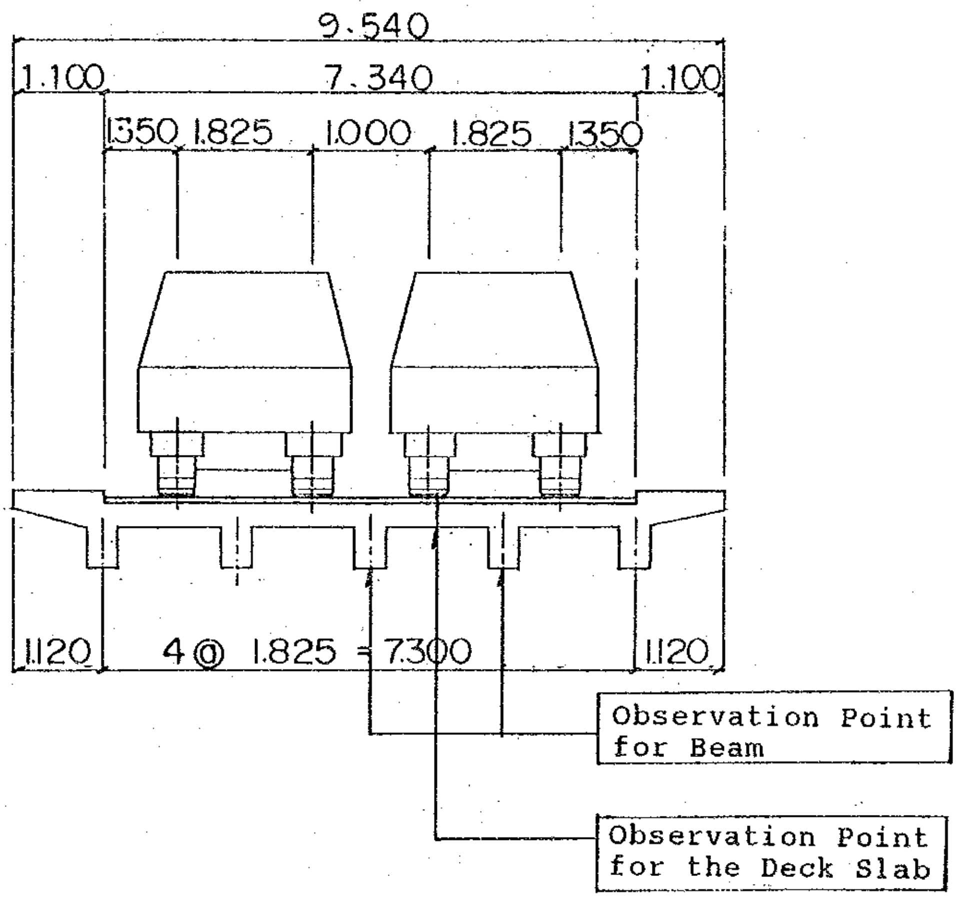
(1) SBC (Steel Beam with R.C Slab)





(2) RCB (Reinforced Concrete Beam)

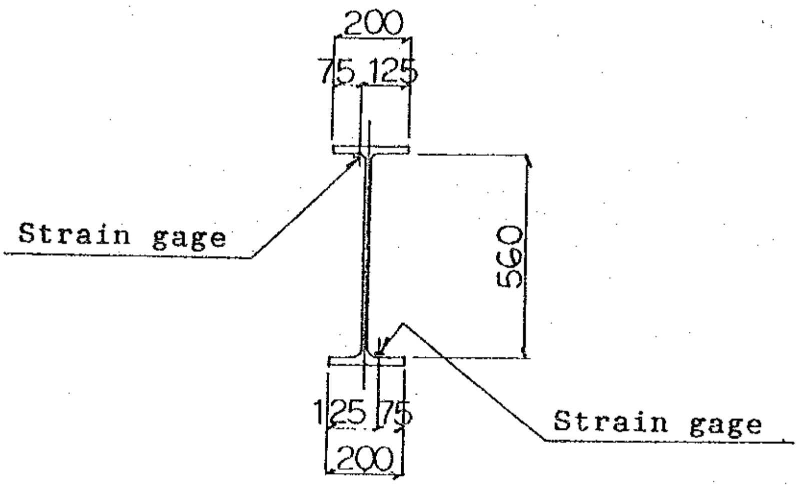




2) The Measurement Point of Strain

(1) Beam of SBC

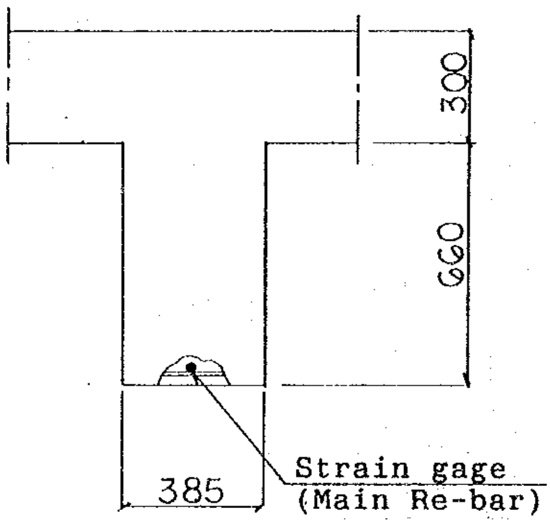
- Number of strain gages ; 2 gages per beam
- Location of strain gages ; Upper & lower flange of the beam at center span



- Static and dynamic strains will be measured at the same location.

(2) Beam of RCB

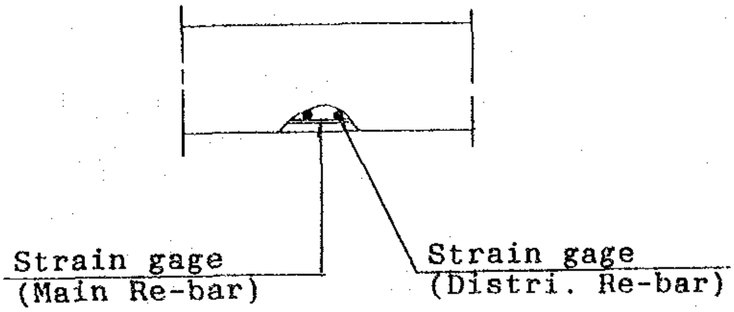
- Number of strain gages ; 1 gage per beam
- Location of strain gages ; Main re-bar exposed in the beam at center span



Appcnd-L

(3) R.C.Deck Slab (SBC & RCB)

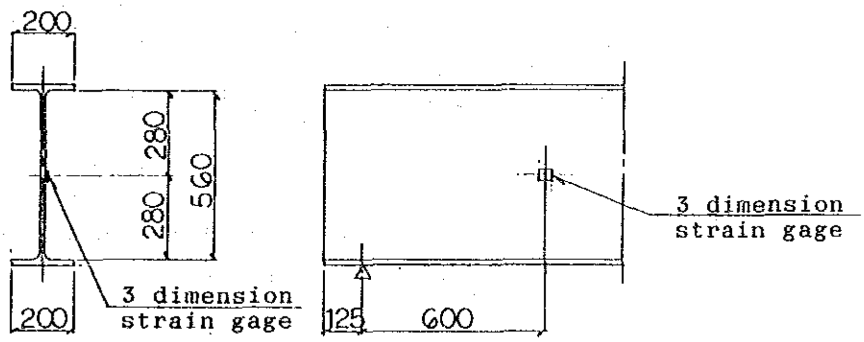
- Number of strain gages ; 2 gages per a point of SBC
  ; 2 gages per a point of RCB
- Location of strain gages ; One for main rebar and other one for distribution rebar

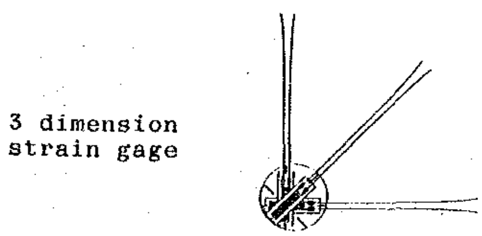


- Both static and dynamic strains will be measured in the deck slab of SBC, but in case of RCB, static strain only will be measured in its deck slab.

(4) 3 dimension strain gage on beam for measuring shear force (SBC only)

- Number of strain gages ; 1 gage per beam
- Location of strain gages ; Web of the beam at nearby bearing point

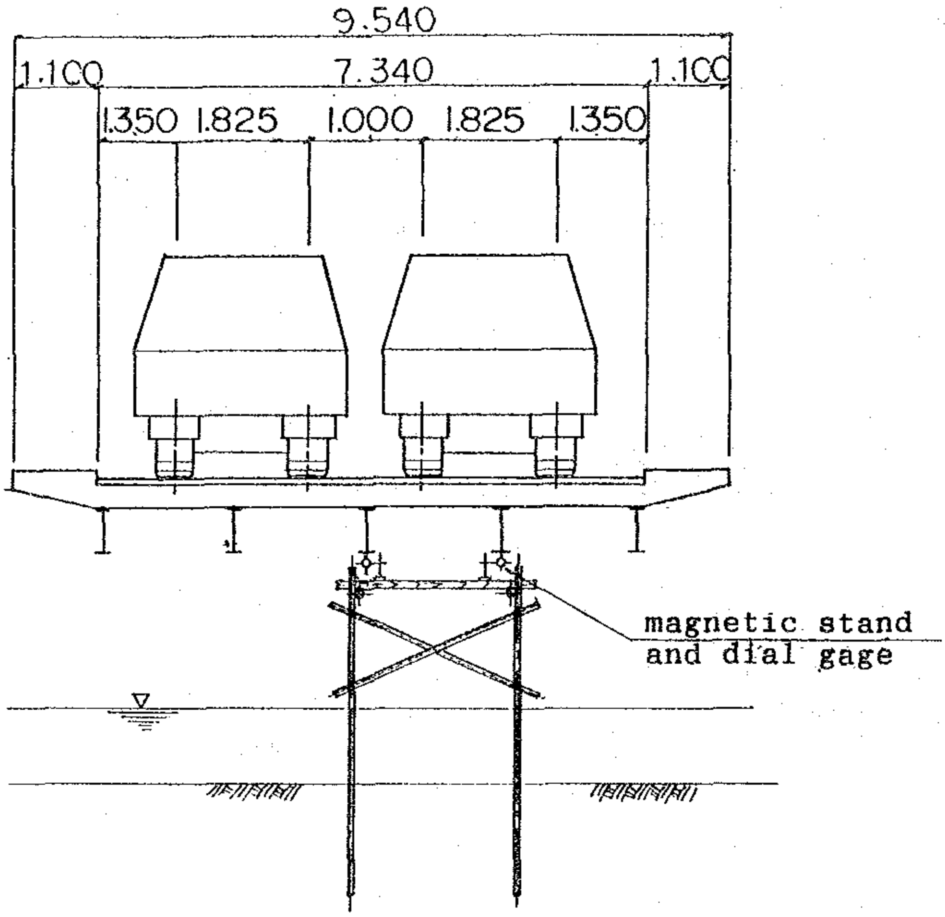




3) Measurement Point of Displacement

(1) Beam (SBC & RCB)

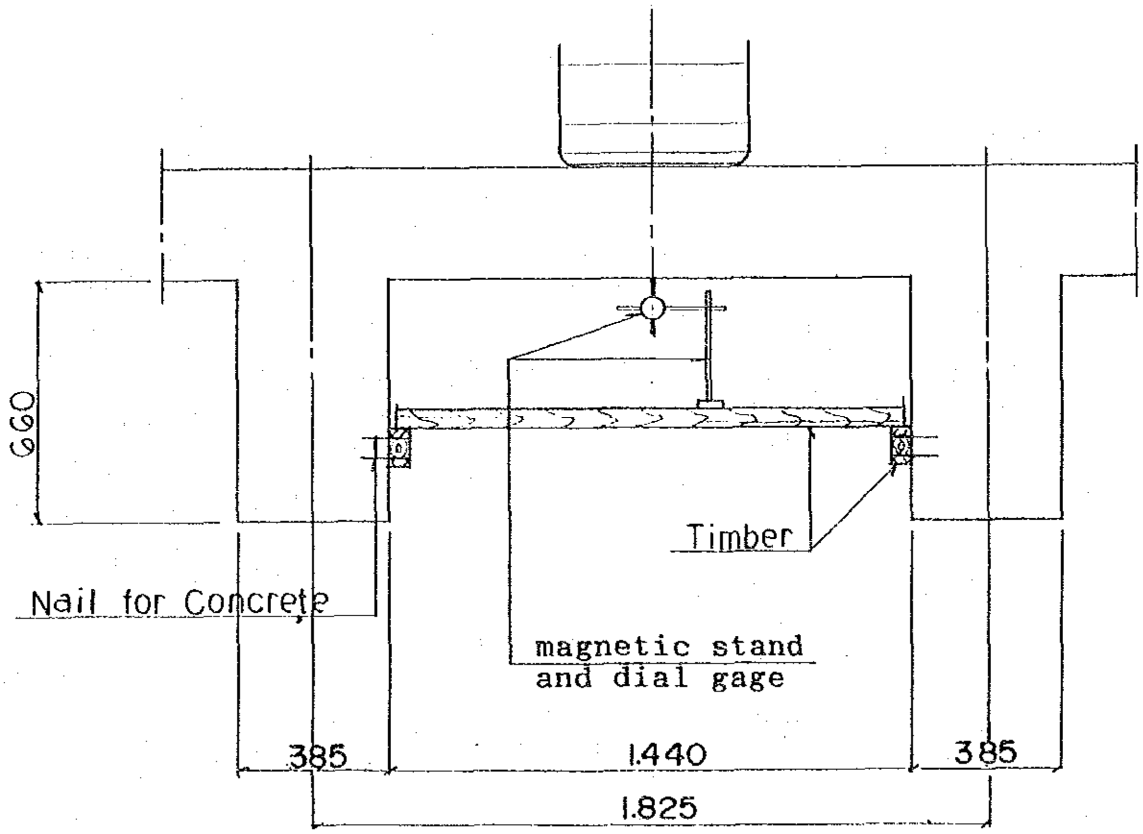
- Number of dial gages ; 1 gage per beam
- Location of dial gages ; At the center of the span



Outline of Displacement Measurement For Beam

(2) R.C. deck slab (SBC & RCB)

- Number of dial gages ; 1 gage per deck slab
- Location of dial gages ; At the center of deck span

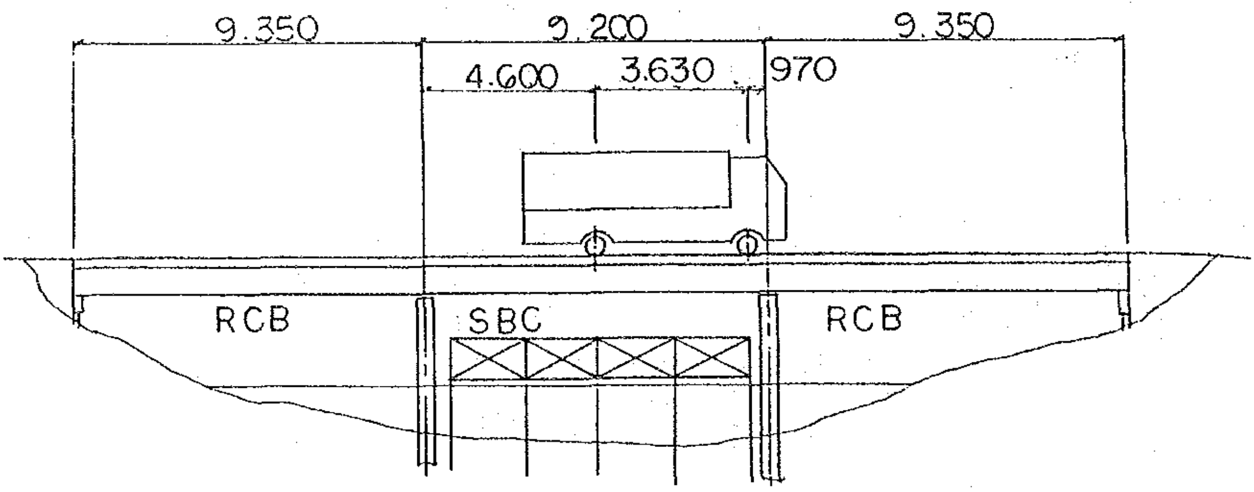


Outline of Displacement Measurement For Deck Slab

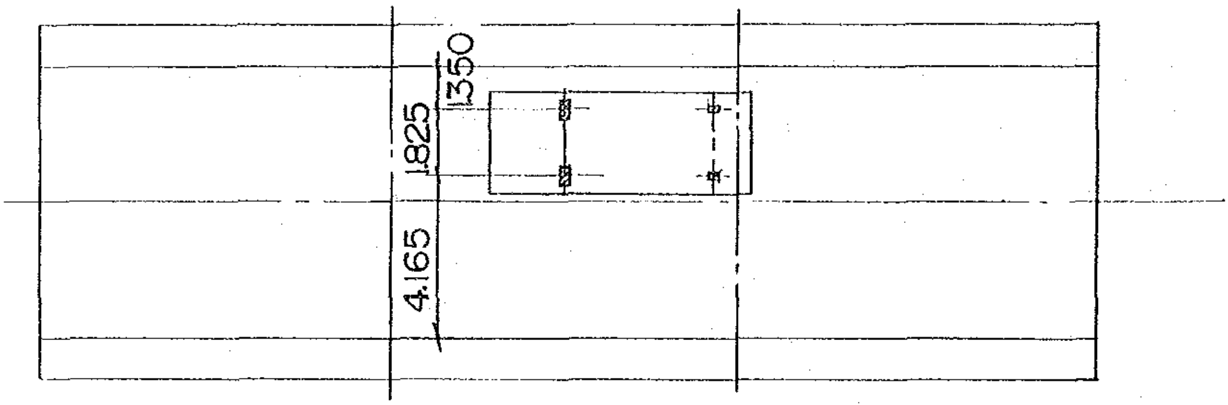
3. **Loading Arrangement**

1) For Beam

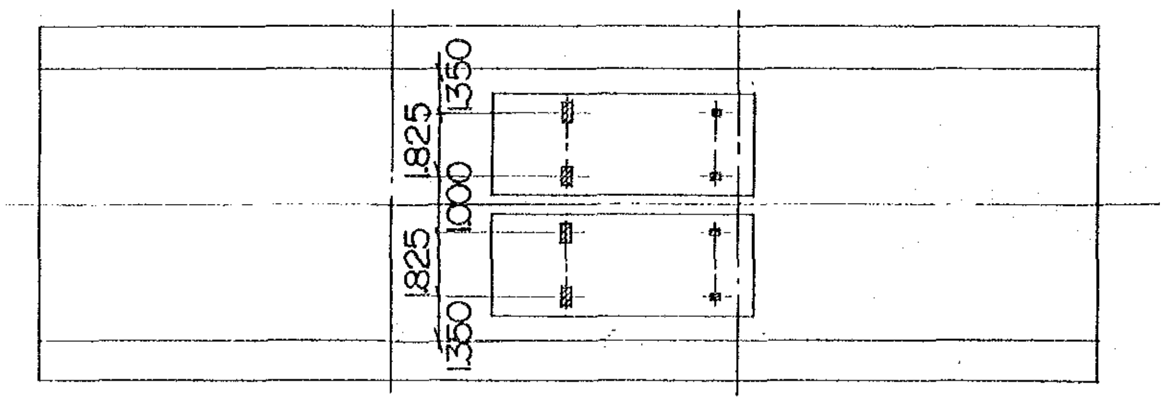
(1) SBC



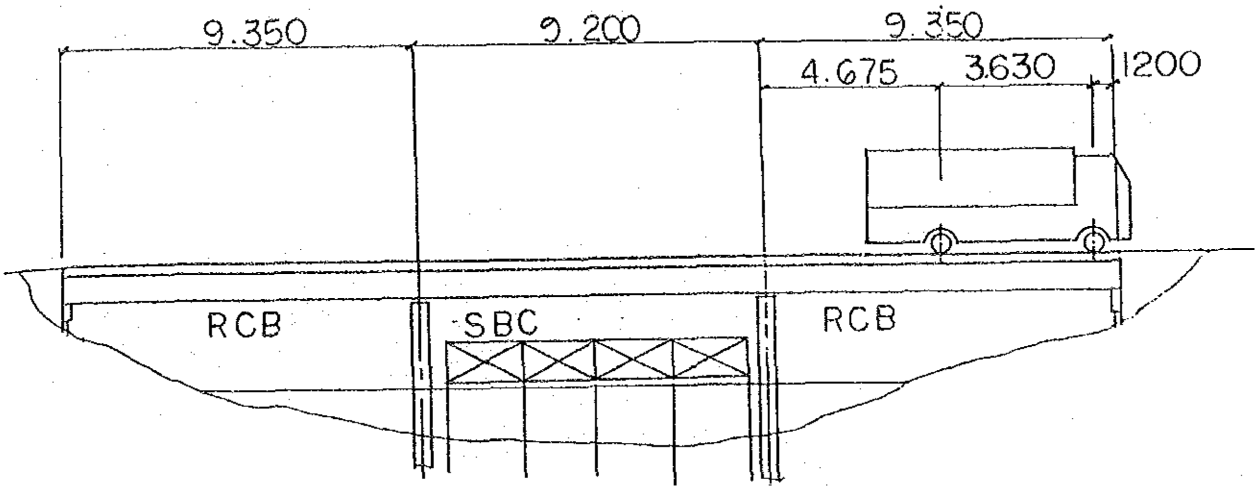
- Loading Case-1



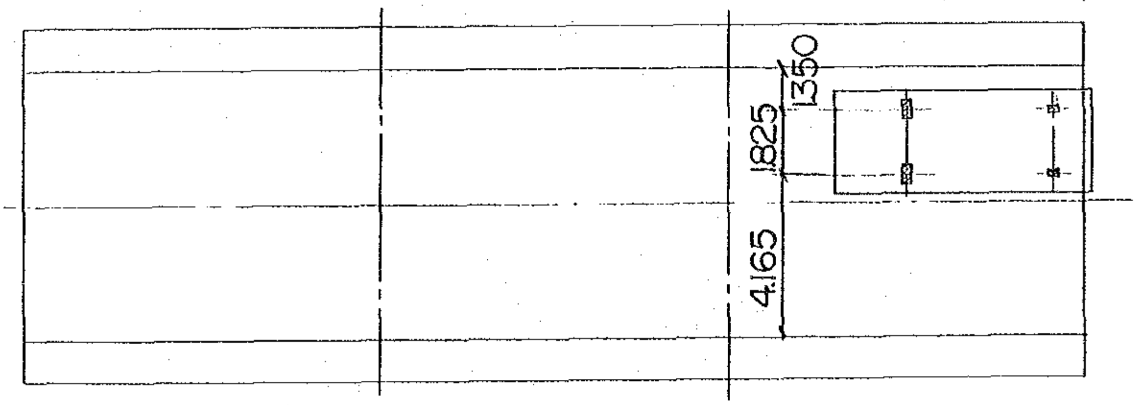
- Loading case-2



(2) RCB



- Loading Case-1



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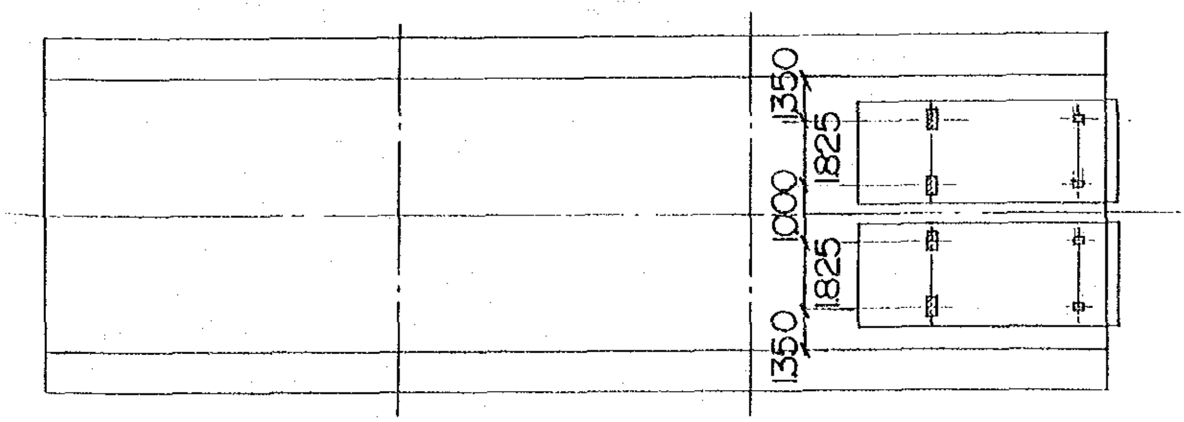
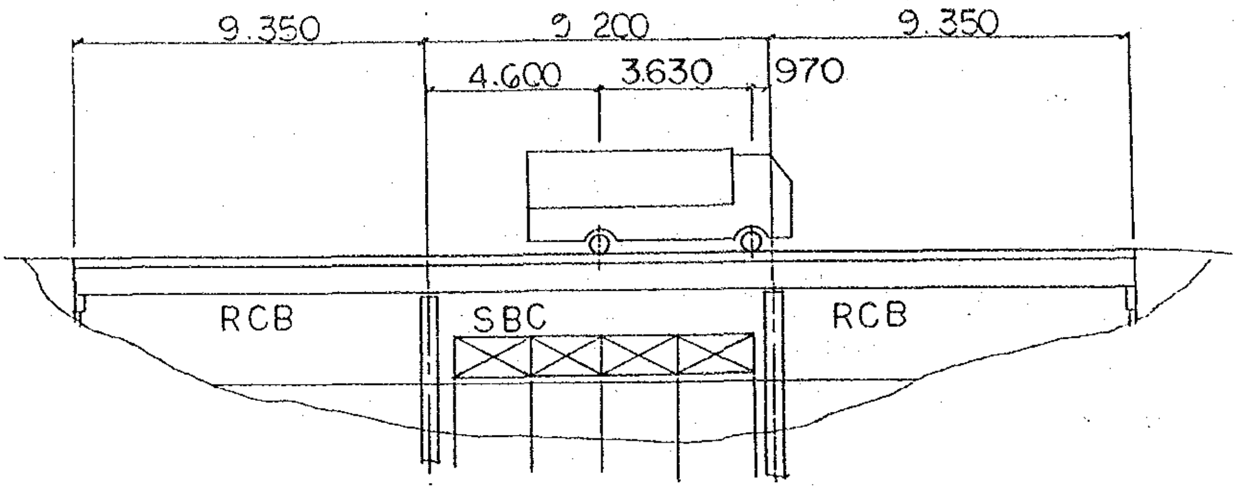
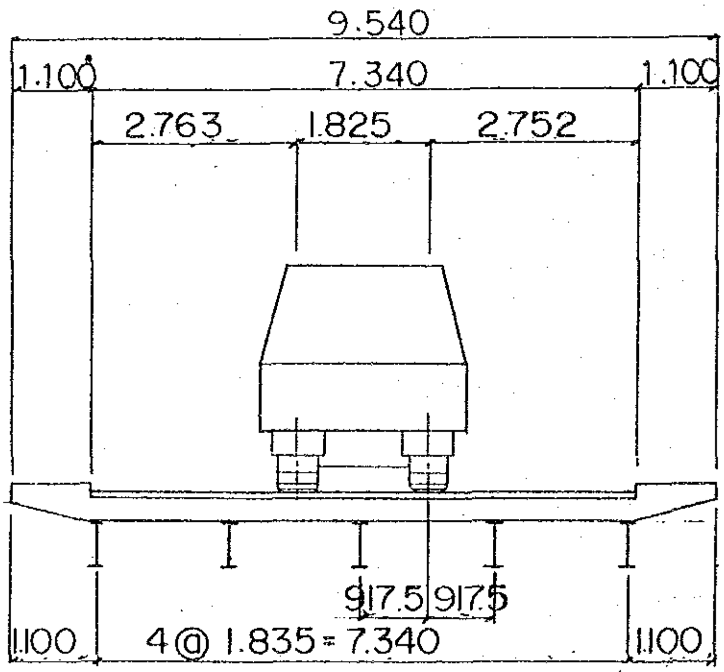


2) For R.C deck slab

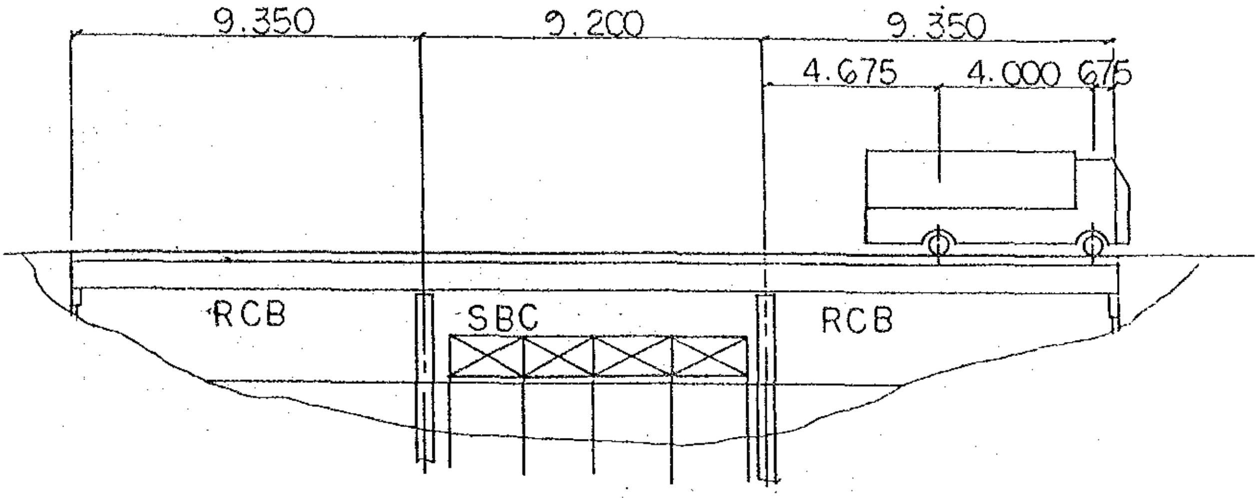
(1) SBC

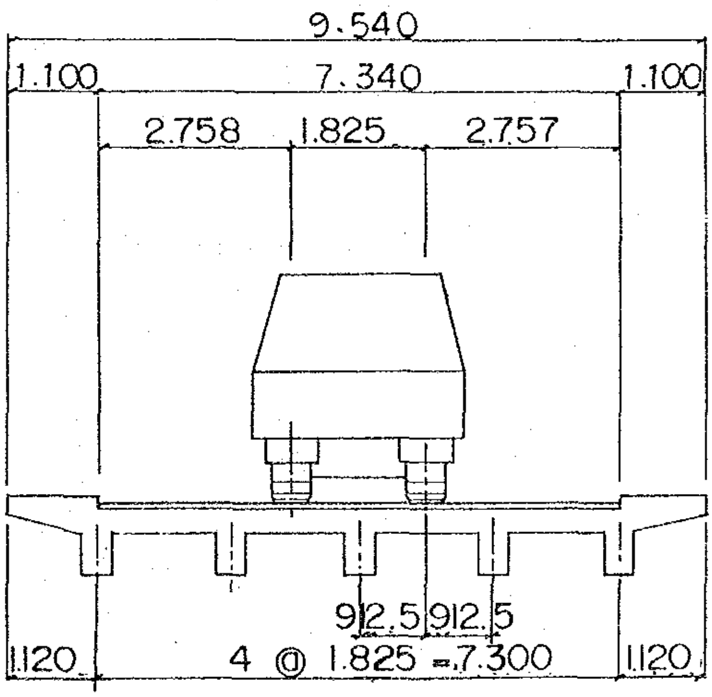




Append-L

(2) RCB

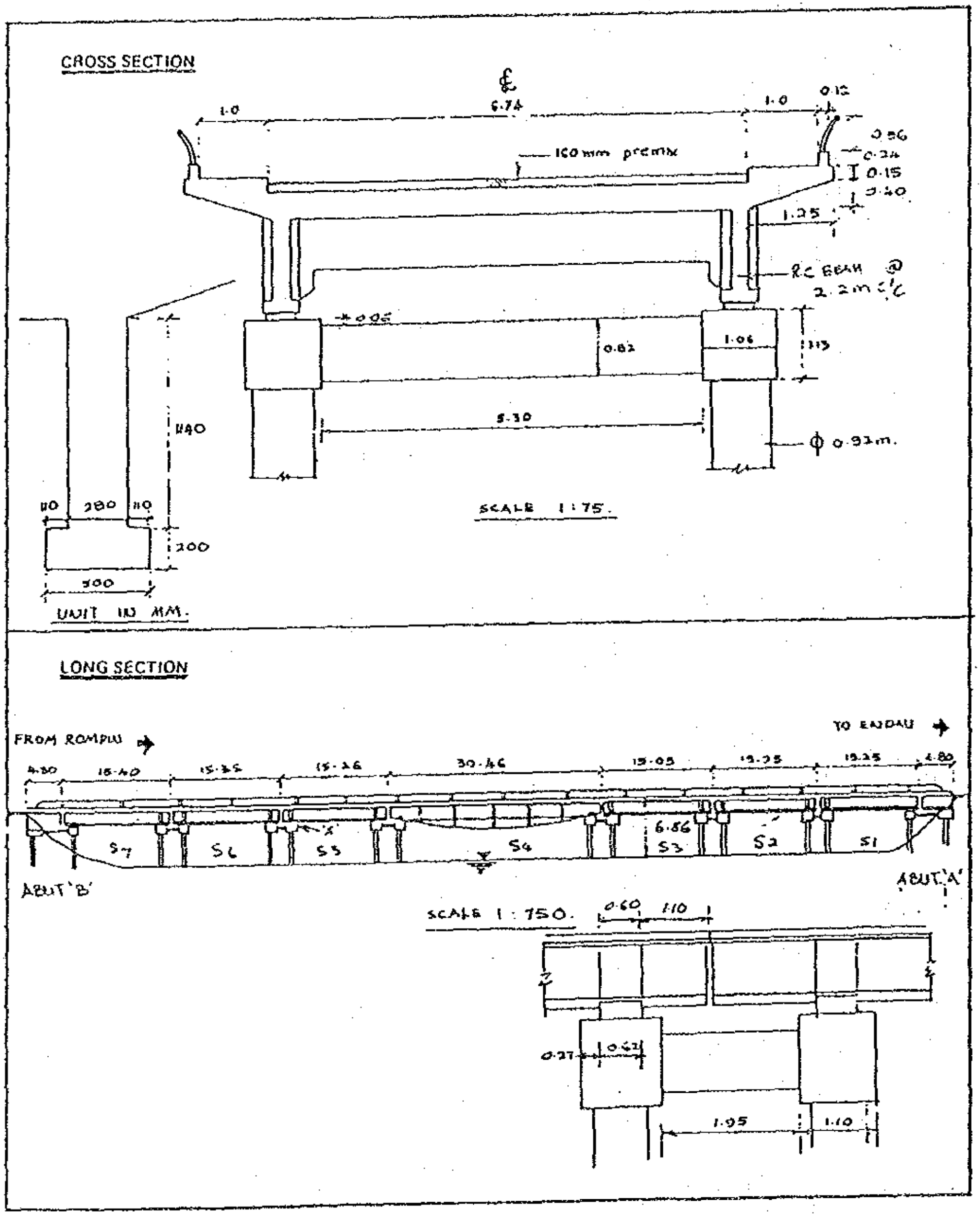




Append-L

<Bridge No. 00319110>

1. General View

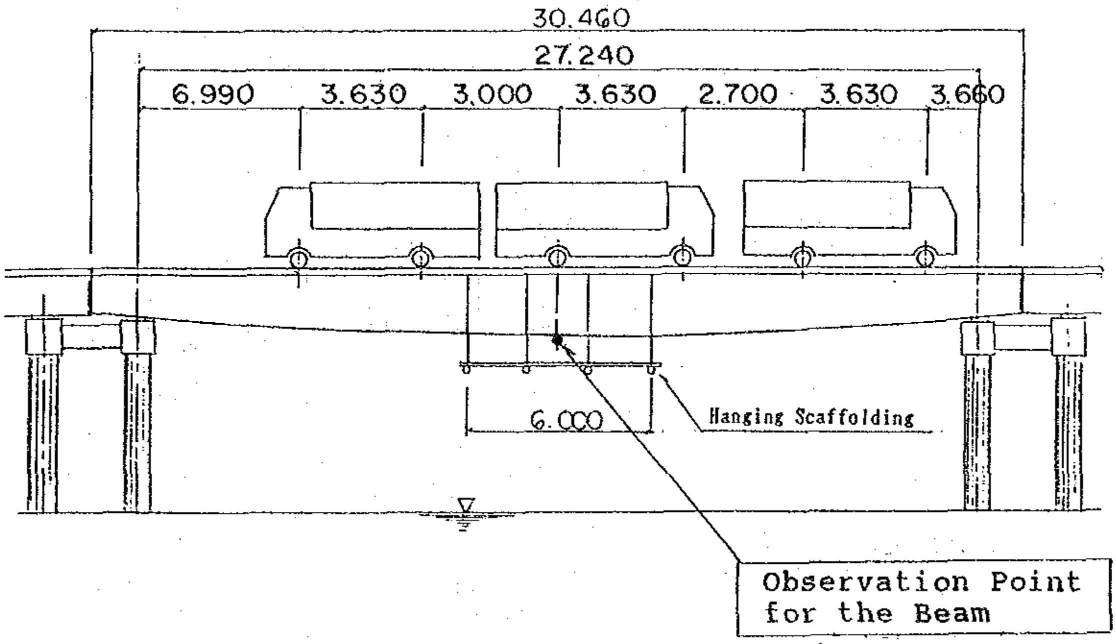


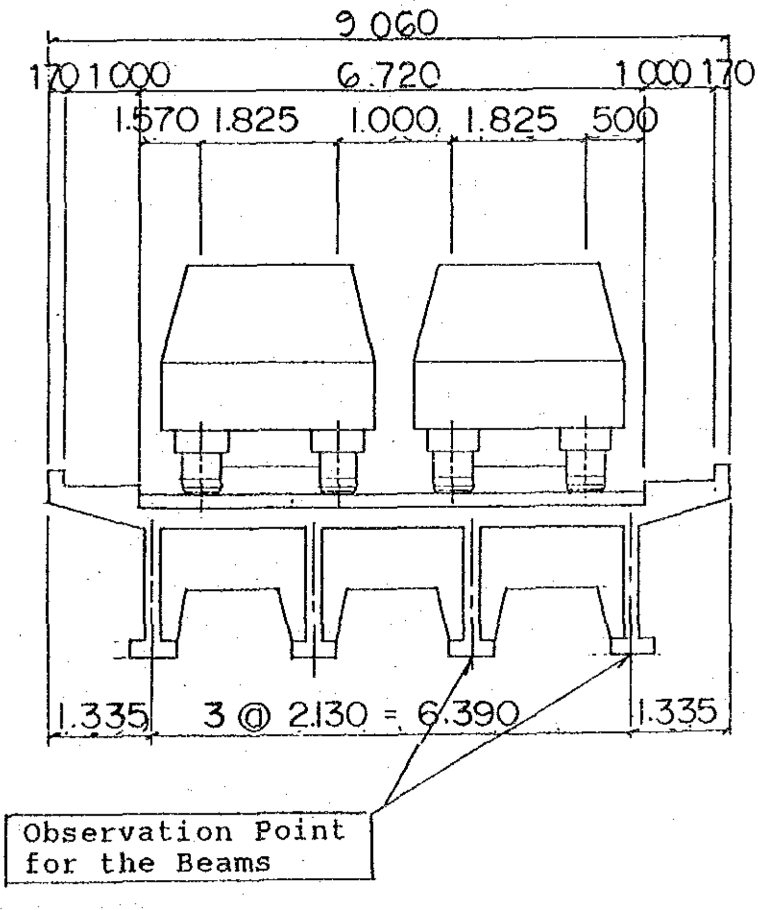
Append-L

2. Measurement of Strain and Displacement

1) Observation Point of strain and displacement

(1) PCB L=30.46 m (Prestressed Concrete Beam)





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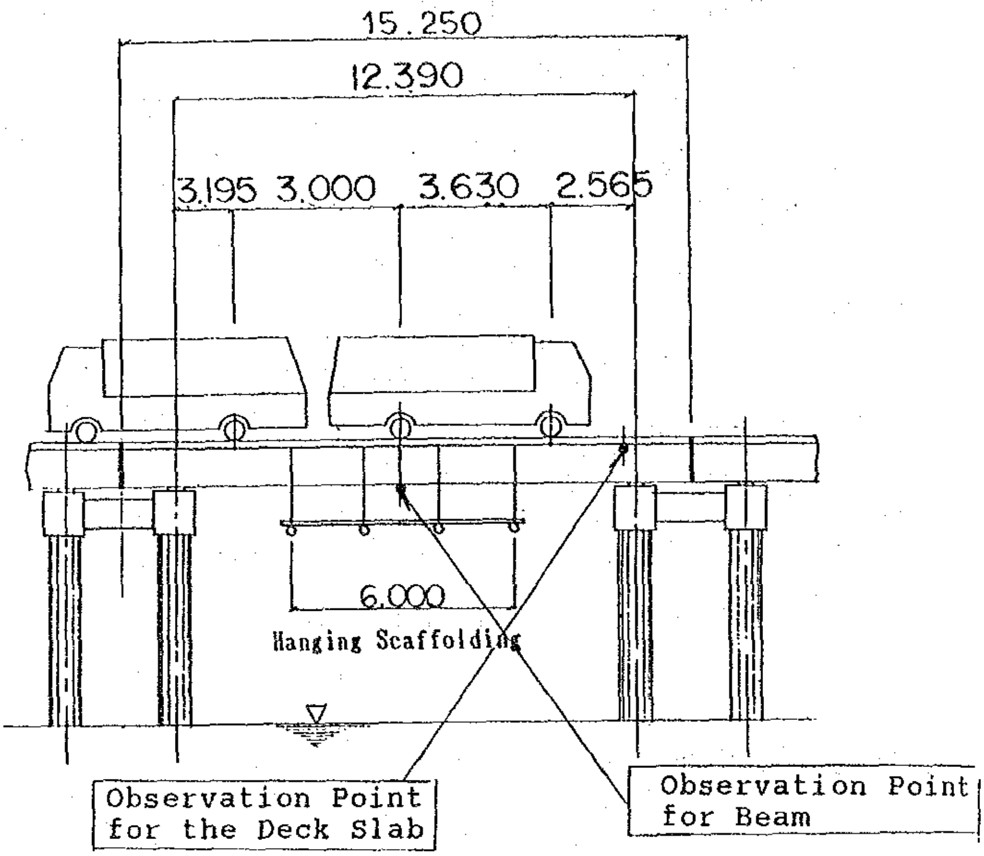
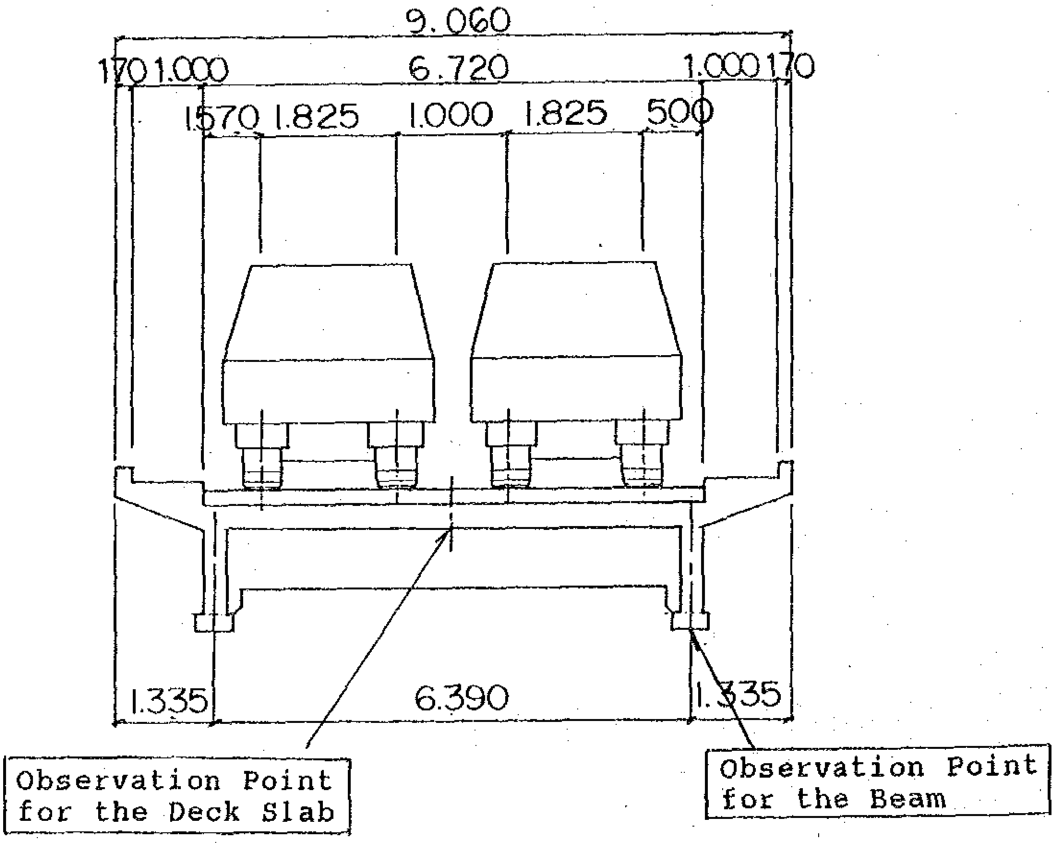
(2) PCB L=15.25 m (Prestressed Concrete Beam)

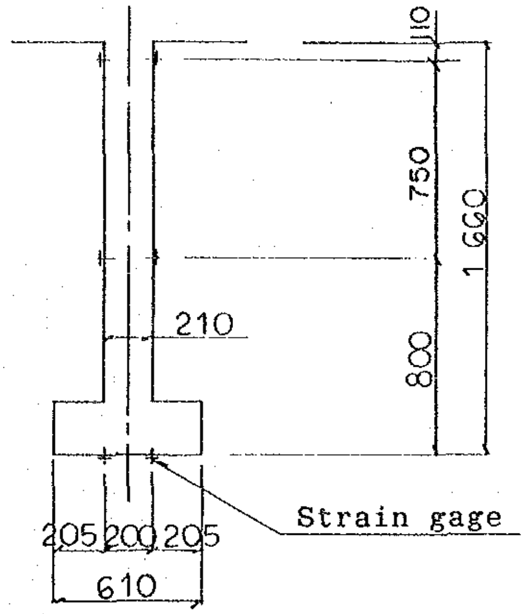




2) The Measurement Point of Strain

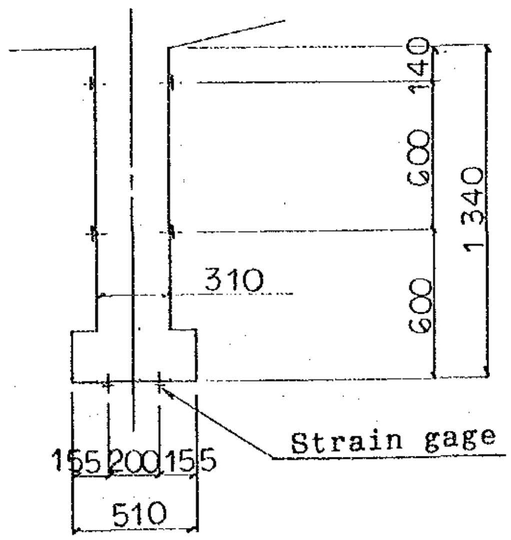
(1) Beam of PCB (L=30.46 m)

- Number of strain gages ; 6 gages per beam
- Location of strain gages ; As shown on the drawing



(2) Beam of PCB (L=15.25 m)

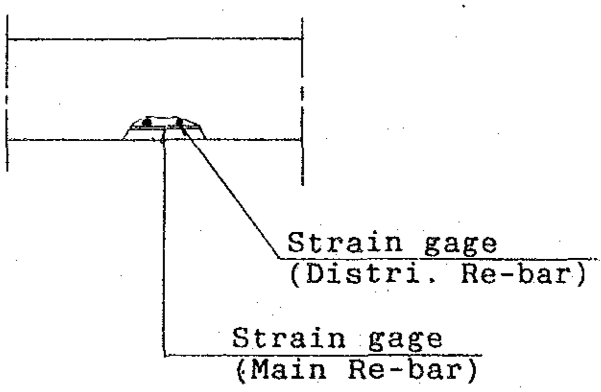
- Number of strain gages ; 6 gages per beam
- Location of strain gages ; As shown on the drawing



Append-L

(3) R.C deck slab of PCB (L=15.25 m only)

- Number of strain gages ; 2 gage per deck slab
- Location of strain gages ; One for main reber and other one for distribution reber

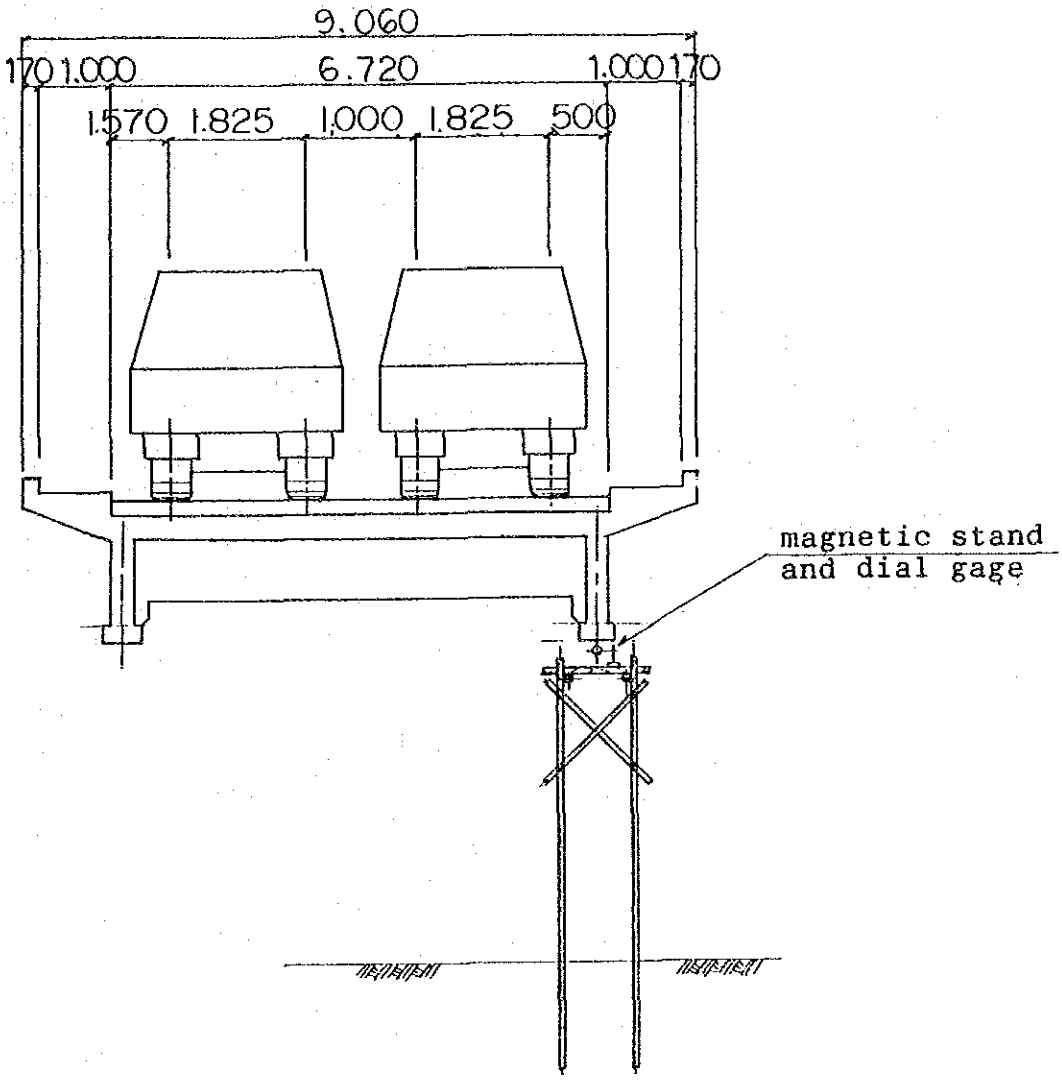


Append-L

3) **Measurement Point of Displacement**

(1) PCB (L=30.46 m)

- Number of dial gages ; 1 gage per beam
- Location of dial gages ; At the center of the span

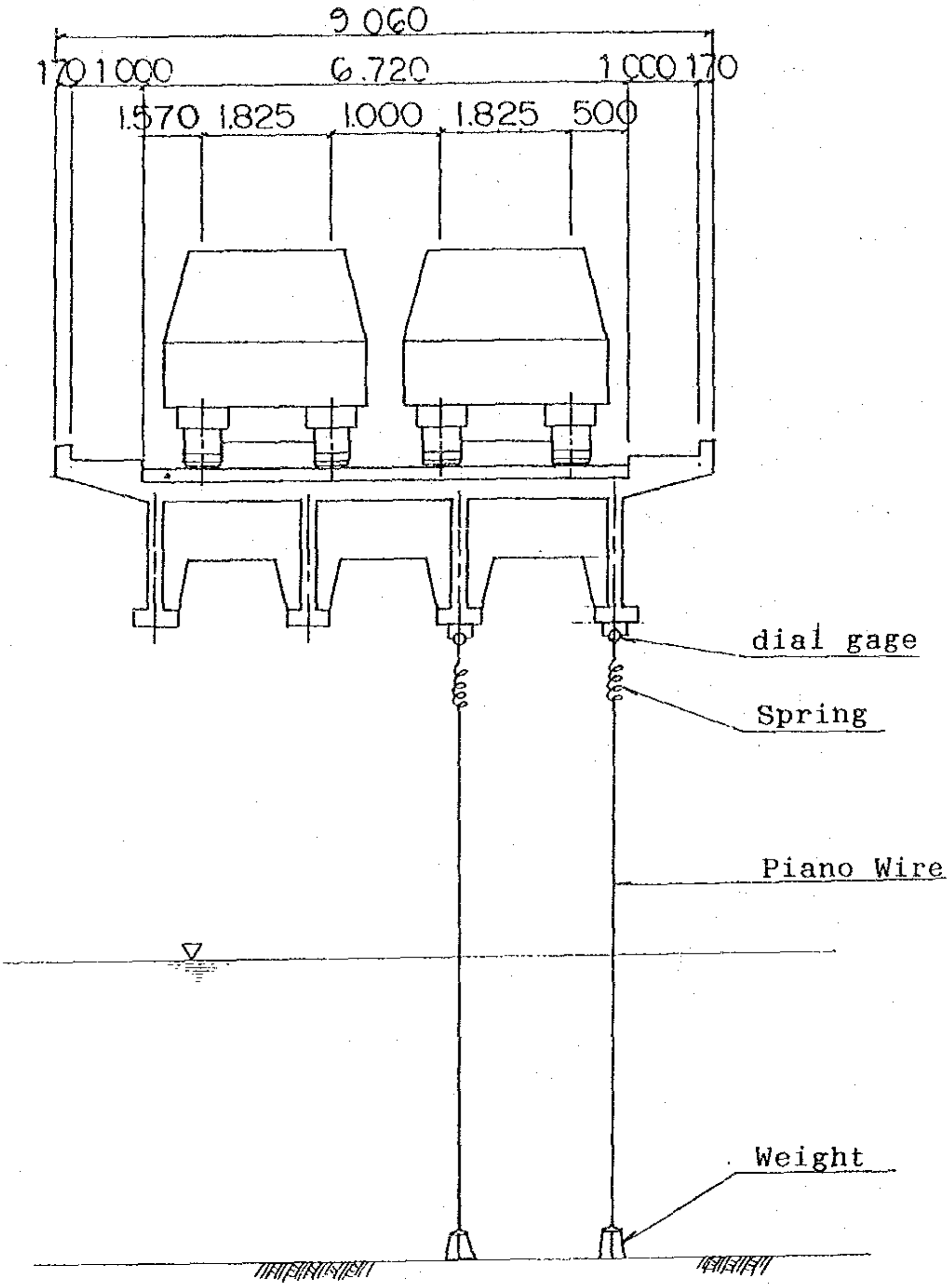


Outline of Displacement Measurement For Beam

Append-L

(2) PCB (L=15.25 m)

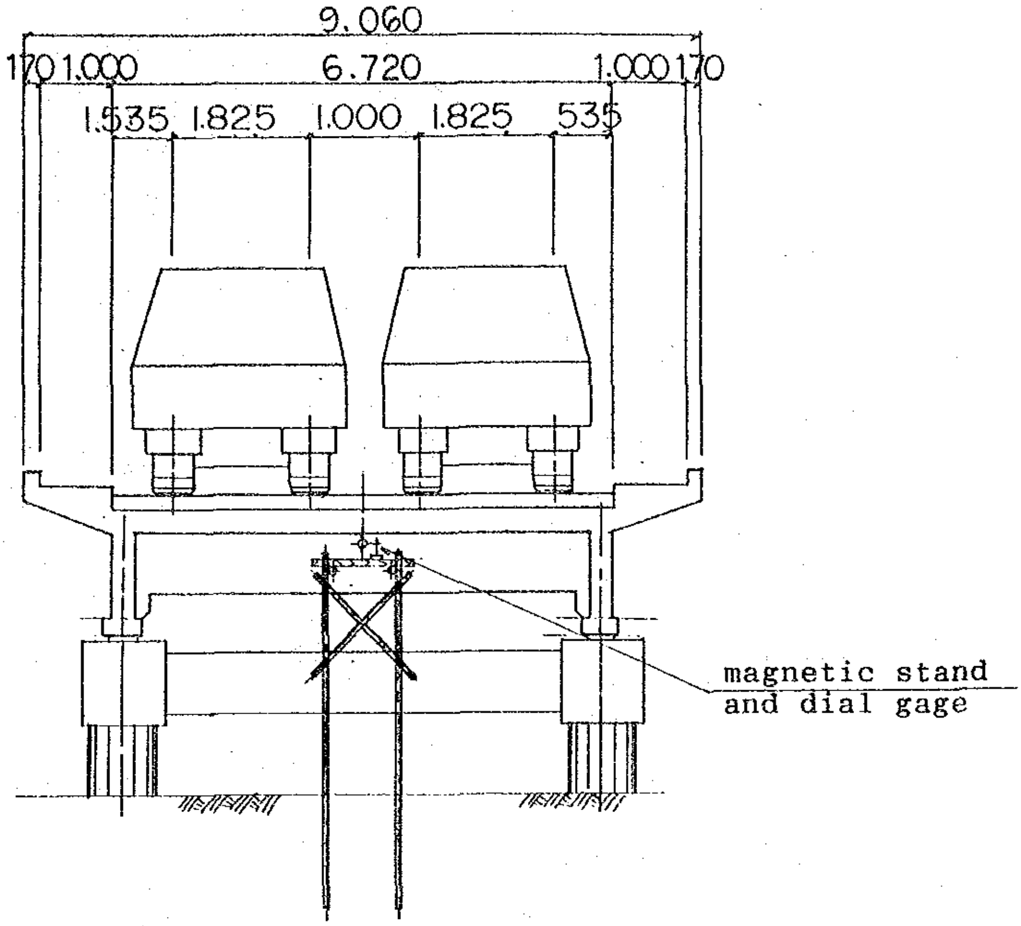
- Number of dial gages ; 1 gage per beam
- Location of dial gages ; At the center of the span



Outline of Displacement Measurement For Beam

(3) R.C. deck slab (PCB L=15.25 m only)

- Number of dial gages ; 1 gage per deck slab
- Location of dial gages ; At the center of deck span

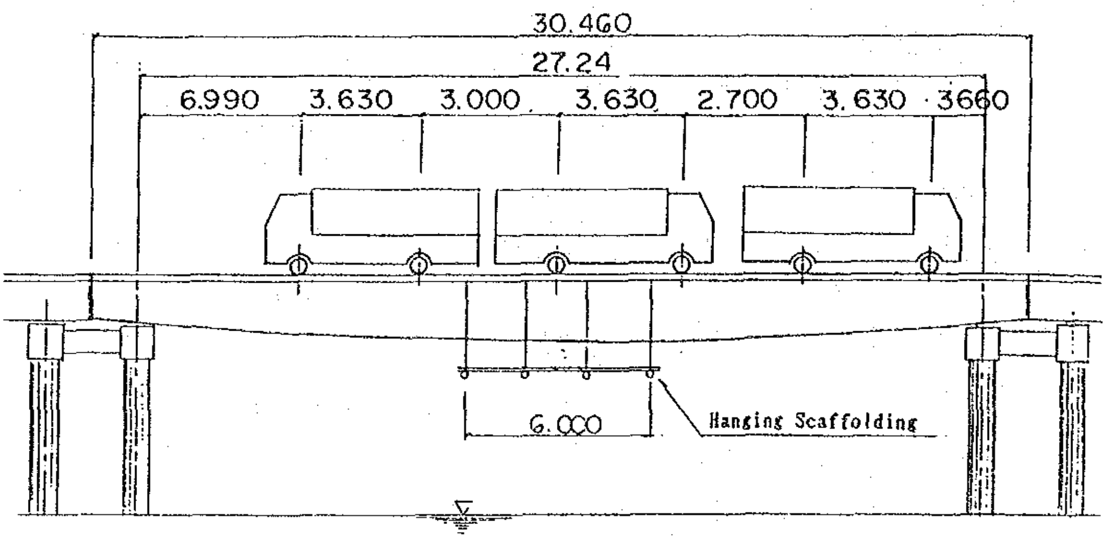


Outline of Displacement Mesurement For R.C Deck Slab

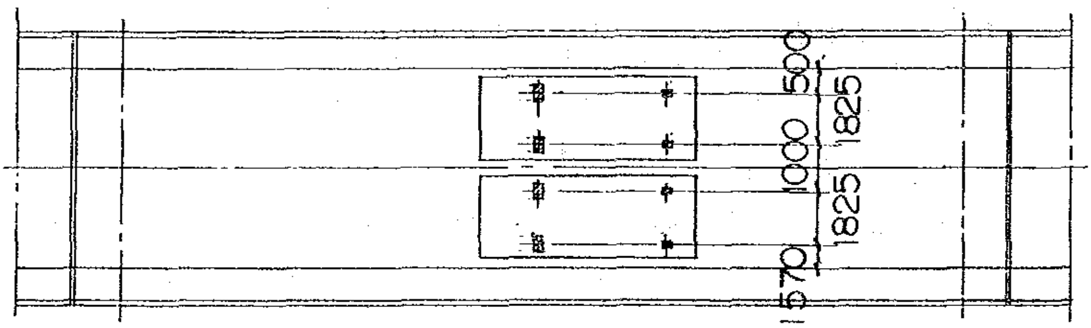
3. Loading Arrangement

1) For beam

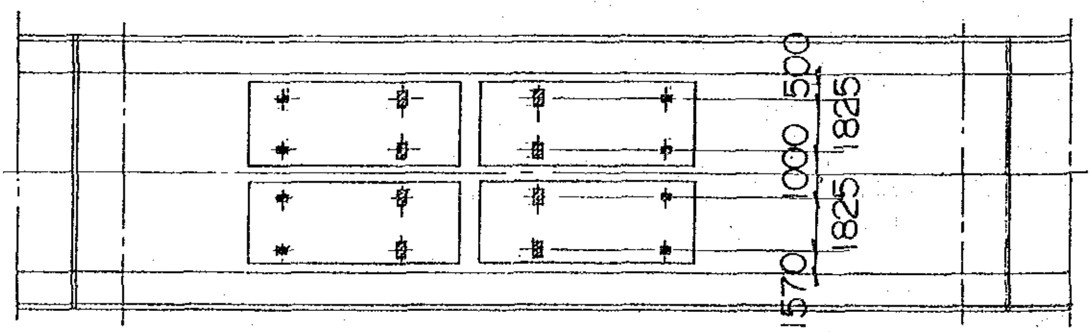
(1) PCB (L=30.46 m)



- Loading Case-1

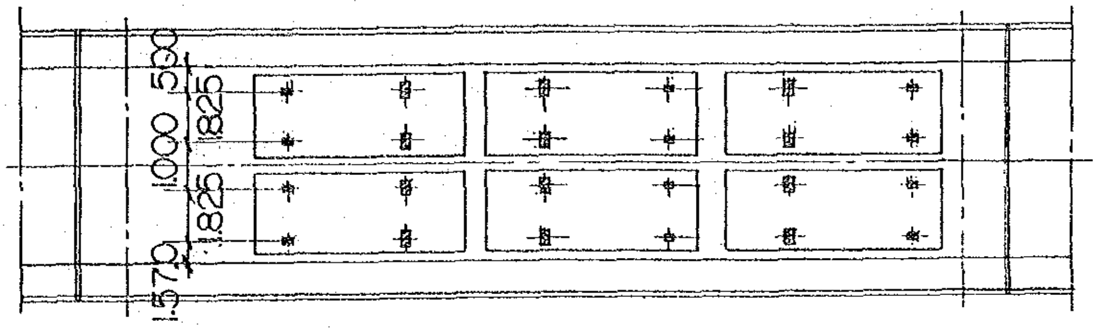


- Loading Case-2



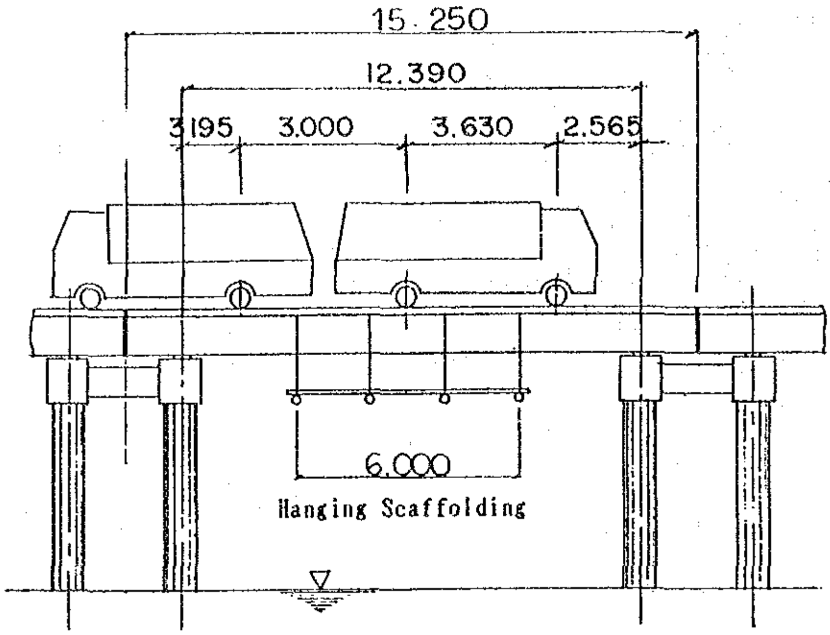
Append-L

- Loading Case-3

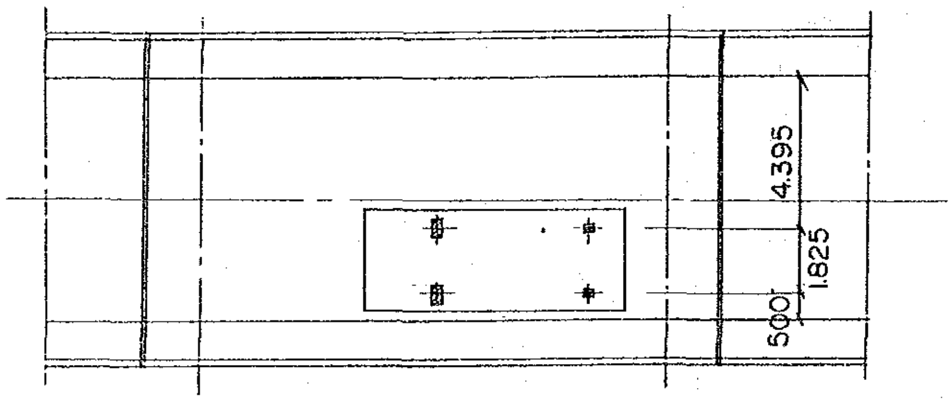


Append-L

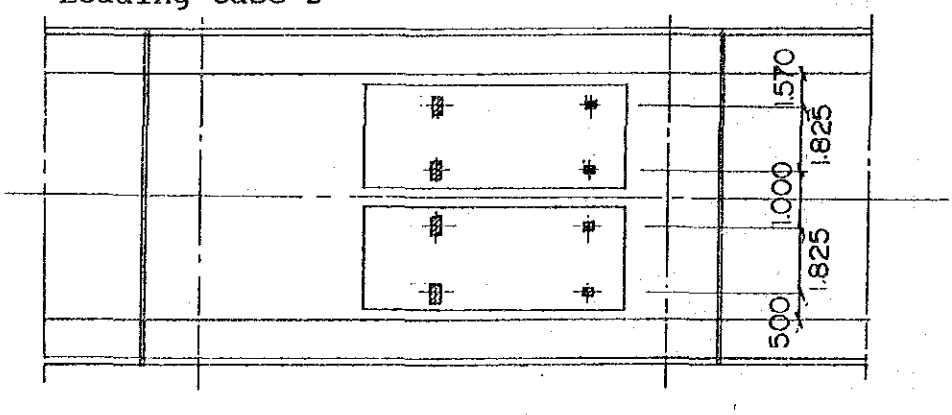
(2) PCB (L=15.25 m)



- Loading Case-1

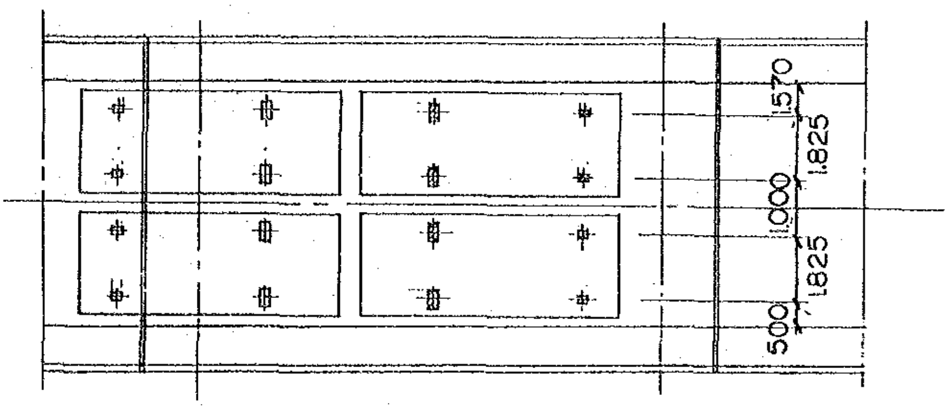


- Loading Case-2



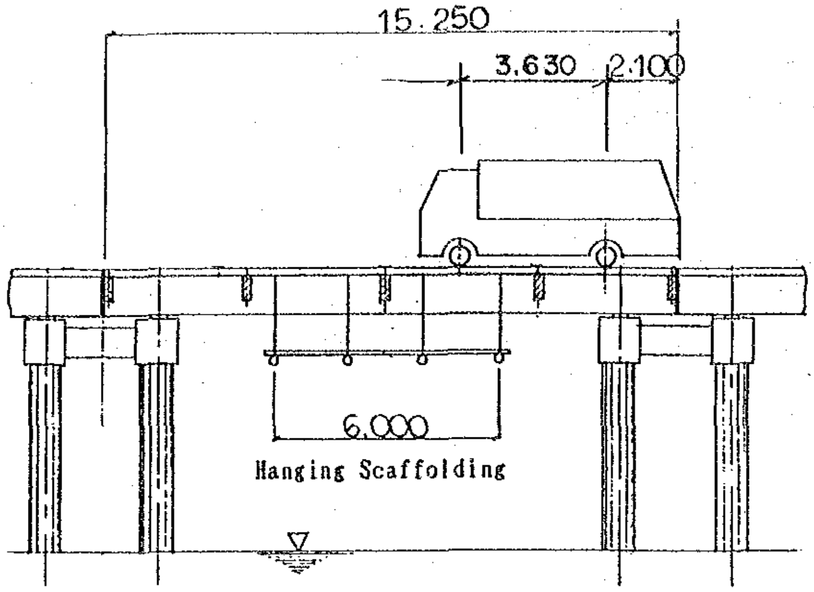
Append-L

- Loading Case-3

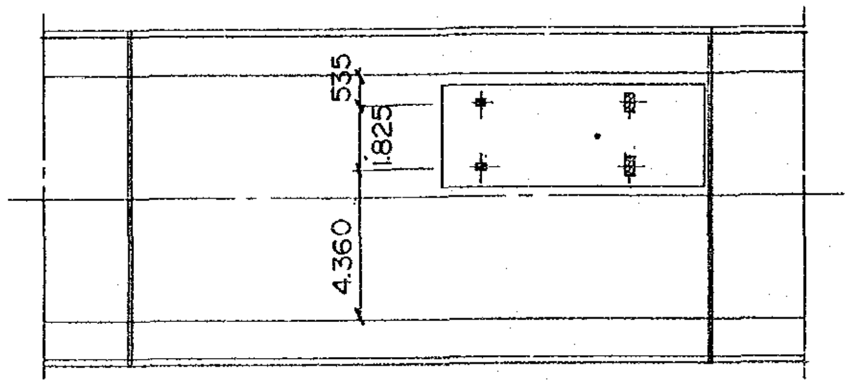


Append-L

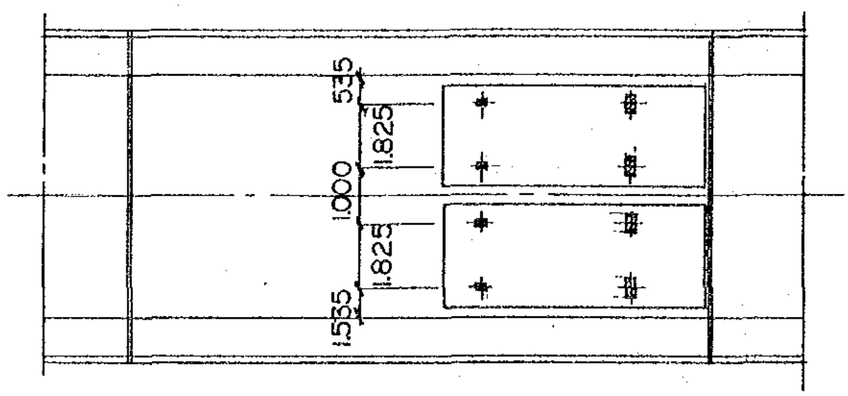
2) For deck slab (PCB L=15.25 m only)



- Loading Case-1



- Loading Case-2

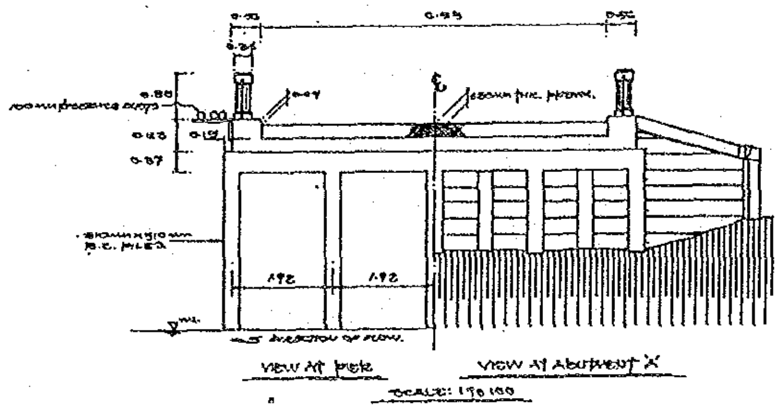


Append-L

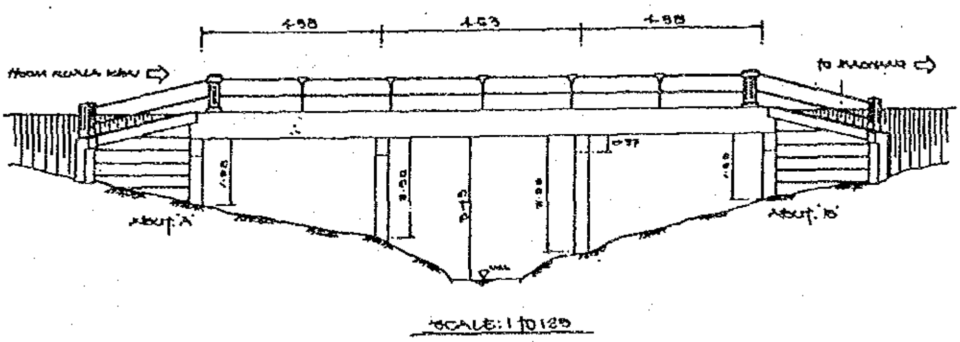
<Bridge No. 00834850>

1. General View

CROSS SECTION



LONG SECTION

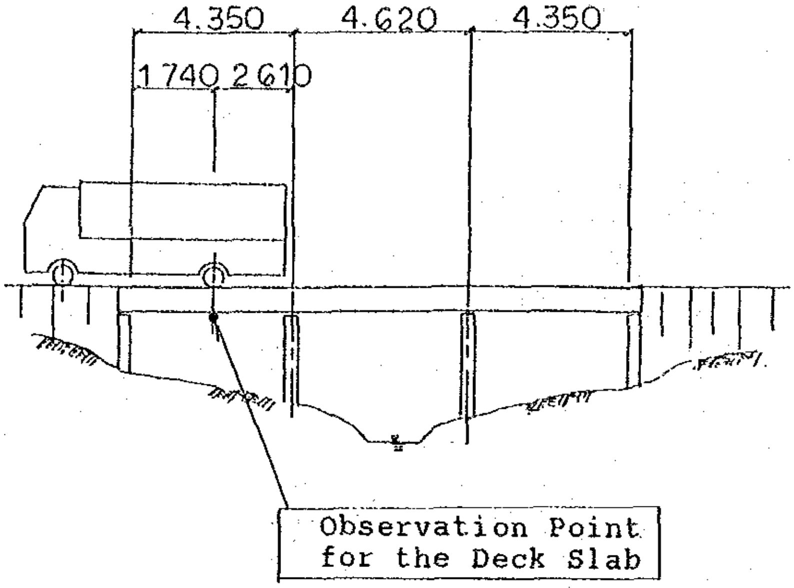


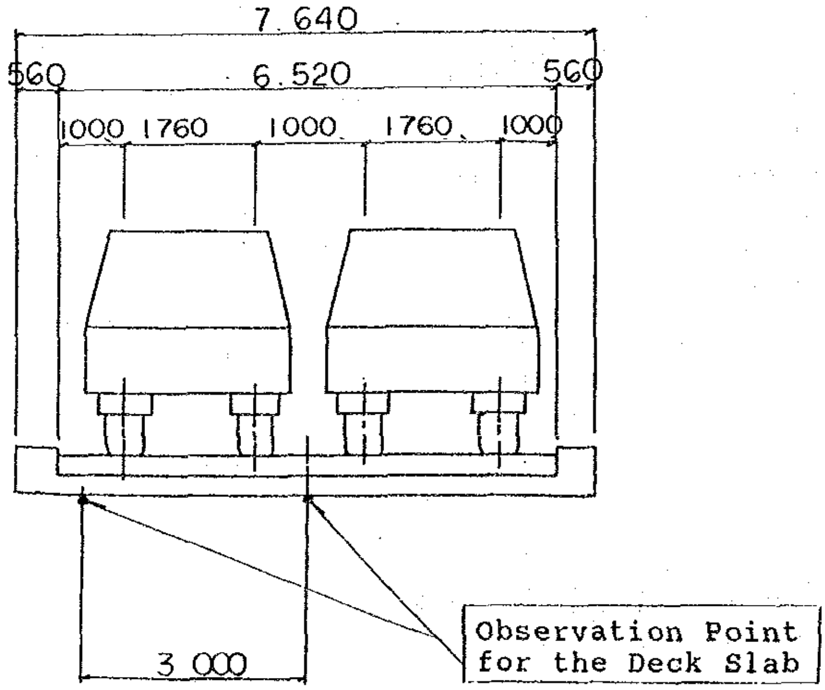
Append-L

2. Measurement of Strain and Displacement

1) Observation point of strain and displacement

(1) RCS (Reinforced Concrete Slab)



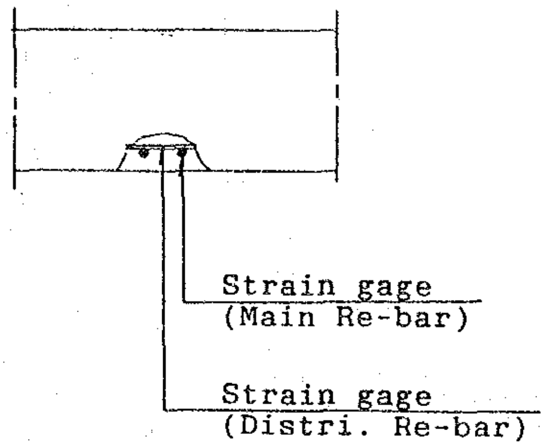


Append-1.

2) Measurement Point of Strain

(1) RCS

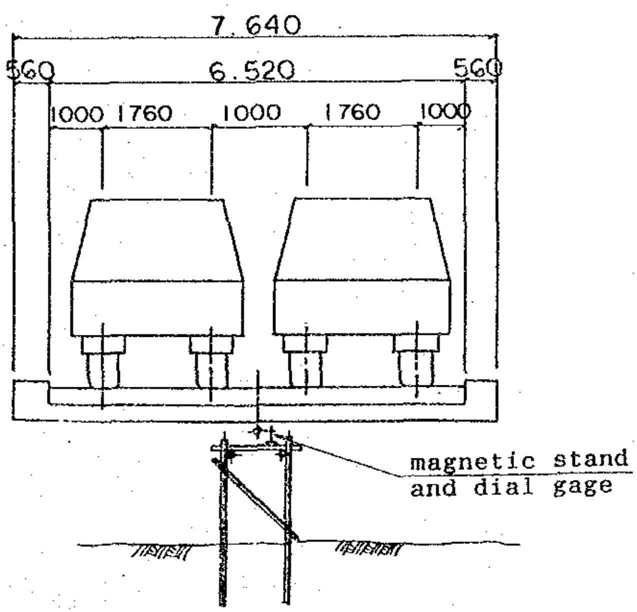
- Number of strain gages ; 2 gages per a observation point
- Location of strain gages ; At the center of the span



3) Measurement Point of Displacement

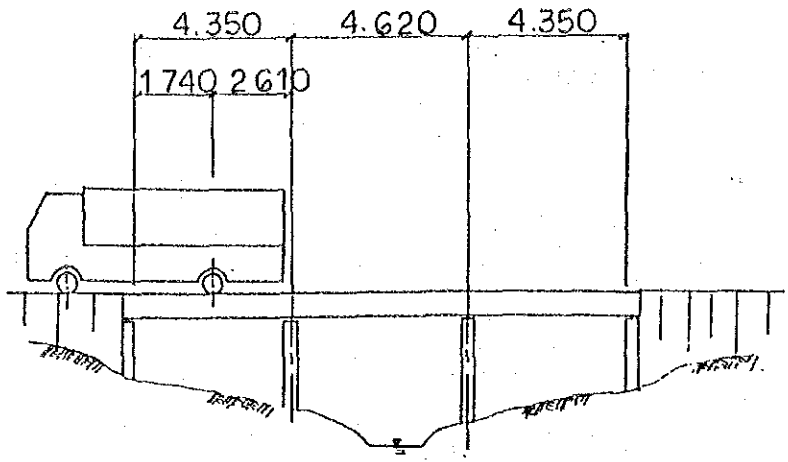
(1) RCS

- Number of dial gages ; 1 gage per a observation point
- Location of dial gages ; At the center of the span

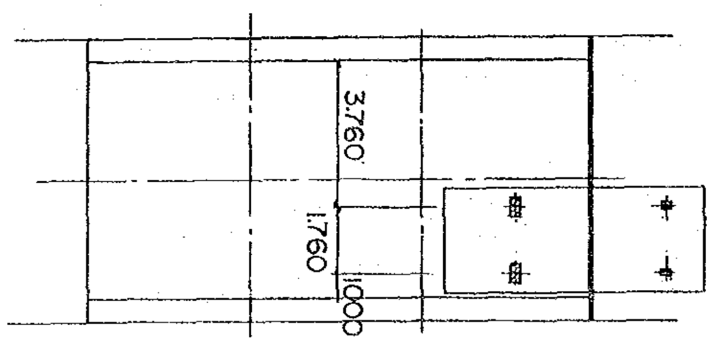


Outline of Displacement Measurement

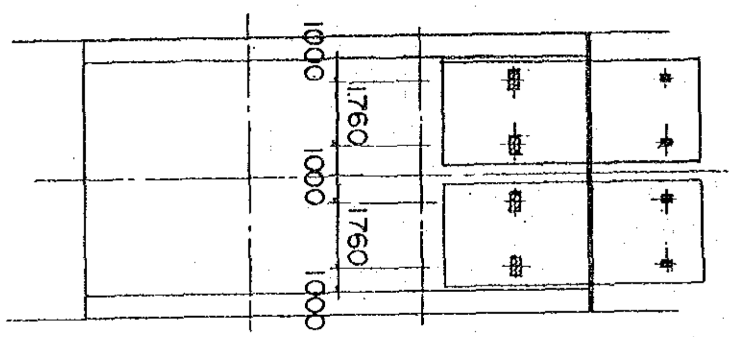
3) **Loading Arrangement**



- Loading Case-1



- Loading Case-2



Append-L

APPENDIX – M

LOADING TEST RESULTS

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APPENDIX – M1

TRAFFIC
DATA DURING DYNAMIC LOADING TEST

RESULTS OF TRAFFIC COUNTING SURVEY FOR DYNAMIC TEST AT BRIDGE NO. 00237200

Direction : Kuantan To Kemaman

Date : 19 November 1991

Time	Car/Taxi Van/Pickup	Medium Lorry (2 Axles)	Heavy Lorry (3 Axles)	Bus
16:00 – 16:10	–	–	–	–
16:10 – 16:20	38	0	1	1
16:20 – 16:30	30	0	1	1
16:30 – 16:40	52	1	3	0
16:40 – 16:50	45	2	1	1
16:50 – 17:00	46	0	2	1
17:00 – 17:10	30	0	3	0
17:10 – 17:20	44	0	2	0
17:20 – 17:30	34	0	2	0
17:30 – 17:40	41	1	4	1
17:40 – 17:50	35	0	0	2
17:50 – 18:00	50	1	0	1
18:00 – 18:10	47	0	1	2
18:10 – 18:20	44	0	2	0
18:20 – 18:30	35	1	4	0
18:30 – 18:40	39	0	1	0
18:40 – 18:50	27	0	0	1
18:50 – 19:00	35	1	2	3
Total	672	7	28	14

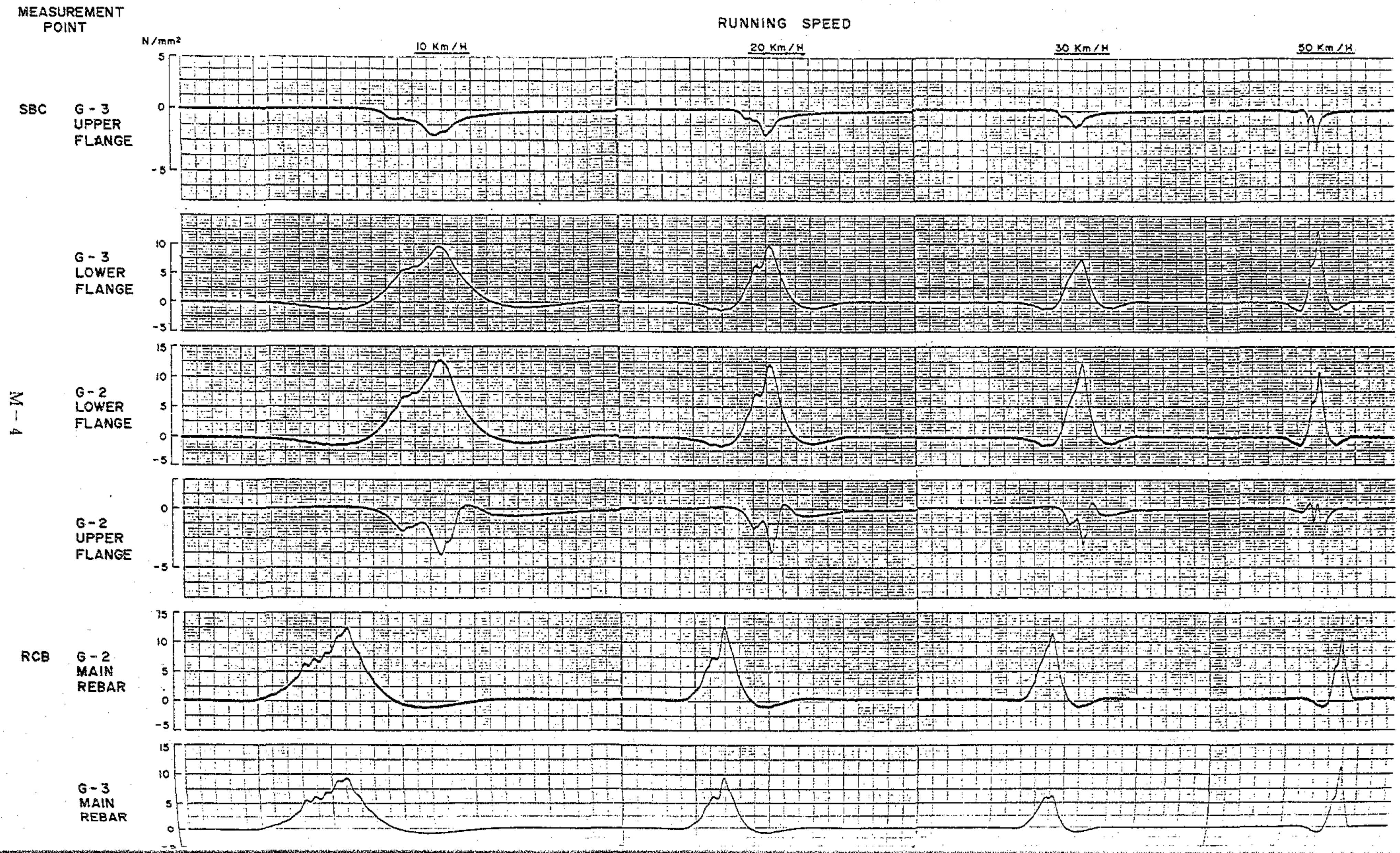
Direction : Kemaman To Kuantan

Time	Car/Taxi Van/Pickup	Medium Lorry (2 Axles)	Heavy Lorry (3 Axles)	Bus
16:00 – 16:10	–	–	–	–
16:10 – 16:20	23	3	3	1
16:20 – 16:30	35	2	1	2
16:30 – 16:40	55	3	1	1
16:40 – 16:50	40	2	0	1
16:50 – 17:00	40	4	1	2
17:00 – 17:10	46	9	4	1
17:10 – 17:20	52	4	2	0
17:20 – 17:30	74	8	2	2
17:30 – 17:40	69	10	2	3
17:40 – 17:50	59	5	4	2
17:50 – 18:00	35	10	2	0
18:00 – 18:10	53	10	4	2
18:10 – 18:20	54	3	2	0
18:20 – 18:30	54	3	1	1
18:30 – 18:40	67	10	0	0
18:40 – 18:50	75	7	1	0
18:50 – 19:00	60	6	1	1
Total	891	99	31	19

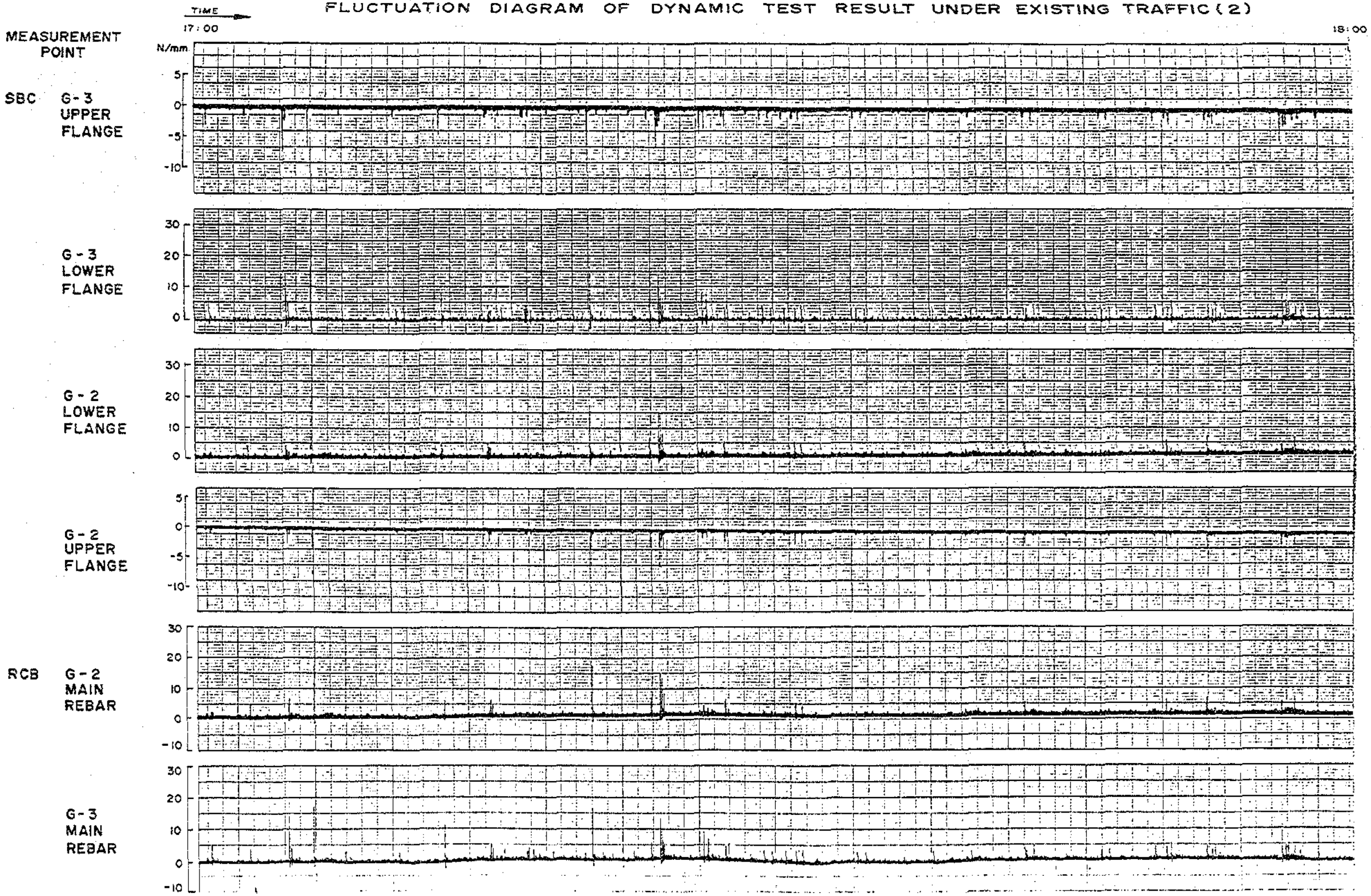
APPENDIX – M2

FLUCTUATION DIAGRAMS OF DYNAMIC LOADING TEST

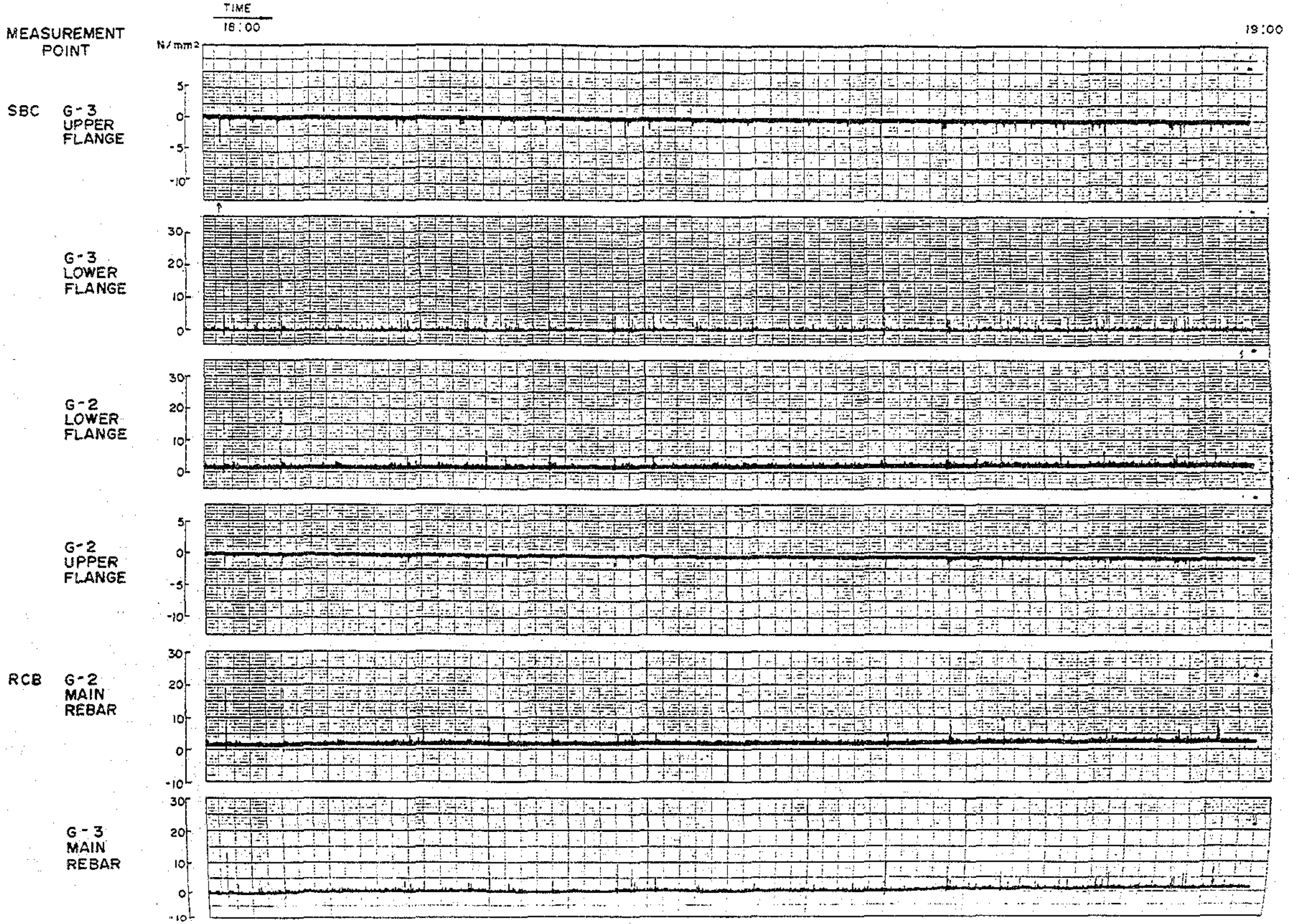
FLUCTUATION DIAGRAM OF DYNAMIC TEST RESULT UNDER KNOWN LOAD



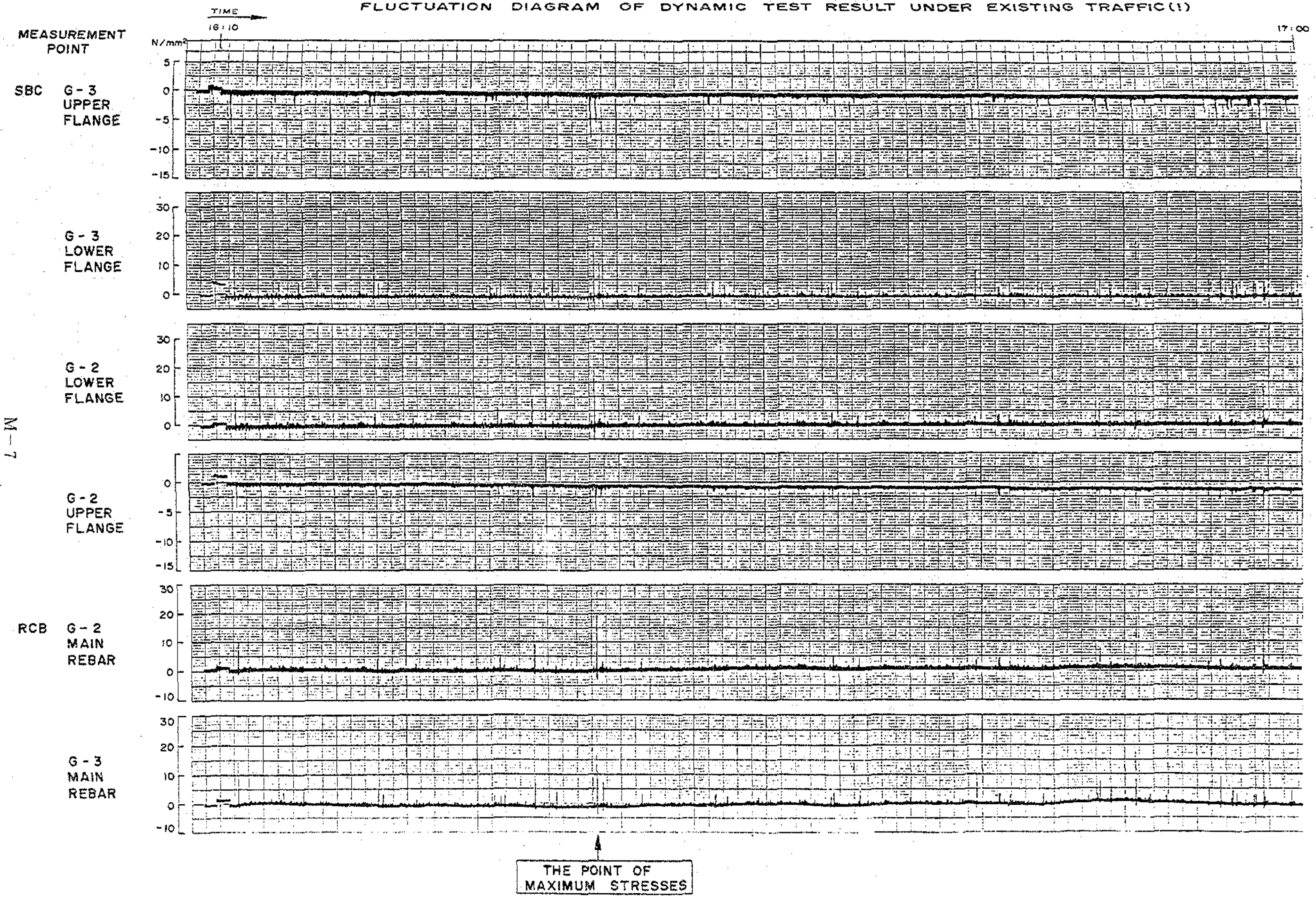
FLUCTUATION DIAGRAM OF DYNAMIC TEST RESULT UNDER EXISTING TRAFFIC (2)



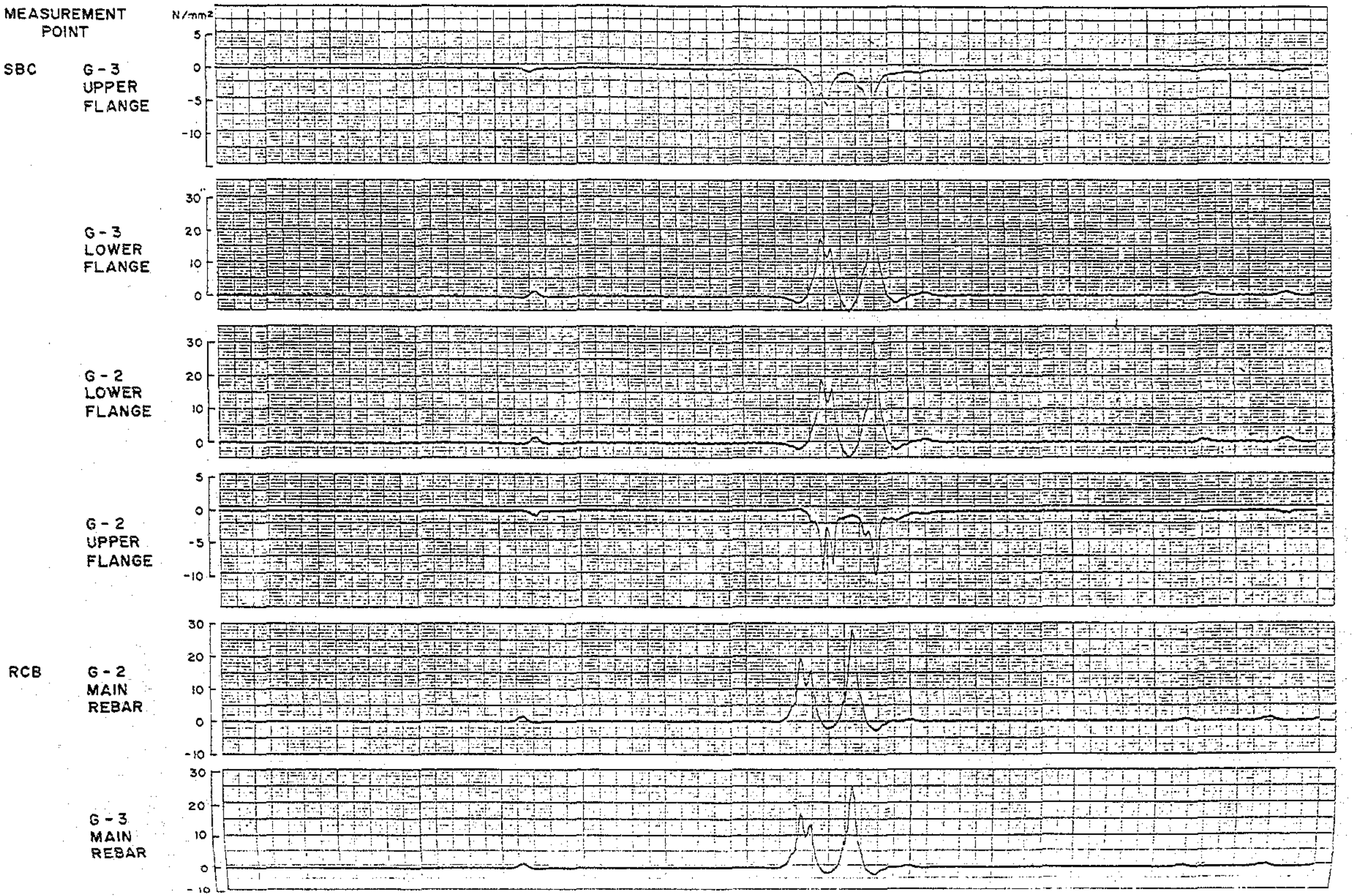
FLUCTUATION DIAGRAM OF DYNAMIC TEST RESULT UNDER EXISTING TRAFFIC (3)



FLUCTUATION DIAGRAM OF DYNAMIC TEST RESULT UNDER EXISTING TRAFFIC(1)



FLUCTUATION DIAGRAM AT THE POINT OF MAXIMUM STRESSES OF DYNAMIC TEST UNDER EXISTING TRAFFIC

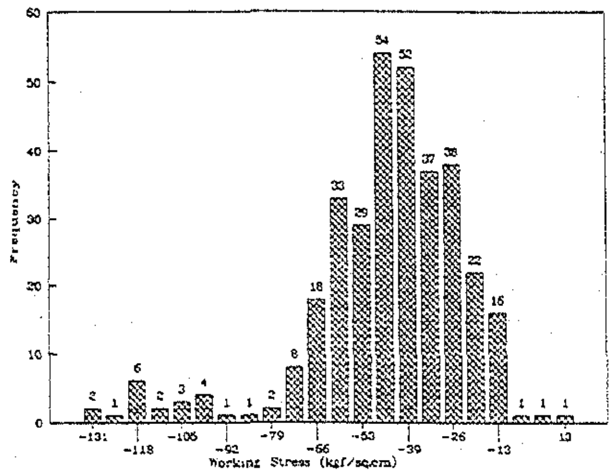


APPENDIX – M3

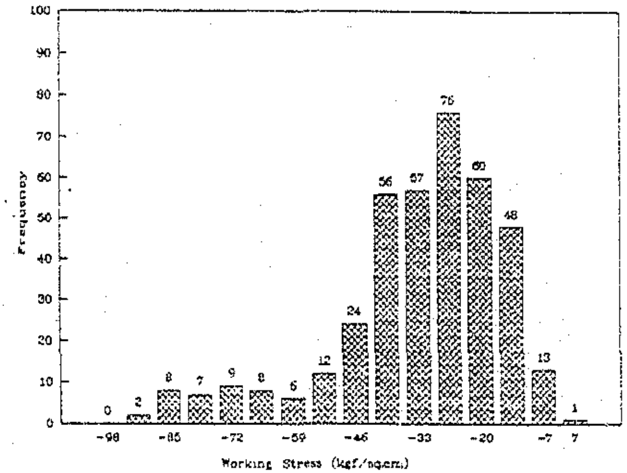
STRESS
HISTOGRAMS OF DYNAMIC LOADING TEST

STRESS HISTOGRAMS

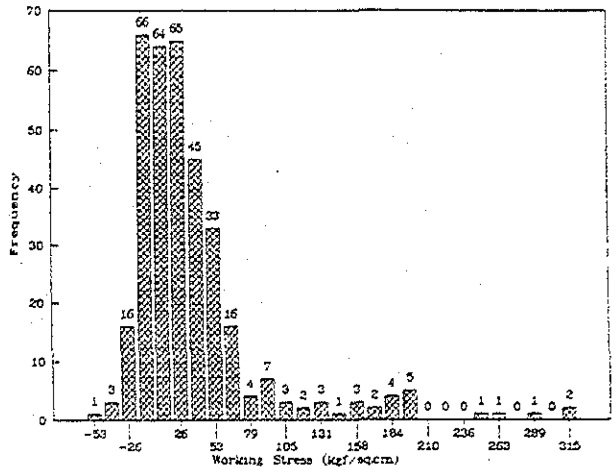
SBC Upper Flange of G-2



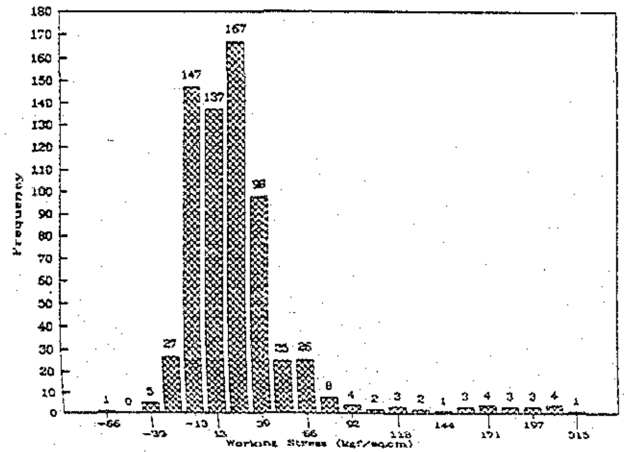
SBC Upper Flange of G-3



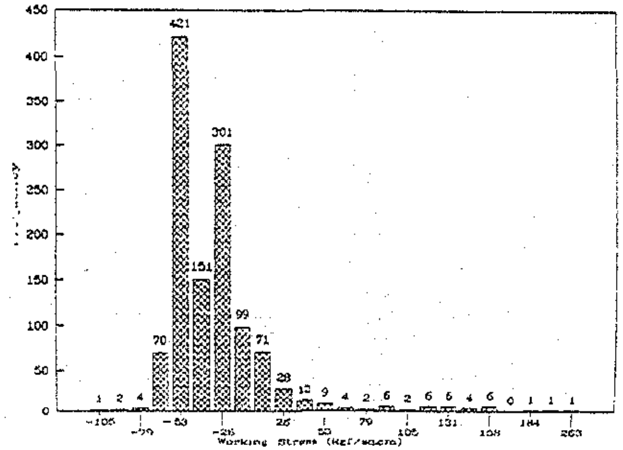
RCB Girder-2



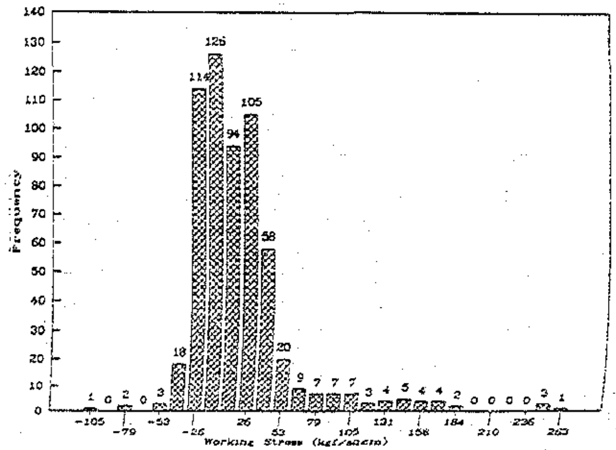
SBC Lower Flange of G-2



SBC Lower Flange of G-3



RCB Girder-3



APPENDIX – N

STRUCTURAL ASSESSMENT CRITERIA

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