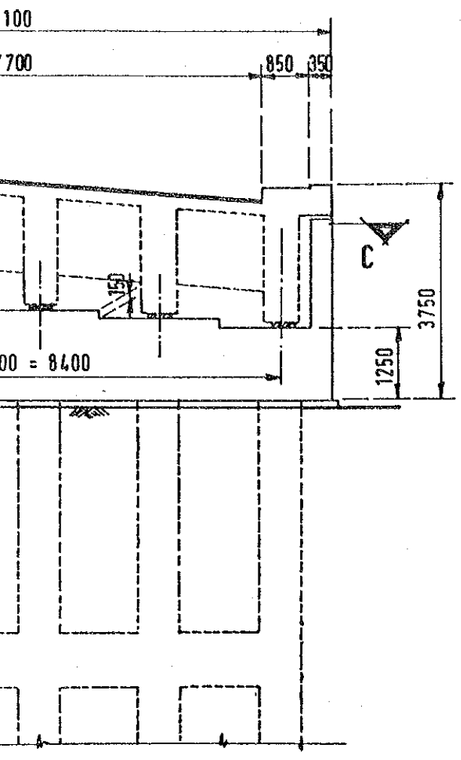
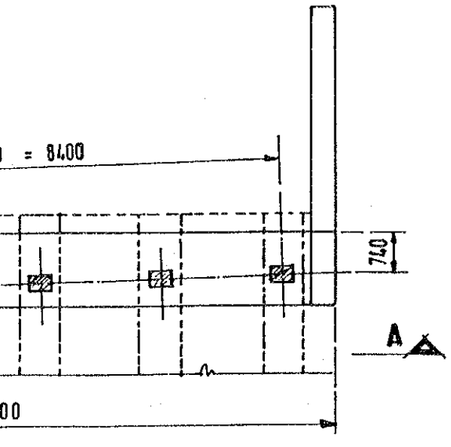
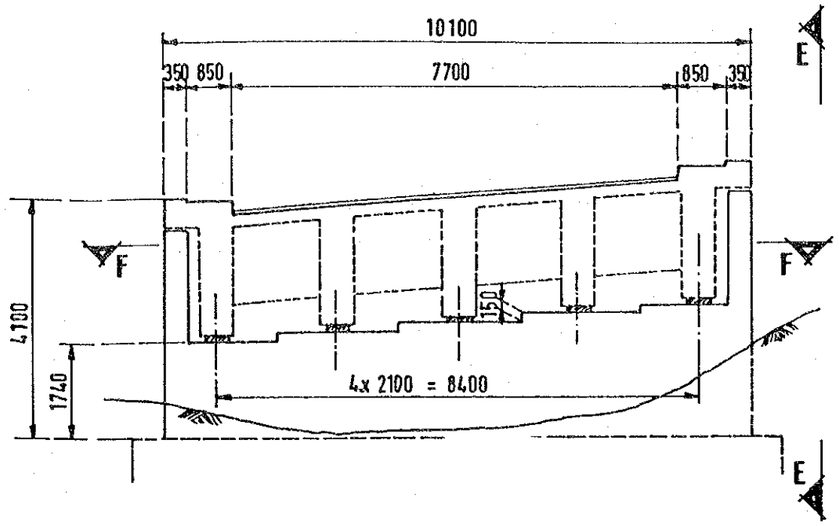


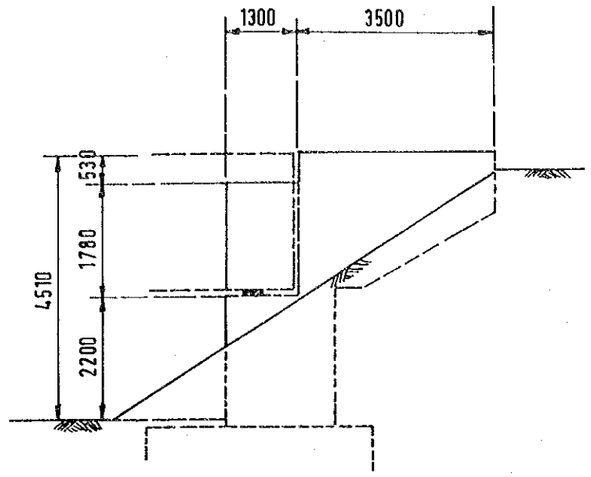
A



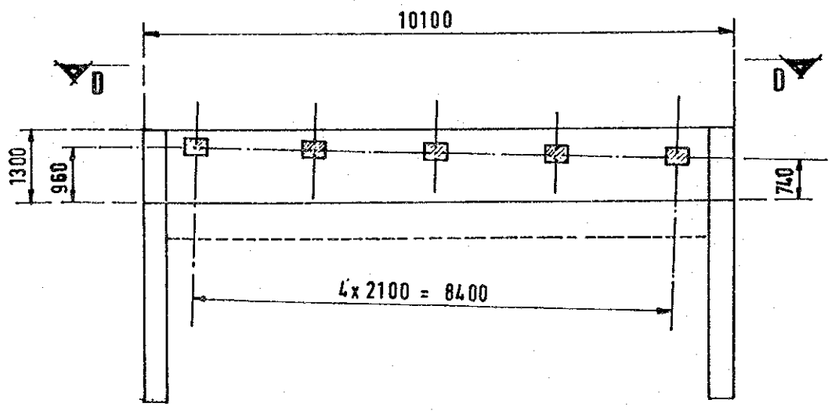
- C



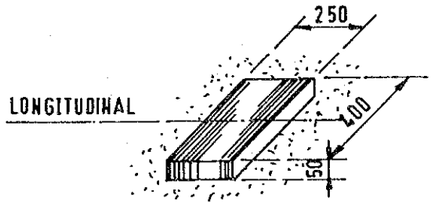
SECTION D - D



SECTION E - E



SECTION F - F

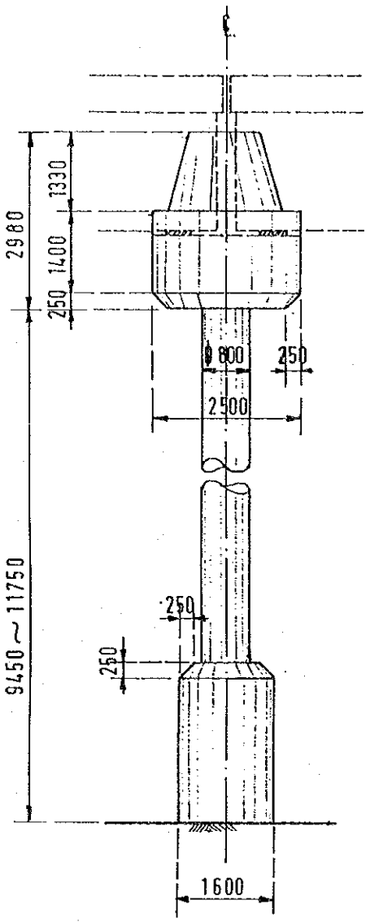


RUBBER BEARING SCALE 1 : 20

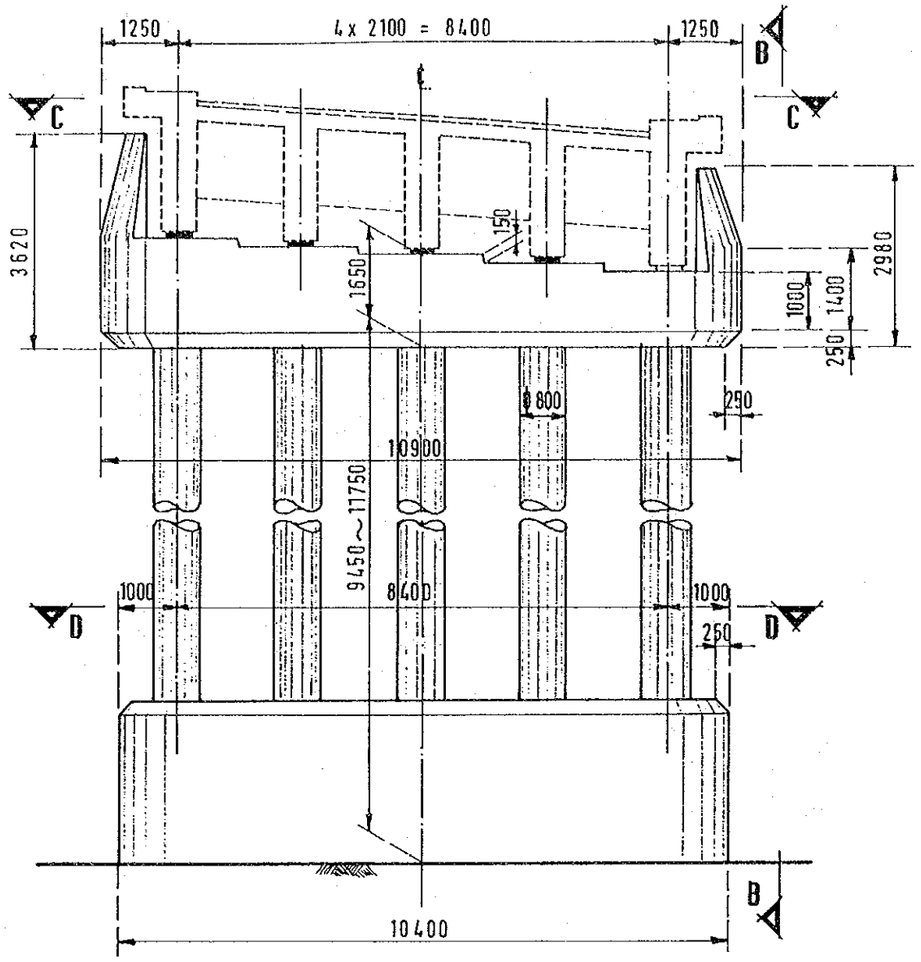
ABUTMENT SCALE 1 : 100

BRIDGE NO.	ROUTE BRIDGE NAME
6	RUSAIL NIZWA DAK - 15/100-01

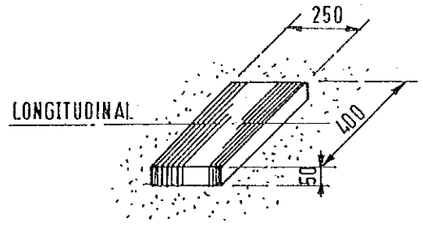
Fig 4.34 General View of Br.No.6



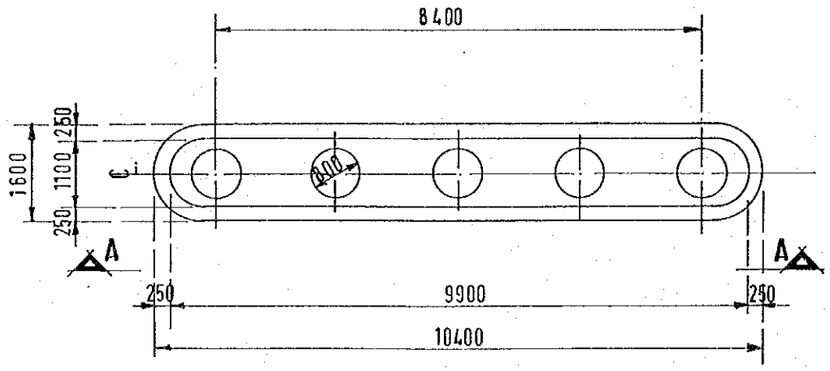
SECTION B - B



SECTION A - A

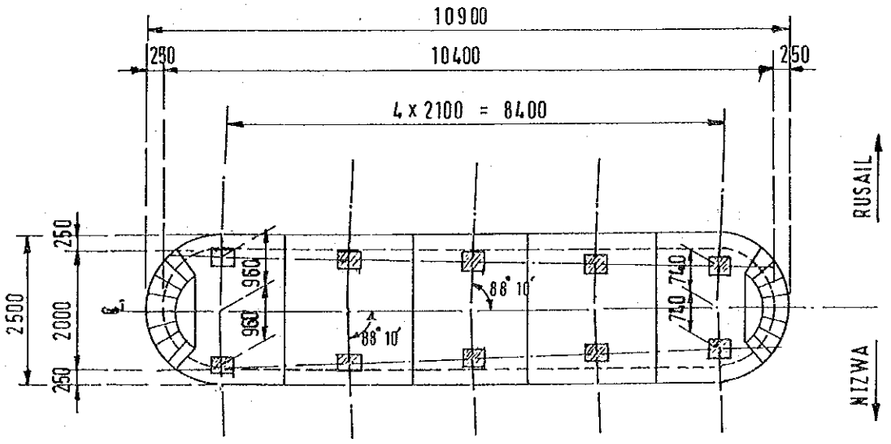


RUBBER BEARING SCALE 1 : 20



SECTION D - D

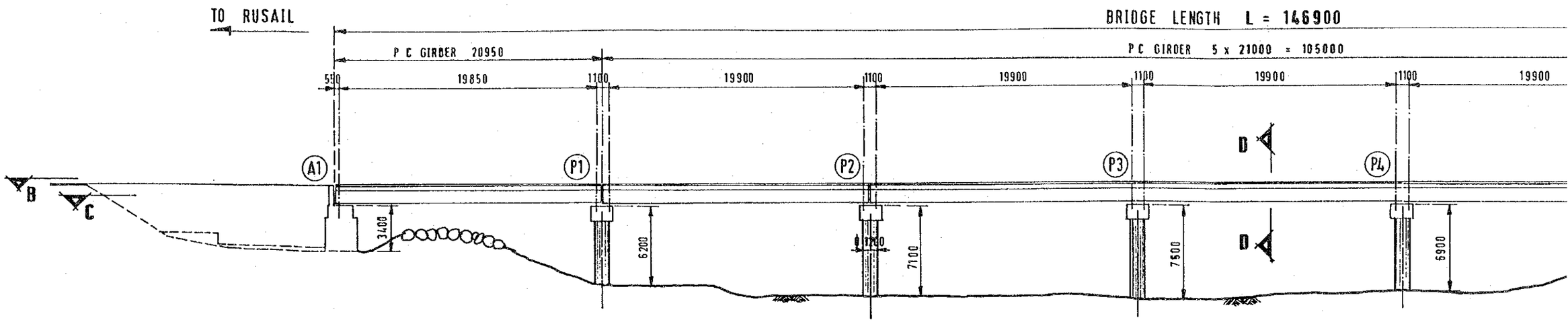
PIER SCALE 1 : 100



SECTION C - C

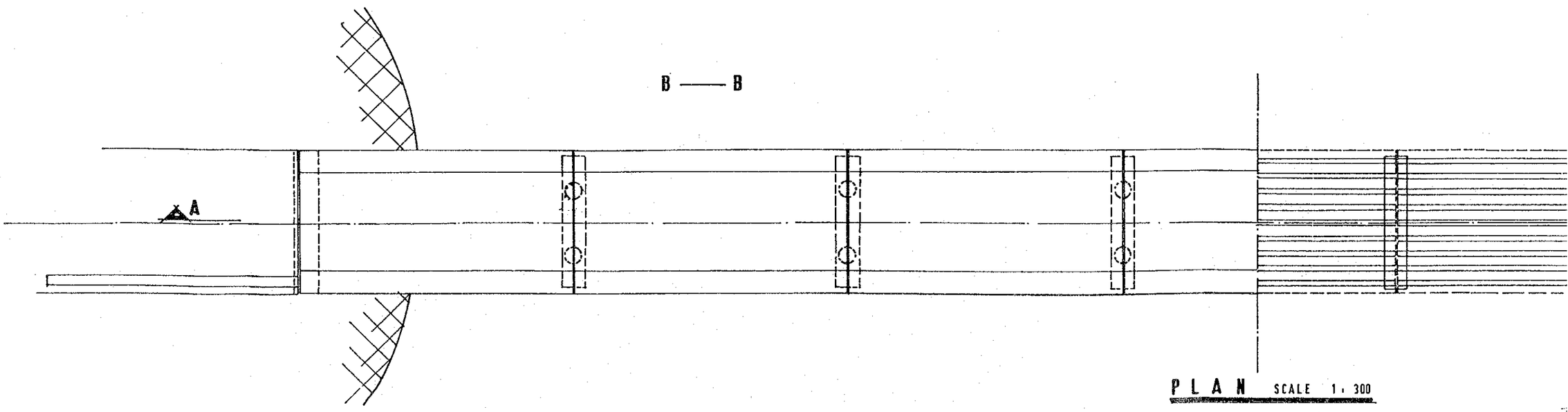
BRIDGE NO.	ROUTE BRIDGE NAME
6	RUSAIL - NIZWA DAK -15 / 100-01

Fig 4.35 General View of Br.No.6

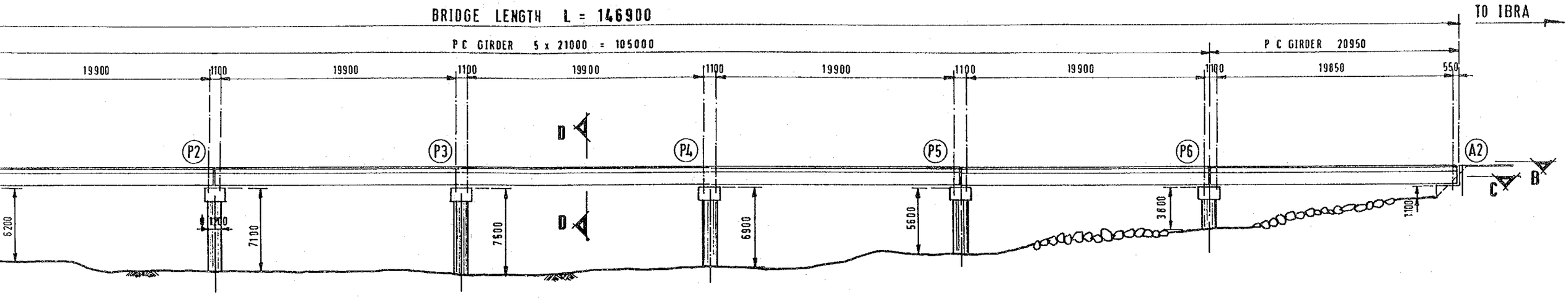


SECTION A - A

SIDE ELEVATION SCALE 1 : 300

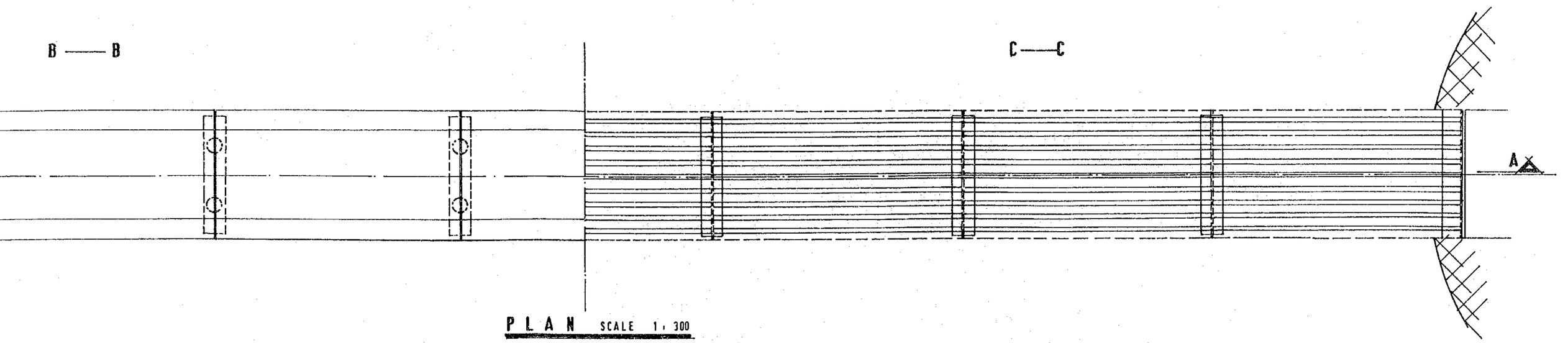


PLAN SCALE 1 : 300

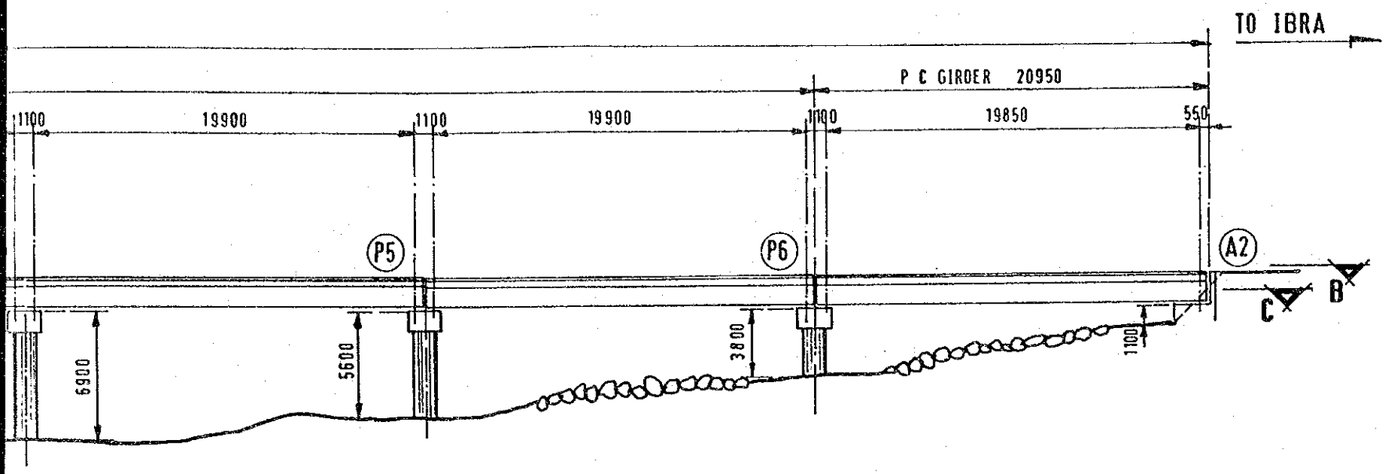


SECTION A - A

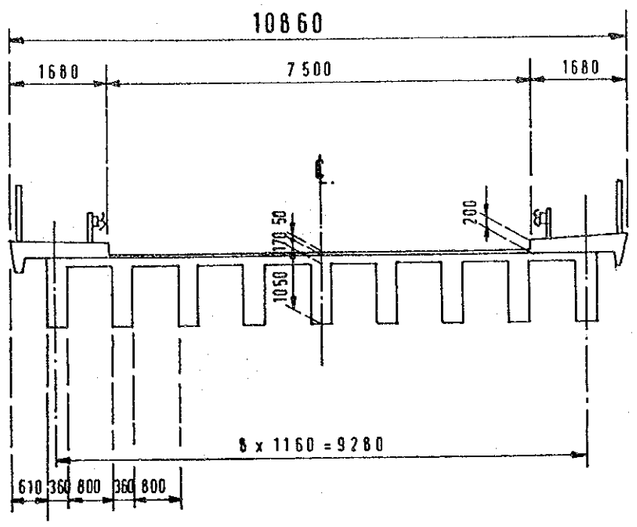
SIDE ELEVATION SCALE 1 : 300



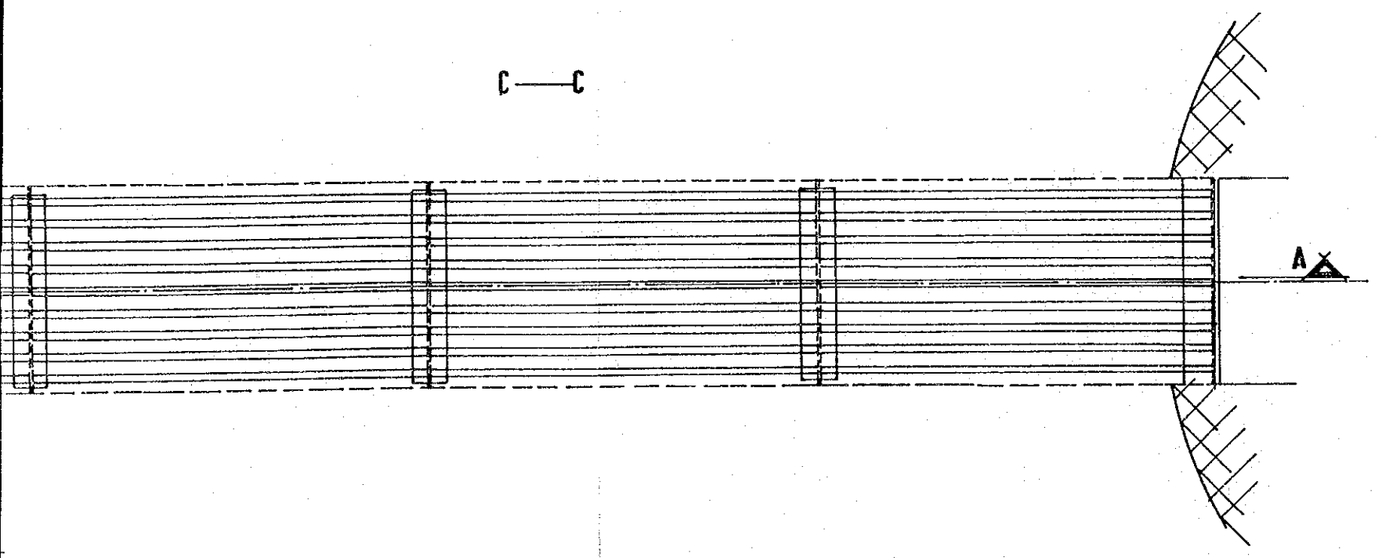
PLAN SCALE 1 : 300

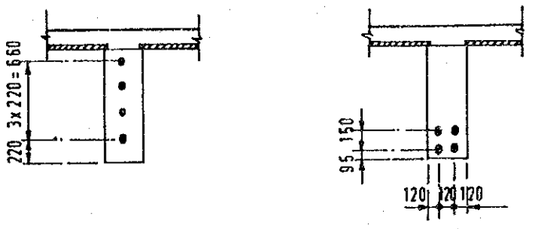


1 : 300



SECTION D - D SCALE 1 : 100



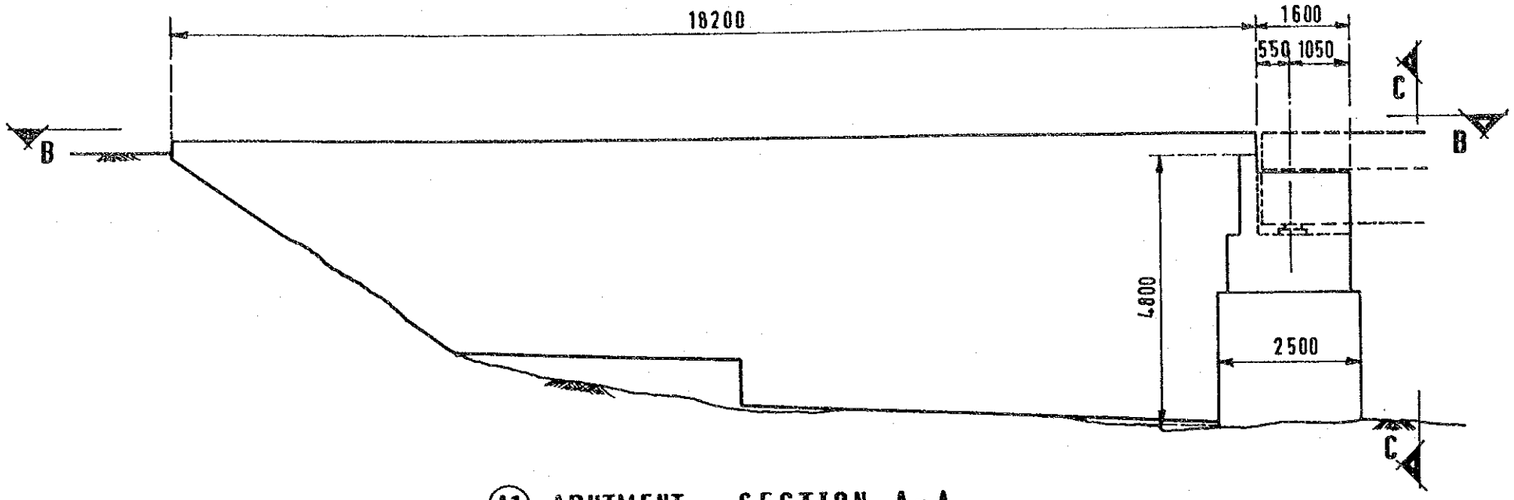


GIRDER END **SPAN CENTER**

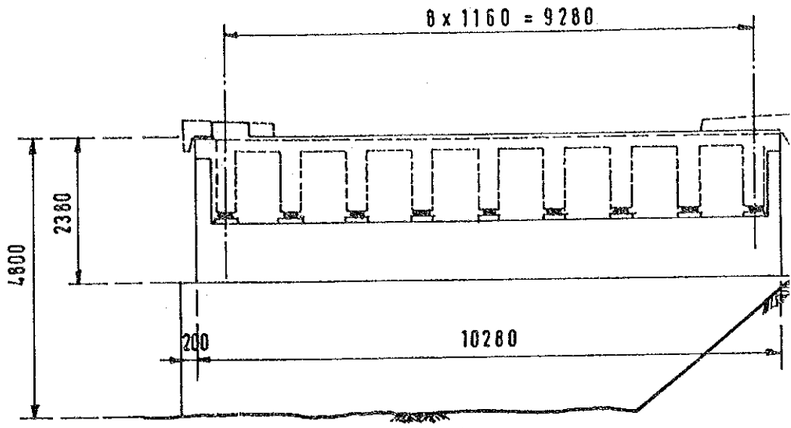
P C CABLE ARRANGEMENT

BRIDGE NO.	ROUTE BRIDGE NAME
7	BID—BID—SUR DAK-23/100 - 2

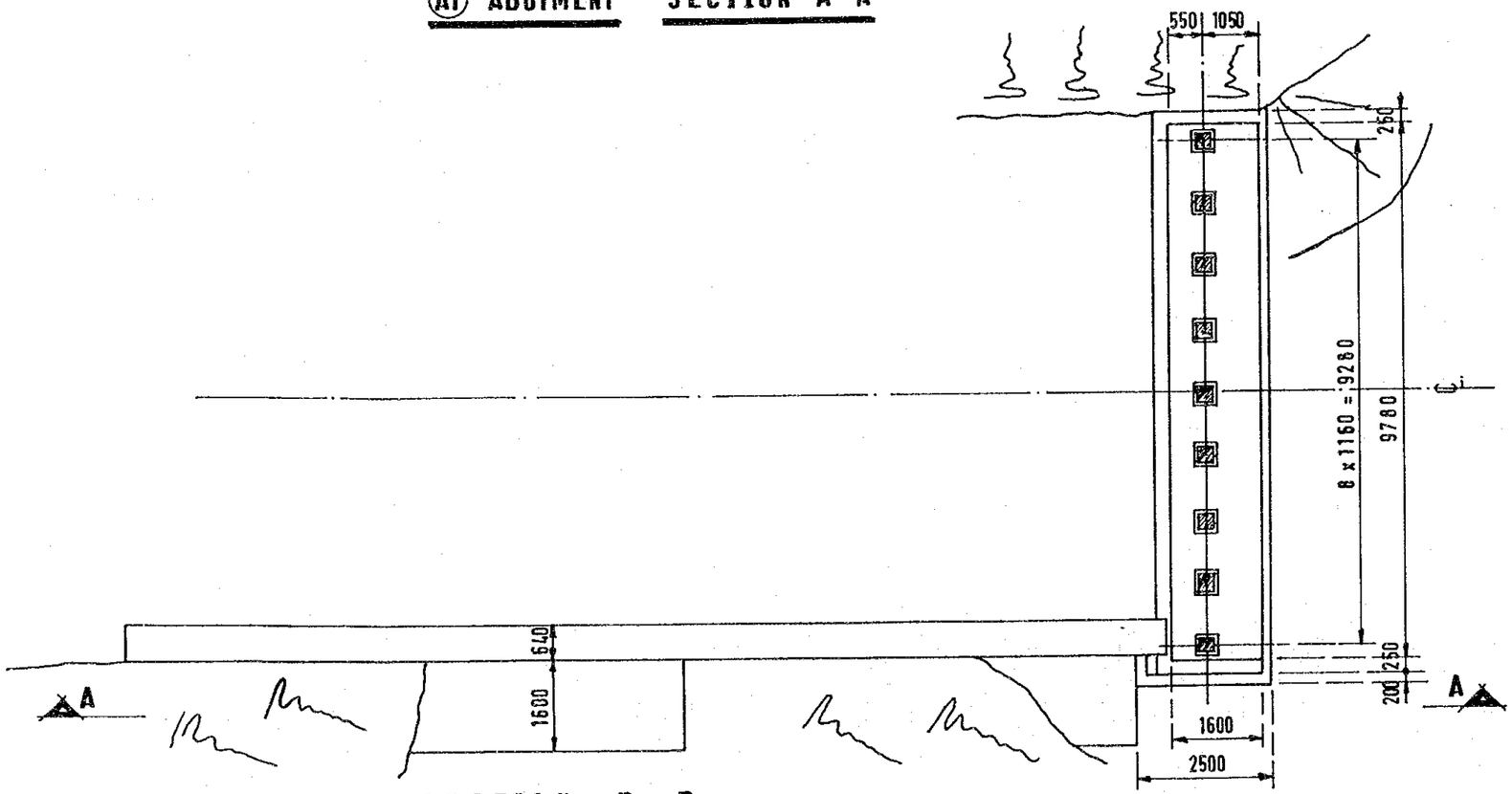
Fig 4.36 General View of Br.No.7



(A1) ABUTMENT SECTION A-A

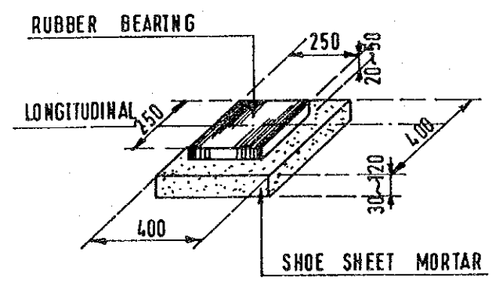


SECTION C - C

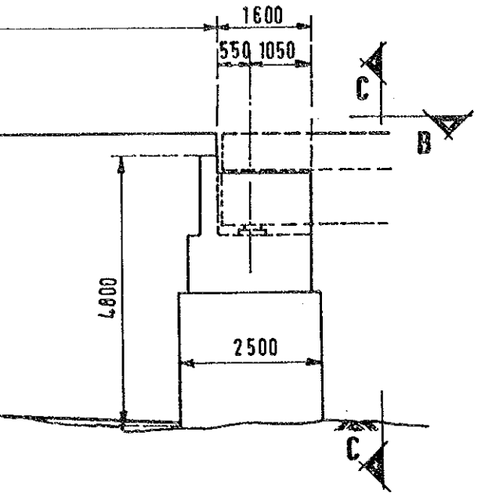


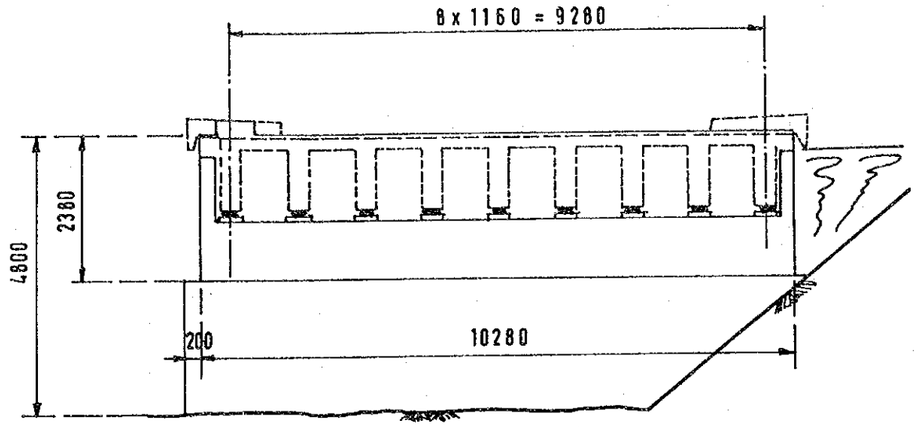
SECTION B - B

ABUTMENT SCALE 1: 100

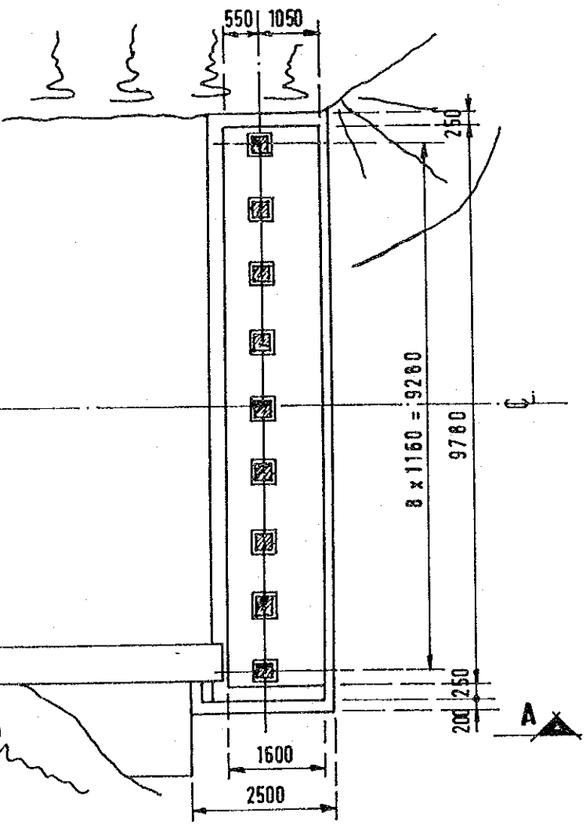


RUBBER BEARING SCALE 1: 20

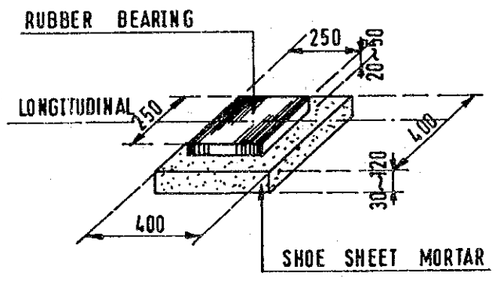




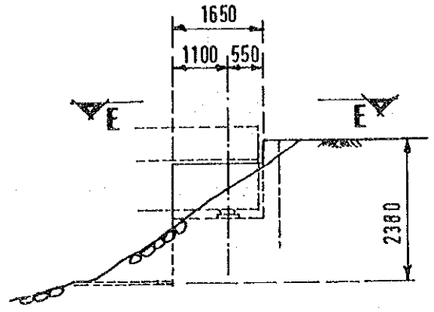
SECTION C - C



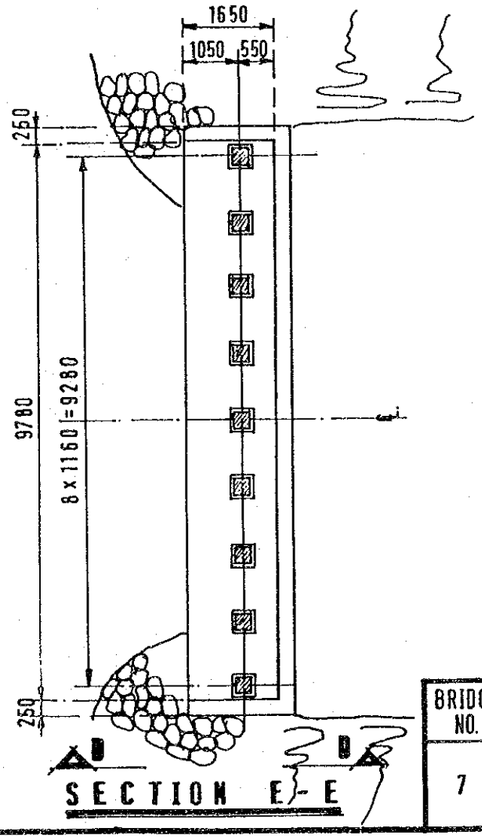
ABUTMENT SCALE 1: 100



RUBBER BEARING SCALE 1: 20



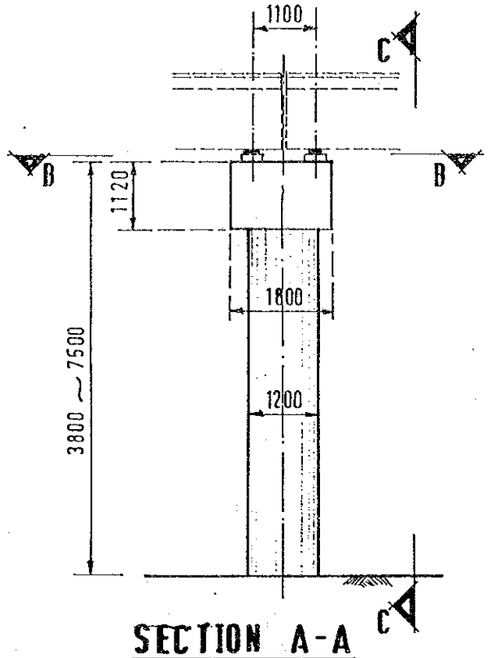
(A2) ABUTMENT SECTION D - D



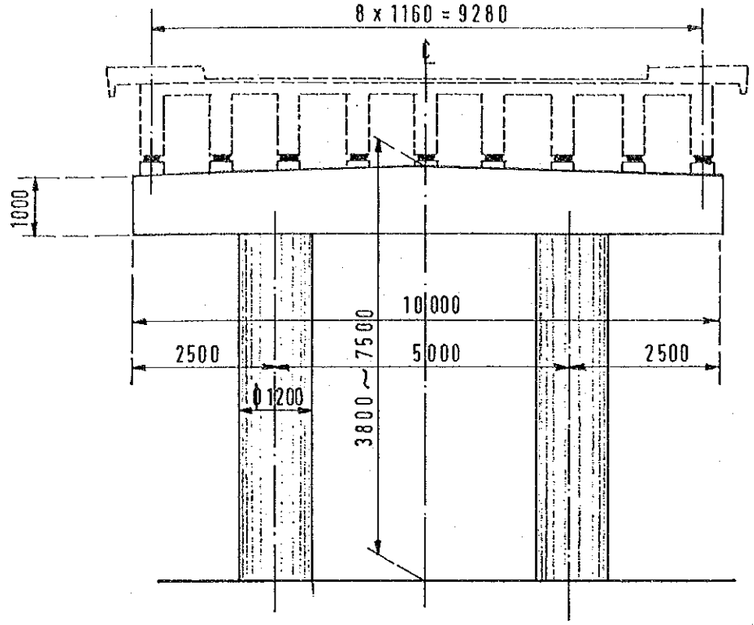
SECTION E - E

BRIDGE NO.	ROUTE BRIDGE NAME
7	BID-BID - SUR DAK-23/100-2

Fig 4.37
General View of Br.No.7

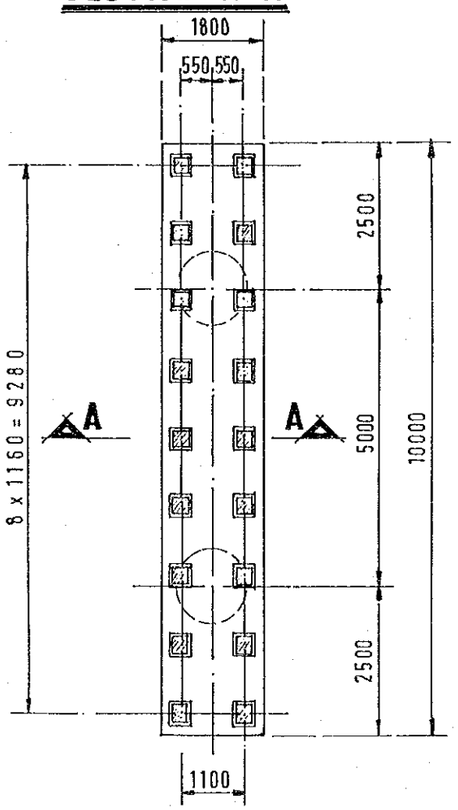


SECTION A-A

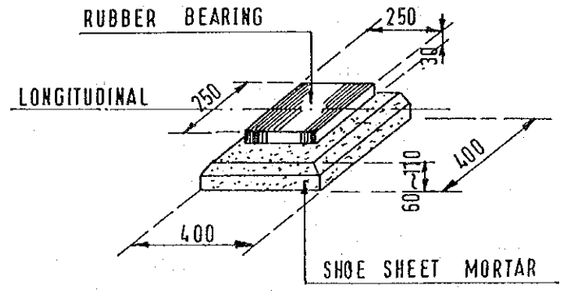


SECTION C-C

PIER SCALE 1:100



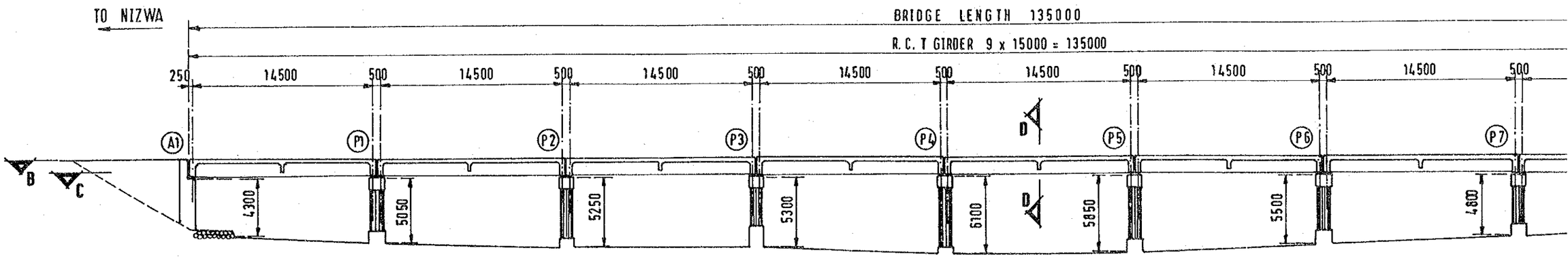
SECTION B - B



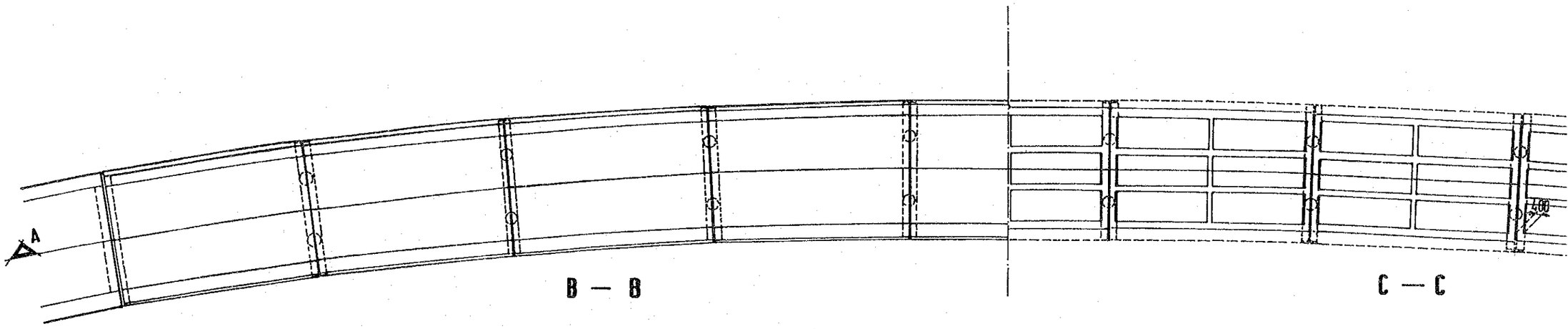
RUBBER BEARING SCALE 1:20

BRIDGE NO.	ROUTE BRIDGE NAME
7	BID - BID - SUR DAK. - 23 / 100 - 2

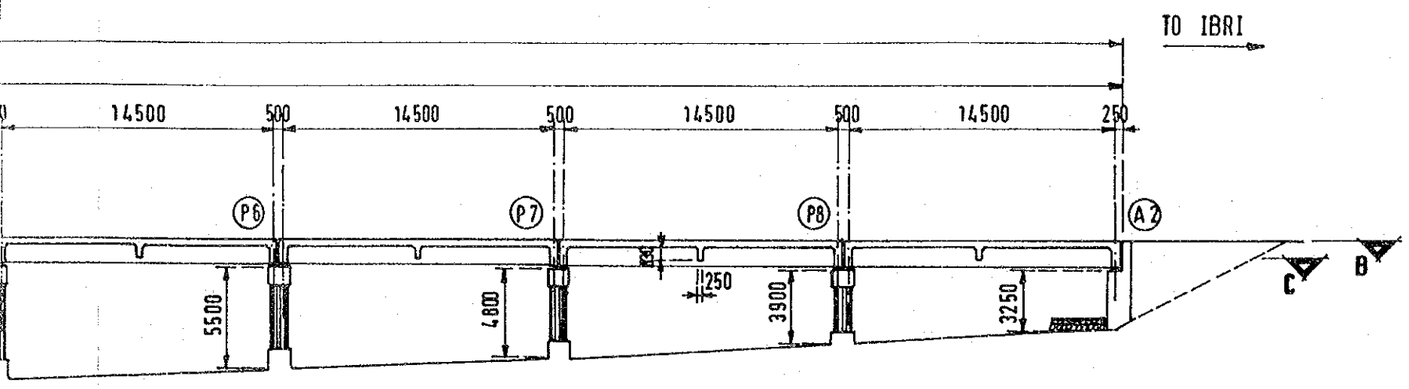
Fig 4.38 General View of Br.No.7

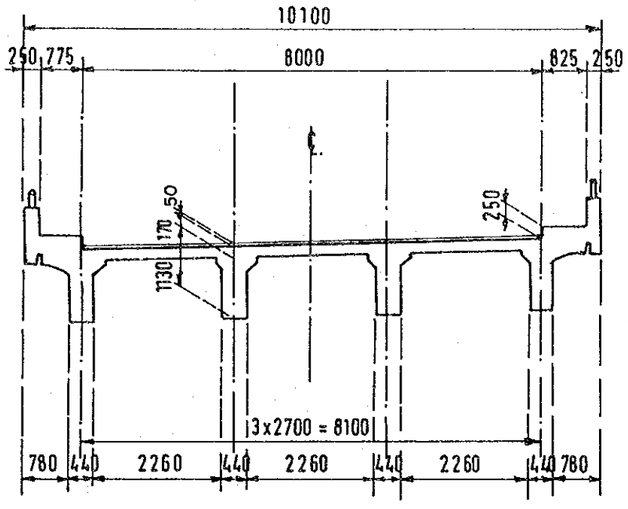


SECTION A - A
SIDE ELEVATION SCALE 1 : 300

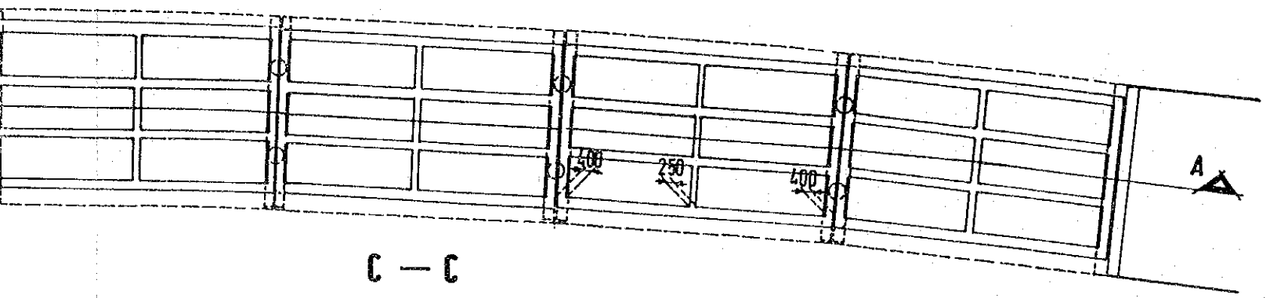


PLAN SCALE 1:300

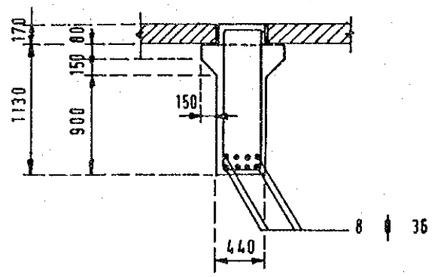




SECTION D - D



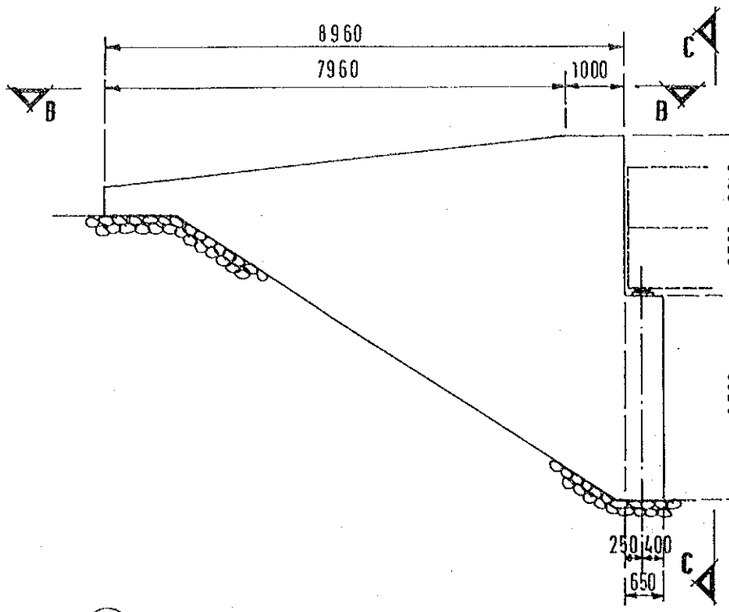
C — C



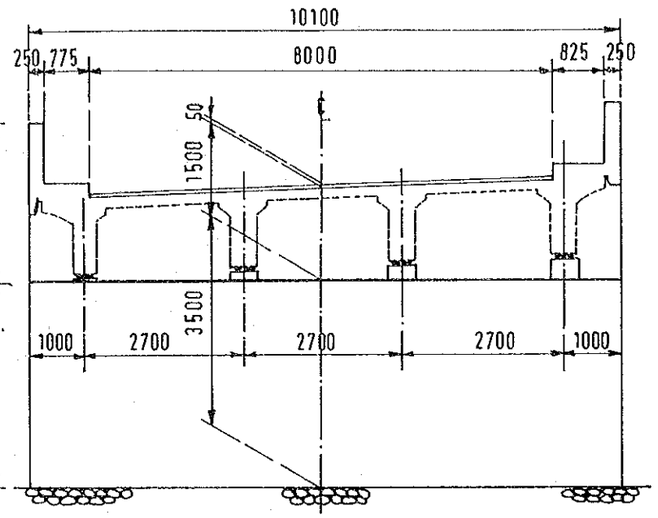
MAIN REINF. ARRANGEMENT

BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI/ NIZWA DAK - 21/600 - 01

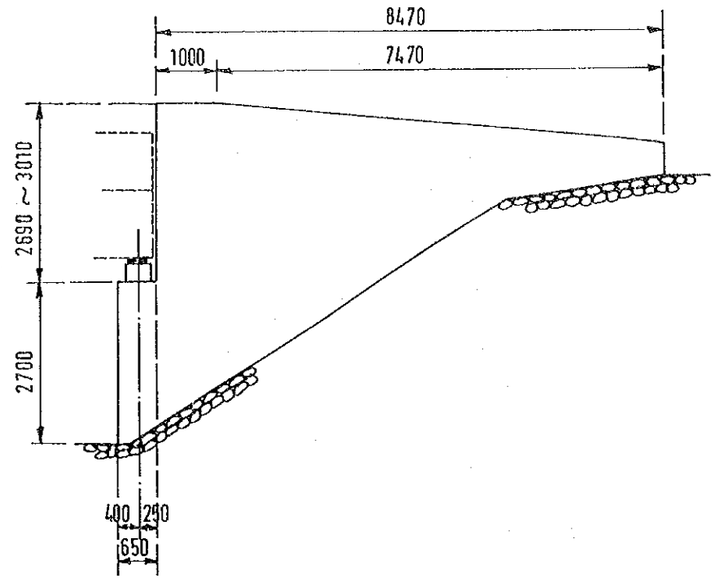
Fig 4.39 General View of Br.No.8



(A1) ABUTMENT SECTION A-A

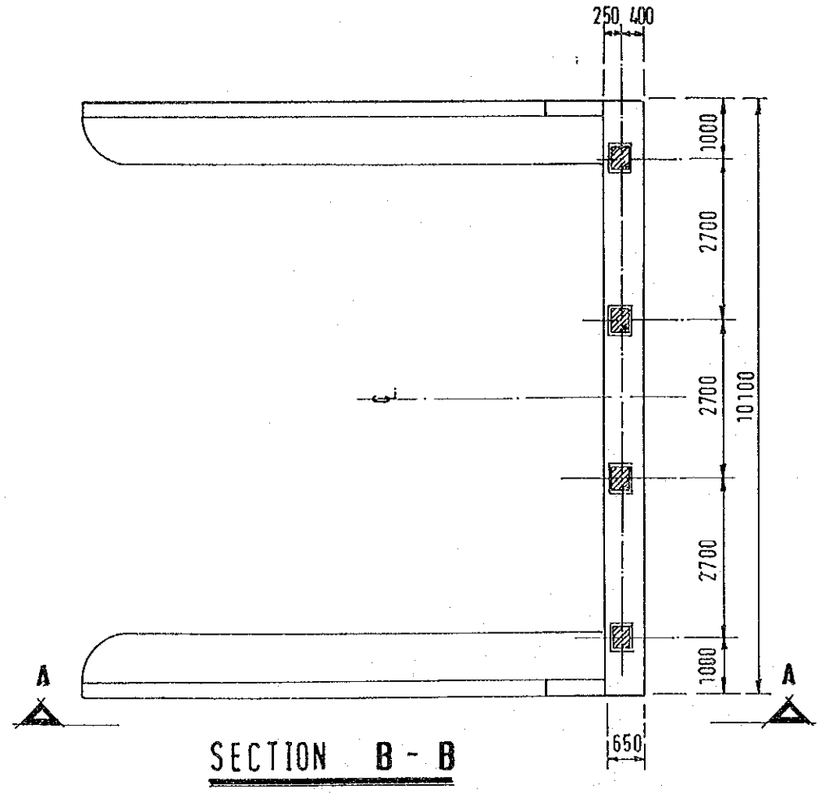


SECTION C-C

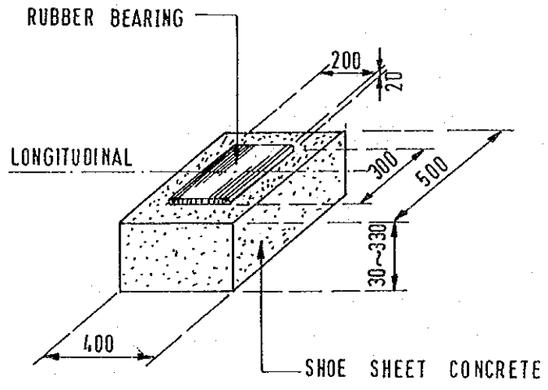


(A2) ABUTMENT

A B U T M E N T SCALE 1 : 100



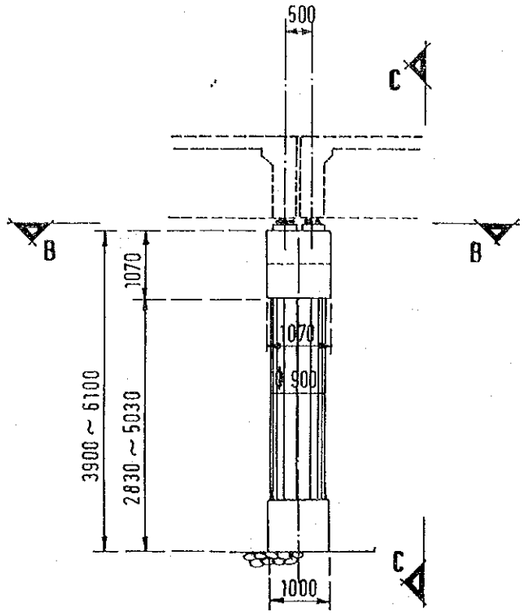
SECTION B - B



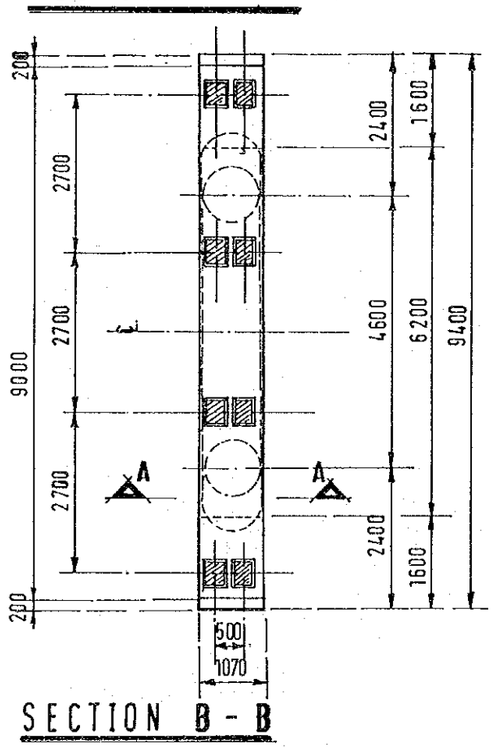
RUBBER BEARING SCALE 1 : 20

BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI/NIZWA DAK - 21/600-01

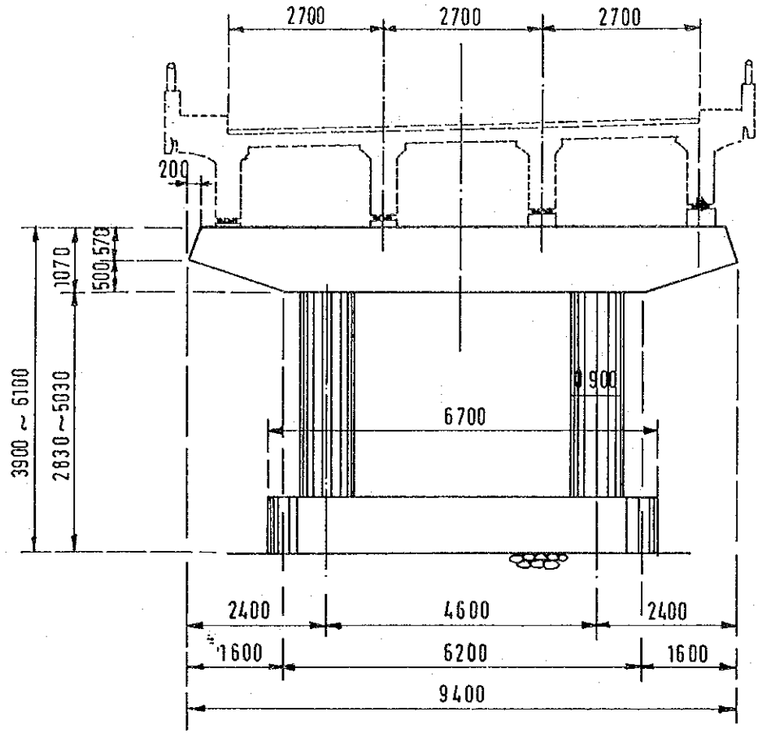
Fig 4.40 General View of Br.No.8



SECTION A-A

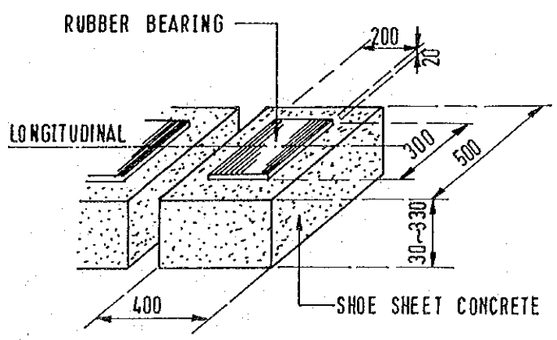


SECTION B-B



SECTION C-C

PIER SCALE 1:100

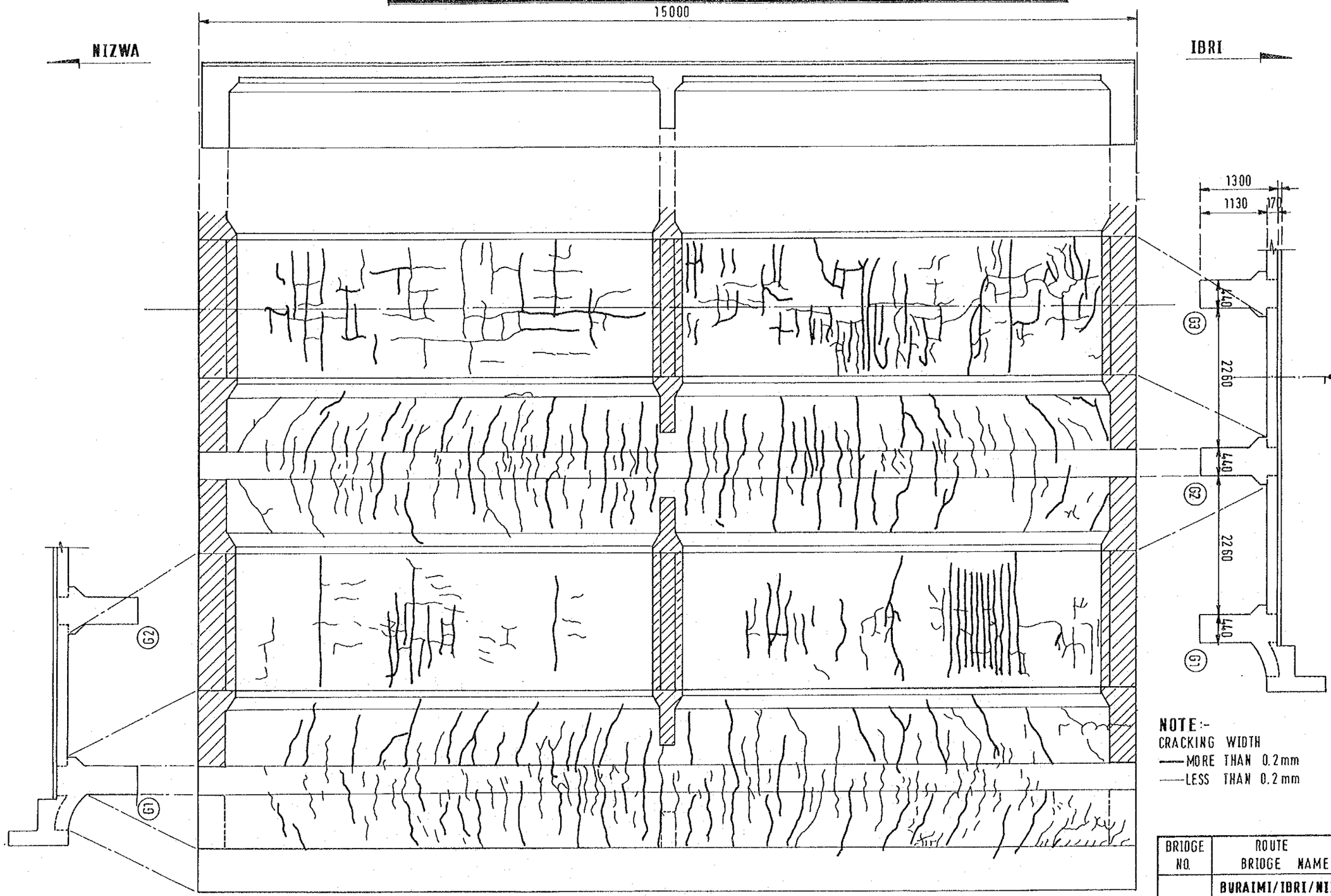


RUBBER BEARING SCALE 1:20

BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI / NIZWA DAK - 21/600- 01

Fig 4.41 General View of Br.No.8

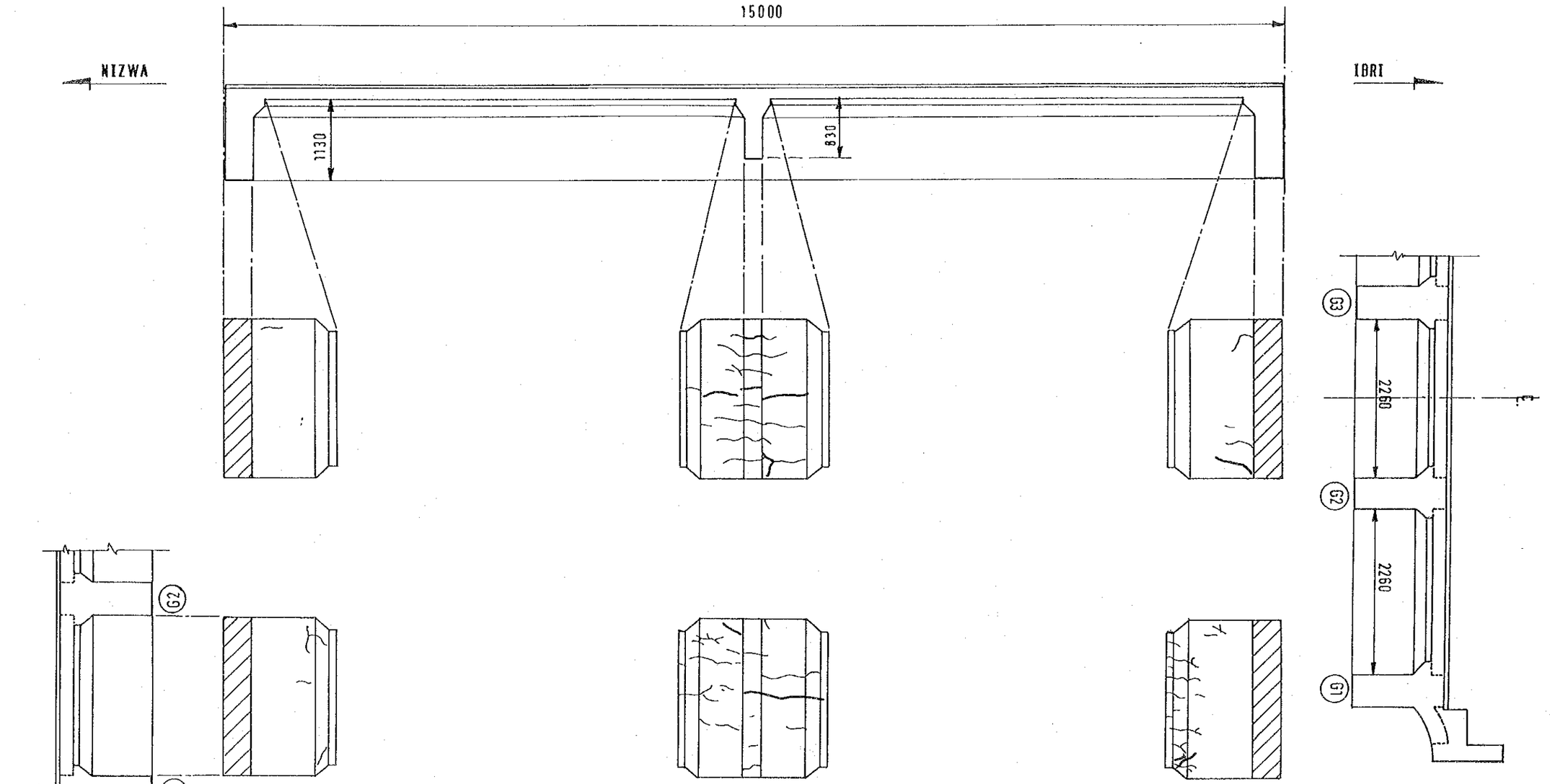
SKETCH OF CRACKING EXAMINATION (Main Girder & Slab) SCALE 1:60



BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI/NIZWA DAK - 21/600-01

Fig 4.42 Cracking Conditions

SKETCH OF CRACKING EXAMINATION (Cross Beam) SCALE 1 : 60



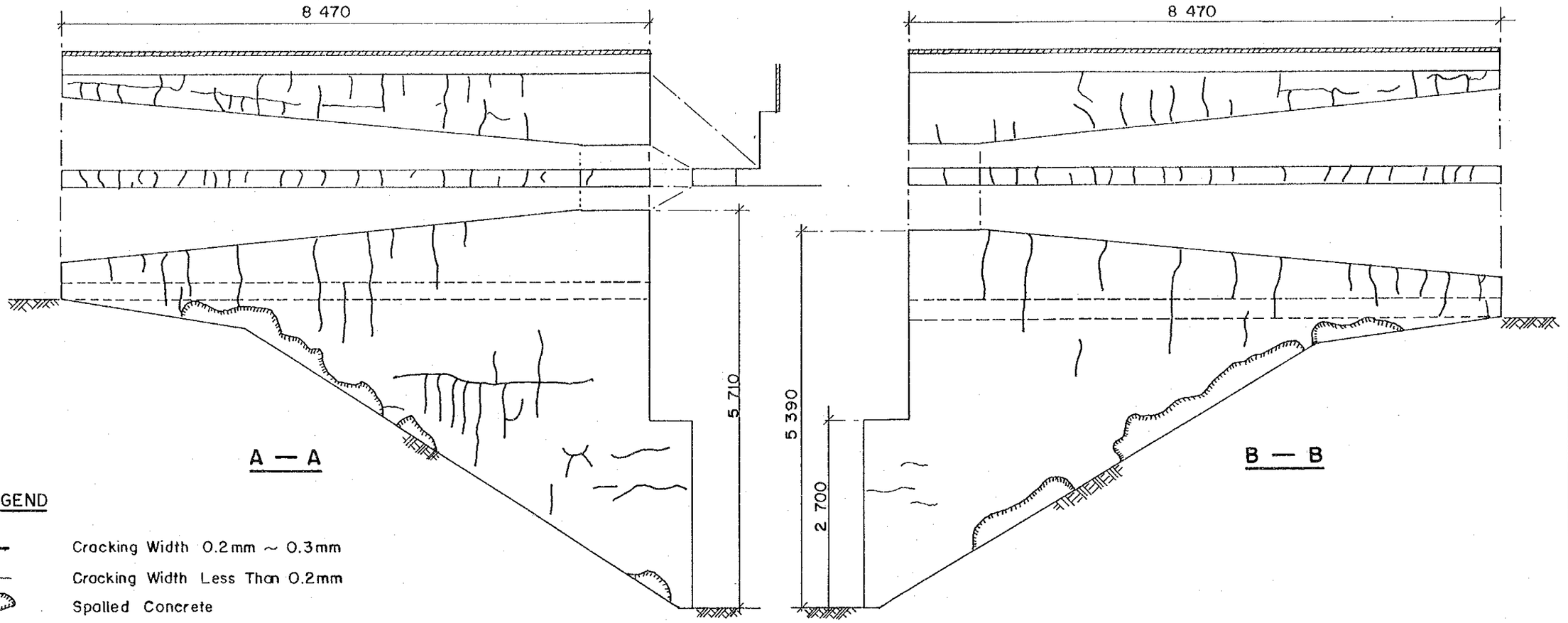
NOTE:-
CRACKING WIDTH
—MORE THAN 0.2mm
—LESS THAN 0.2mm

BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI/NIZWA DAK - 21/600-01

Fig 4.43 Cracking Conditions

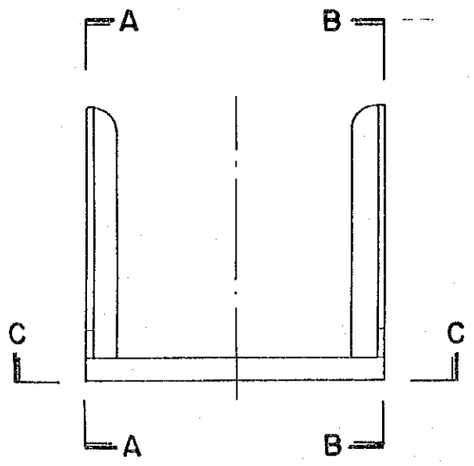
SKETCH OF CRACKING EXAMINATION (A2 ABUTMENT)

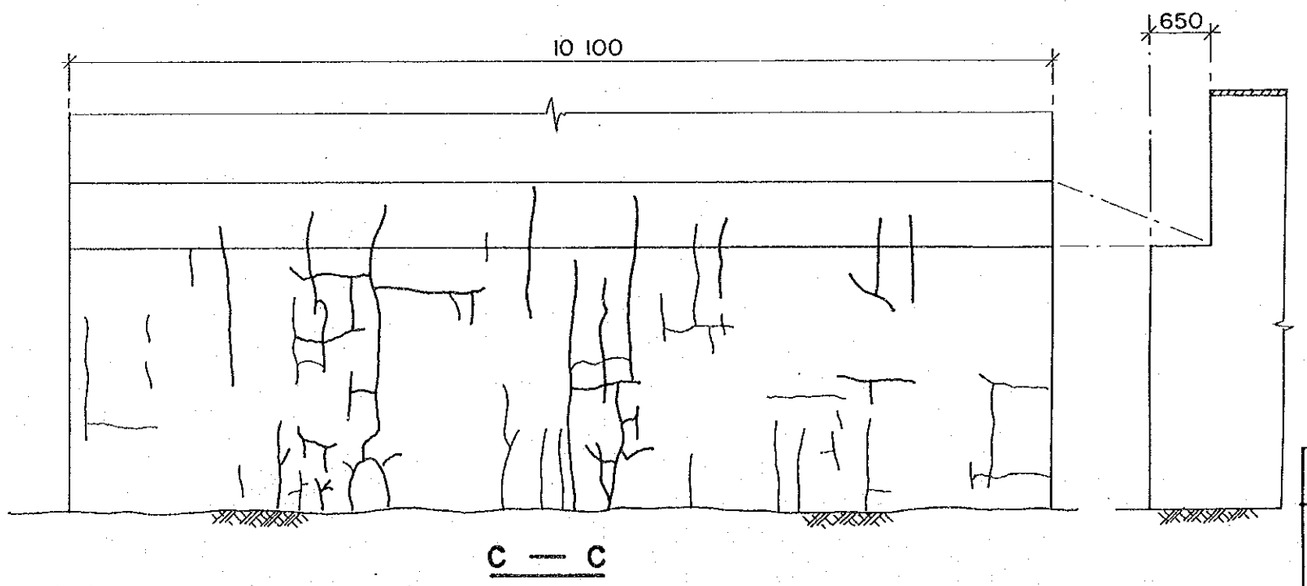
(SCALE 1:60)



LEGEND

- Cracking Width 0.2mm ~ 0.3mm
- Cracking Width Less Than 0.2mm
- Spalled Concrete
- Exposed Re-Bar



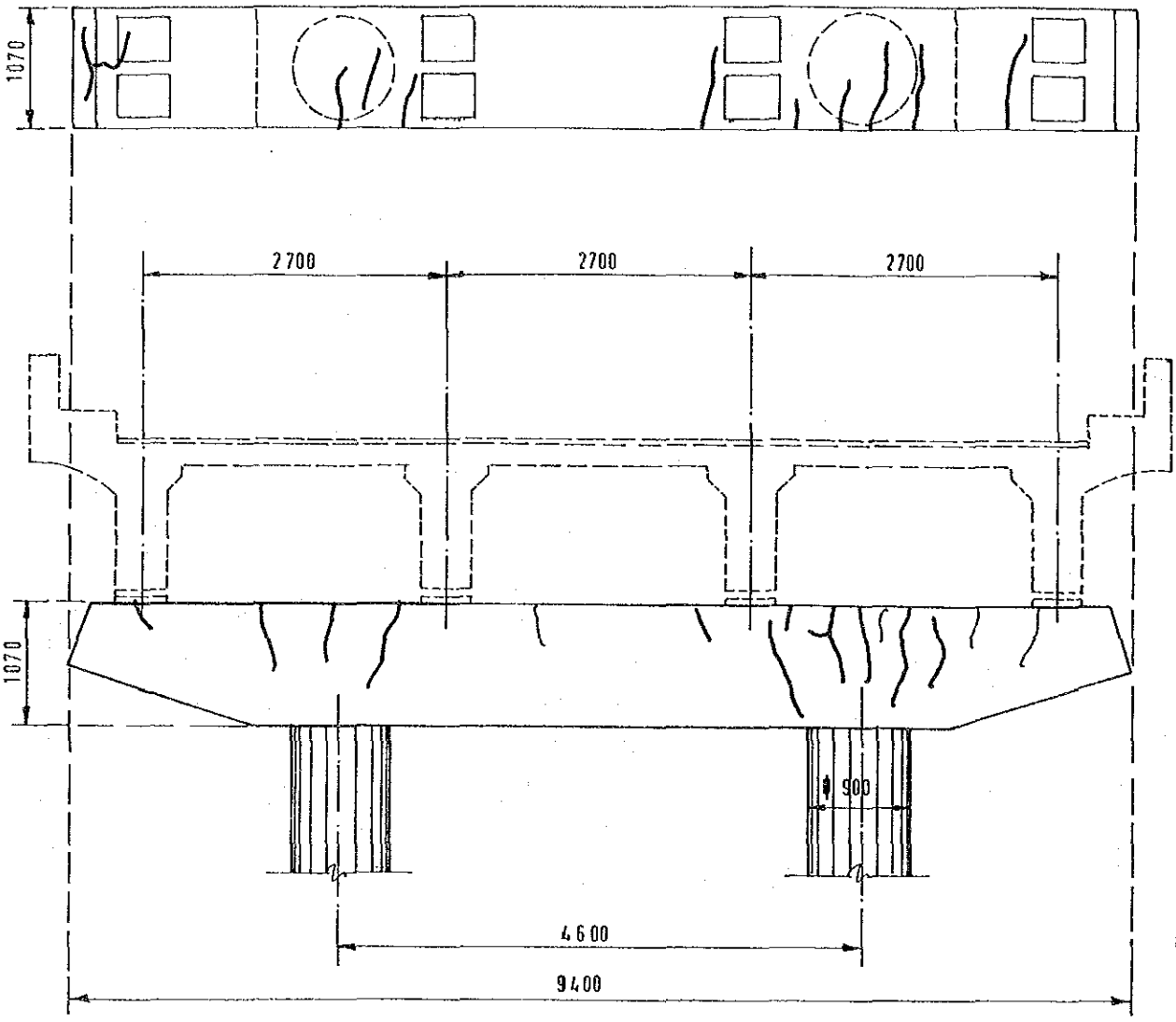


BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI/NIZWA DAK-21/600-01

Fig 4.44 Cracking Conditions

SKETCH OF CRACKING EXAMINATION

(P8) PIER SCALE 1 : 60



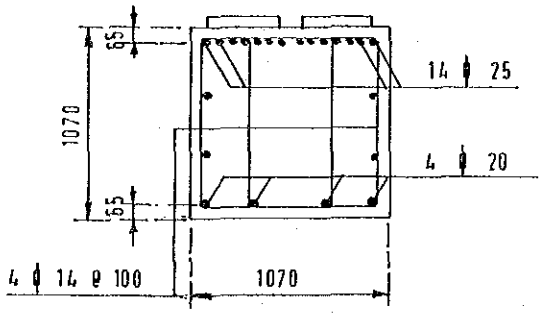
NOTE:-

CRACKING WIDTH

— MORE THAN 0.2 mm

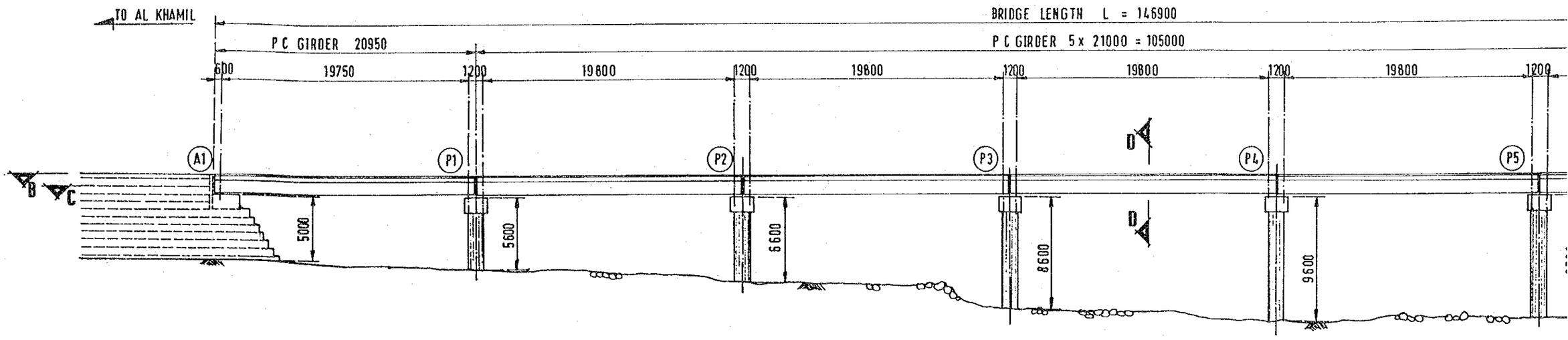
— LESS THAN 0.2 mm

MAIN REINF. ARRANGEMENT



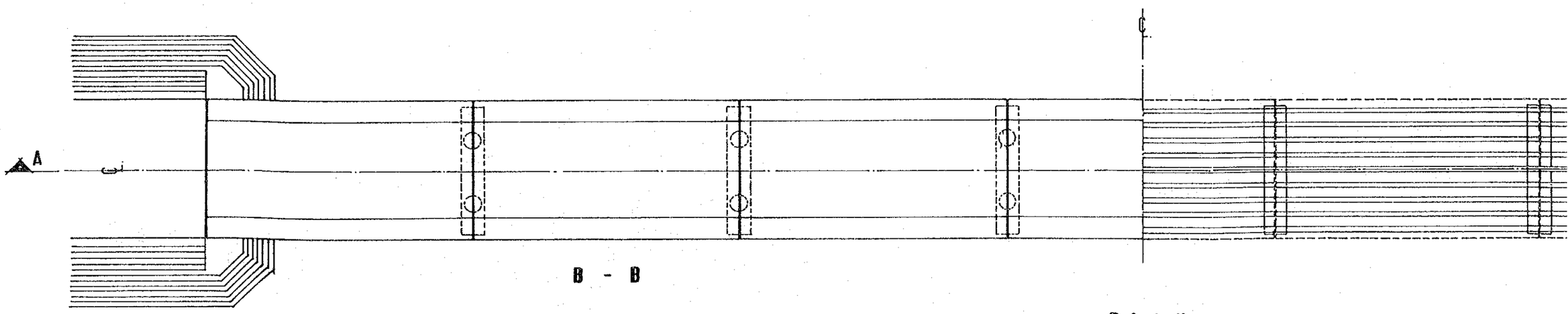
BRIDGE NO.	ROUTE BRIDGE NAME
8	BURAIMI/IBRI/NIZWA DAK - 21/600-01

Fig 4.45 Cracking Conditions



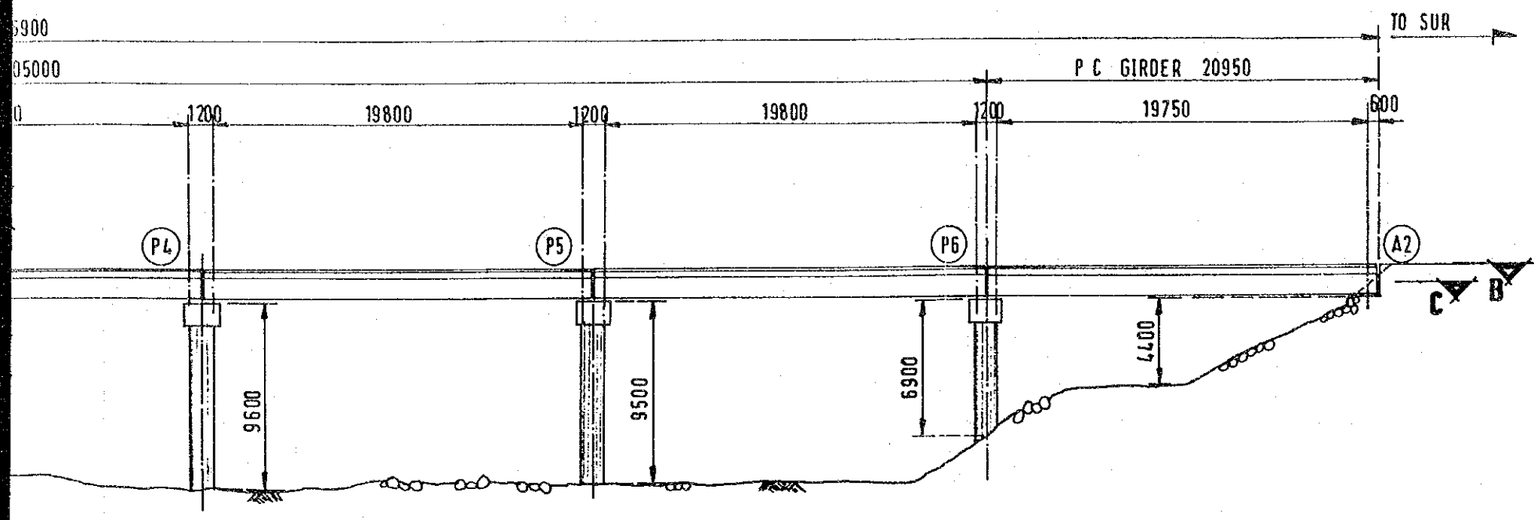
SECTION A - A

SIDE ELEVATION SCALE 1 : 300



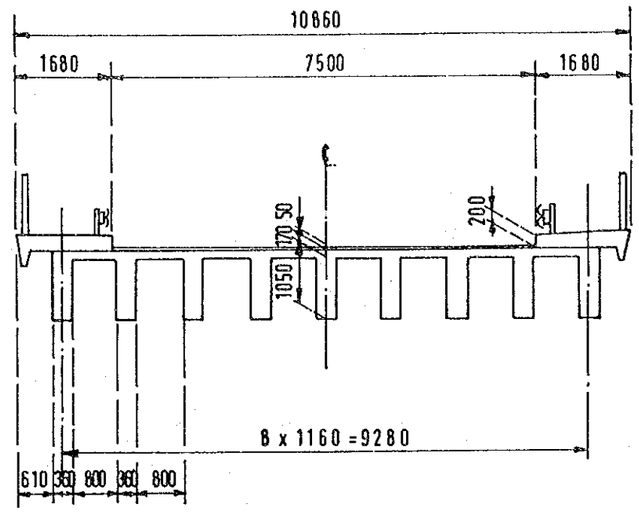
B - B

PLAN SCALE 1 : 300

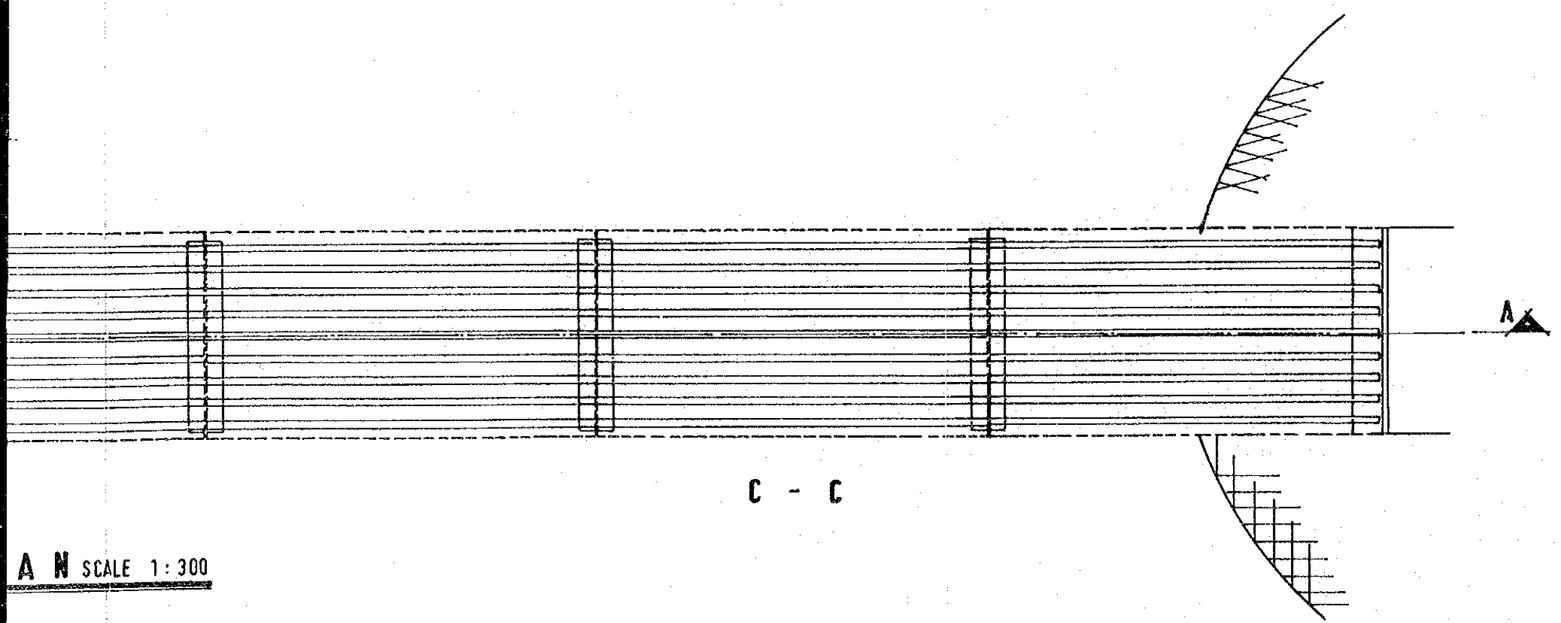


ON A-A

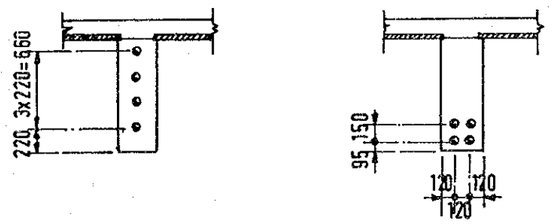
ELEVATION SCALE 1:300



SECTION D-D SCALE 1:100



A N SCALE 1:300

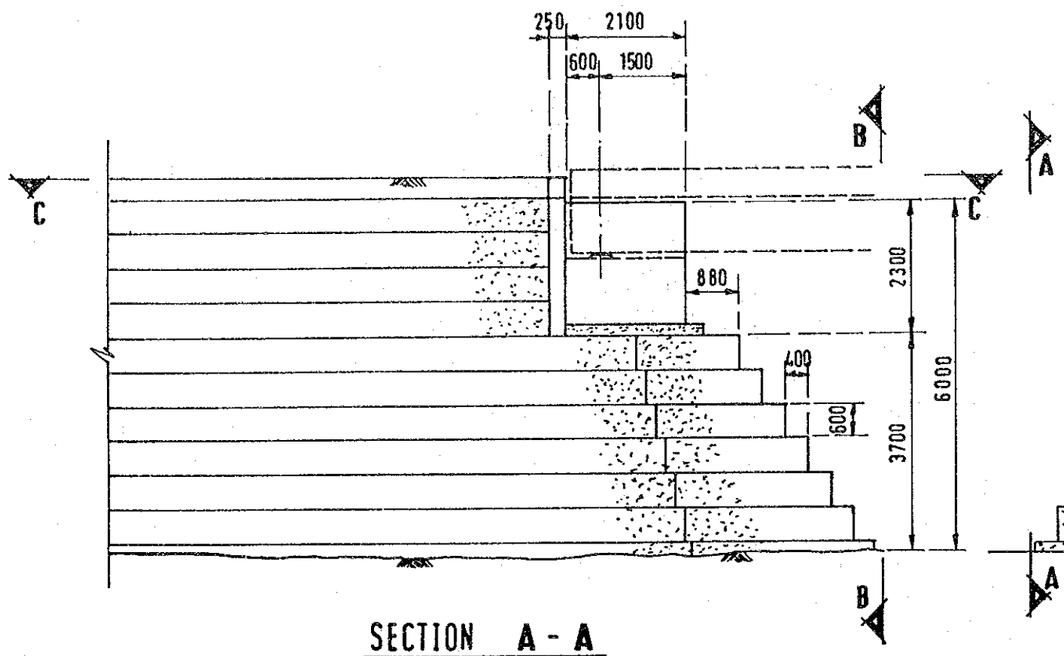


GIRDER END SPAN CENTER

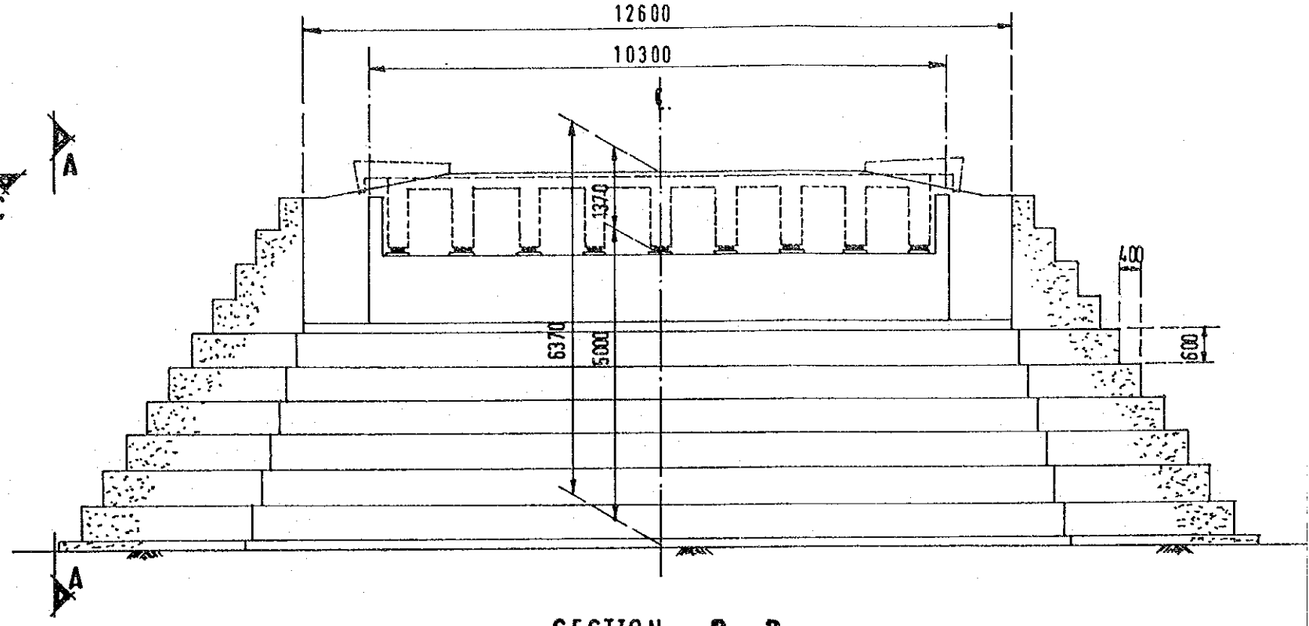
P. C. CABLE ARRANGEMENT

BRIDGE NO.	ROUTE BRIDGE NAME
9	BID-BIO-SUR SRQ-23/600-12

Fig 4.46 General View of Br.No.9

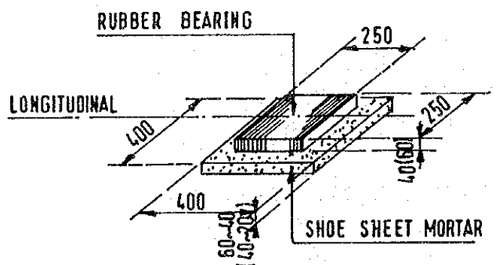


SECTION A - A



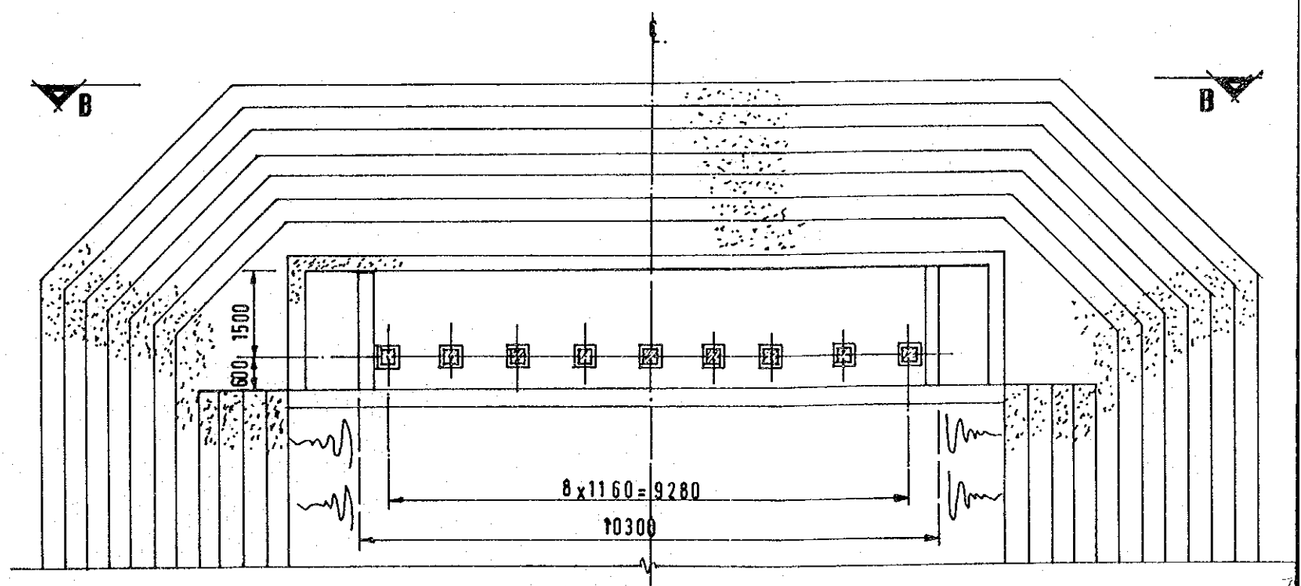
SECTION B - B

(A1) ABUTMENT

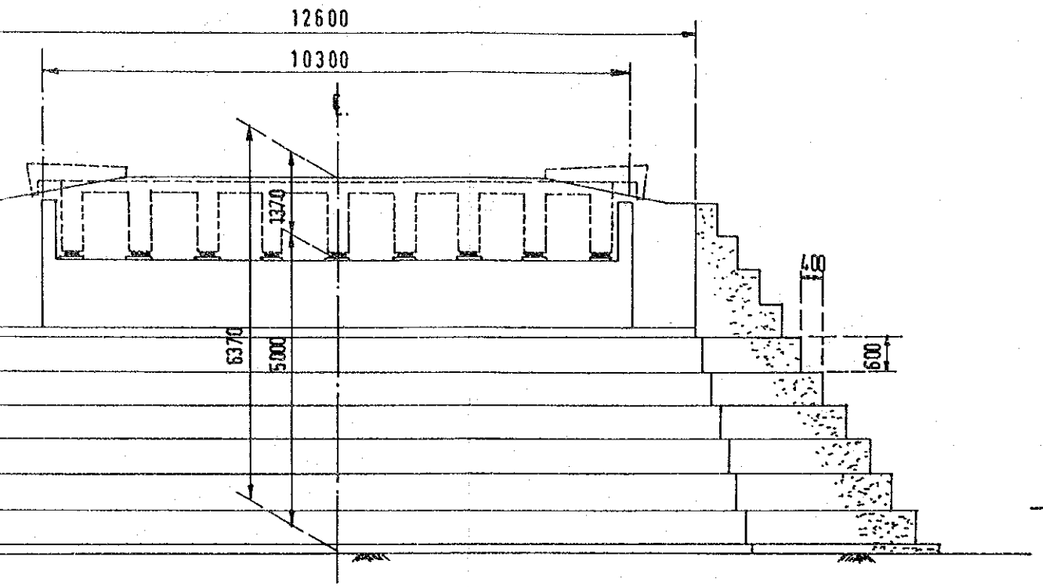


RUBBER BEARING SCALE 1 : 20

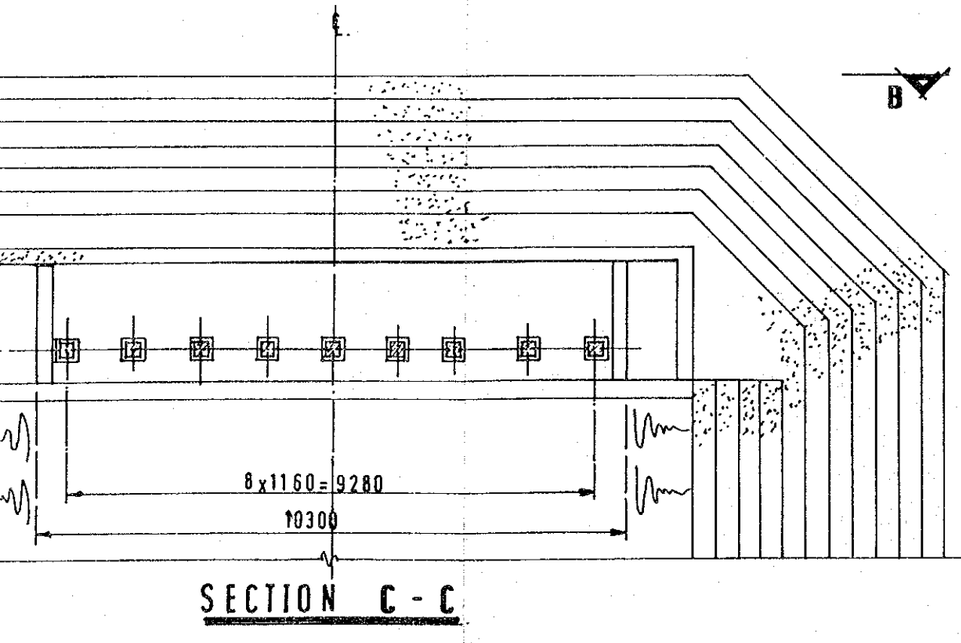
NOTE : ( ) SHOWS
A2 ABUTMENT



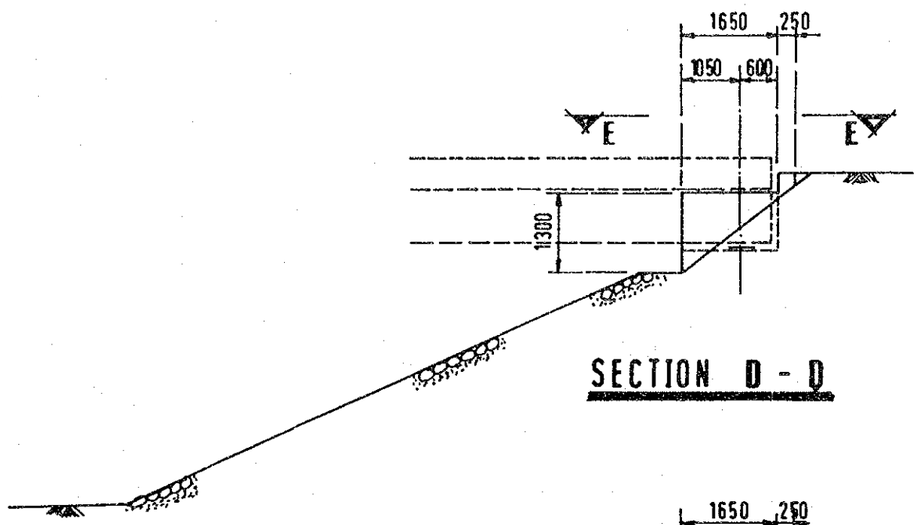
SECTION C - C



SECTION B - B

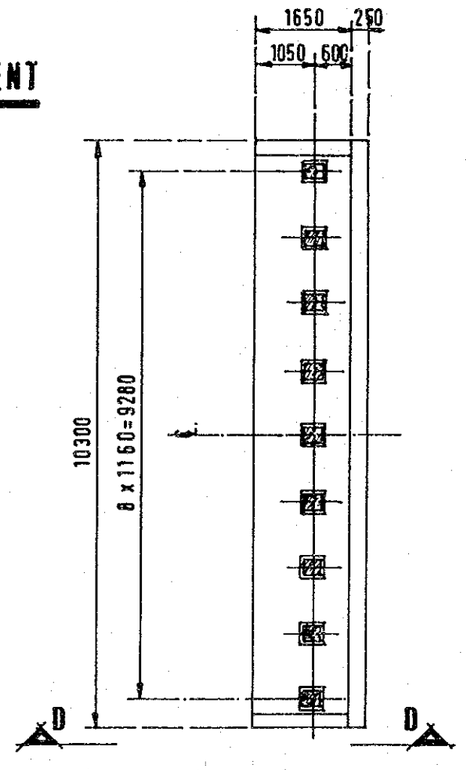


SECTION C - C



SECTION D - D

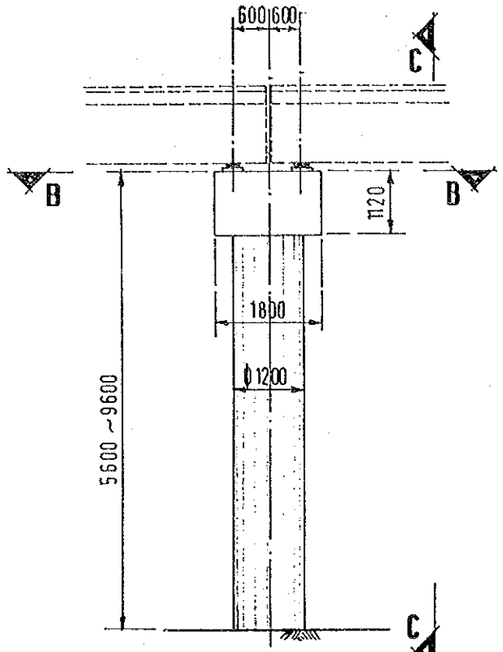
(A2) ABUTMENT



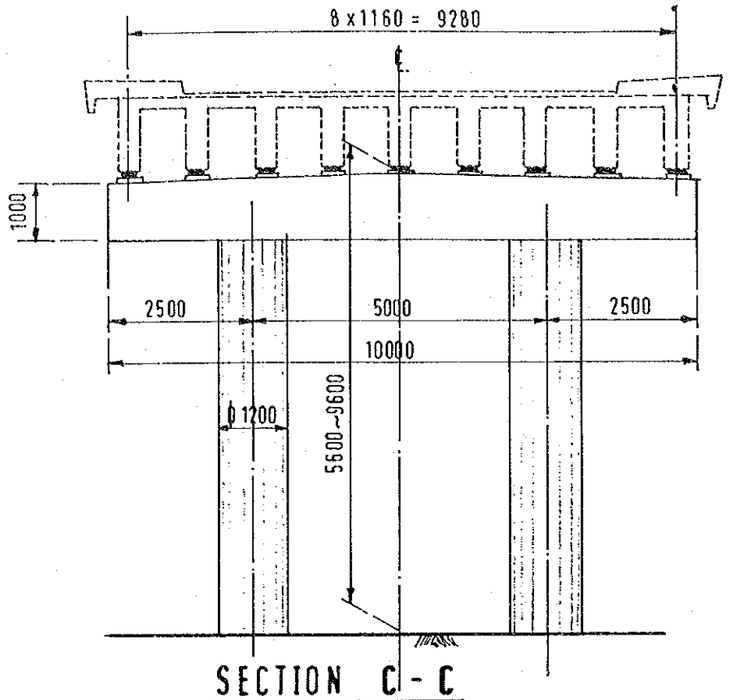
SECTION E - E

BRIDGE NO.	ROUTE BRIDGE NAME
9	BID BID SUR SRQ-23/600-12

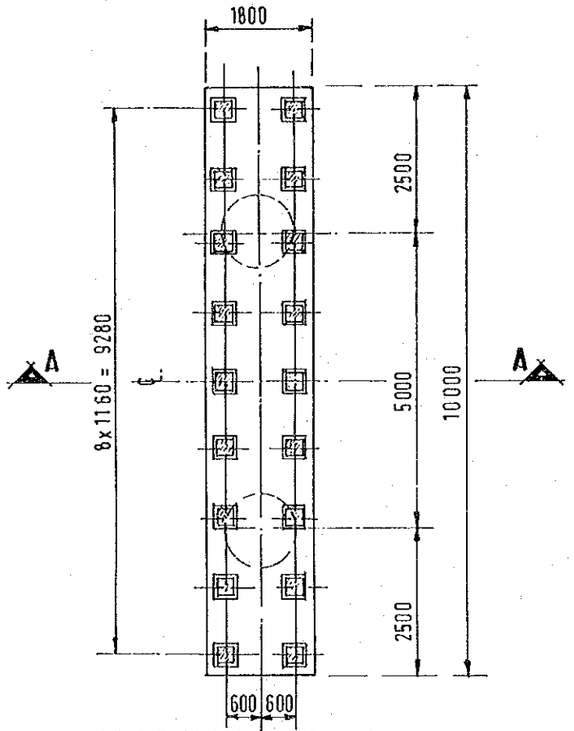
Fig 4.47 General View of Br.No.9



SECTION A-A

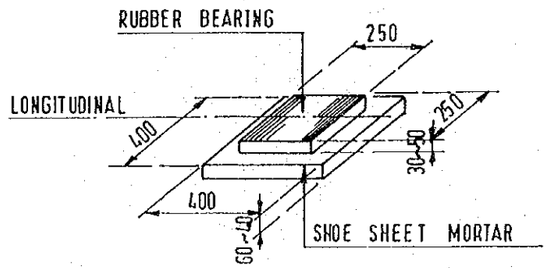


SECTION C-C



SECTION B-B

PIER SCALE 1:100



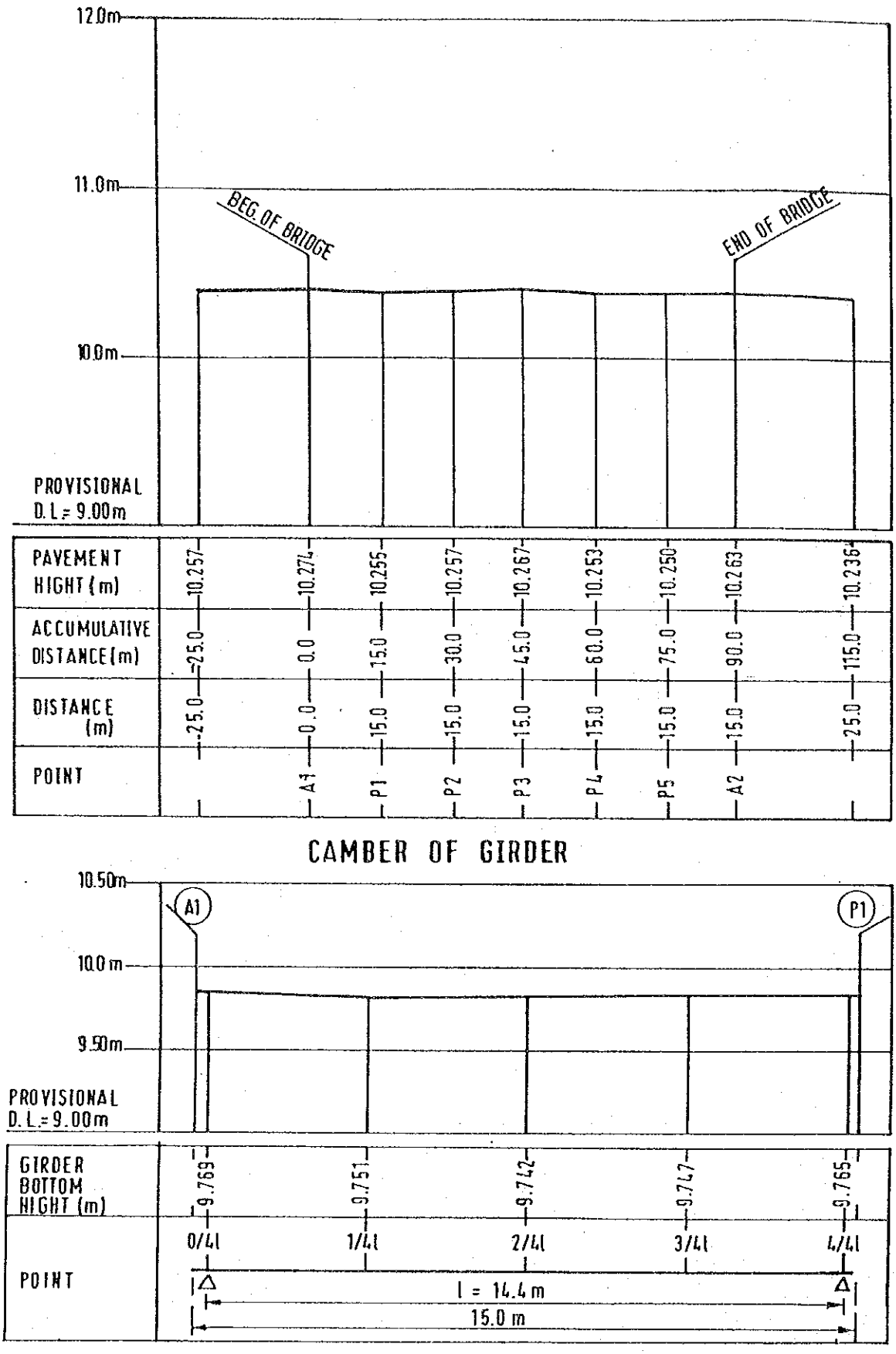
RUBBER BEARING SCALE 1:20

BRIDGE NO.	ROUTE BRIDGE NAME
9	BID-BID-SUR SRQ-23/600-12

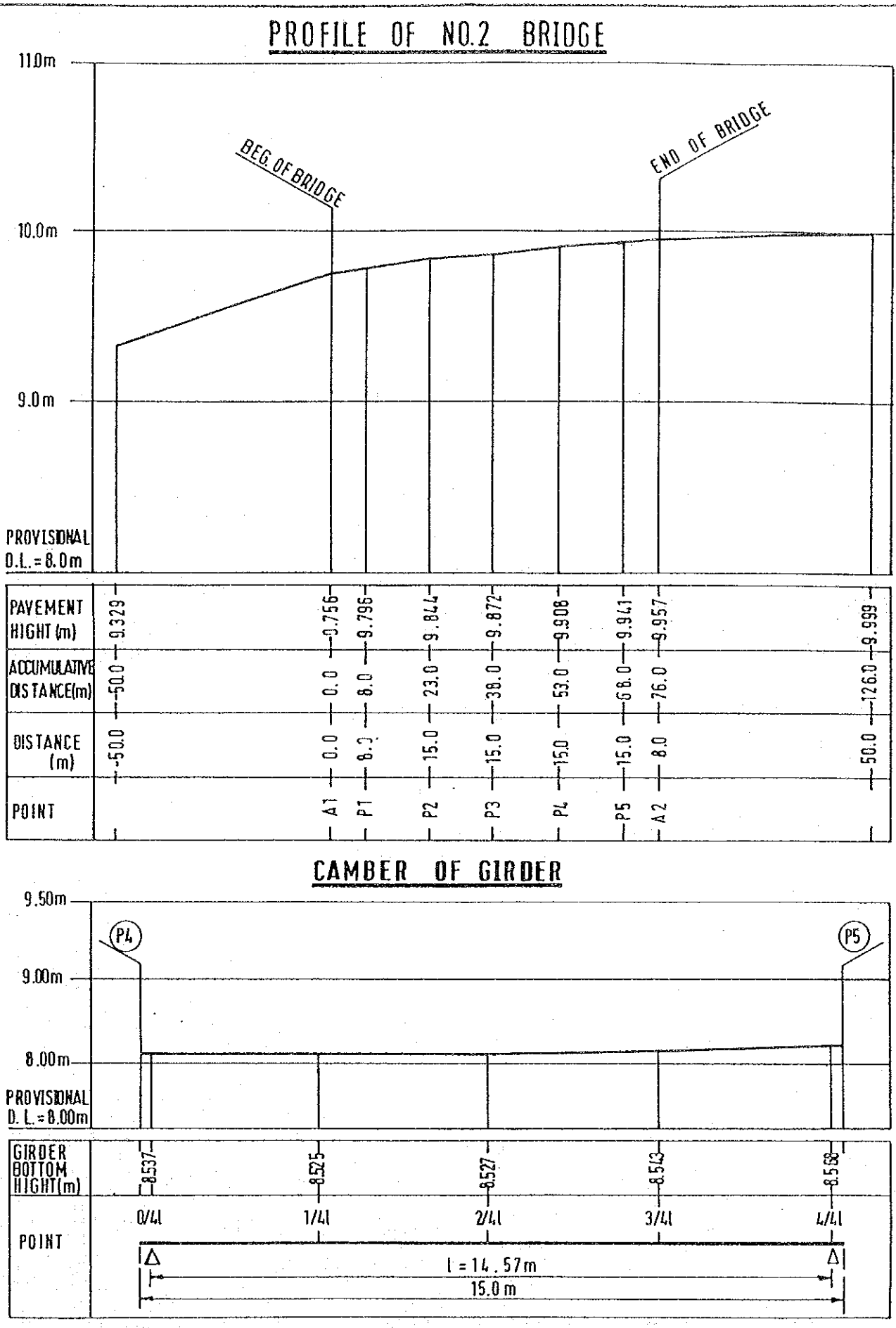
Fig 4.48 General View of Br.No.9

4.2.2 The Survey Data for Longitudinal Sections and Bridge Cambers

The results of the survey data for longitudinal sections and bridge cambers are summarized in Fig. 4.49 through Fig. 4.57.

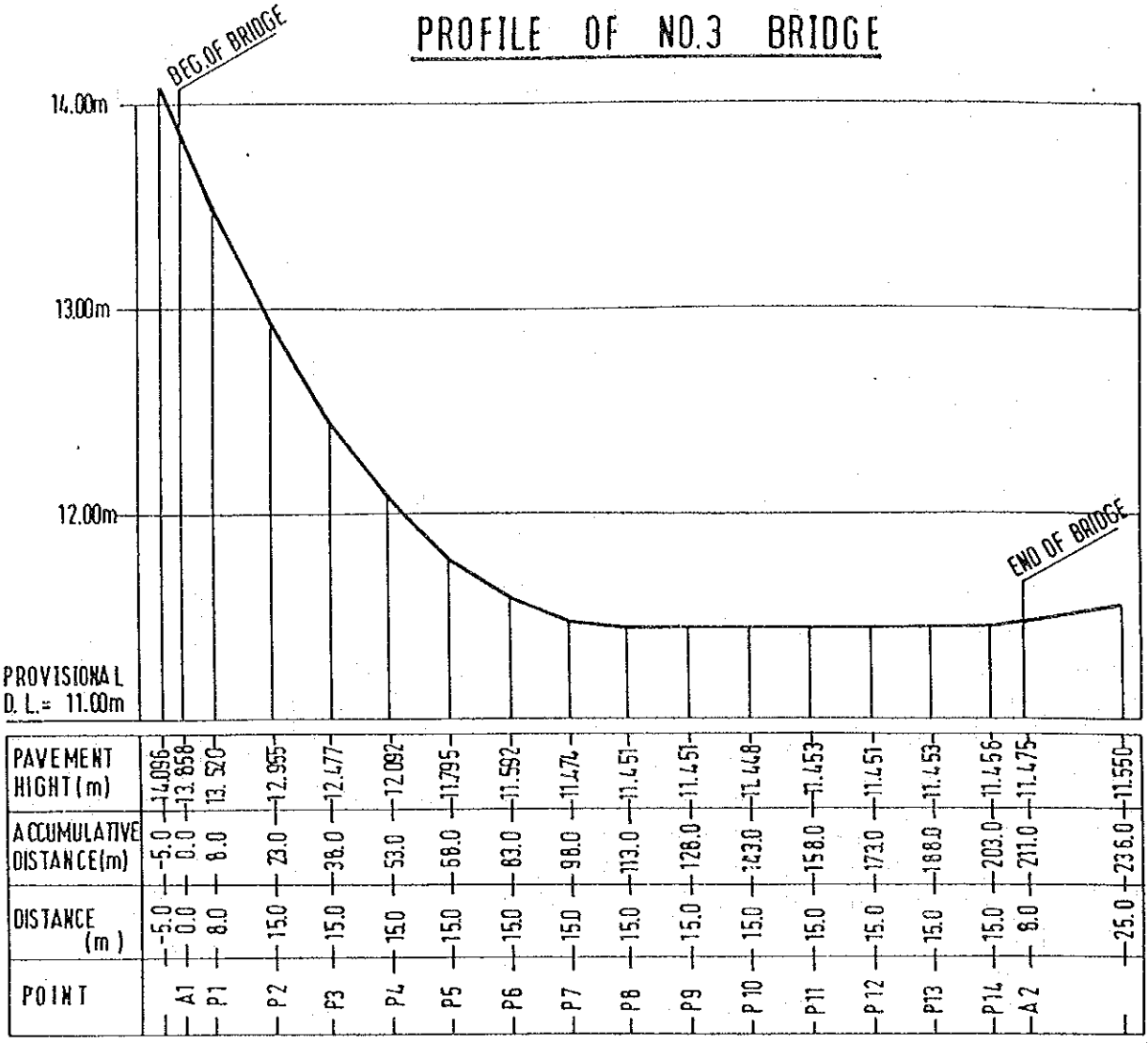


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.49 Profile and Camber of Br.No.1



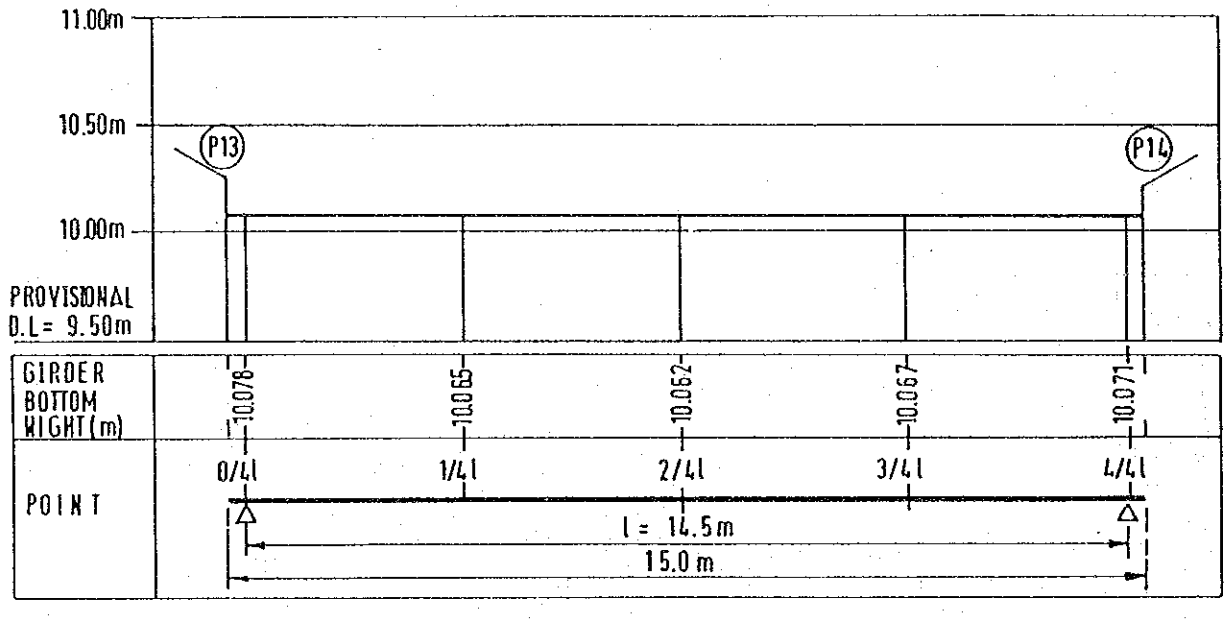
THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.50 Profile and Camber of Br.No.2

PROFILE OF NO.3 BRIDGE



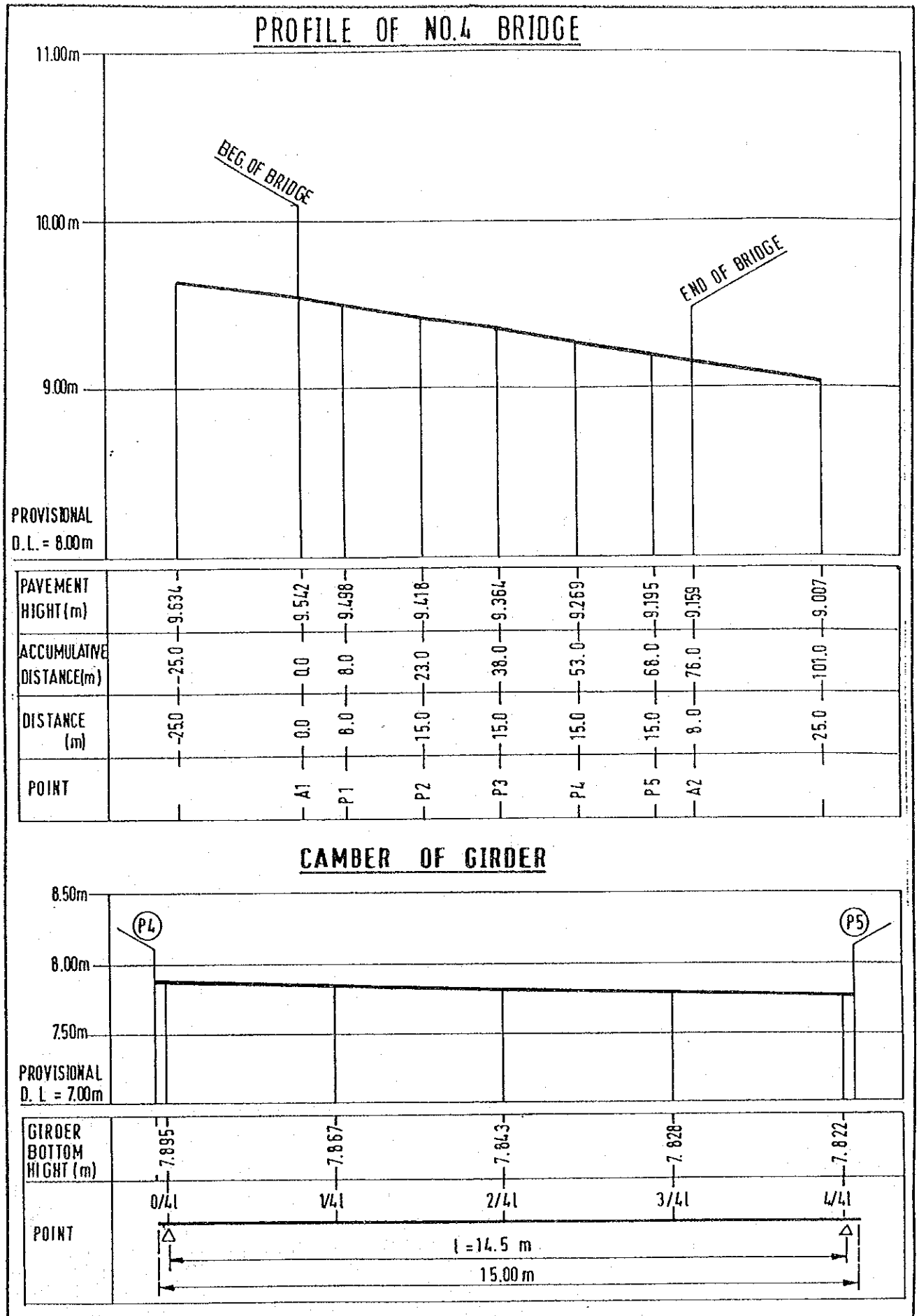
POINT	A1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	A2	
DISTANCE (m)	-5.0	0.0	8.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	8.0	25.0
ACCUMULATIVE DISTANCE(m)	-5.0	0.0	8.0	23.0	38.0	53.0	68.0	83.0	98.0	113.0	128.0	143.0	158.0	173.0	188.0	203.0	211.0	236.0
PAVEMENT HIGHT(m)	14.096	13.858	13.520	12.955	12.477	12.092	11.795	11.592	11.474	11.451	11.451	11.448	11.453	11.451	11.453	11.456	11.475	11.550

CAMBER OF GIRDER



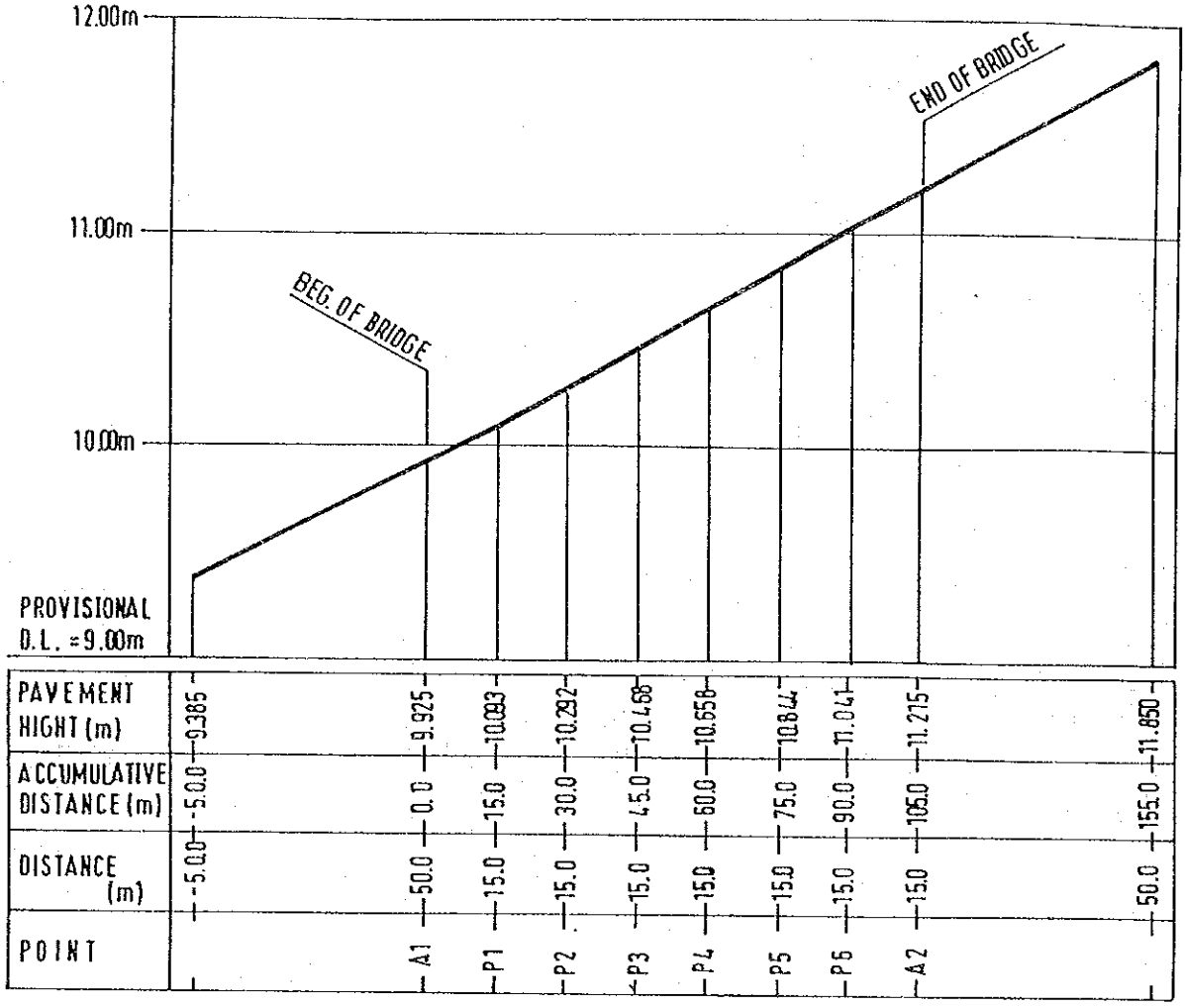
POINT	0/4l	1/4l	2/4l	3/4l	4/4l
GIRDER BOTTOM HIGHT(m)	10.078	10.065	10.052	10.067	10.071

THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.51 Profile and Camber of Br.No.3

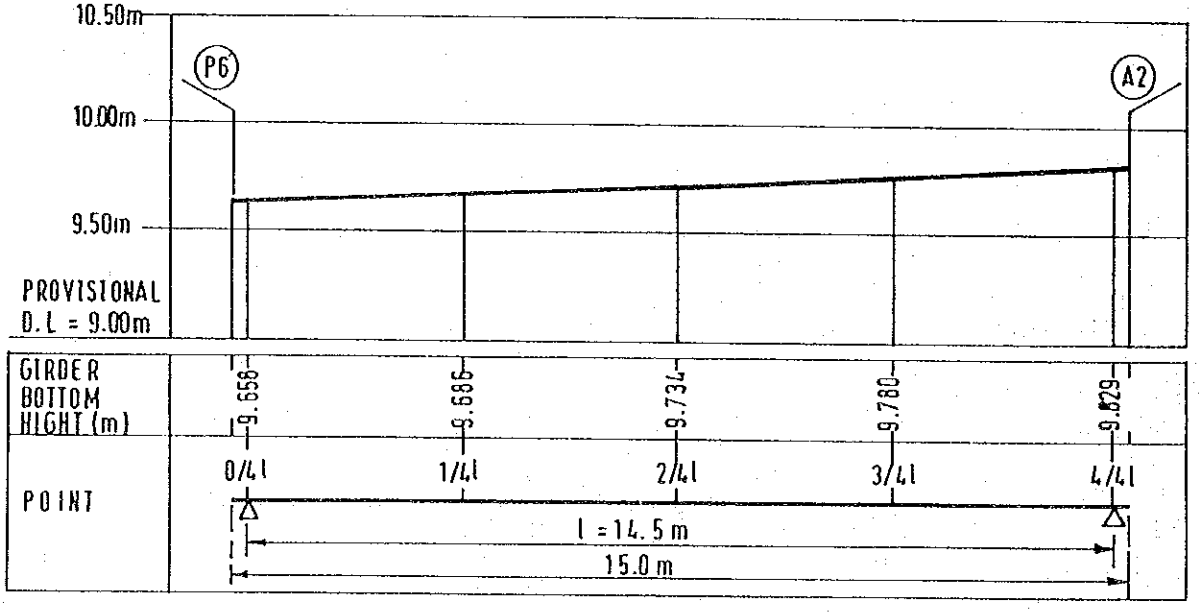


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.52 Profile and Camber of Br.No.4

PROFILE OF NO.5 BRIDGE

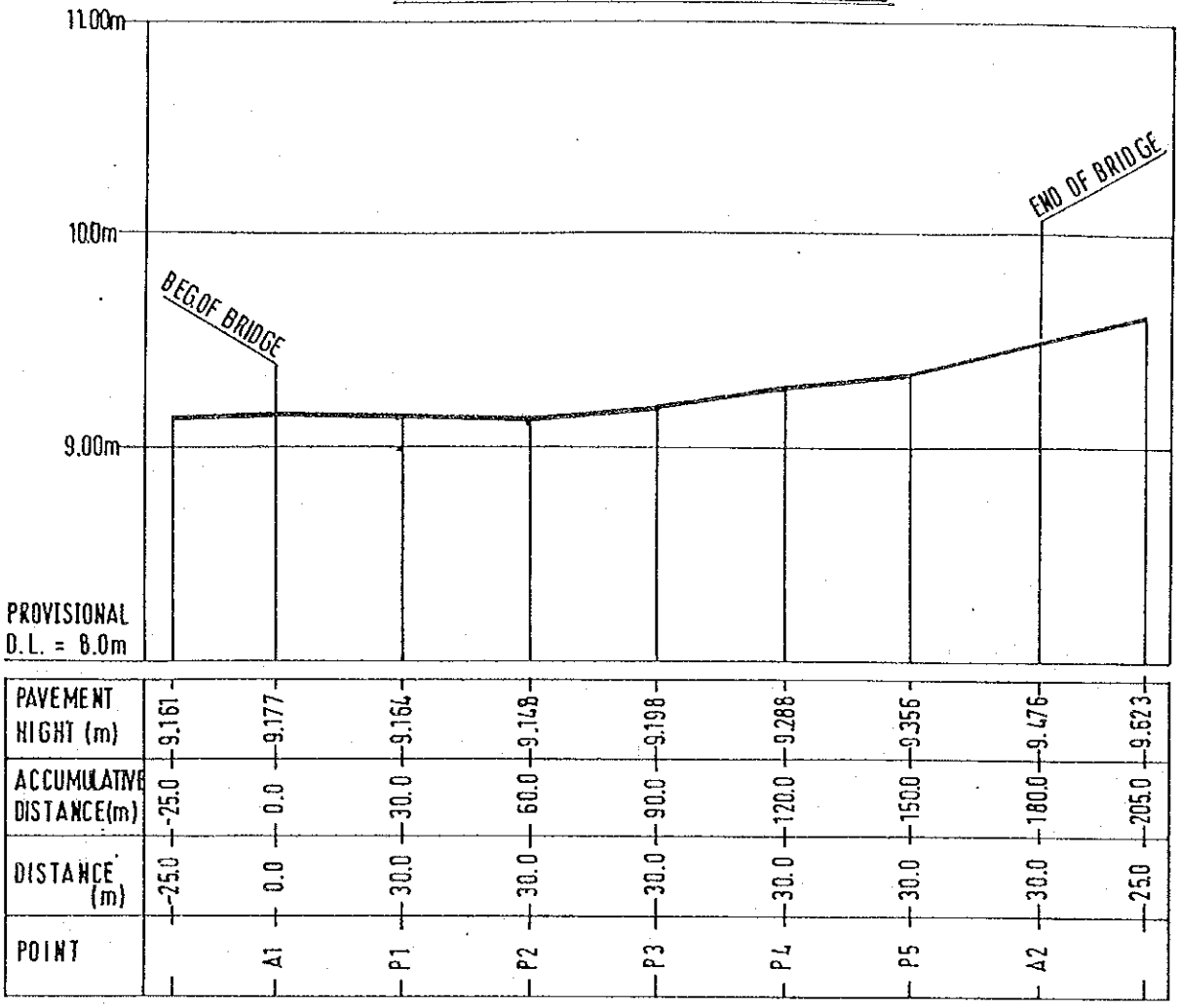


CAMBER OF GIRDER

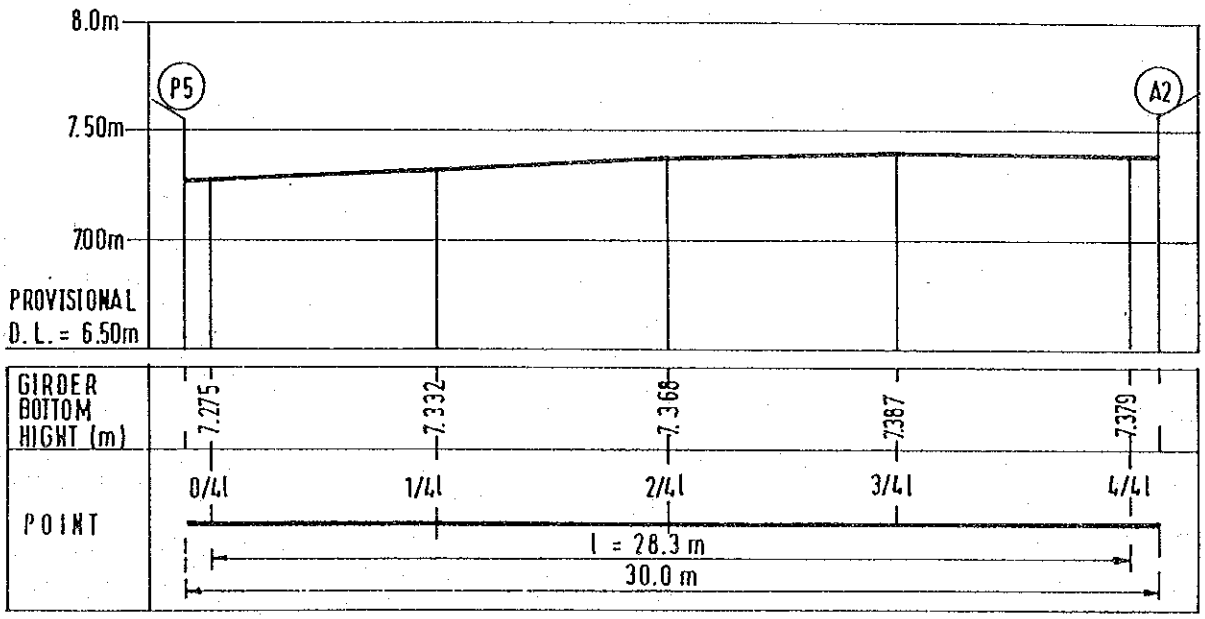


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.53 Profile and Camber of Br.No.5

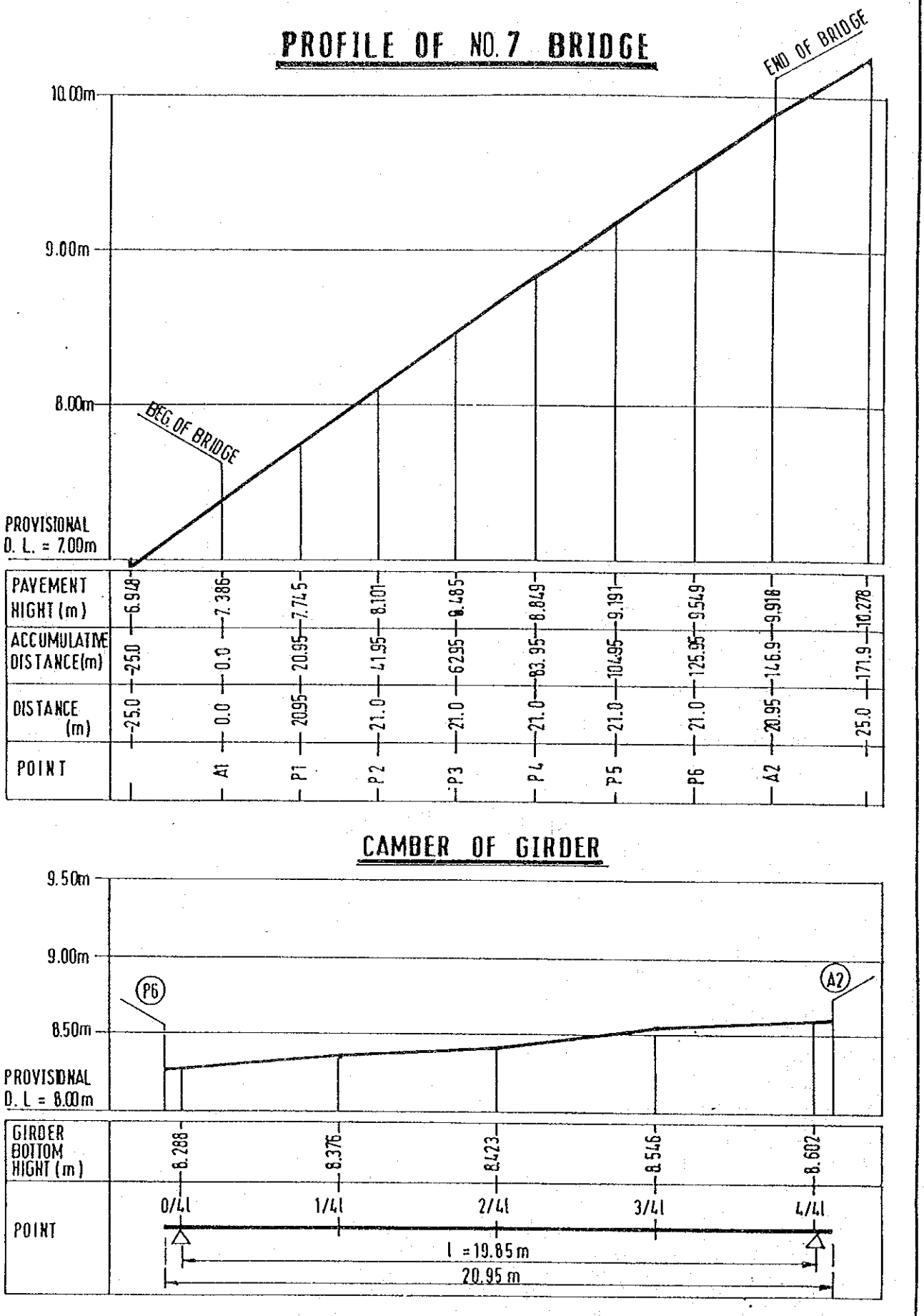
PROFILE OF NO. 6 BRIDGE



CAMBER OF GIRDER

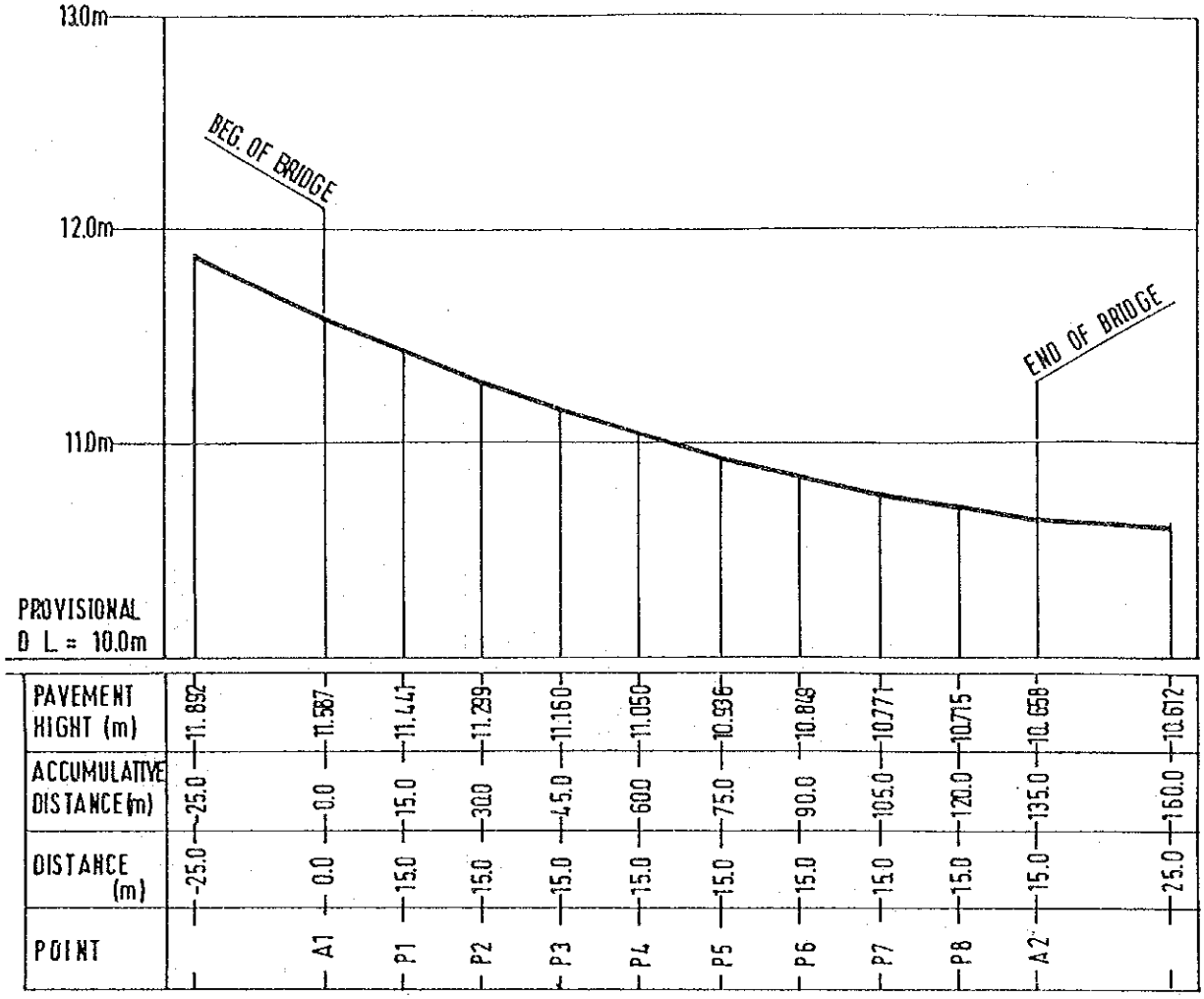


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.54 Profile and Camber of Br.No.6

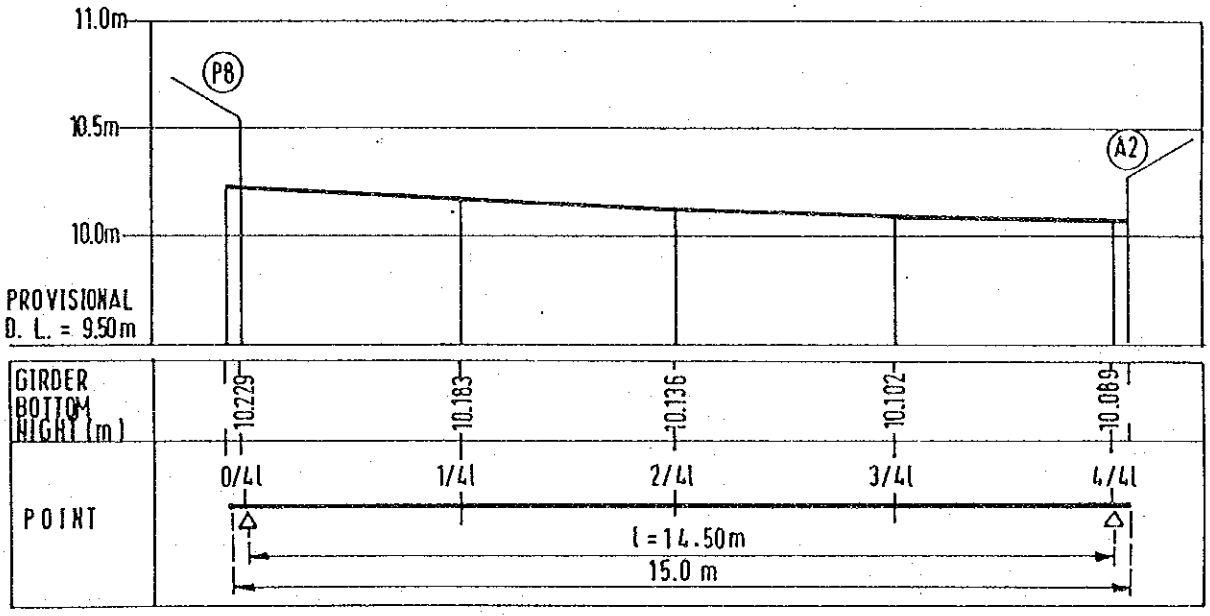


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.55 Profile and Camber of Br.No.7

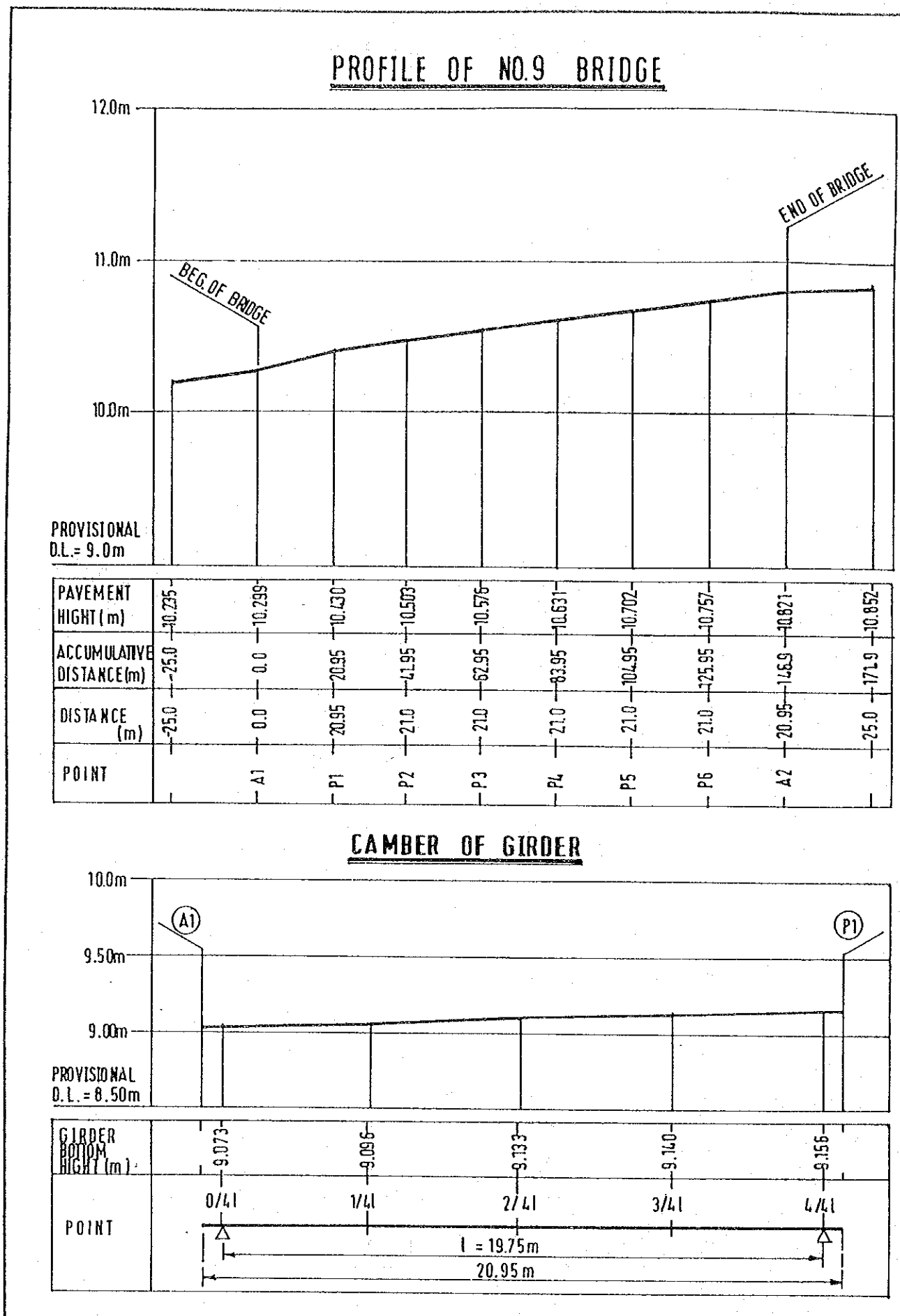
PROFILE OF NO. 8 BRIDGE



CAMBER OF GIRDER



THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.56 Profile and Camber of Br.No.8



THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.57 Profile and Camber of Br.No.9

4.2.3 The Results of Concrete Strength

The results of concrete strength by concrete core test and Schmidt Hammer test are summarized in Table 4.5 through Table 4.16.

Table 4.5 Concrete Core Test Results

For Bridge No. 1

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
20 BR1-1 Φ=7.35xL=14.85	2464	406.87	320,267	–	1.85	2.17	
21 BR1-2 Φ=7.35xL=14.78	2500	387.49	334,379	–	1.73	2.31	
22 BR1-3 Φ=7.35xL=14.73	2536	355.88	337,200	–	1.71	2.11	
23 BR1-4 Φ=7.35xL=14.81	2500	–	–	30.69	1.85	2.06	
24 BR1-5 Φ=7.35xL=14.94	2475	–	–	22.64	1.69	2.18	
25 BR1-6 Φ=7.35xL=14.95	2484	–	–	25.70	1.66	2.02	
36 BR1 (slab) Φ=4.55xL=9.69	2285	*197.83	–	–	–	–	* No count
Average Beam	2493	383	3.3062x10^5	26	1.7	2.1	
Average Slab	2285						

Table 4.6 Concrete Core Test Results

For Bridge No. 2

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
6 G1-1 Φ=9.95xL=19.95	2308	–	–	17.13	4.17	1.14	
7 G1-2 Φ=9.96xL=19.94	2245	–	–	23.66	4.27	1.13	
8 G1-3 Φ=9.94xL=19.89	2276	–	–	23.66	4.62	1.14	
10 G2-1 Φ=9.95xL=19.60	2395	–	–	22.74	3.62	1.47	
11 G2-2 Φ=9.94xL=19.85	2425	–	–	20.09	1.04	1.11	* No count
12 G2-3 Φ=9.95xL=19.80	2401	–	–	24.42	3.90	1.09	
1 G3-1 Φ=9.95xL=19.85	2361	345.15	242,249	–	4.24	2.07	
5 G3-2 Φ=9.95xL=19.86	2358	361.60	197,733	–	3.67	1.23	
9 G3-3 Φ=9.95xL=19.93	2355	391.61	225,945	–	3.80	1.89	

Table 4.6 Concrete Core Test Results (Cont'd)

For Bridge No. 2

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
4 G4-1 Φ=9.95xL=19.90	2361	358.60	211,903	–	3.87	1.66	
2 G4-2 Φ=9.95xL=19.85	2405	383.10	230,313	–	3.82	1.53	
3 G4-3 Φ=9.95xL=19.87	2391	396.29	222,945	–	3.43	1.83	
32 BR2-1 (Slab) Φ=4.55xL=9.71	2678	371.18	–	–	2.20	2.26	
33 BR2-2 (Slab) Φ=4.55xL=9.63	2336	372.20	–	–	–	–	
Average Beam	2357	373	2.218x10^5	22	3.9	1.4	
Average Slab	2507	372	–	–	2.2	2.3	

Table 4.7 Concrete Core Test Results

For Bridge No. 3

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
1 Br 3-1 Φ=9.95xL=9.79	2457	318.98	–	–	3.67	0.15	
2 Br 3-2 Φ=9.95xL=19.69	2458	247.41	273,058	–	3.81	0.24	
3 Br 3-3 Φ=9.95xL=19.83	2447	296.50	*81,684	–	3.91	0.94	* No count
4 Br 3-4 Φ=9.95xL=19.88	2423	–	–	23.63	3.93	0.08	
5 Br 3-5 Φ=9.95xL=19.85	2466	–	–	28.59	3.47	0.03	
6 Br 3-6 Φ=9.95xL=19.85	2467	–	–	30.20	3.44	0.08	
7 Br 3-7 (Slab) Φ=4.65xL=9.42	2584	*490.31	–	–	1.97	1.60	* No count
8 Br 3-8 (Slab) Φ=4.64xL=9.70	2475	244.52	–	–	2.27	2.12	
Average Beam	2453	288	2.731x10^5	27	3.7	0.25	
Average Slab	2530	245	–	–	2.1	1.9	

Table 4.8 Concrete Core Test Results

For Bridge No. 4

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
20 Br 4-1 Φ=9.94xL=19.98	2303	371.73	223,880	–	4.40	1.43	
21 Br 4-2 Φ=9.94xL=19.68	2358	363.87	240,466	–	4.23	1.13	
22 Br 4-3 Φ=9.95xL=19.84	2336	354.83	237,377	–	3.83	1.39	
23 Br 4-4 Φ=9.94xL=20.03	2359	345.96	230,695	–	4.04	1.01	
24 Br 4-5 Φ=9.95xL=19.95	2396	–	–	35.4	3.90	1.34	
25 Br 4-6 Φ=9.95xL=19.94	2390	–	–	29.8	3.80	0.94	
26 Br 4-7 Φ=9.95xL=19.98	2399	–	–	21.8	3.80	1.26	
27 Br 4-8 Φ=9.95xL=19.83	2403	–	–	23.9	3.85	0.82	
28 Br 4-9 (Slab) Φ=4.58xL=8.18	2515	275.80	–	–	–	–	
29 Br 4-10 (Slab) Φ=4.58xL=9.85	2330	196.65	–	–	–	–	
Average Beam	2368	359	$2.331x10^5$	28	4.0	1.2	
Average Slab	2423	236	–	–	–	–	

Table 4.9 Concrete Core Test Results

For Bridge No. 5

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
13 G 4-1 Φ=9.95xL=19.85	2314	–	–	22.54	4.03	1.28	
14 G 4-2 Φ=9.96xL=19.85	2290	–	–	28.86	4.19	1.06	
15 G 4-3 Φ=9.96xL=19.90	2315	–	–	19.07	3.60	1.73	
16 G 4-4 Φ=9.95xL=19.78	2322	345.94	220,529	–	3.97	1.92	
17 G 3-1 Φ=9.95xL=19.65	2303	286.00	181,516	–	4.71	2.08	
18 G 4-6 Φ=9.95xL=17.60	2327	336.85	236,072	–	4.36	2.08	
19 G 4-6 Φ=9.95xL=7.60	2388	370.04	–	–	4.07	1.71	
34 Br 5-1 (Slab) Φ=4.55xL=9.68	2489	306.94	–	–	–	–	
35 Br 5-2 Φ=4.55xL=4.35	2368	220.26	–	–	–	–	
Average Beam	2323	335	$2.127x10^5$	23	4.1	1.7	
Average Slab	2429	264	–	–	–	–	

Table 4.10 Concrete Core Test Results

For Bridge No. 6

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
30 Br 6-1 Φ=9.95xL=19.60	2370	315.19	313,560	–	4.28	0.94	
31 Br 6-2 Φ=9.95xL=19.65	2375	336.32	290,828	–	3.70	1.27	
32 Br 6-3 Φ=9.95xL=19.45	2374	356.97	306,973	–	3.69	1.28	
33 Br 6-4 Φ=9.95xL=19.65	2376	–	–	30.41	3.50	1.21	
34 Br 6-5 Φ=9.95xL=19.45	2324	–	–	25.74	3.92	1.56	
35 Br 6-6 Φ=9.95xL=19.75	2297	–	–	26.59	4.27	1.09	
36 Br 6-7 (Slab) Φ=4.58xL=9.05	2341	413.48	–	–	3.83	2.95	
37 Br 6-8 (Slab) Φ=4.58xL=8.85	2315	243.28	–	–	4.54	2.12	
Average Beam	2353	336	$3.038x10^5$	28	3.9	1.2	
Average Slab	2328	328	–	–	4.2	2.5	

Table 4.11 Concrete Core Test Results

For Bridge No. 7

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
9 Br 7-1 Φ=9.95xL=16.66	2445	347.10	–	–	2.66	1.70	
10 Br 7-2 Φ=9.95xL=19.98	2449	330.20	188,837	–	3.15	0.51	
11 Br 7-3 Φ=9.95xL=20.06	2424	259.91	*147,190	–	3.29	0.45	* No count
12 Br 7-4 Φ=9.95xL=19.98	2435	331.64	204,472	–	3.37	0.21	
13 Br 7-5 Φ=9.95xL=20.06	2434	–	–	26.92	3.17	0.43	
14 Br 7-6 Φ=9.95xL=10.11	2443	329.01	–	–	3.60	0.83	
15 Br 7-7 Φ=9.95xL=20.04	2432	–	–	27.49	3.37	0.18	
16 Br 7-8 Φ=9.94xL=20.05	2411	–	–	26.59	3.56	0.14	
17 Br 7-9 (Slab) Φ=9.94xL=9.43	2427	*436.17	–	–	2.45	1.14	* No count
18 Br 7-10 (Slab) Φ=7.35xL=8.21	2522	308.80	–	–	1.75	2.28	
19 Br 7-11 (Slab) Φ=7.34xL=8.13	2562	357	–	–	2.14	1.78	
Average Beam	2434	320	$1.967x10^5$	27	3.3	0.56	
Average Slab	2504	333	–	–	2.1	1.7	

Table 4.12 Concrete Core Test Results

For Bridge No. 8

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
26 Br 8-1 Φ=9.95xL=19.51	2260	263.09	236,460	–	4.32	2.46	
27 Br 8-2 Φ=9.95xL=19.71	2275	291.64	246,959	–	3.94	2.50	
28 Br 8-3 Φ=9.95xL=19.70	2245	260.03	244,352	–	4.82	2.80	
29 Br 8-4 Φ=9.95xL=19.68	2249	–	–	17.54	4.89	2.92	
30 Br 8-5 Φ=9.95xL=17.83	2208	–	–	20.29	4.97	2.64	
31 Br 8-6 Φ=9.95xL=16.66	2241	–	–	20.70	4.42	2.70	
Average Beam	2246	271	2.426x10^5	19	4.6	2.6	

Table 4.13 Concrete Core Test Results

For Bridge No. 9

Core No. Position Size	Unit Weight kg/cm^3	Compressive Strength kg/cm^2	Modulus of Elasticity kg/cm^2	Tensile Strength kg/cm^2	Ratio of Absorption %	Moisture Content %	Remarks
38 Br 9-1 Φ=9.94xL=9.95	2386	341.85	357,639	–	1.63	0.14	
39 Br 9-2 Φ=7.34xL=14.60	2368	–	–	23.44	1.88	0.17	
40 Br 9-3 Φ=7.35xL=14.80	2398	–	–	27.99	1.96	0.03	
41 Br 9-4 Φ=7.34xL=14.62	2397	264.12	*260,983	–	1.22	0.41	* No count
42 Br 9-5 Φ=7.34xL=14.57	2420	279.79	385,958	–	1.14	0.44	
43 Br 9-6 Φ=7.34xL=14.51	2396	–	–	38.76	1.56	0.00	
44 Br 9-7 (Slab) Φ=4.57xL=4.51	2339	242.32	–	–	2.37	2.37	
45 Br 9-8 (Slab) Φ=4.57xL=8.82	2431	179.09	–	–	1.75	2.48	
Average Beam	2394	295	3.718x10^5	30	1.6	0.20	
Average Slab	2385	211	–	–	2.1	2.4	

Table 4.14 Carbonation Test Results

Bridge No.	Member	Depth of Carbonation (mm)								Remarks
		Core 1	Core 2	Core 3	Core 4	Core 5	Core 6	Core 7	Average	
1	Beam	5.0	7.8	6.6	4.6	3.2	6.4		5.6	6 cores
	Slab									
2	Beam	15.4	16.0	15.4	15.0	15.5	16.0	14.2	–	
	Slab	2.5	2.0						2.2	2 cores
2	Beam	16.5	15.0	15.0	15.7	15.8			15.5	12 cores
	Slab									
3	Beam	18.4	20.0	20.0	18.4	16.8	14.8		18.1	6 cores
	Slab	0	0							2 cores
	Beam	(29.1)	(31.1)	(33.7)	(41.9)				(34.0)	(Crack Parts)
	Slab									
4	Beam G1	16.1	17.8	20.5	15.5	17.8	13.3		16.8	
	Slab	21.0	22.9						22.0	2 cores
4	Beam G2	5.0	4.3	4.4	5.0	6.0	6.3		5.2	12 cores
	(Beam G1) (Beam G2)	(32.1) (6.9)	(45.5) (7.4)						(38.8) (7.2)	( ) Crack parts
5	Beam	15.0	16.0	16.0	17.0	*0	20.0	15.5	16.6	7 cores * No count
	Slab	2.5	3.0						2.7	2 cores
6	Beam	19.4	20.7	21.0	19.8	20.9	16.8		19.8	8 cores
	Slab	2.9	4.4	3.7					3.7	3 cores
7	Beam	4.5	3.8	4.0	7.0	5.0	5.5	4.2		
	Slab	1.5	1.8	2.0					1.8	3 cores
	Beam	3.8							4.7	8 cores
	Slab									
8	Beam	10.0	12.0	12.0	10.0	15.0	18.0		12.8	6 cores
	Slba									
9	Beam G7 (L)	14.7	14.3	12.6					13.9	
	Slab G7-G8	0	0						0	2 cores
9	Beam G8 (R)	13.7	10.8	11.5					12.0	6 cores
	Slab									

Table 4.15 Schmidt Hammer Test for Concrete Structure

Bridge No.	Location (Beam, Slab, etc.)	Reaction Degree (Ro)	Inclination Angle (±α°)	Ratio of Concrete Age (αn)	Concrete Strength (kg/cm^2)		Remarks
					Zm (Graph)	F=Zm.αn	
1	Beam G1	58.3	+90	0.63	600 more	378	Average 378 kg/cm^2 more
	Beam G2	62.0	+90	0.63	600 more	378	
	Beam G3	59.9	+90	0.63	600 more	378	
	Beam G4	60.4	+90	0.63	600 more	378	
1	Slab G1-G2	61.0	+90	0.63	600 more	378	Average 378 kg/cm^2 more
	Slab G2-G3	61.2	+90	0.63	600 more	378	
	Slab G3-G4	60.8	+90	0.63	600 more	378	
1	Abutment A1	50.9	±0	0.63	530	334	Average 352 kg/cm^2
	Pier P1	54.1	±0	0.63	581	366	
	Column	53.0	±0	0.63	565	356	
2	Beam G1	49.0	±0	0.63	500	315	Average 311 kg/cm^2
	Beam G2	45.8	±0	0.63	445	280	
	Beam G3	49.1	±0	0.63	502	316	
	Beam G4	50.9	±0	0.63	530	334	
2	Slab G1-G2	50.1	+90	0.63	465	293	Average 291 kg/cm^2
	Slab G2-G3	49.9	+90	0.63	461	290	
	Slab G3-G4	50.0	+90	0.63	462	291	
2	Abutment A2	47.8	±0	0.63	480	302	Average 250 kg/cm^2
	Pier P4	40.7	±0	0.63	350	220	
	Beam	40.7	±0	0.63	362	228	

Table 4.15 Schmidt Hammer Test for Concrete Structure (Cont'd)

Bridge No.	Location (Beam, Slab, etc.)	Reaction Degree (Ro)	Inclination Angle (±α°)	Ratio of Concrete Age (αn)	Concrete Strength (kg/cm^2)		Remarks
					Zm (Graph)	F=Zm.αn	
3	Beam G1	43.52	±0	0.63	410	258	Average 278 kg/cm^2
	Beam G2	47.80	±0	0.63	480	302	
	Beam G3	46.83	±0	0.63	460	290	
	Beam G4	43.95	±0	0.63	415	261	
3	Slab G1-G2	53.79	+90	0.63	530	334	Average 335 kg/cm^2
	Slab G2-G3	56.15	+90	0.63	600	378	
	Slab G3-G4	50.40	+90	0.63	465	293	
3	Cross Beam P13~P14 (G3~G4)	38.61	+90	0.63	330	208	Average 244 kg/cm^2
	Abutment A2	40.09	±0	0.63	355	224	
3	Pier P13 (R)	41.99	±0	0.63	385	243	
	Pier P14 (L)	44.14	±0	0.63	420	265	
4	Beam G1	39.8	±0	0.63	350	221	Average 285 kg/cm^2
	Beam G2	50.0	±0	0.63	515	324	
	Beam G3	50.3	±0	0.63	520	328	
	Beam G4	44.7	±0	0.63	425	268	
4	Slab G1-G2	52.4	+90	0.63	510	321	Average 343 kg/cm^2
	Slab G2-G3	57.7	+90	0.63	600	378	
	Slab G3-G4	53.5	+90	0.63	525	331	
4	Abutment A2	51.7	±0	0.63	545	343	Average 307 kg/cm^2
	Pier P3	47.7	±0	0.63	475	299	
	Beam	45.8	±0	0.63	445	280	

Table 4.15 Schmidt Hammer Test for Concrete Structure (Cont'd)

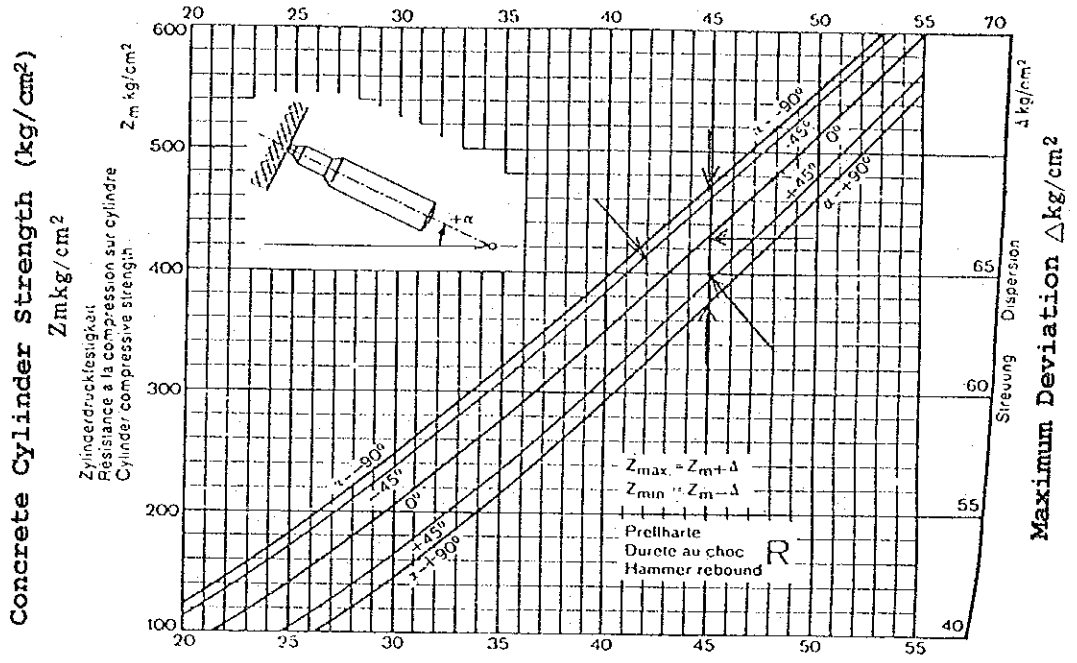
Bridge No.	Location (Beam, Slab, etc.)	Reaction Degree (Ro)	Inclination Angle (±α°)	Ratio of Concrete Age (αn)	Concrete Strength (kg/cm^2)		Remarks
					Zm (Graph)	F=Zm.αn	
5	Beam G1	50.8	±0	0.63	528	333	Average 331 kg/cm^2
	Beam G2	45.9	±0	0.63	448	282	
	Beam G3	52.4	±0	0.63	560	353	
	Beam G4	53.0	±0	0.63	565	356	
5	Slab G1-G2	49.2	+90	0.63	450	284	Average 322 kg/cm^2
	Slab G2-G3	51.0	+90	0.63	481	303	
	Slab G3-G4	58.2	+90	0.63	600	378	
5	Abutment A2	44.9	±0	0.63	430	271	Average 263 kg/cm^2
	Pier P5	42.2	±0	0.63	385	243	
	Column	45.1	±0	0.63	435	274	
6	Beam G1	56.1	±0	0.63	600	378	Average 378 kg/cm^2
	Beam G2	56.8	±0	0.63	600	378	
	Beam G3	56.7	±0	0.63	600	378	
	Beam G4	60.1	±0	0.63	600	378	
	Beam G5	60.6	±0	0.63	600	378	
6	Slab G1-G2	54.9	+90	0.63	548	345	Average 308 kg/cm^2
	Slab G2-G3	47.7	+90	0.63	420	265	
	Slab G3-G4	50.8	+90	0.63	475	299	
	Slab G4-G5	52.7	+90	0.63	510	321	
6	Abutment A2	51.4	±0	0.63	540	340	Average 310 kg/cm^2
	Beam	46.8	±0	0.63	460	290	
	Pier P5 (1)	47.7	±0	0.63	475	299	

Table 4.15 Schmidt Hammer Test for Concrete Structure (Cont'd)

Bridge No.	Location (Beam, Slab, etc.)	Reaction Degree (Ro)	Inclination Angle (±α°)	Ratio of Concrete Age (αn)	Concrete Strength (kg/cm²)		Remarks
					Zm (Graph)	F=Zm.αn	
7	Beam G1	46.5	±0	0.63	455	287	Average 278 kg/cm²
	Beam G2	49.7	±0	0.63	510	321	
	Beam G3	43.6	±0	0.63	410	258	
	Beam G4	44.4	±0	0.63	425	268	
	Beam G4-G5	45.0	+90	0.63	375	236	Precast concrete Average 271 kg/cm²
	Beam G5 (L)	38.9	±0	0.63	335	211	
	Beam G6 (L)	49.4	±0	0.63	505	318	
	Beam G7 (R)	49.6	±0	0.63	510	321	
7	Slab G1-G2	47.6	+90	0.63	420	265	
	Slab G2-G3	50.1	+90	0.63	465	293	
	Slab G3-G4	46.7	+90	0.63	405	255	
7	Abutment A2	37.4	±0	0.63	315	198	Average 257 kg/cm²
	Pier P6 (L)	47.6	±0	0.63	475	299	
	Pier P6 (R)	45.4	±0	0.63	435	274	
8	Beam G1	42.8	±0	0.63	400	252	Average 269 kg/cm²
	Beam G2	43.3	±0	0.63	410	258	
	Beam G3	48.5	±0	0.63	490	309	
	Beam G4	43.5	±0	0.63	410	258	
8	Slab G1-G2	46.5	+90	0.63	405	255	Average 252 kg/cm²
	Slab G2-G3	47.9	+90	0.63	415	261	
	Slab G3-G4	45.1	+90	0.63	380	239	
8	Abutment A2	48.1	±0	0.63	481	303	Average 271 kg/cm²
	Pier P8	41.6	±0	0.63	379	239	
	Beam	40.9	±0	0.63	410	258	

Table 4.15 Schmidt Hammer Test for Concrete Structure (Cont'd)

Bridge No.	Location (Beam, Slab, etc.)	Reaction Degree (Ro)	Inclination Angle (±α°)	Ratio of Concrete Age (αn)	Concrete Strength (kg/cm^2)		Remarks
					Zm (Graph)	F=Zm.αn	
9	Beam G1 (L)	50.4	±0	0.63	520	328	Average 369 kg/cm^2
	Beam G2 (L)	54.8	±0	0.63	590	372	
	Beam G3 (L)	53.0	±0	0.63	565	356	
	Beam G4 (R)	59.6	±0	0.63	600	378	
	Beam G5 (R)	58.4	±0	0.63	600	378	
	Beam G6 (R)	58.4	±0	0.63	600	378	
	Beam G7 (L)	58.0	±0	0.63	600	378	
	Beam G8 (L)	59.3	±0	0.63	600	378	
	Beam G9 (L)	60.3	±0	0.63	600	378	
9	Slab G1-G2	53.4	+90	0.63	525	331	Average 338 kg/cm^2
	Slab G2-G3	53.1	+90	0.63	520	328	
	Slab G3-G4	56.7	+90	0.63	600	378	
	Slab G4-G5	53.8	+90	0.63	530	334	
	Slab G5-G6	52.6	+90	0.63	510	321	
	Slab G6-G7	49.8	+90	0.63	460	290	
	Slab G7-G8	60.0	+90	0.63	600	378	
	Slab G8-G9	54.3	+90	0.63	540	340	
9	Abutment A1	47.1	±0	0.63	465	293	Average 323 kg/cm^2
	Abutment P1	57.0	±0	0.63	600	378	
	Pier P1 (R)	47.8	±0	0.63	475	299	



Reaction Degree (R)

Fig. 4.58 Curve Graph for Reaction Degree – Concrete Strength

Table 4.16 Ratio of Concrete Age

Concrete Age (days)	10	20	28	50	100	150	200	300	500	1000	3000
Ratio (αn)	1.55	1.15	1.00	0.87	0.78	0.74	0.72	0.70	0.67	0.65	0.63

4.2.4 The Results of Reinforcing Bar Strength

The results of reinforcing bar strength are summarized in Table 4.17.

Table 4.17 Reinforcing Bar Test Results

Bridge No.	Sample No.	Nominal Diameter (mm)	Unit Weight (kg/mm^2)	Yield Stress (kg/mm^2)	Tensile Strength (kg/mm^2)	Modulus of Elasticity (kg/cm^2)	Elonga-tion (%)	Chemical Component (%)					Remarks
								C	Si	Mn	P	S	
1	B1-1	ø32	6.278	46	63		19	0.19	0.34	0.77	0.02	0.03	
	B1-2	ø32	6.210	45	64		19						
2	B2	ø36	7.833	42	66	–	22	0.38	0.27	1.38	0.02	0.02	
	B2-1	ø36	7.73	40	66	$1.87x10^6$	18	–	–	–	–	–	Test in Japan
	B2-3	ø36	7.822	43	70	$1.80x10^6$	21						
3	B3-1	ø36	7.818	42	64		22	0.25	0.22	1.28	0.02	0.02	
	B3-2	ø36	7.755	41	62		22						
4	B4-1	ø36	8.164	40	65	$1.83x10^6$	21	0.37	0.22	1.40	0.03	0.03	
	B4-2	ø36	7.788	43	63		21						
5	B5	ø32	6.030	48	69	–	*9	0.37	0.24	1.15	0.03	0.02	* No count
	B5-2	ø32	5.99	47	69	$1.94x10^6$	23	–	–	–	–	–	
	B5-3	ø32	6.00	47	69	$2.04x10^6$	24	–	–	–	–	–	Test in Japan
8	B8	ø36	7.820	42	67	–	22	0.37	0.27	1.39	0.02	0.02	Test in Japan
	B8-2	ø36	7.91	41	64	$1.82x10^6$	26	–		–	–	–	Test in Japan

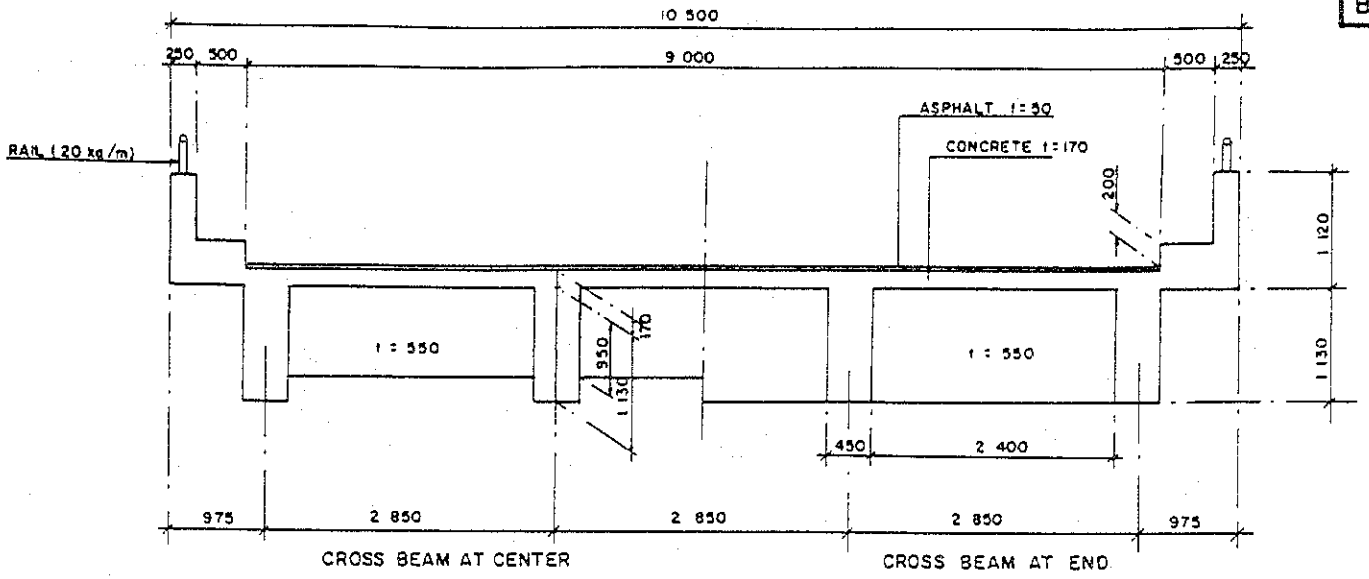
4.2.5 Structural Drawings of Existing Bridges

The detailed drawings of the 9 bridges (6 RC bridges, 3 PC bridges) showing the girders and decks together with the reinforcing bars or the prestressed tendons are indicated in Fig. 4.59 through Fig. 4.63.

The structural details were prepared from the original construction drawings and the deck details were made from the core drillings and the reinforcing bar arrangements were made from the reinforcing bar sensor instrument readings.

In the case of the RC bridges, the concrete cover over the reinforcing bars were made by chipping away the concrete cover at the center of bridge spans and the quarter points. The prestressing tendons of prestressed bridges were read off the original construction drawings.

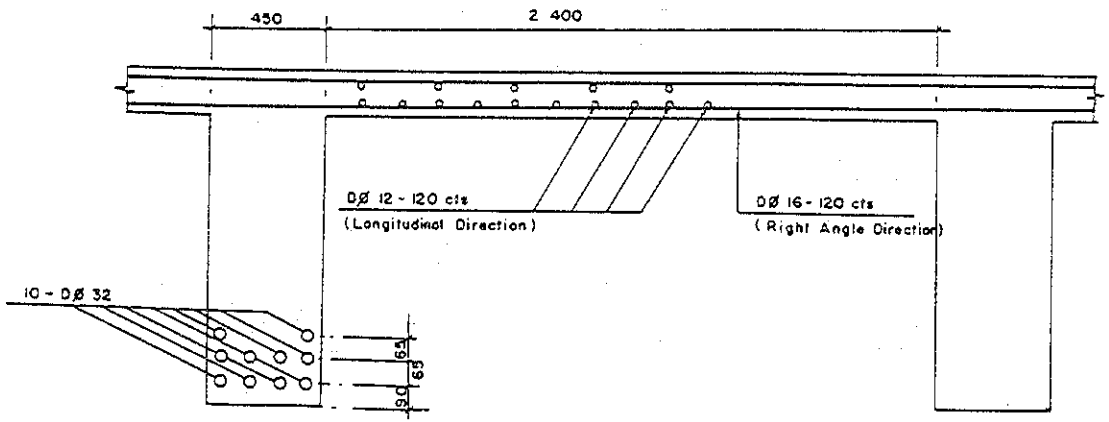
Bridge No. 1



Bridge Length 15.000 m

Span Length 14.400 m

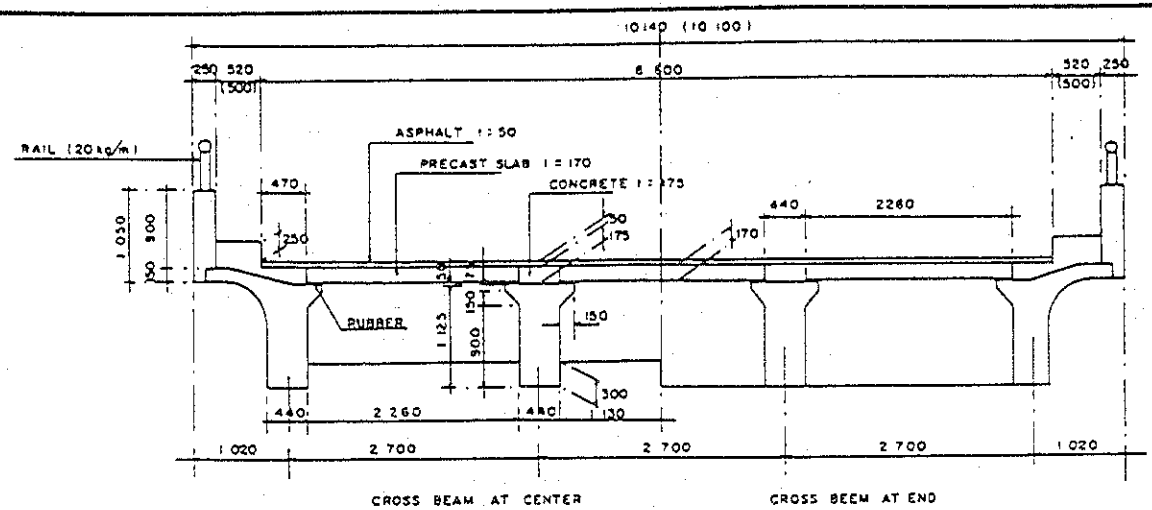
CROSS SECTION



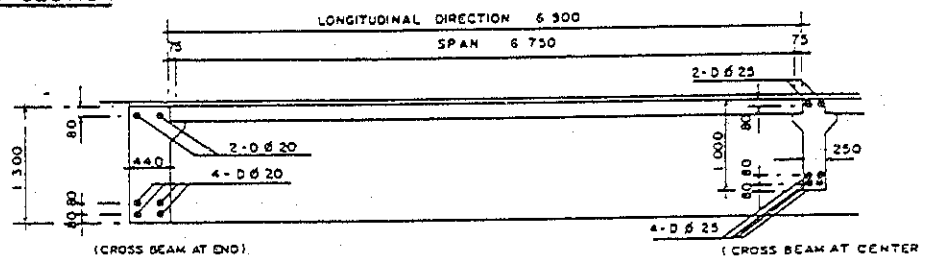
SECTION FOR CALCULATION

THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.59 Detailed Structural Section for Br.No.1

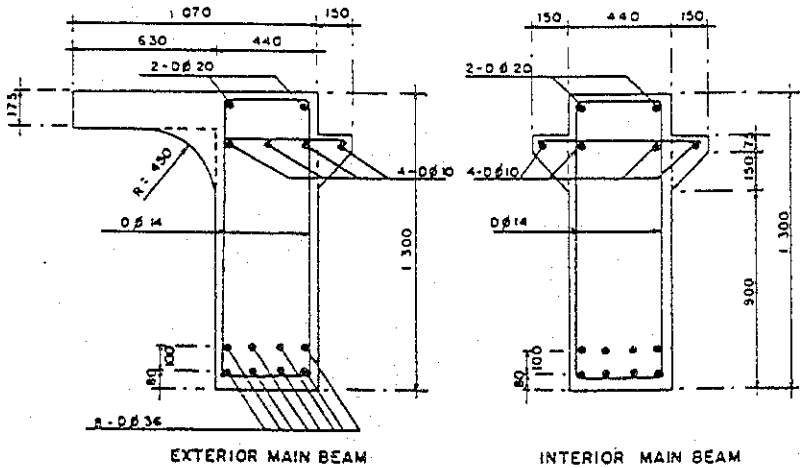
Bridge No. 2, No. 3, No. 4



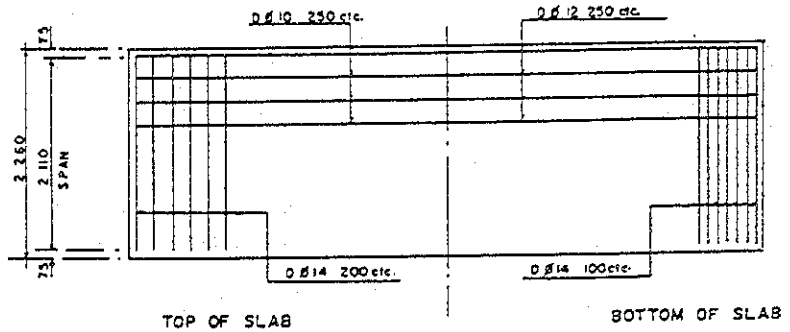
CROSS SECTION



PROFILE FOR SLAB

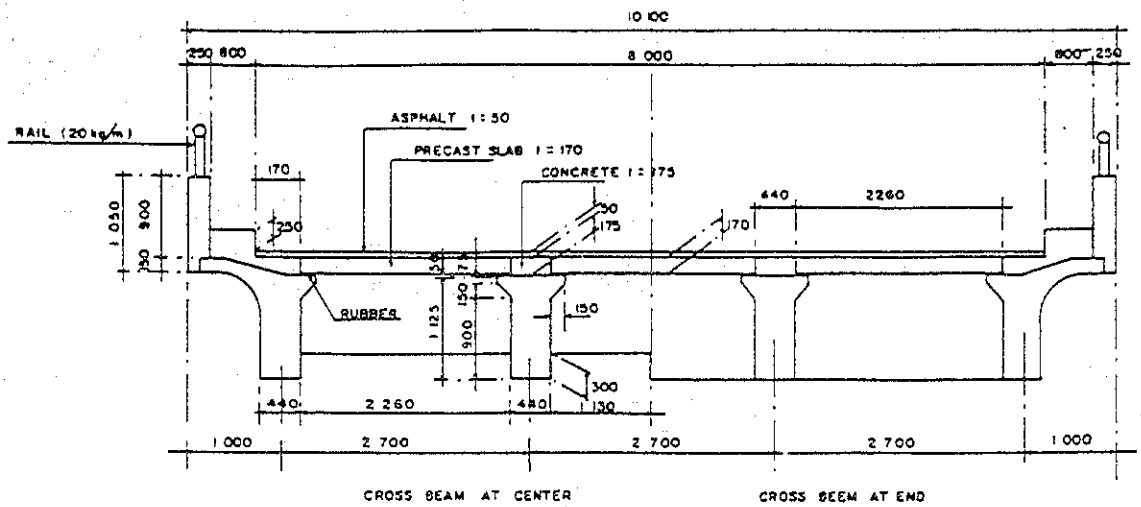


SECTION FOR CALCULATION

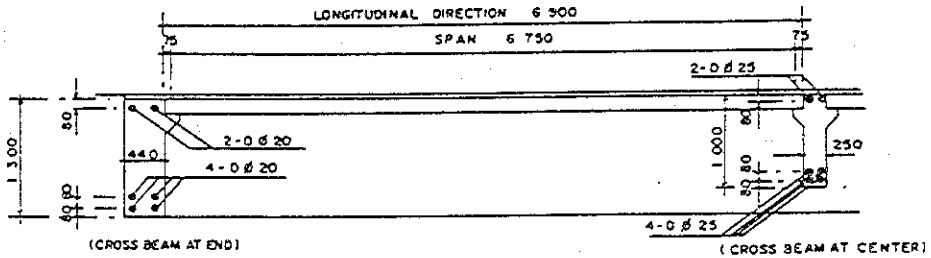


PLAN FOR SLAB

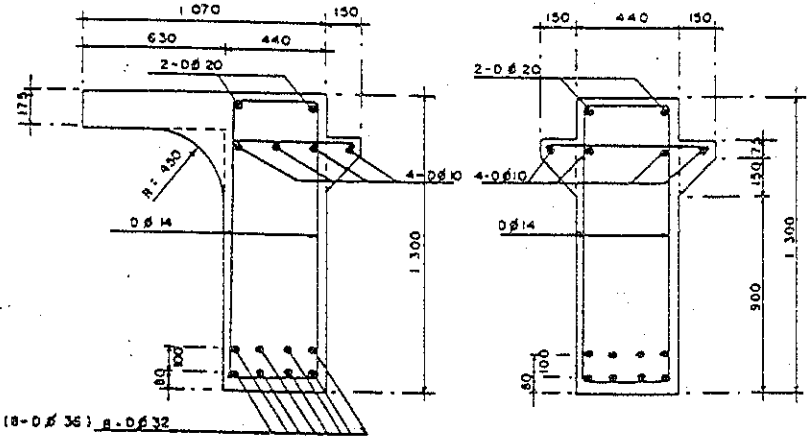
THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.60 Detailed Structural Section for Br.No.2,3,4



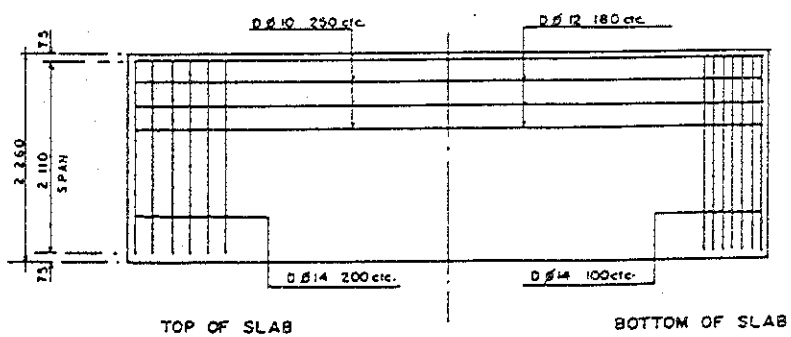
CROSS SECTION



PROFILE FOR SLAB

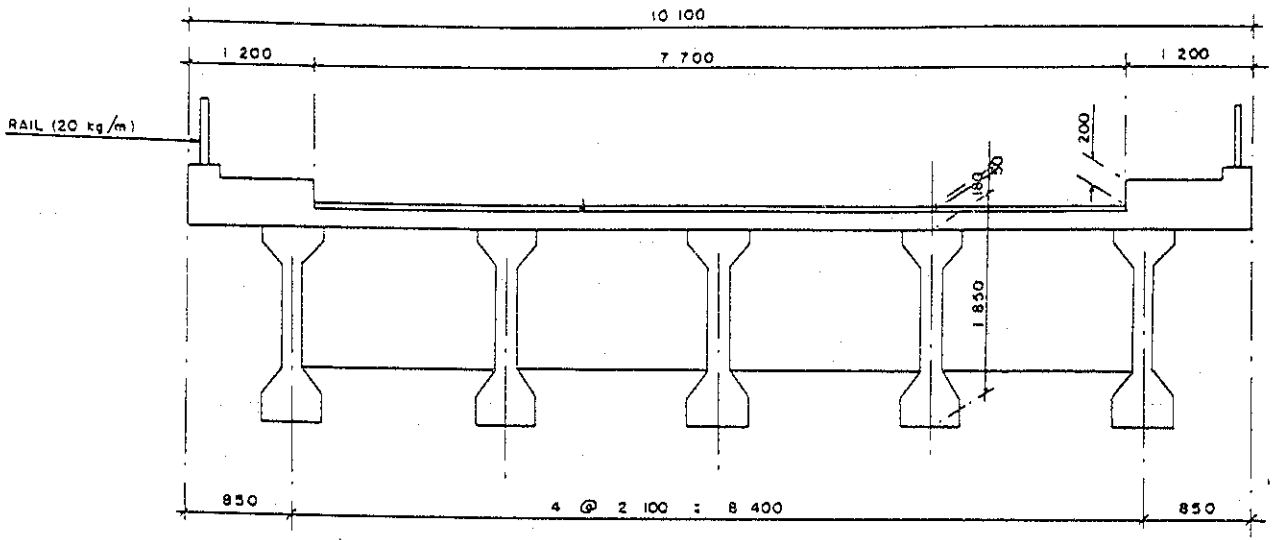


SECTION FOR CALCULATION



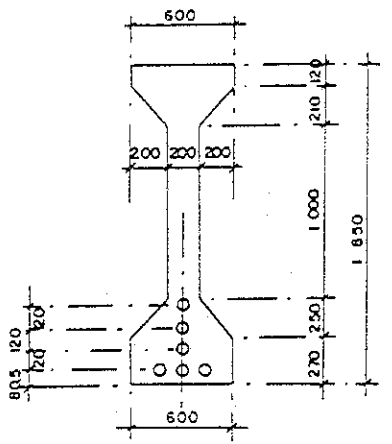
PLAN FOR SLAB

THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.61 Detailed Structural Section for Br.No.5,8

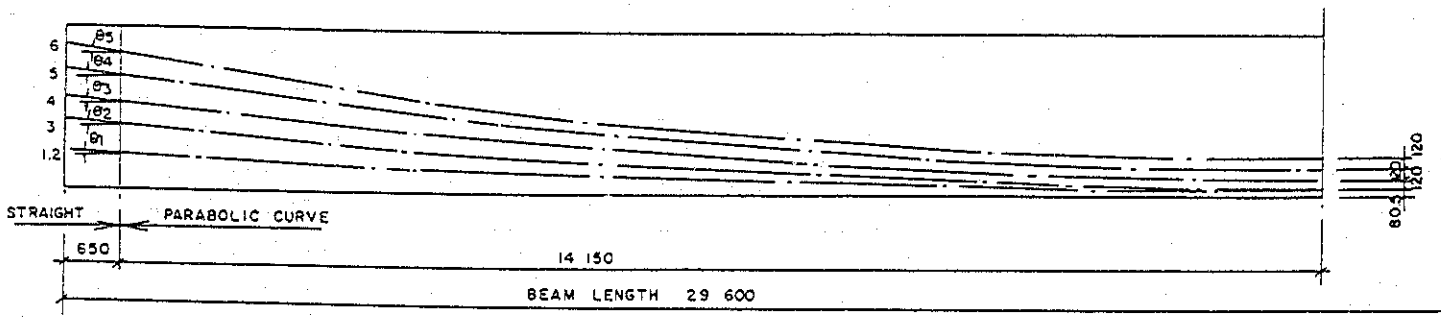


SECTION

Bridge No. 6



SECTION OF BEAM



θ1 = 2° 44'
θ2 = 5° 19'
θ3 = 6° 38'
θ4 = 7° 57'
θ5 = 9° 15'

PC CABLES ARRANGEMENT
(Capacity of 86.4 MP Stressed from One End)

FROM : AS-BUILT DRAWING

ULTIMATE STRENGTH 170 kg/mm^2
ELASTIC LIMIT 150 kg/mm^2
ELASTIC MODULAS E = 2.1 x 10^6 kg/cm^2

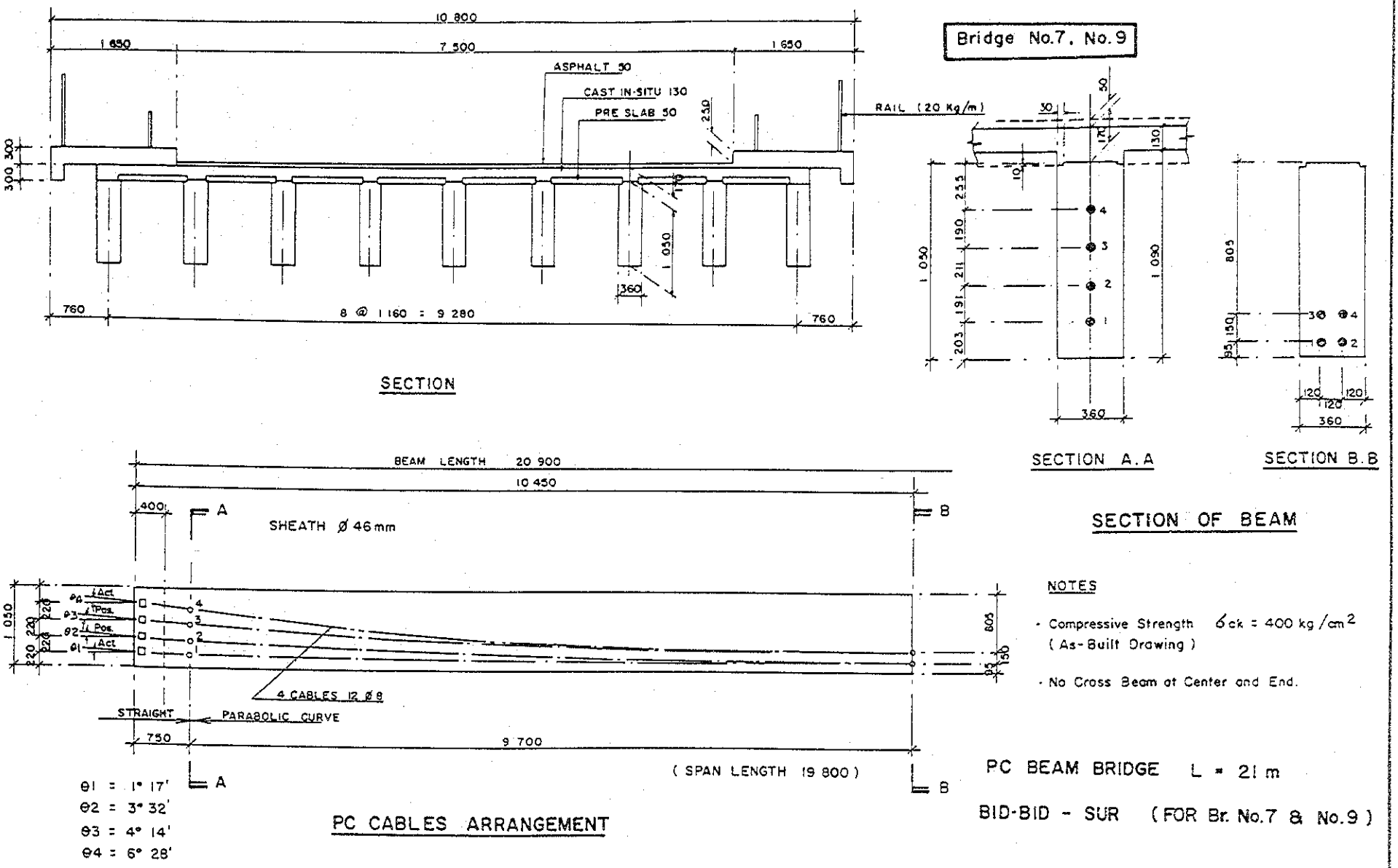
NOTES

- Compressive Strength ck = 430 kg/cm^2 (As-Built Drawing)
- 3 Cross Beam at Center and 2 Cross Beam at End

PC BEAM BRIDGE L = 30 m

SEEB - NIZWA (For Br. No. 6)

THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.62 Detailed Structural Section for Br.No.6

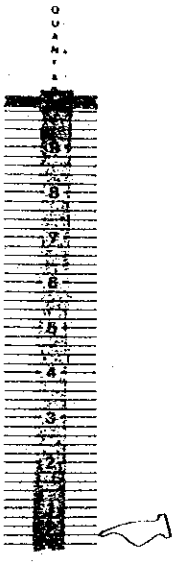
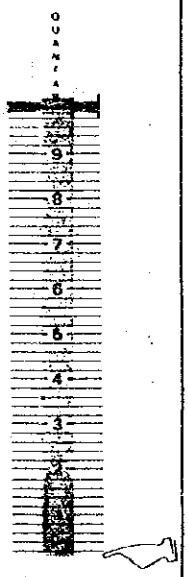
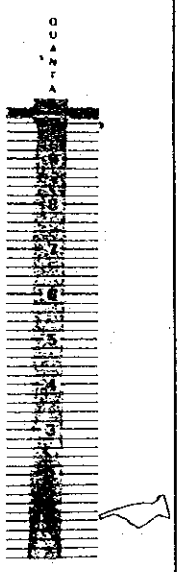
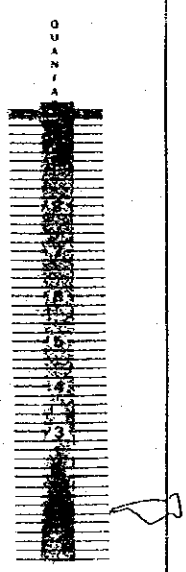


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 4.63 Detailed Structural Section for Br.No.7,9

4.2.6 Chloride Contents Measurement Results in Hardened Concrete Using Quantab

The results of chloride ion contents taken from concrete cores in RC Bridge No. 4 and PC Bridge No. 6 are given in the following Table 4.18. From the results the amount of chloride is very small and satisfies the standard values.

Table 4.18 Results of Chloride Measurement of Hardened Concrete

	Bridge No. 4 (RC Girder)		Bridge No. 6 (PC Girder)	
Sample No.	1	2	1	2
Measure of Quantab	0.2	0.0	1.1	1.2
Cl Ion Content (%)	Less than 0.0027	0.0	Less than 0.0027	Less than 0.0027
Cl Contents in Hardened Concrete	0.0023 < 0.04	0.0 < 0.04	0.0025 < 0.04	0.0025 < 0.04
	1	2	1	2
				

4.2.7 Damage Ranking Lists

According to the observations for the results of investigations, the Damage Ranking Lists are established in Table 4.19 through Table 4.45.

Table 4.19 Damage Ranking List (1)

Bridge No. 1
Batinah Coastal Highway
Bat-1/308-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	NONE	Minor	△ Major	–	–
			Discoloration	△ NONE	Minor		Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam Stringer	Cracking	△ NONE		Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△ Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	△ NONE	One way	Two way Interval more than 50cm	Two way Interval less than 50cm	Two way with corrosion
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.20 Damage Ranking List (2)

Bridge No. 1
Batinah Coastal Highway
Bat-1/308-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	△ Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Scour	△ NONE	Minor	–	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	△ NONE	–	Minor	–	Major
			Staffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	NONE	Minor	Major	△ Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.21 Damage Ranking List (3)

Bridge No. 1
Batinah Coastal Highway
Bat-1/308-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	△ NONE	–	Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	△ NONE	Less than 5mm	5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.22 Damage Ranking List (1)

Bridge No. 2
Wadi Al Jizi
Bat-7/102-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	NONE	–	–	△ Present	–
			Abnormal Strain	NONE	–	–	△Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	NONE	One way	Two way Interval more than 50cm	Two way △Interval less than 50cm	Two way With corrosion
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.23 Damage Ranking List (2)

Bridge No. 2
Wadi Al Jizi
Bat-7/102-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Scour	△ NONE	Minor	–	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	△ NONE	–	Minor	–	Major
			Staffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.24 Damage Ranking List (3)

Bridge No. 2
Wadi Al Jizi
Bat-7/102-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	NONE	–	Interval more than 50cm	△Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	△ NONE	–	Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	△ NONE	△Less than 5mm	5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.25 Damage Ranking List (1)

Bridge No. 3
Wadi Al Jizi
Bat-7/105-15

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	△ Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△ Present	–	–	–
			Honeycombs	NONE	△ Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	△ NONE	One way	Two way Interval more than 50cm	Two way Interval less than 50cm	Two way With corrosion
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.26 Damage Ranking List (2)

Bridge No. 3
Wadi Al Jizi
Bat-7/105-15

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	NONE	△Minor	Major	–	–
			Scour	NONE	△Minor	–	–	–
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	△ NONE	–	Minor	–	Major
			Staffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.27 Damage Ranking List (3)

Bridge No. 3
Wadi Al Jizi
Bat-7/105-15

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	NONE	–	△Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	△ NONE	Less than 5mm	5mm ~ 10mm	More than 10mm	–
			Rutting	NONE	Less than 20mm	△20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.28 Damage Ranking List (1)

Bridge No. 4
Wadi Al Jizi
Dah-7/202-27

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	△ Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	△ Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	Exposed Rebar Minor	△Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△ Present	–	–	–
			Honeycombs	NONE	Minor	△ Major	–	–
			Discoloration	NONE	△ Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	NONE	–	△ Minor	–	Major
		Slab	Corrosion of Rebar Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△Present	–	–	–
			Honeycombs	NONE	△Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	NONE	One way	Two way Interval more than 50cm	△Two way Interval less than 50cm	Two way With corrosion
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.29 Damage Ranking List (2)

Bridge No. 4
Wadi Al Jizi
Dah-7/202-27

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar, Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	NONE	△Minor	Major	–	–
			Scour	NONE	△Minor	–	–	–
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	△ NONE	–	Minor	–	Major
			Staffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	NONE	–	△Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.30 Damage Ranking List (3)

Bridge No. 4
Wadi Al Jizi
Dah-7/202-27

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	NONE	△Minor	–	Major	–
			Loss of Member	NONE	–	△Minor	–	Major
Asphalt Pavement			Step Corrugation	NONE	Less than 20mm	△20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	NONE	Less than 5mm	△5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.31 Damage Ranking List (1)

Bridge No. 5
Barka-Rustaq
Bat-13/200-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	NONE	–	–	△Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△IPresent	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	NONE	One way	Two way Interval more than 50cm	Two way △Interval less than 50cm	Two way With corrosion
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.32 Damage Ranking List (2)

Bridge No. 5
Barka-Rustaq
Bat-13/200-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	Interval more than 50cm	△Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	Exposed Rebar Minor	Exposed Rebar Major	△Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Scour	△ NONE	Minor	–	–	–
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	NONE	–	Minor	–	△Major
Shoe	Shoe	Rubber	Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	NONE	–	△Minor	–	Major
			Staffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.33 Damage Ranking List (3)

Bridge No. 5
Barka-Rustaq
Bat-13/200-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	NONE	–	△Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	NONE	△Less than 5mm	5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	NONE	–	–	–	△Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	NONE	–	△Minor	–	Major
			Loss of Member	NONE	–	△Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.34 Damage Ranking List (1)

Bridge No. 6
Rusail - Nizwa
Dak-15/100-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	NONE	–	Exposed Rebar Minor	△Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	△ NONE	One way	Two way Interval more than 50cm	Two way Interval less than 50cm	Two way With corrosion
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.35 Damage Ranking List (2)

Bridge No. 6
Rusail - Nizwa
Dak-15/100-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Scour	NONE	△Minor	–	–	–
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	NONE	–	△Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	NONE	–	△Minor	–	Major
			Stuffed	NONE	–	△Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	NONE	△Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.36 Damage Ranking List (3)

Bridge No. 6
Rusail - Nizwa
Dak-15/100-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	△ NONE	–	Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	NONE	Less than 5mm	△5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	NONE	–	–	–	△Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	NONE	–	Minor	–	△Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.37 Damage Ranking List (1)

Bridge No. 7
Bid Bid - Sur
Dak-23/100-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	Present	–	–	–
			Honeycombs	NONE	Minor	Major	–	–
			Discoloration	NONE	Minor	–	Major	–
			Leakage	NONE	Present	–	–	–
			Loss of Member	NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	△ NONE	One way	Two way Interval more than 50cm	Two way Interval less than 50cm	Two way With corrosion
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.38 Damage Ranking List (2)

Bridge No. 7
Bid Bid - Sur
Dak-23/100-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Scour	△ NONE	Minor	–	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	NONE	–	△Minor	–	Major
			Stuffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.39 Damage Ranking List (3)

Bridge No. 7
Bid Bid - Sur
Dak-23/100-02

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	NONE	Present	–	–	–
			Honeycombs	NONE	Minor	Major	–	–
			Discoloration	NONE	Minor	–	Major	–
			Loss of Member	NONE	–	Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	△ NONE	Less than 5mm	5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

Table 4.40 Damage Ranking List (1)

Bridge No. 8
Buraimi/Iburi/Nizwa
Dak-21/600-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△Present	–	–	–
			Honeycombs	NONE	Minor	△Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	Interval more than 50cm	△ Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	NONE	One way	Two way Interval more than 50cm	△Two way Interval less than 50cm	Two way With corrosion
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.41 Damage Ranking List (2)

Bridge No. 8
Buraimi/Iburi/Nizwa
Dak-21/600-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Scour	NONE	Minor	△ –	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	NONE	–	△Minor	–	Major
			Stuffed	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Deformation	△ NONE	–	Minor	–	Major

Table 4.42 Damage Ranking List (3)

Bridge No. 8
Buraimi/Iburi/Nizwa
Dak-21/600-01

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	NONE	–	△ Minor	–	Major
Asphalt Pavement			Step Corrugation	NONE	△ Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	NONE	Less than 5mm	△5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	NONE	–	–	Minor	Major
			Loosen	NONE	–	–	Minor	Major
			Falling	NONE	–	–	Minor	Major
			Failure	NONE	–	–	–	Present
			Interior of Paint	NONE	–	Present	–	–
			Discoloration	NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	NONE	–	–	Present	–
			Deformation	NONE	–	–	Present	–
			Stuffed	NONE	–	–	Present	–
			Loss of Member	NONE	–	Minor	–	Major

Table 4.43 Damage Ranking List (1)

Bridge No. 9
Bid Bid - Sur
Srq-23/600-12

Member			Damage	Damage Ranking				
				A	B	C	D	E
Super-structure	Con-crete	Main Beam	Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Abnormal Vibration	△ NONE	–	–	Present	–
			Abnormal Strain	△ NONE	–	–	Present	–
			Loss of Member	NONE	–	△Minor	–	Major
		Cross Beam, Stringer	Cracking	NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	Present	–	–	–
			Honeycombs	NONE	Minor	Major	–	–
			Discoloration	NONE	Minor	–	Major	–
			Leakage	NONE	Present	–	–	–
			Loss of Member	NONE	–	Minor	–	Major
		Slab	Corrosion of Rebar Scaling	NONE	–	△Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	NONE	△Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Falling, Come-off	△ NONE	–	–	–	Present
			Damage of Joint	△ NONE	–	Minor	–	Major
			Cracking of Slab	△ NONE	One way	Two way Interval more than 50cm	Two way Interval less than 50cm	Two way With corrosion
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–

Table 4.44 Damage Ranking List (2)

Bridge No. 9
Bid Bid - Sur
Srq-23/600-12

Member			Damage	Damage Ranking				
				A	B	C	D	E
Sub-structure	Con-crete	Abut-ment Pier	Cracking	NONE	–	△Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Corrosion of Rebar Scaling	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Rebar Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	NONE	△Minor	Major	–	–
			Scour	NONE	△Minor	–	–	–
			Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Loss of Member	△ NONE	–	Minor	–	Major
Shoe	Shoe	Rubber	Discoloration	NONE	△Minor	–	Major	–
			Leakage	△ NONE	Present	–	–	–
			Deformation	NONE	–	△Minor	–	Major
			Stuffed	NONE	–	△Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
	Mortar		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Loss of Member	△ NONE	–	Minor	–	Major
	Anchor Bolt		Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Deformation	△ NONE	–	Minor	–	Major
Hand Rail Curb	Steel		Corrosion	NONE	△Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Discoloration	NONE	△Minor	Major	Scaling Minor	Scaling Major
			Deformation	NONE	–	△Minor	–	Major

Table 4.45 Damage Ranking List (3)

Bridge No. 9
Bid Bid - Sur
Srq-23/600-12

Member			Damage	Damage Ranking				
				A	B	C	D	E
Hand Rail Curb	Concrete		Cracking	△ NONE	–	Interval more than 50cm	Interval less than 50cm	Width Several Millimeter
			Scaling Corrosion of Rebar	△ NONE	–	Exposed Rebar Minor	Exposed Rebar Major	Loss of Section
			Free Lime	△ NONE	Present	–	–	–
			Honeycombs	△ NONE	Minor	Major	–	–
			Discoloration	△ NONE	Minor	–	Major	–
			Loss of Member	△ NONE	–	Minor	–	Major
Asphalt Pavement			Step Corrugation	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Pot Holes	△ NONE	Less than 10mm	10mm ~ 30mm	More than 30mm	–
			Cracking	△ NONE	Less than 5mm	5mm ~ 10mm	More than 10mm	–
			Rutting	△ NONE	Less than 20mm	20mm ~ 40mm	More than 40mm	–
			Leakage	△ NONE	Present	Present	–	–
Expan-sion	Joint	Rubber	Abnormal Condition of Space	△ NONE	–	–	Present	–
			Failure	△ NONE	–	–	–	Present
			Abnormal Sound	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	Minor	–	Major
			Loss of Member	△ NONE	–	Minor	–	Major
Drainage			Corrosion	△ NONE	Surface Minor	Surface Major	Loss of Section Minor	Loss of Section Major
			Cracking	△ NONE	–	–	Minor	Major
			Loosen	△ NONE	–	–	Minor	Major
			Falling	△ NONE	–	–	Minor	Major
			Failure	△ NONE	–	–	–	Present
			Interior of Paint	△ NONE	–	Present	–	–
			Discoloration	△ NONE	Minor	Major	Scaling Minor	Scaling Major
			Leakage	△ NONE	–	–	Present	–
			Deformation	△ NONE	–	–	Present	–
			Stuffed	△ NONE	–	–	Present	–
			Loss of Member	△ NONE	–	Minor	–	Major

4.3 Engineering Consideration on the Results of Inspection

4.3.1 Engineering Consideration on Cracks

(1) The Cause of Cracks in Bridge Concrete:

The main causes of cracks in the bridge concrete are generally classified into the following:

a. Cracks Attributed to Material Characteristics:

Abnormal hardening of the cement, heat of hydration, bleeding, drying shrinkage, popouts and reactive aggregates, etc.

b. Cracks Attributed to Workmanship:

Concrete mix at time of placement, insufficient compaction vibration, incorrect placing of reinforcing steel, improper placement of construction joints, movement of concrete forms, vibration of concrete prior to hardening, premature drying-out during curing, etc.

c. Cracks Attributed to Usage and Environments:

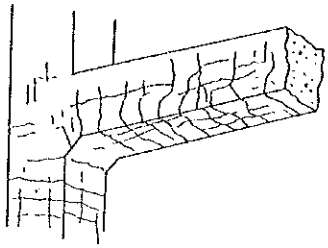
Temperature of surroundings, rapid changes in temperature, temperature differential on both sides of structures, corrosion of reinforcing bar, chemical attack on concrete, etc.

d. Cracks due to Collision by Outside Forces:

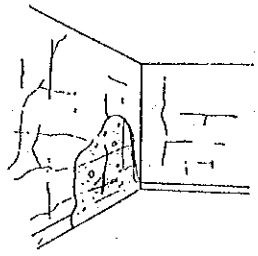
Loads exceeding design capacity, insufficient reinforcing bar, earthquake loads, differential settlement of structures, etc.

(2) The Propagation of Cracks in Concrete Structures:

The deterioration of concrete described in subparagraphs c and d are further described as shown in Fig. 4.64.



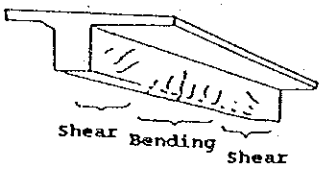
C6



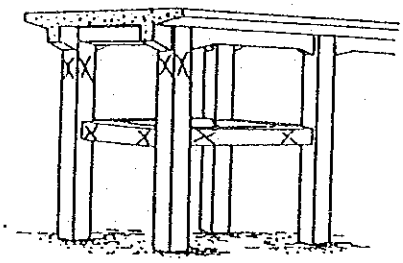
C7

C6. Overly rapid drying of concrete will cause extensive hairline cracks in the columns and beams. There will be spalling of the concrete and delamination of the surface concrete.

C7. Attack by chemical agents will disintegrate the surface of the concrete and will cause cracks and spalling along the reinforcing steel. There will be extensive rusting of the exposed reinforcing steel and delamination of the concrete.



D1·D,

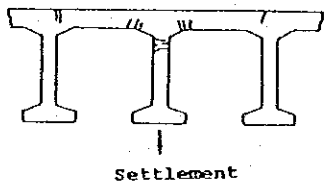


D3

D1, D2. Structural members subject to bending moment will be subject to hairline cracks (0.1 ~ 0.2mm width), and when they start to grow wider than 0.2mm or there are cracks due to shear forces, there will be some distress with the bridge and they should be kept under close observation and special efforts should be made to determine their causes.

D3. Load Stress (mainly due to earthquake forces):
When diagonal cracks appear as shown on the drawing, they are representative of horizontal earthquake forces.

D4



D5

D4. When there is insufficient reinforcing in the structure, there will be cracks similar to Case D1, and it will be necessary to study the construction drawings to determine whether they are caused by the loads or from insufficient reinforcing in the structure.
The crack patterns in the drawing have been caused by insufficient reinforcing.

D5. Differential Settlement:
In statically indeterminate structures, when there is a differential settlement in any of the supports, there will be cracks in the framework similar to those shown in the diagram.

Fig. 4.64 Subparagraph for Deterioration of Concrete Cracks

(3) Allowable Width of Cracks in Girders and Slab

The repair of cracks in the bridge concrete will have to be determined based on the frequency of use and their degree of durability of the bridge. In general, the relation of the allowable width of cracks and the surrounding conditions are as follows:

Surrounding Conditions	Allowable Maximum Width of Crack (mm)
General locations	0.2 mm
Places where corrosion could occur	0.1 mm

Allowable cracks of 0.1 ~ 0.2 mm can be found all over the structure, and it will not be practical to repair them.

The following guide is given from experience for which the cracks to repair:

(a) Active cracks which grow wider by 0.1 mm every 6 months
(b) Cracks which do not grow wider but increase in number
(c) Cracks wider than 0.3 mm
(d) Crack widths being 0.2 mm, but not structurally safe

(4) Engineering Consideration on the Study Bridges

The cracks occurred on the girders and slabs of all reinforced concrete bridges which were examined in the study area, however, the repair of cracks were conducted only for Bridge No. 1 (Batinah Highway) and Bridge No. 2 (Route No. 7). According to the inspection, the cracks have been observed not to proceed after repair.

On the other hand, cracks have not been observed on the prestressed concrete bridges.

Example of crack characteristics in the main girder during load test are shown in Fig. 4.65 Cracking of Girders due to Ultimate Bending Test.

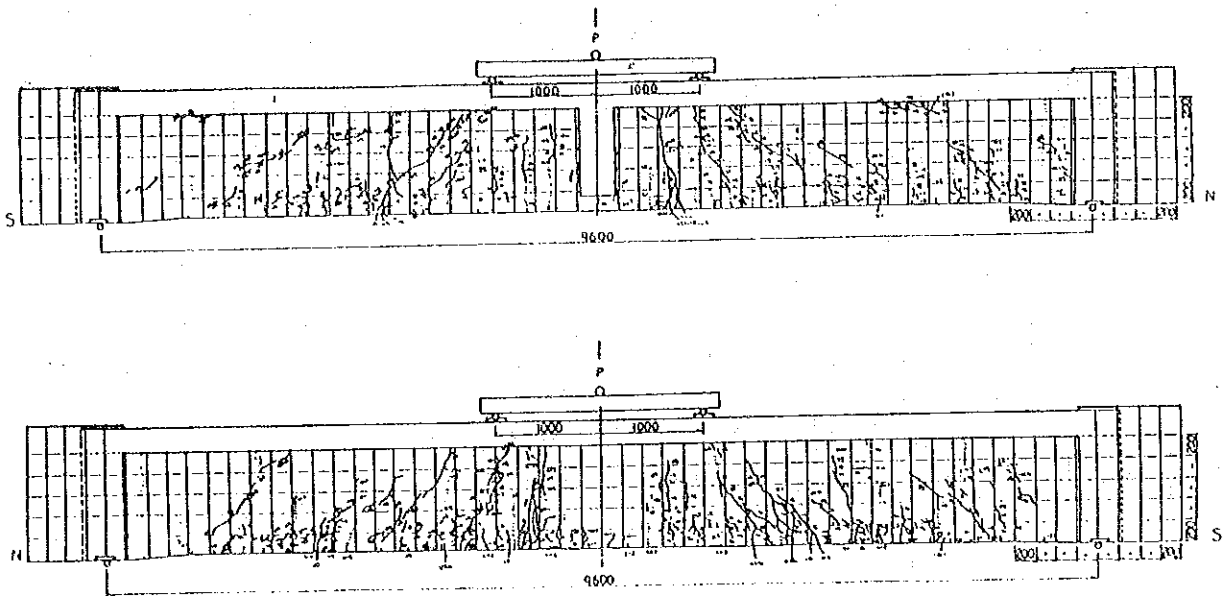


Fig. 4.65 Cracking of Girders due to Ultimate Bending Test (Laboratory Test)

The distribution of cracks occurring on the girders of the examined bridges are similar with the cracks indicated in Fig. 4.65. Therefore, it can be judged that the cause of cracks on the girders is due to the overloading.

From the fact that the cracks have not progressed after the repair, it is considered that the overloading conditions were temporary.

The cracks on the bridge slabs also occurred by the overloading of wheel loads.

4.3.2 Engineering Consideration on the Characterisiic of Materials

(1) The Quality of Concrete

The strength of the concrete in the existing RC and PC bridges was compared with the strength requirement of the concrete specified when they were originally placed or compared with current Japanese standard specifications for bridges in order to determine their deterioration over 20 years of use, and to determine their soundness.

The results of the concrete strength test are as follows:

Superstructure of reinforced concrete bridges (from design documents used in original construction: As-built drawings)

Case I $\sigma_{28} = 270$ kg/cm^2 (Precast beams)
Case II $\sigma_{28} = 215$ kg/cm^2 (Cast in-place beams)

Superstructure of prestressed concrete bridges (from design documents used in original construction):

Case I $\sigma_{28} = 340$ kg/cm^2 (Bridge No. 6)
Case II $\sigma_{28} = 315$ kg/cm^2 (Bridge No. 7, 9)

These values were compared with Standard Strength Values used in Japan (Civil Engineering Association) for concrete in bridges. Copies are extracted as follows:

- Minimum standard strength of concrete, minimum σ_{28} :
  The minimum design strength of concrete will in general be as stipulated in Table 4.46.

Table 4.46 Minimum Design Strength of Concrete

Type of Structure		Minimum Design Strength (kg/cm^2)
Non-reinforced concrete member		160
Reinforced concrete member		210
Prestressed concrete member	Pre-tensioned	350
	Post-tensioned	300

The factor most affecting the strength and durability of concrete is the water-cement ratio, and water-cement ratio is stipulated as the minimum and specified for the minimum design strength.

- Compressive Strength of Concrete

Table 4.47 Allowable Compressive Strength for Concrete

Type of Stress		Allowable Design Compressive Stress in Concrete (kg/cm^2)			
		210	240	270	300
Compression	(1) Bending	70	80	90	100

- The Mechanical Properties of Concrete

Table 4.48 Modulus of Elasticity for Concrete

Standard Design Strength (kg/cm^2)	210	240	270	300	400	500
Young's Modulus (kg/cm^2)	2.35×10^5	2.5×10^5	2.65×10^5	2.8×10^5	3.1×10^5	3.3×10^5

(2) The Carbonation of Concrete

Freshly poured concrete will have a high alkali content, but with the exposure of the concrete structure to the natural elements, the carbon gases will react with the hydrated calcium and change it into a neutral calcium carbonate, reducing its alkalinity. This process of the exterior atmosphere penetrating into concrete is called neutralizing. This process of neutralizing will not progress rapidly, other than to cause some structural and chemical deterioration.

The reinforcing bar embedded in concrete is attacked by the intrusion of chlorides which enables water and oxygen to form iron oxide (i.e. rust). The iron chloride can reach the reinforcing bar by diffusing through the concrete by penetrating cracks in the concrete.

To measure the depth of the neutral concrete, there is the alcohol testing method using a alcohol liquid containing a 1% phenol phtalene reagent. The reagent will be colorless when the pH value is less than 9, and for higher values it will exhibit a red color.

The depth of the neutralized concrete will differ with the type of concrete and the concrete structure, together with the time in service of the concrete, and the following formula is proposed to be used to determine the depth.

$$x = \frac{t \cdot R^2}{k}$$

where, x : depth of neutralized layer (cm)

t : time element (year)

R : $\gamma_c \cdot \gamma_a \cdot \gamma_s$ (refer to Table 4.68)

k : $0.3 \cdot (1.15 + 3\omega)/(\omega - 0.5)^2$

ω : water-cement ratio

Table 4.49 Ratio of Carbonate Components

Type of Cement (γ_c)	Portland Cement		Blast-Furnace Cement		Silica Cement	Fly Ash Cement (FA20%)
	Normal 1.0	Quick Hardn'g 0.6	Slag 30%-40% 1.4	Slag 60% 2.2	1.7	1.9
Aggregate (γ_a)	River Sand, River Aggregate 1.0		River Sand, Light Aggregate 1.2		Light Sand, Light Aggregate 2.9	Cinder (Fine, Rough) 3.3
Additives (γ_s)	Plain 1.0		AE Additive 0.6		Dispersant 0.4	

From the above table it can be seen that the neutralizing of concrete depends largely on the type of materials used in the concrete. Neutralizing of concrete is a natural phenomena and the process cannot be arrested or stopped. The problem is the corrosion of steel items embedded in the concrete. The neutralization of concrete is the result of the reaction of carbon dioxides and other acidic gases in the air, and it will proceed with the passing of time after the completion of the structure. The relation of the depth of carbonation with the passing of time is given in the example in Fig. 4.66. This graph is based for the neutralization ratio (Table 4.49) when $\gamma_c = 1.0$, $\gamma_a = 1.0$, $\gamma_s = 1.0$.

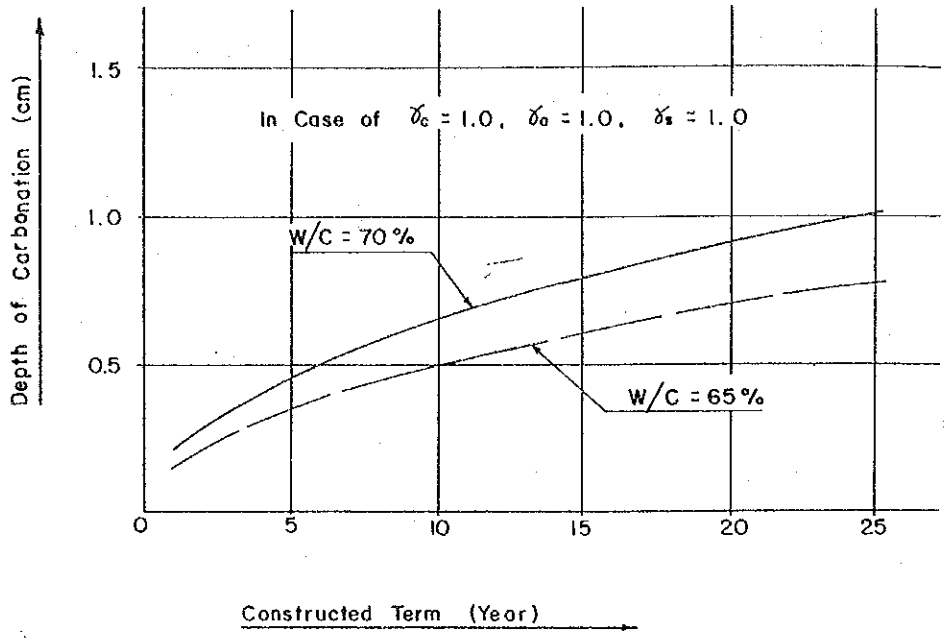


Fig. 4.66 Relation between Depth of Carbonation and Time

Corrosion of reinforcing bar embedded in concrete is caused by the cracks in the concrete. This process is indicated in Fig. 4.67.

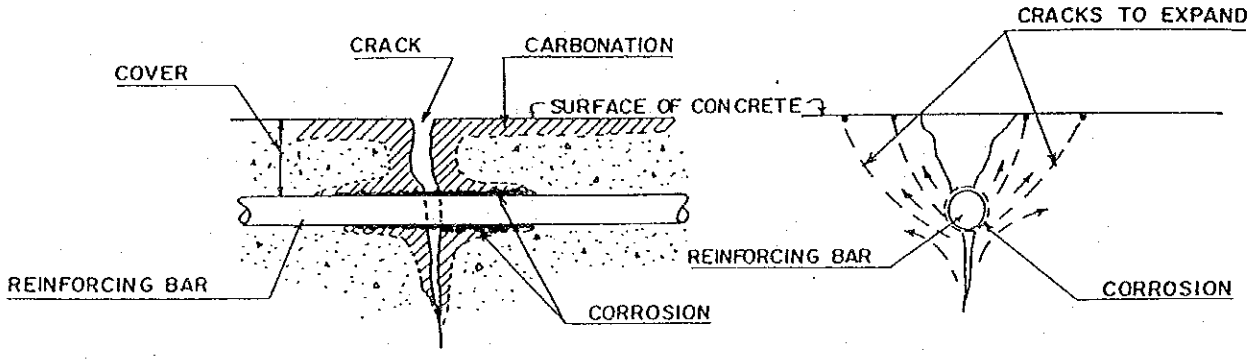


Fig. 4.67 Deterioration of Concrete Structures by Carbonation

As indicated in the above diagram, the exposed reinforcing bar reacts with the carbon dioxide gases in the air through the cracks, and water and oxygen combine to cause corrosion in the reinforcing bar. With the passing of time, a layer of iron oxide forms on the surface of the steel and rusting advances further into the concrete and the iron oxide expands to twice its original volume causing internal pressures on the concrete impairing its use. Where the concrete cover over the steel is inadequate, cracks in the concrete will

develop along the reinforcing bar and cause further rusting of the reinforcing bar. It can be seen that the density of the concrete and the concrete cover over the steel have an important relation with the neutralization of the concrete and the development of cracks.

(3) Ratio of Absorption and Moisture Contents

Concrete is a porous body with air voids, gels and capillary wall spaces, water passage routes, and air spaces under the aggregates. In addition there are other voids caused by poor workmanship, exterior forces and the drying process. It is through these voids that water and air penetrates into the concrete.

Various pollutants such as carbon dioxide, chlorines, and oxygen ions can easily enter into the concrete and cause corrosion of the reinforcing bar, and cause weakening of the concrete. For this reason, it becomes important to test the water absorption ratio and the water contents of the concrete to determine the water tightness and air voids to test the durability of the concrete.

Ratio of Absorption

$$\text{Absorption Contents (\%)} = \frac{\left[\begin{array}{c}\text{Wet Weight}\\ \text{of Sample}\end{array}\right] - \left[\begin{array}{c}\text{Normal Dry Weight}\\ \text{of Sample}\end{array}\right]}{\left[\begin{array}{c}\text{Normal Dry Weight}\\ \text{of Sample}\end{array}\right]}$$

Moisture Contents

$$\text{Moisture Contents (\%)} = \frac{\left[\begin{array}{c}\text{Normal Weight}\\ \text{of Sample}\end{array}\right] - \left[\begin{array}{c}\text{Dry Weight of Sample}\\ \text{72 hrs @110°C}\end{array}\right]}{\left[\begin{array}{c}\text{Dry Weight of Sample}\\ \text{72 hrs @110°C}\end{array}\right]}$$

Based on the above formulas, the ratio of absorption and moisture contents of the bridge slabs and girders will be measured, however the characteristics of the original cement, aggregates, and other materials are not available and it is difficult to determine the standard of evaluation. As a general rule, it will be necessary to decide the concrete which will give the absorption rate and moisture content for all the 9 bridges.

(4) The Quality of Reinforcing Bar

The main girders of the six RC bridges in this study are all reinforced with deformed steel reinforcing bars of ø36 mm and ø32 mm in size. The reinforcing bars used in the girders all have a concrete cover ranging from 5 cm to 10 cm to prevent their corrosion and deterioration. In order to obtain information of the reinforcing bars, 60 cm long samples were removed from the girders and tested. The test results were compared with the standard values used in Japan in order to determine the soundness of the reinforcing bars.

Deformed Reinforcing Bar	Yield Strength	4,200 kg/cm^2	(from original construction documents)

The reinforcing bars were specified to conform to British Standards, BS 4499 and BS 4461.

The design strength requirements for reinforcing bars used in Japan (Japan Civil Engineering Association) are as follows:

Table 4.50 Strength of Reinforcing Bars

Description	Tensile Test		
	Yield Strength (kgf/mm^2)	Ultimate Tensile Strength (kgf/mm^2)	Elongation (%)
SR 24	more than 24	39 ~ 53	more than 20
			more than 24
SR 30 A	more than 30	45 ~ 61	more than 16
			more than 18
SD 30 B	30 ~ 40	more than 45	more than 16
			more than 18
SD 35	35 ~ 45	more than 50	more than 18
			more than 20

Table 4.51 Allowable Strength of Reinforcing Bars (Less than 32 mm ø)

Classification			SR 24	SD 30 A SD 30 B	SD 35
Description of Strength and Members					
Allowable Tensile Strength	Basic Value Excluding Collision or Earthquake Cases	(1) Original Member	1.400	1.800	1.800
		(2) Slab Bridge Span less than 10m	1.400	1.400	1.400
		(3) Under Water or Ground	1.400	1.600	1.600
	(4) Basic Value Including Collision or Earthquake Cases		1.400	1.800	2.000
	(5) Basic Value in Case of Overlap of Reinforcing Bars		1.400	1.800	2.000
(6) Allowable Compressive Strength			1.400	1.800	2.000

The other standard specifications for reinforcing bar by JIS G3112, AASHTO and BS4449 are listed as following reference.

JIS G3112

Table 4.52 Chemical Composition of Steel Grade

Grade	Chemical Composition (%)					
	C	Si	Mn	P	S	$C+\frac{Mn}{6}$
SR 235	–	–	–	Less than 0.050	Less than 0.050	–
SR 295	–	–	–	Less than 0.050	Less than 0.050	–
SD 295 A	–	–	–	Less than 0.050	Less than 0.050	–
SD 295 B	Less than 0.27	Less than 0.55	Less than 1.5	Less than 0.040	Less than 0.040	–
SD 345	Less than 0.27	Less than 0.55	Less than 1.6	Less than 0.040	Less than 0.040	Less than 0.50
SD 390	Less than 0.29	Less than 0.55	Less than 1.8	Less than 0.040	Less than 0.040	Less than 0.55
SD 490	Less than 0.32	Less than 0.55	Less than 1.8	Less than 0.040	Less than 0.040	Less than 0.60

AASHTO SI Units

Table 4.53 Dimension of Reinforcing Steel Bar

Nominal Dimensions/a					Deformation Requirements, mm		
Bar Designation No./b	Nominal Weight kg/m	Diameter mm	Cross-sectional Area cm^2	Perimeter mm	Maximum Average Spacing	Minimum Average Height	Maximum Gap (Chord of 12.5% of Nominal Perimeter)
3	0.560	9.52	0.71	29.9	6.7	0.38	3.5
4	0.994	12.70	1.29	39.9	8.9	0.51	4.9
5	1.552	15.88	2.00	49.9	11.1	0.71	6.1
6	2.235	19.05	2.84	59.8	13.3	0.96	7.3
7	3.042	22.22	3.87	69.8	15.5	1.11	8.5
8	3.973	25.40	5.10	79.8	17.8	1.27	9.7
9	4.960	28.65	6.45	90.0	20.1	1.42	10.9
10	6.403	32.26	8.19	101.4	22.6	1.62	11.4
11	7.906	35.81	10.06	112.5	25.1	1.80	13.6

/a: The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same weight per foot as the deformed bar.

/b: Bar numbers are based on the number of eight of an inch included in the nominal diameter of the bars.

BS 4449 Deformed Steel Bar (Grade 460/425)

Table 4.54 Cross Sectional Area and Mass

Nominal Size (mm)	Cross Sectional Area (mm^2)	Mass per Meter (kg)
8	50.3	0.395
10	78.5	0.616
12	113.1	0.888
16	201.1	1.579
20	314.2	2.466
25	490.9	3.854
32	804.2	6.313
40	1256.6	9.864

Table 4.55 Chemical Composition of Steel Grade

Element	Grade 460/425 (% max.)	(Grade 250) - Round Bar (% max.)
Carbon	0.40	0.25
Sulphur	0.050	0.60
Phosphorus	0.050	0.060

Table 4.56 Tensile Properties

Grade: 460/425 (Deformed Steel Bar)

Grade	Nominal Size (mm)	Specified Characteristic Strength	Minimum Elongation (%)
460/425	8 up to and including 16	460 $N/mm^2 \rightarrow 47$ kg/mm^2	12
	Over 16	425 $N/mm^2 \rightarrow 43$ kg/mm^2	14

(5) The Quality of PC Cables

The original construction documents describe the main PC cables used in the PC bridges as 12-strand, 8ømm wires. As it was not possible to obtain samples nor check the PC cables, information of the PC cables was obtained from the original construction documents.

Data of the values for the PC cables (from original construction documents).

Ultimate Strength	(σ_{pu})	170 kg/mm^2
Yield Strength	(σ_{pr})	150 kg/mm^2
Modulus of Elasticity for Steel Member		2.1 x 10^6 kg/mm^2
PC Cable Standard		12 ø 8 mm

The design values for PC cables used in Japan (Japan Civil Engineering Association) is given in Table 4.57 and Table 4.58.

Table 4.57 Steel Member Constant for Calculation

Classification	Constant
Young's Modulus of Steel, Cast Steel	2.1 x 10^6 kg/cm^2
Young's Modulus of PC Wire, PC Strand, PC Bar	2.0 x 10^6 kg/cm^2
Young's Modulus of Cast Iron	1.0 x 10^6 kg/cm^2
Young's Modulus of Elasticity of Steel	8.1 x 10^5 kg/cm^2
Poisson's Ratio of Steel, Cast Steel	0.30
Poisson's Ratio of Cast Iron	0.25

Table 4.58 PC Wire and PC Strand Standard by Freyssinet Method

Specification Standard	Diameter & Composition of Strands	Area of PC	Unit Weight	Ultimate Strength (σ_{pu}) & Ultimate Load		Yield Strength (σ_{py}) & Yield Load		Allowable Tensile Stress (σ_{pa})						Remarks
								Initial Prestressing		Immediately after Prestressing		At Service Load		
								$\sigma_{pa} \leq 0.8\sigma_{pu}$ or $\leq 0.9\sigma_{py}$		$\sigma_{pa} \leq 0.76\sigma_{pu}$ or $\leq 0.85\sigma_{py}$		$\sigma_{pa} \leq 0.6\sigma_{pu}$ or $\leq 0.75\sigma_{py}$		
	mm	mm^2	kg/m	kg/mm^2	kg	kg/mm^2	kg	kg/mm^2	kg	kg/mm^2	kg	kg/mm^2	kg	
Civil Engineering Institute of Japan	ø5 12 ø5	19.64 235.68	0.154 1.848	175	3450 41400	155	3050 36600	140	2745 32940	123	2415 28980	105	2070 24840	
	ø7 12 ø7	38.48 461.76	0.302 3.624	165	6350 76200	145	5600 67200	131	5040 60480	116	4445 53340	99	3810 45720	
	ø8 12 ø8	50.27 603.24	0.395 4.740	160	8050 96600	140	7050 84600	126	6345 76140	112	5635 67620	96	4830 57960	
	T12.4 12T12.4	92.90 114.80	0.729 8.748	175	16300 195600	150	13900 166800	135	12510 150120	123	11410 136920	105	9780 117360	

Tabl4 4.77 **PC Wire and PC Strand Standard by Freyssinet Method**

Specification Standard	Diameter & Composition of Strands	Area of PC	Unit Weight	Ultimate Strength (σ_{pu}) & Ultimate Load		Yield Strength (σ_{py}) & Yield Load		Allowable Tensile Stress (σ_{pa})						Remarks
								Initial Prestressing		Immediately after Prestressing		At Service Load		
								$\sigma_{pa} \le 0.8\sigma_{pu}$ or $\le 0.9\sigma_{py}$		$\sigma_{pa} \le 0.76\sigma_{pu}$ or $\le 0.85\sigma_{py}$		$\sigma_{pa} \le 0.6\sigma_{pu}$ or $\le 0.75\sigma_{py}$		
	mm	mm^2	kg/m	kg/mm^2	kg	kg/mm^2	kg	kg/mm^2	kg	kg/mm^2	kg	kg/mm^2	kg	
Civil Engineering Institute of Japan	ø5 12 ø5	19.64 235.68	0.154 1.848	175	3450 41400	155	3050 36600	140	2745 32940	123	2415 28980	105	2070 24840	
	ø7 12 ø7	38.48 461.76	0.302 3.624	165	6350 76200	145	5600 67200	131	5040 60480	116	4445 53340	99	3810 45720	
	ø8 12 ø8	50.27 603.24	0.395 4.740	160	8050 96600	140	7050 84600	126	6345 76140	112	5635 67620	96	4830 57960	
	T12.4 12T12.4	92.90 114.80	0.729 8.748	175	16300 195600	150	13900 166800	135	12510 150120	123	11410 136920	105	9780 117360	