CHAPTER VI

BRIDGE CONSTRUCTION WORKS

1. General aspect of the proposed sites for bridge construction.

1-1 Weather

Data on weather conditions in the sites and their vicinity which were collected and analyzed by the River Training Team are quoted in this report in form of diagrams so as to make use of them as basic data for investigation of bridge design and its construction method.

1-1-1 Temperature

Fig. VI-1 shows the ranges of maximum and minimum temperature and their mean values for every month for the past five years from April 1964 to March 1969 at three meteorological stations, Bogra, Sirajganj and Faridpur.

The diagrams for the three stations show same tendency on the whole. The fluctuation of monthly mean temperature during rainy season from May to September is rather small and the temperature varies within a range of 28°C - 31°C. After October, the monthly mean temperature falls gradually to reach the lowest temperature of about 17°C - 19°C and raises again gradually. The annual discrepancy of monthly mean temperature is about 11°C - 13°C.

The monthly discrepancy for maximum and minimum temperature for the five years shows its smallest value in high rainy season from July to September. After the season, the discrepancy increases gradually to reach its maximum value in February or March.

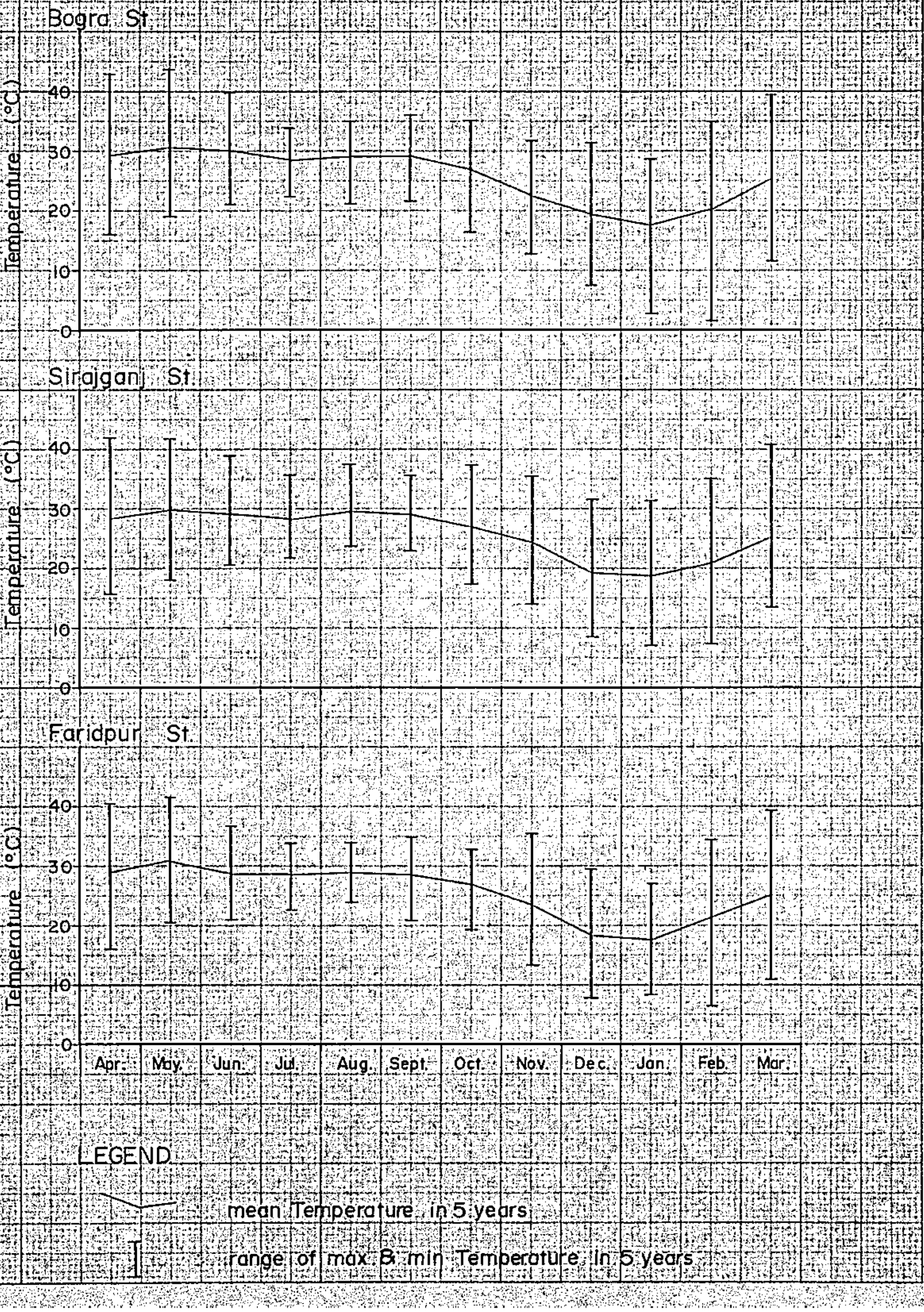
Table VI-1 shows the maximum and minimum temperature recorded at each station with date observed for the five years.

Table VI-1 Maximum and Minimum Temperature (for five years)

Meteorological station	max. temperature (°C)		min. temperature (°C)	
	date	temperature	date	temperature
Bogra	3 May, 1966	43.4	4 Feb. 1968	1.7
Sirajganj	2 May, 1965 17 Apr. 1966 3~5 May, 1966	41.7	1~2 Jan. 1965	6.7
Faridpur	1~2 May, 1965	41.7	4~5 Feb. 1968	6.7

Fig. VI - I Mean Temperature

(according to date from Apr. 1964 to Mar. 1969)



Dia section

1-1-2 Wind speed

Fig. VI-2 shows the recorded maximum wind speed for every month and its mean value for the five years.

Fig. VI -3 shows monthly mean days which the wind of speed more than 10, 20, and 30 kt/sec were recorded at the three meteorological stations for the five years.

It is remarkable that the wind speed higher than 10 kt/sec never observed during the period from November to February for the five years.

In Bangladesh, special attention must be paid to cyclones.

1-1-3 Rainfall

Fig. VI-4 shows the maximum and minimum monthly rainfall depth and mean monthly rainfall depth for the five years.

The ratio of mean rainfall depth during the period from May to October to mean annual rainfall depth observed at each meteorological station for the five years are shown in Table VI-2.

Table VI-2 Ratios of seasonal rainfall to annual rainfall

Meteorological station	1 Annual rainfall depth (mm)	2 Seasonal rainfall depth (May-Oct.) (mm)	Ratio 2 / 1 (%)
Bogra	1,651.9	1,566.1	94.8
Sirajganj	1,621.6	1,497.9	92.4
Faridpur	1,426.6	1,298.2	91.0

Fig. VI-5 shows the maximum and minimum daily rainfall depth for every month at the meteorological stations for the five years and their mean values.

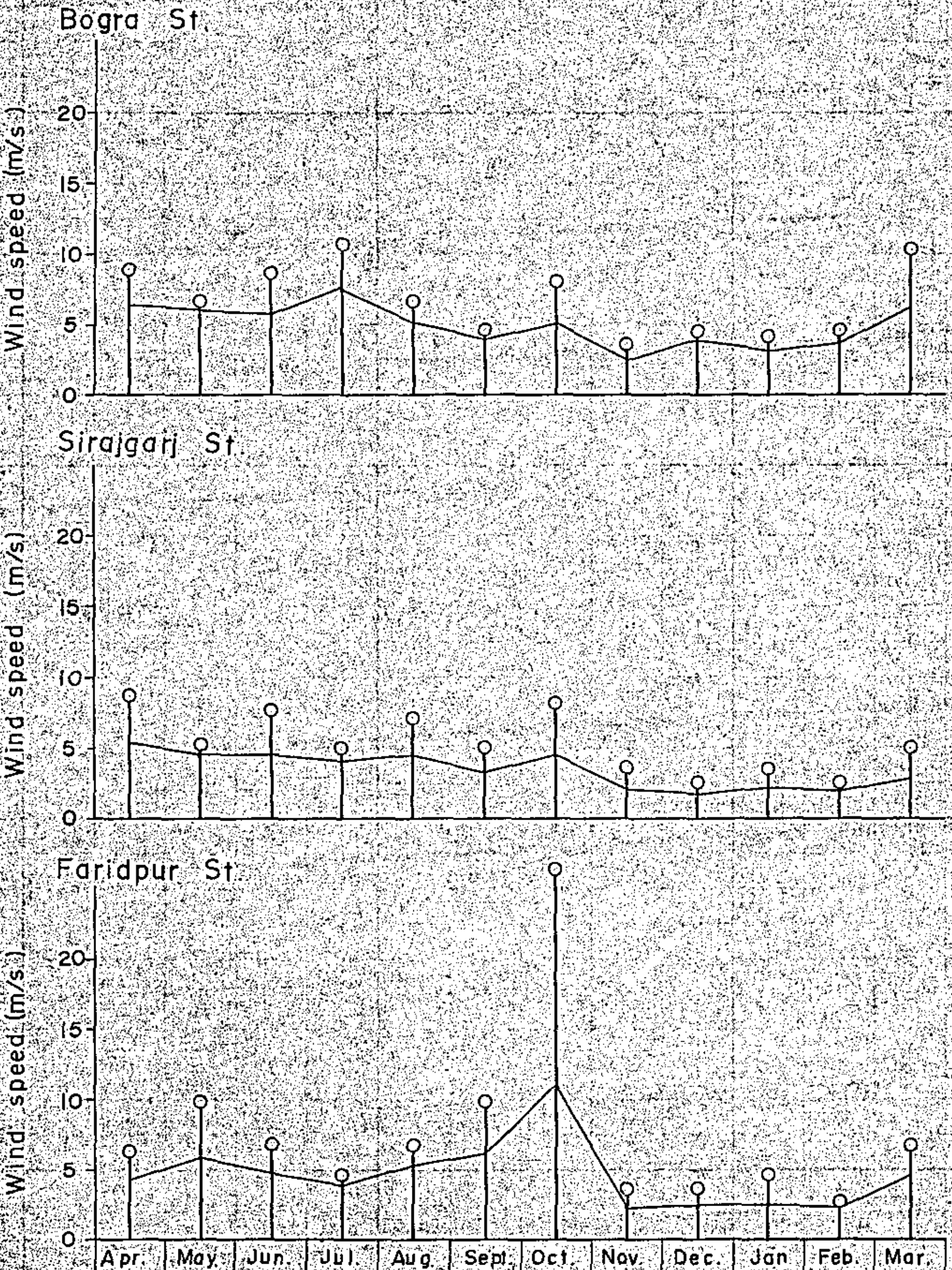
The maximum daily rainfall depth at three stations for the five years are shown in Table VI-3.

Table VI-3 Maximum daily rainfall depth

Meterological station	Date observed	Max. daily rainfall depth (mm)
Bogra	30 Jul. 1965	171.5
Sirajganj	9 Jul. 1965	172.8
Faridpur	15 Jun. 1964	152.4

Fig. VI-2 Maximum Wind Speed

(according to data from Apr 1964 to Mar. 1969)



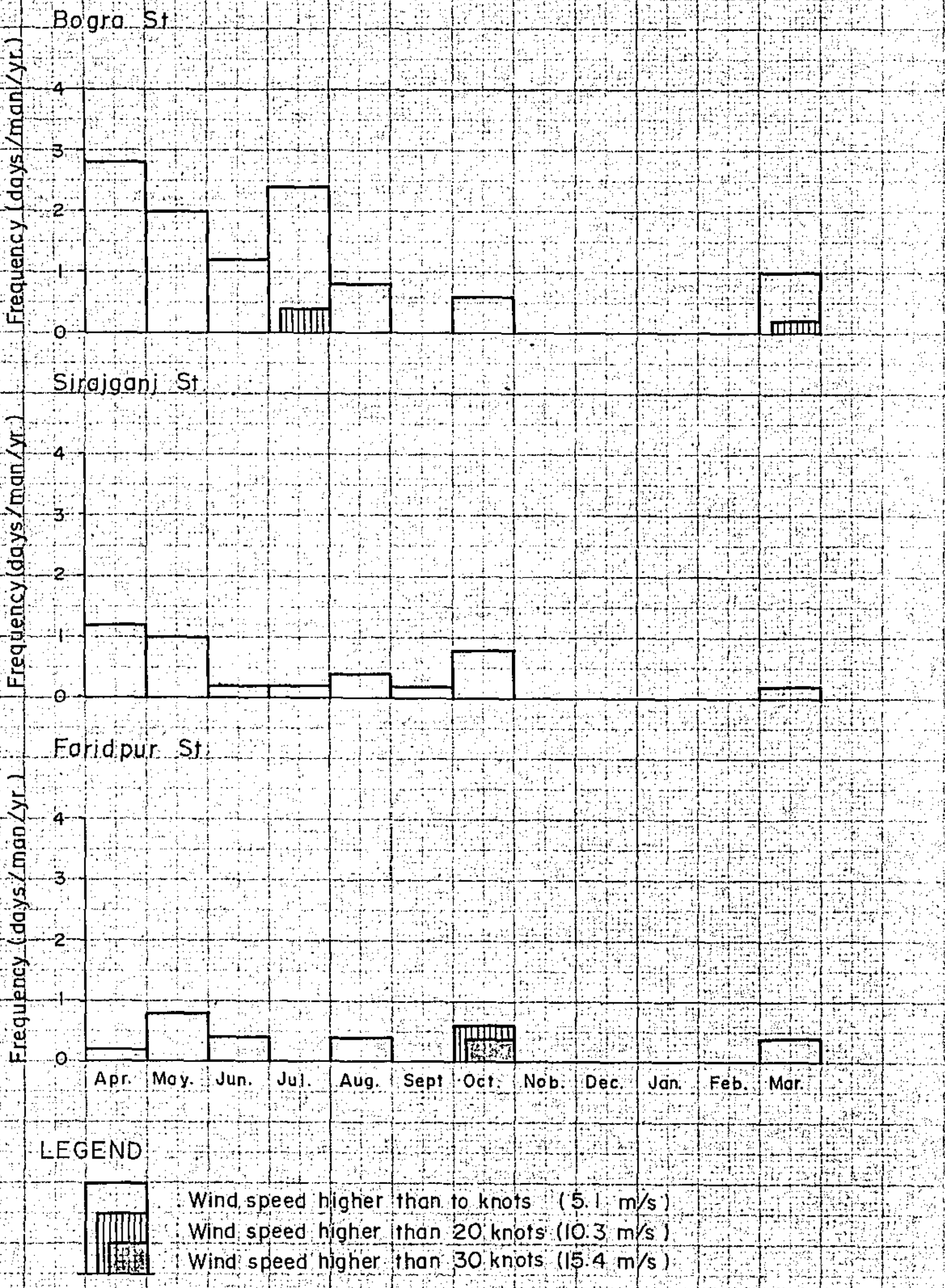
LEGEND

o : max. wind speed in 5 years.

⌒ : mean value of max. wind speeds in 5 years.

Fig. VI-3 Frequency of Wind Speed

(According to data from Apr. 1964 to Mar. 1969)



Dia Section

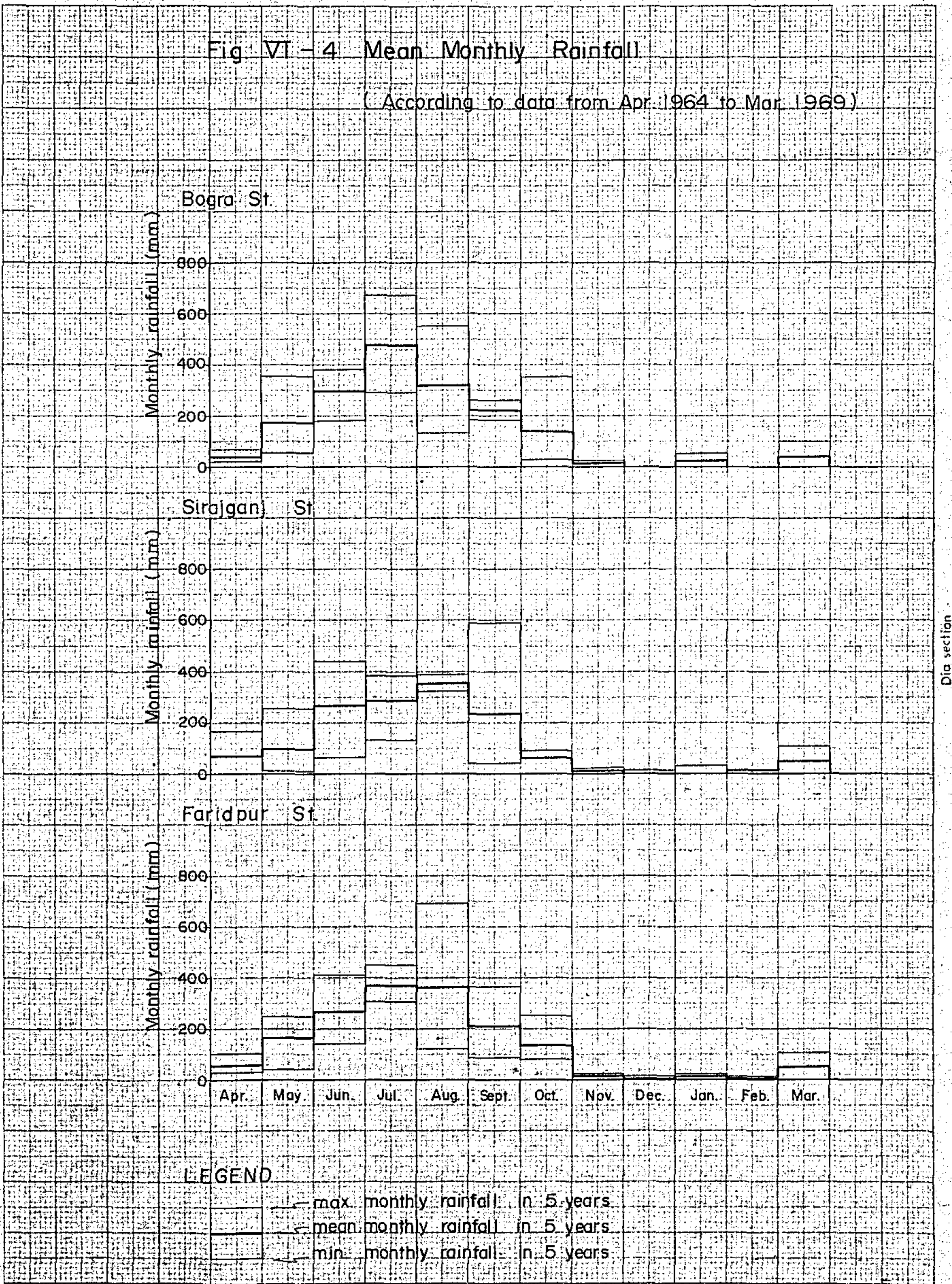
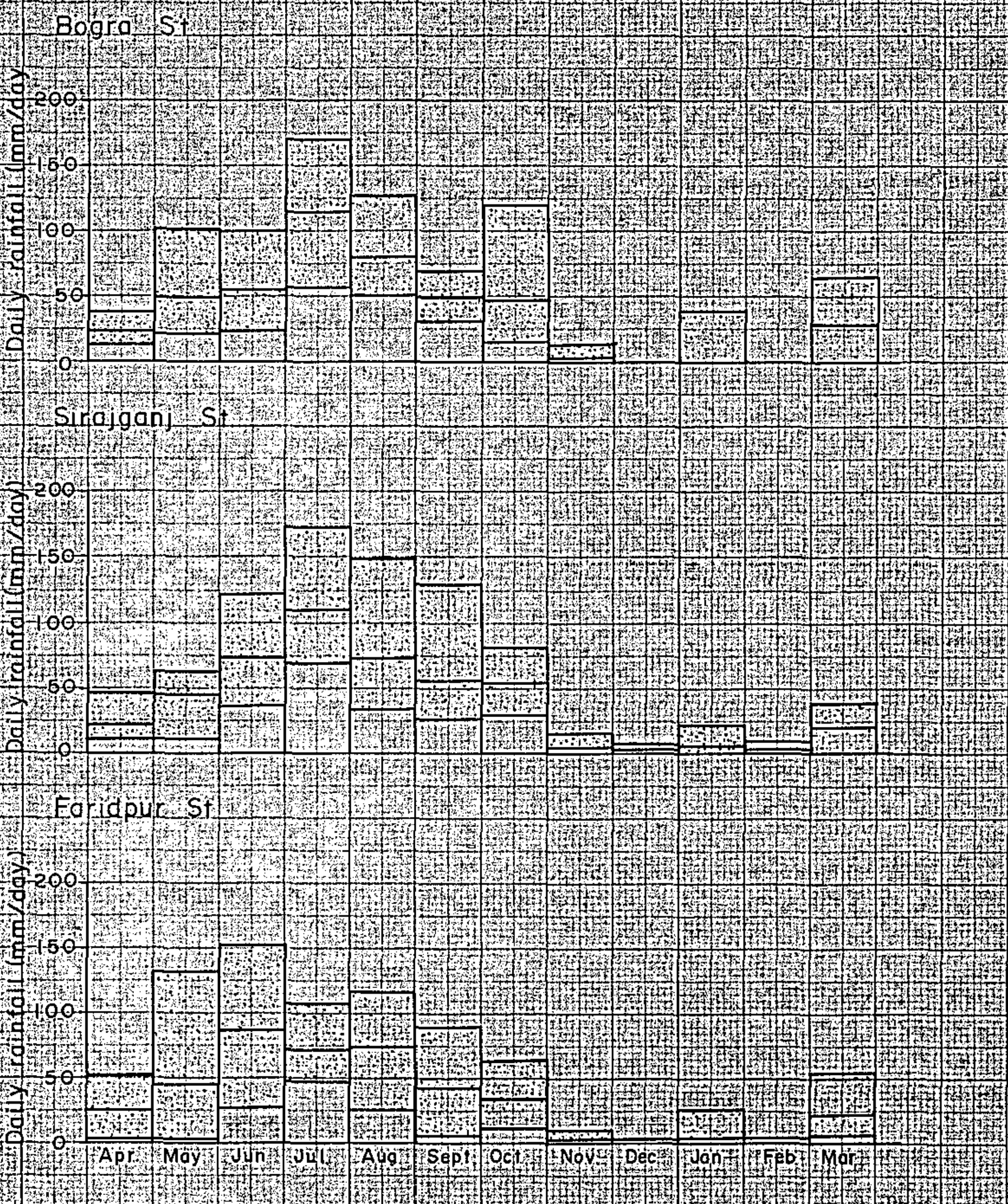


Fig VI - 4 Mean Monthly Rainfall
(According to data from Apr. 1964 to Mar. 1969)
Bogra St.
Monthly rainfall (mm)
800
600
400
200
0
Sirajganj St.
Monthly rainfall (mm)
800
600
400
200
0
Faridpur St.
Monthly rainfall (mm)
800
600
400
200
0
Apr.
May.
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
LEGEND
max. monthly rainfall in 5 years
mean monthly rainfall in 5 years
min. monthly rainfall in 5 years
Dia section

Fig. VI-5 Daily Rainfall

(According to data from Apr 1964 to Mar 1969)



Dia section

Fig. VI-6 shows the ranges of frequency of rainy days for every month for each grade of five rainfall depths for the five years and their mean values are shown in Figs. VI-7-1～3.

1-2 Water level of the river.

The River Training Team estimated monthly mean water levels at four proposed sites by the correlations of the water levels among the five gage stations, (Bahadurabad st., Sirajganj st., and Kadamtali st., under the control of BWDB and other two stations Tagannathganj st., Mahura st.) taking the distances among the stations into consideration, on the basis of the data collected by the Team at these stations.

The estimated monthly mean water levels mentioned above are shown in Fig. VI-8 with ground level and graded river bed.

In general, mean water level at each proposed site reaches its **minimum** level in July and August and then decrease to reach its minimum level in February and March.

The variation of the monthly mean water level during these period are about 21.5 ft.～23.0 ft. (6.5m～7.0m)

1-3 Workable days for construction works.

Fig. VI-9 shows the results of survey for wind speed and water level in the period from 1960 to 1969 and for rainy days in the period from April 1964 to March 1969 at Sirajganj site.

In the figure, the days which wind speed more than 10 knots/hr was observed are presented with the speed.

The period which water level more than 40 ft. (equivalent to the mean ground level at Sirajganj meteorological station) lasted and monthly mean rainy days which rainfall depth more than 0.5 mm/day was observed for the five years are also presented in the figure.

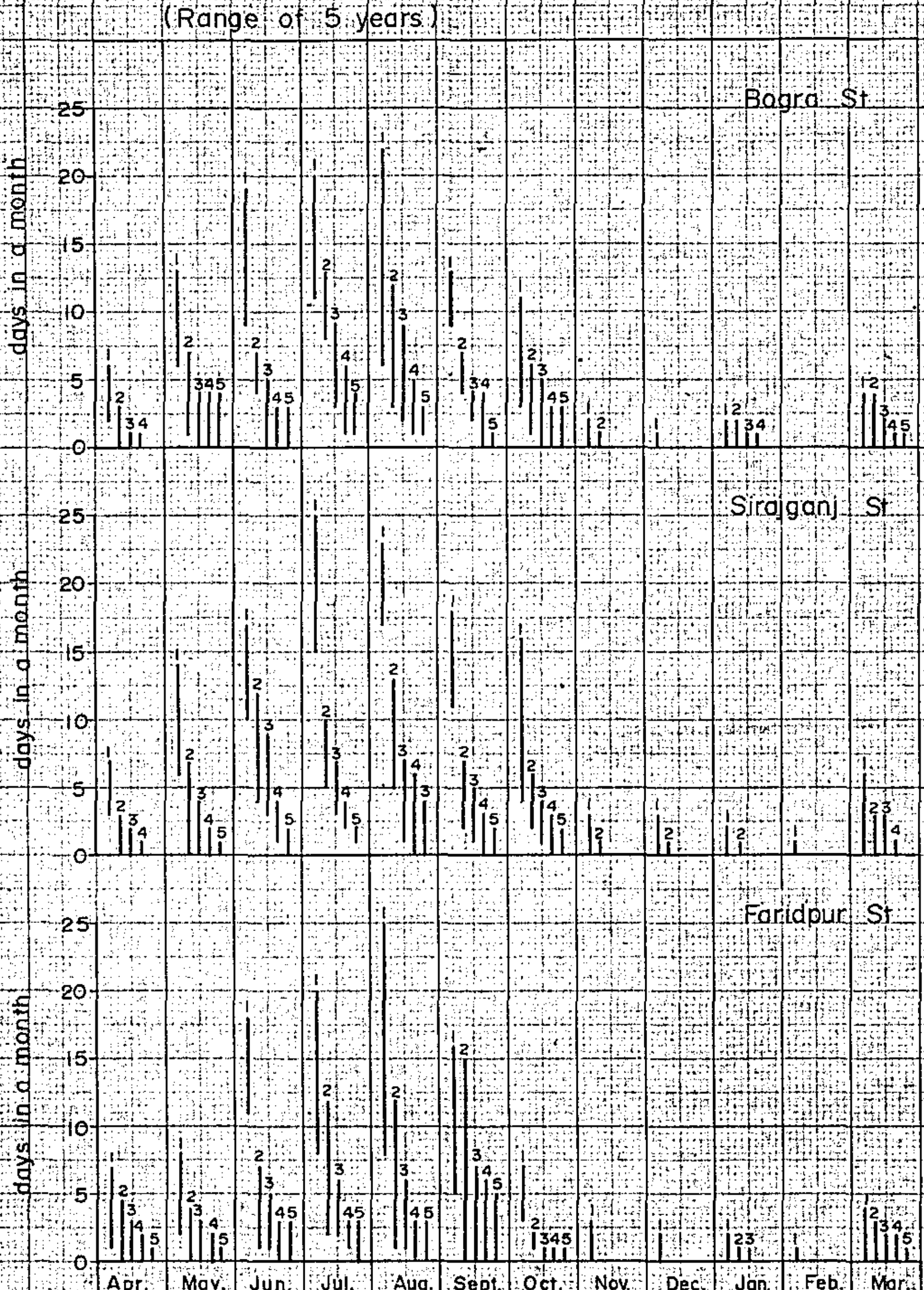
Workable days for the bridge construction works in a year at Sirajganj site was estimated as follows and the same idea was applied to the other sites.

a) Days restricted by water level of the river.

As to the substructures, the elevation of top surface of well foundation was designed to be one meter higher than MLLWL and the elevation of

Fig. VI-6 Frequency of Rainfall in Each Month

(according to data from Apr 1964 to Mar 1969)



1,2,3,4,5 case of intensity of daily rainfall more than 0.1, 0.5, 0.1, 1.5 and 2.0m/day, respectively

range of days at each intensity in 5 years.

Dia section

Fig. VI-7-1 Frequency of Rainfall at Bogra St.

according to data from Apr. 1964 to Mar. 1969)

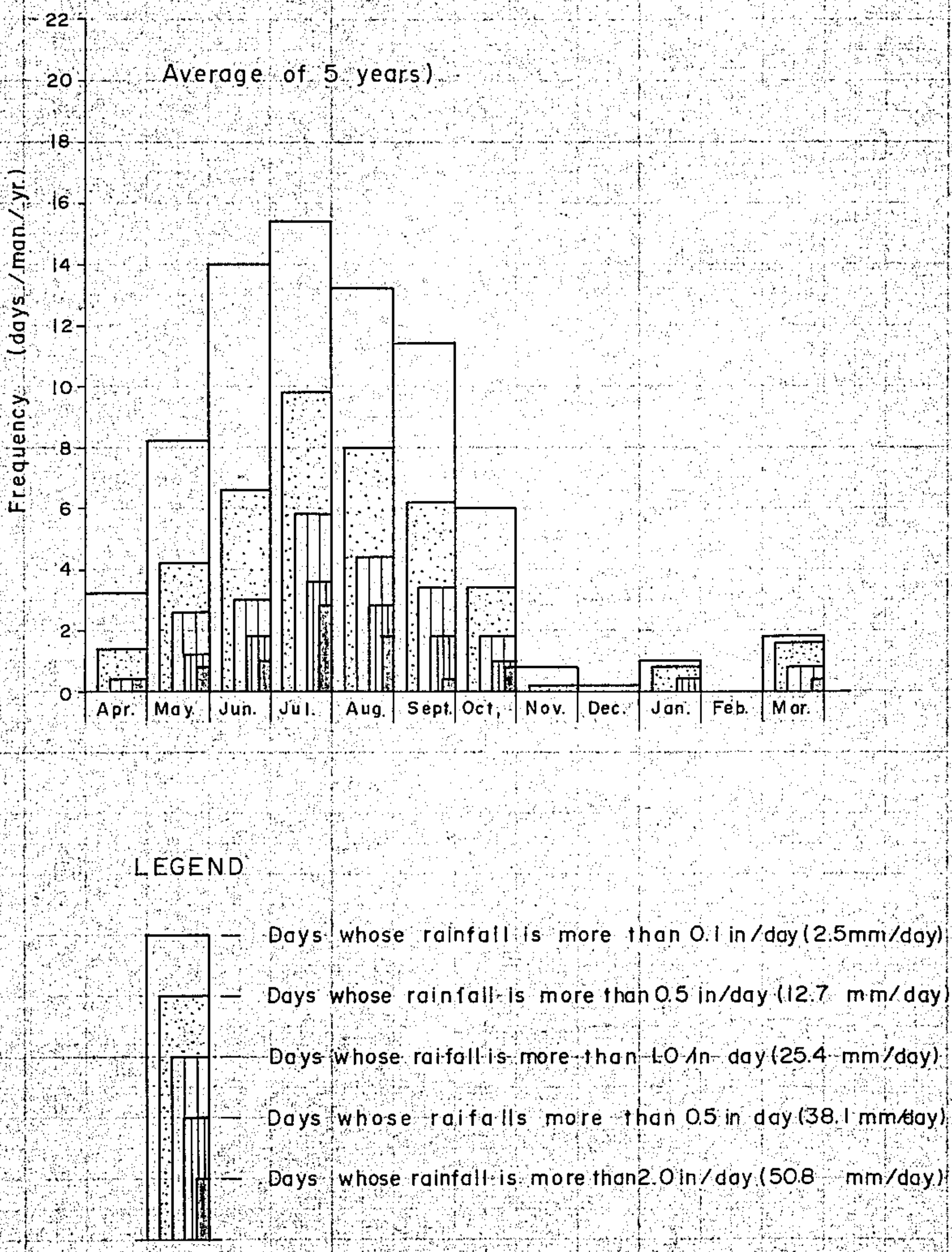


Fig VI-7-2 Frequency of Rainfall at Sirajganj St.

(according to data from Apr. 1964 to Mar. 1969)

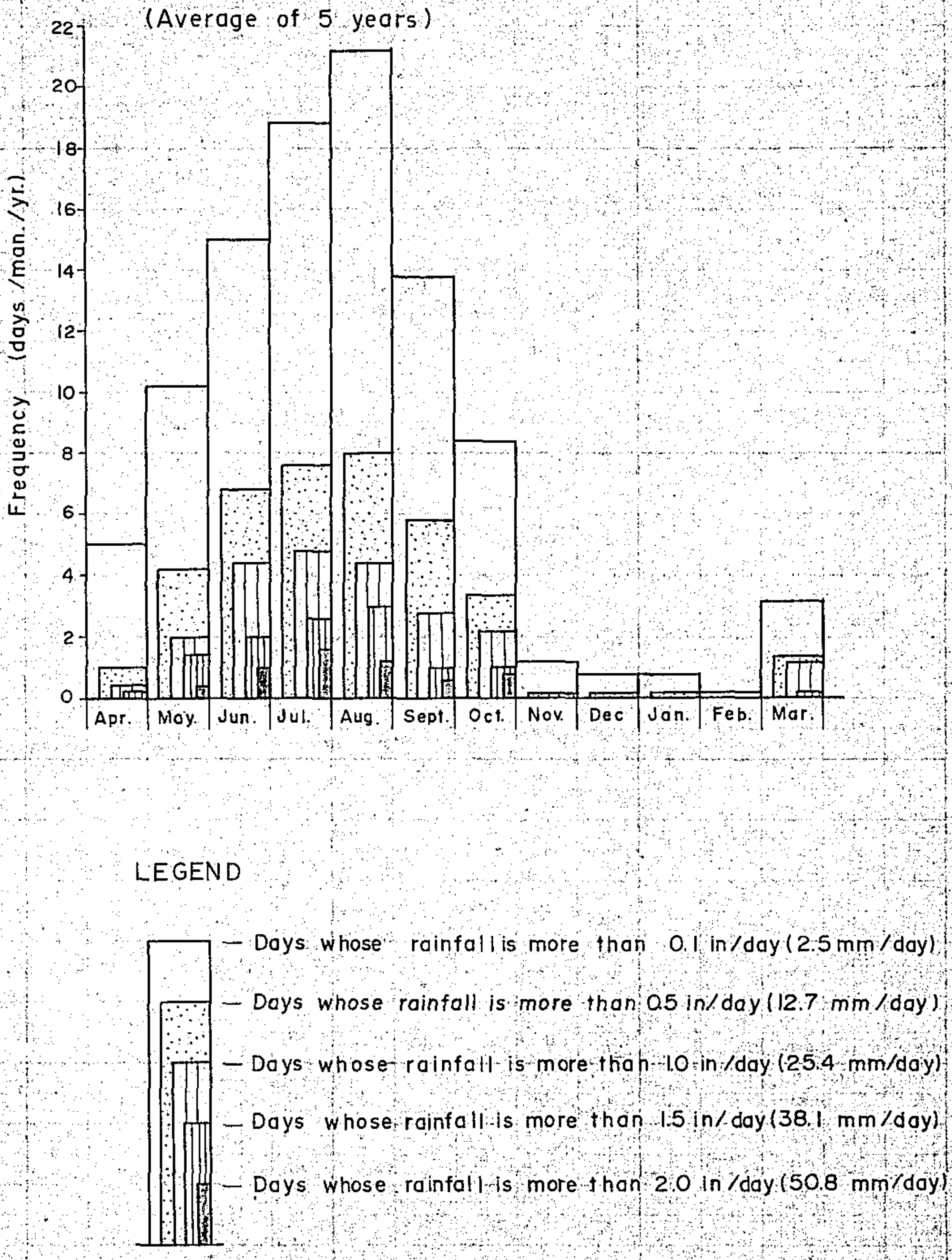
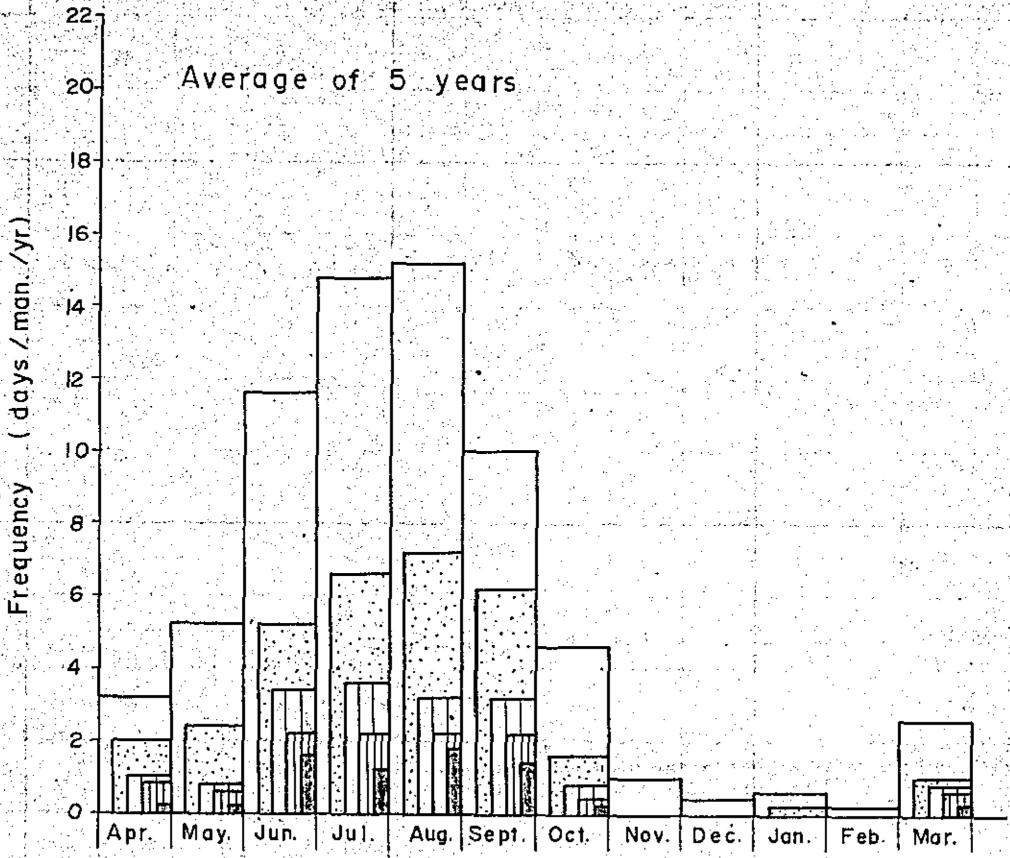


Fig. VI-7-3 Frequency of Rainfall at Faridpur St

(according to data from Apr. 1964 to Mar. 1969)



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— Days whose rainfall is more than 0.1 in/day (2.5 mm/day)
— Days whose rainfall is more than 0.5 in/day (12.7 mm/day)
— Days whose raifall is more than 1.0 in/day (25.4 mm/day)
— Days whose rainfall is more than 1.5 in/day (38.1 mm/day)
— Days whose rainfall is more than 2.0 in/day (50.8 mm/day)

Fig. VI - 8 Monthly Mean Water Level at Each Site

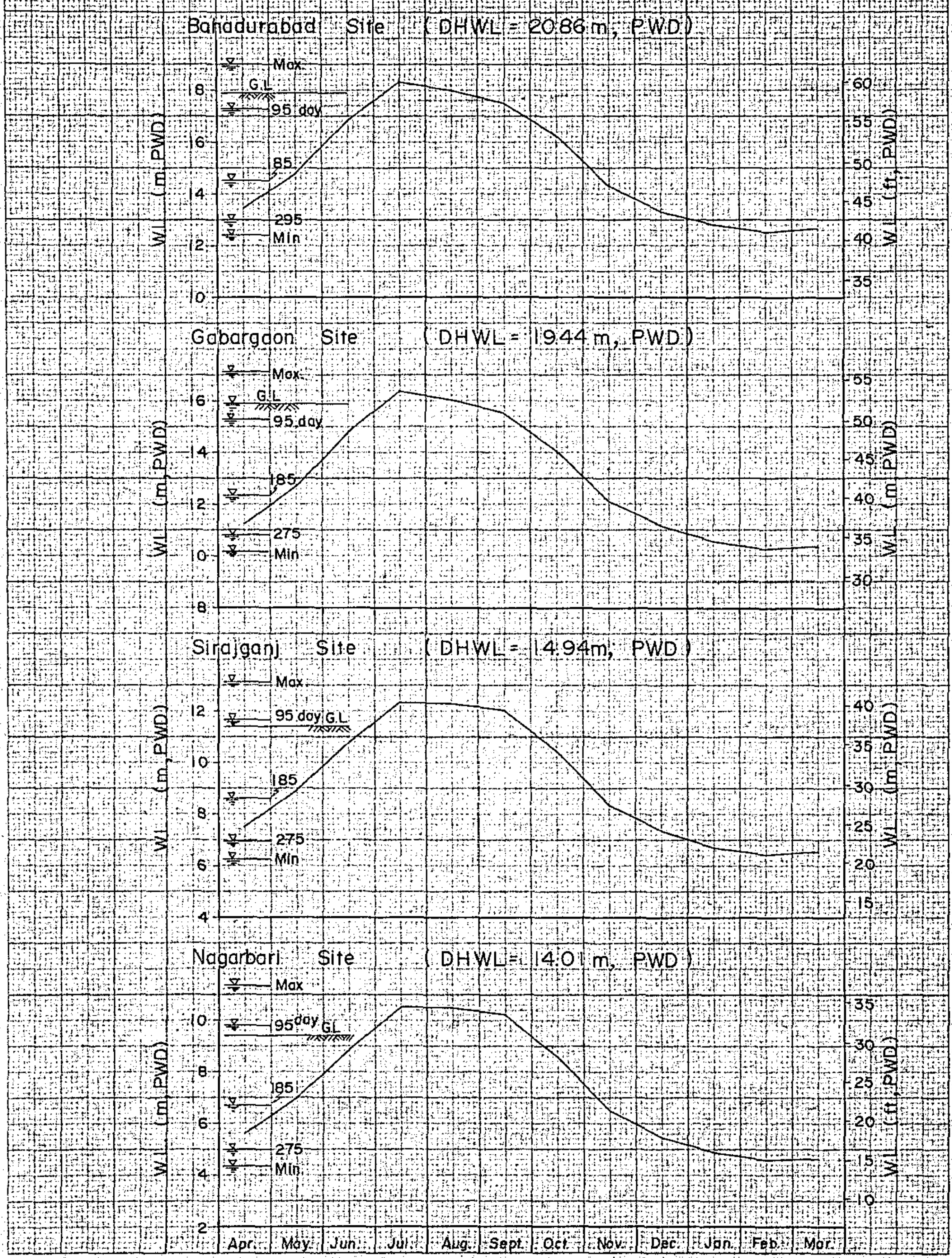
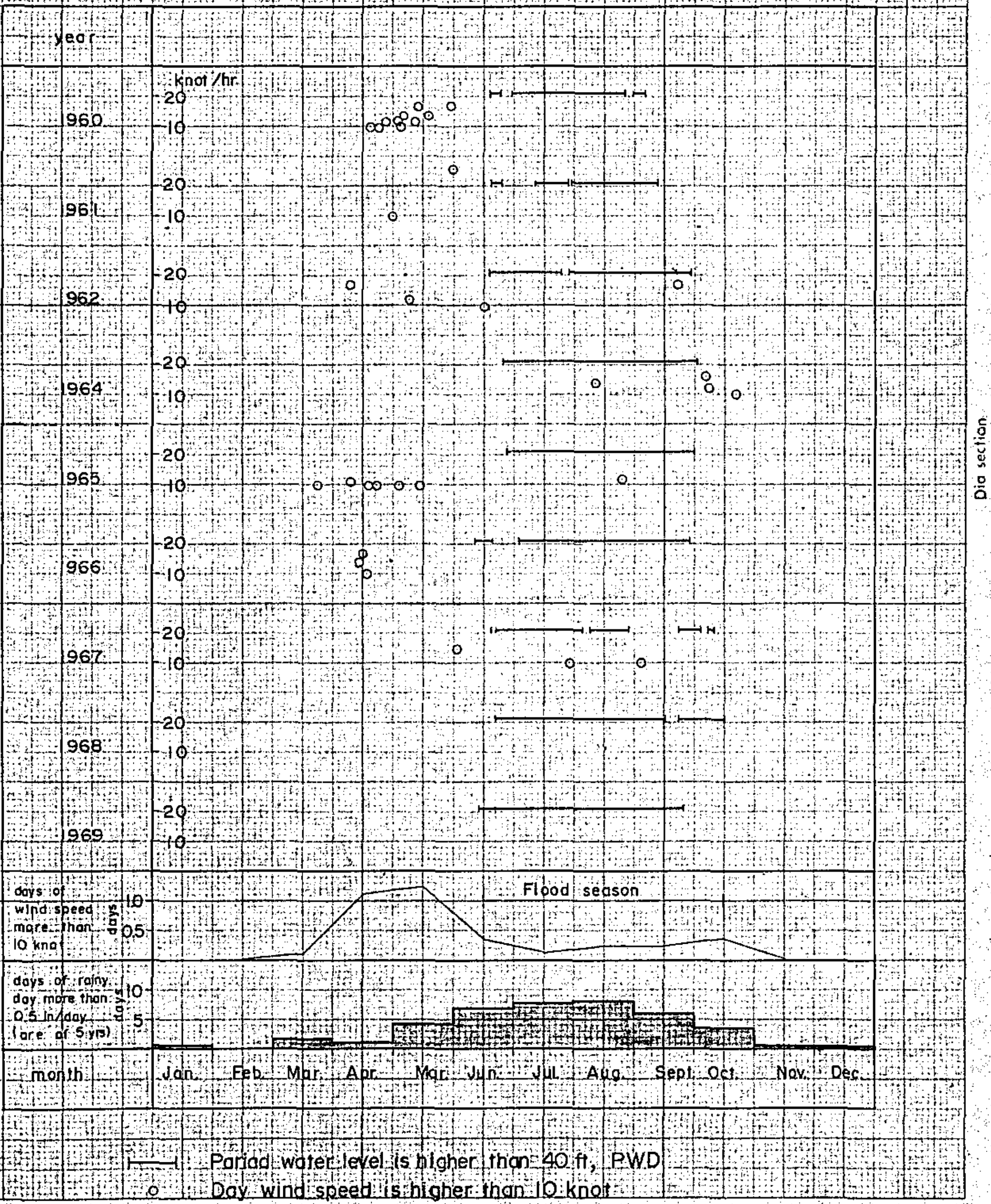


Fig. VI-9 Natural Condition at Sirajganji St.



bottom of top slab of multipile foundation was designed to be same level to DHWL.

On the basis of above mentioned designs, relation between water level of the river and height of cut-off wall of well foundation or construction speed of pier body were investigated for dry works of piers.

Period from middle of July to middle of September, correspond to peak of flood is judged to be unworkable period for the construction of well foundation.

For multi-piles foundation, the conditions for construction works are not so severe as compared with that of well foundation. But taking transportation by river for construction materials into consideration, the same unworkable period mentioned above was judged to be applied also in this case.

As to the superstructure, in the event that the materials for construction are transported through the approach bridges which constructed before that, none of days will restricted by water level, but when the materials have to be transported by ship the construction works will be restricted by flood period. It means the same unworkable period for substructures is available too.

After all, the period from 16th July to 15th September is adopted as unworkable period which is restricted by water level of the river.

b) Days restricted by rainfall.

The day which daily rainfall depth exceed 0.5 in/day (12.7 mm/day) was regarded as unworkable day for the construction. From Fig. VI-9, monthly mean days which daily rainfall depth exceeded 0.5 in/day for the five years were estimated as follows.

Month	1	2	3	4	5	6	7	8	9	10	11	12
days	0.2	0	1.4	1.0	4.2	6.8	7.6	8.0	5.8	3.4	0.2	0.2

c) Holidays.

Holidays which suspend the construction works were estimated twice a month.

d) Days restricted by wind speed.

Wind speed under 10 knots/sec was not regarded as harmfull to the construction works on the basis of the data on wind speed mentioned before. It is obvious that the construction works will not be suspended by wind during a year. In this case, a sudden of wind more than 10 knots/sec was ignored.

e) Workable days.

The remaining days other than the unworkable days defined in a) ~ d) were regarded as workable days in a year and it turned out 261 days in total as presented in Table VI-4.

2. Quantity of works.

2-1. Superstructure.

Fig. VI-10 shows each unit length of bridge for the three span continuous truss (for 100m and 150m span length) and cantilever truss (for 250m and 350m span length) for the purpose of estimating the quantity of the works.

On the basis of the unit length, metal weight of the truss for each case is estimated as shown in Table VI-5. Table VI-6 shows metal weight per one meter of the bridge length and Fig. VI-11 shows its diagram. Pavement area, concrete form area, reinforced concrete volume and metal weight for each span of bridges and for every distance of guide banks were estimated as seen in Table VI-7-1~4. In addition, the total metal weight was summerized in Table VI-8.

2-2. Substructure.

2-2-1. Well foundation.

The quantity of works for well foundation at each of four proposed sites for every type of superstructure and each distance between guide banks was estimated for case a and b. as seen in Tables 9-1~4. The cross sections of the well foundation are also seen in the same tables. The length of the foundation is 70m for Bahadurabad site, 72m for Gabargaon site, 68m for Sirajganj site, and 78m for Nagarbari site respectively.

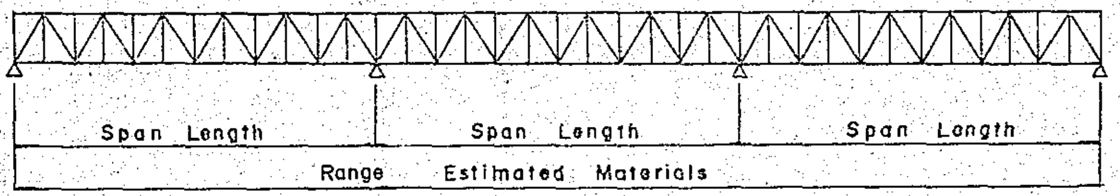
Tables VI-9-5~6 show total concrete volume of substructure and total amount of excavation for well foundation for case a and b.

Table. VI-4 Working days

	Month	Days in month	No Working days				Total Working days	30 days 20 10
			High Water days (H > MCL)	Rainy days (>0.5 in/day)	Holidays	Total no Working days		
Substructure	Oct.	31	0	3.4	2	5.4	26	
	Nov.	30	0	0.2	2	2.2	28	
	Dec.	31	0	0.2	2	2.2	29	
	Jan.	31	0	0.2	2	2.2	29	
	Feb.	28	0	0	2	2.0	26	
	Mar.	31	0	1.4	2	3.4	28	
	Apr.	30	0	1.0	2	3.0	27	
	May	31	0	4.2	2	6.2	25	
	June	30	0	6.8	2	8.8	21	
	Jul.	31	15	7.6	2	19.8	11	
	Aug.	31	31	8.0	2	31.0	0	
	Sept.	30	15	5.8	2	18.9	11	
	Total	365	61	38.8	24	105.1	261	

Fig. VI-10 Range estimated materials

Marking Diagram for Span of 328' or 492'.



Marking Diagram for Span of 820' or 1 148'

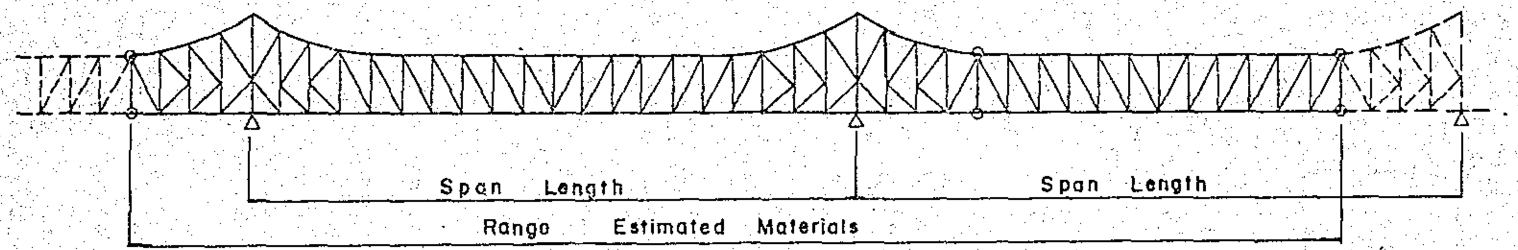


Table VI-5 Statement list of steel weight

ITEMS \ Case / L	Case a		Case b	
	100 m	150 m	100 m	150 m
Main truss	1,289	2,834	1,529	3,549
Floor system	725	1,109	1,250	1,841
Lateral bracing	232	422	154	340
Sway bracing	—	241	—	211
Subtotal	2,246	4,606	2,933	5,941
Exp. joint	9	11	18	22
Bearing	70	108	103	226
Hand Rail	45	68	75	113
Side walk	60	90	120	180
Subtotal	184	277	316	541
Total	2,430	4,833	3,249	6,482

ITEMS \ Case / L	Case a		Case b	
	250 m	350 m	250 m	350 m
Main truss	6,271	14,378	8,327	16,958
Floor system	1,016	1,597	2,700	3,879
Lateral bracing	627	1,609	833	2,024
Sway bracing	314	719	416	848
Deck plate	1,193	1,670	2,469	3,457
Subtotal	9,421	19,973	14,745	27,186
Exp. joint	14	18	29	37
Bearing	173	398	314	650
Hand Rail	75	105	125	175
Side walk	100	140	200	280
Subtotal	362	661	668	1,142
Total	9,783	20,634	15,413	28,328

Table VI-6 Comparison of steel weight per unit length

Case	Type	Span (m)	Bridge length (m) A	Steel weight (t) B	Per 1m (t/m) B/A
a	3 span continuous truss	100	300	2 430	8.10
		150	450	4 833	10.7
	Cantilever truss	250	500	9 783	19.6
		350	700	20 634	26.6
b	3 span continuous truss	100	300	3 249	10.8
		150	450	6 482	14.4
	Cantilever truss	250	500	15 413	30.8
		350	700	28 328	40.5

Fig. VI-11 Comparison of steel weight per unit length

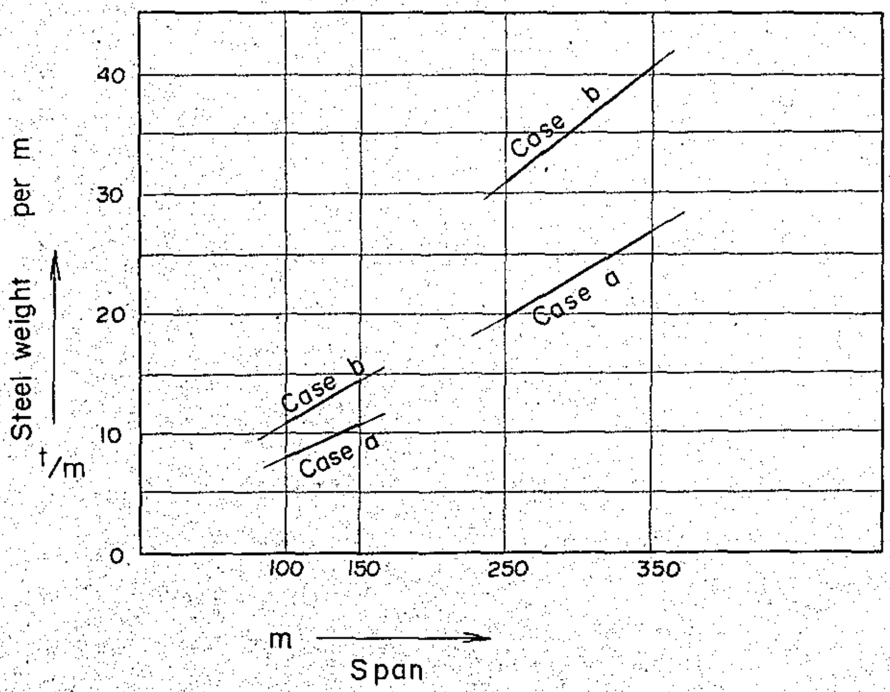


Table VI-7-1 Rough estimation of construction materials of superstructure

Span length L=100 m

Case	ITEMS		UNIT	DISTANCE BETWEEN GUIDE BANKS (km)			
				2.0	4.2	5.2	5.6
a	Structural steel	SS41	t	7,764	16,288	20,170	21,718
		SM50	t	7,993	16,786	20,783	22,381
		SM58	t				
	Cast steel (shoe)		t	473	980	1,065	1,313
	Reinforced concrete (slab)		m^3	4,420	9,282	11,492	12,376
	Form		m^2	20,900	43,890	54,340	58,520
	Asphalt pavement		m^2	14,633	30,730	38,047	40,973
b	Structural steel	SS41	t	9,669	20,147	25,108	27,031
		SM50	t	9,054	19,012	23,538	25,350
		SM58	t	2,287	4,802	5,945	6,403
	Cast steel (shoe)		t	695	1,442	1,803	2,009
	Reinforced concrete (slab)		m^3	9,693	20,356	25,203	27,141
	Form		m^2	37,280	78,288	96,928	104,384
	Asphalt pavement		m^2	29,260	61,446	76,076	81,928

Table VI-7-2 Rough estimation of construction materials of superstructure

Span length L=150 m

Case	ITEMS		UNIT	DISTANCE BETWEEN GUIDE BANKS (km)			
				2.0	4.2	5.2	5.6
a	Structural steel	SS41	t	7,452	15,420	18,608	20,201
		SM50	t	11,092	22,977	27,731	30,108
		SM58	t	3,766	7,801	9,415	10,222
	Cast steel (shoe)		t	513	1,053	1,269	1,377
	Reinforced concrete (slab)		m^3	4,625	9,580	11,562	12,553
	Form		m^2	21,966	45,501	54,915	59,622
	Asphalt pavement		m^2	15,362	31,823	38,407	41,699
b	Structural steel	SS41	t	10,841	22,424	27,058	29,374
		SM50	t	9,459	19,594	23,648	25,675
		SM58	t	8,937	18,512	22,342	24,257
	Cast steel (shoe)		t	1,074	2,204	2,656	2,882
	Reinforced concrete (slab)		m^3	10,351	21,441	25,877	28,095
	Form		m^2	41,958	86,913	104,895	113,886
	Asphalt pavement		m^2	30,725	63,645	76,813	83,397

Table VI-7-3 Rough estimation of construction materials of superstructure

Span length L=250 m

Case	ITEMS		UNIT	DISTANCE BETWEEN GUIDE BANKS (km)			
				2.0	4.2	5.2	5.6
a	Structural steel	SS41	t	20,210	42,893	52,113	52,113
		SM50	t	8,239	17,493	21,255	21,255
		SM58	t	13,736	29,165	35,437	35,437
	Cast steel (shoe)		t	865	1,730	2,076	2,076
	Reinforced concrete (slab)		m^3	1,001	2,125	2,582	2,582
	Form		m^2	2,409	5,115	6,215	6,215
	Asphalt pavement		m^2	16,020	34,015	41,330	41,330
b	Structural steel	SS41	t	34,630	73,494	89,290	89,290
		SM50	t	13,446	28,551	34,691	34,691
		SM58	t	18,234	38,716	47,042	47,042
	Cast steel (shoe)		t	1,570	3,140	3,768	3,768
	Reinforced concrete (slab)		m^3	2,402	5,101	6,198	6,198
	Form		m^2	3,504	7,440	9,040	9,040
	Asphalt pavement		m^2	32,040	68,030	82,660	82,660

Table VI-7-4 Rough estimation of construction materials of superstructure

Span length L=350 m

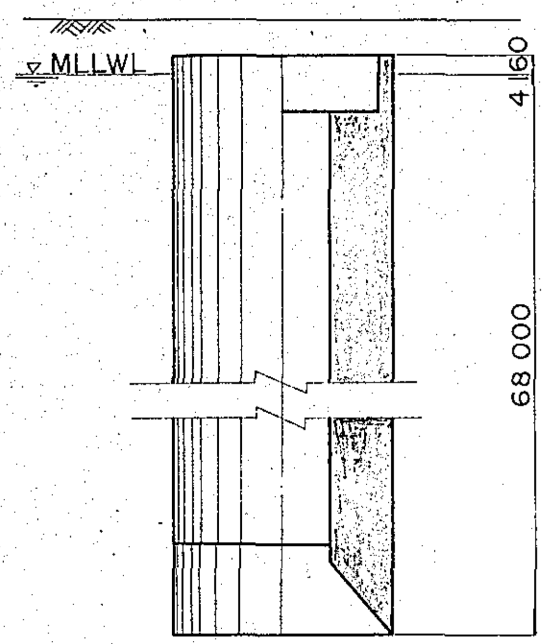
Case	ITEMS		UNIT	DISTANCE BETWEEN GUIDE BANKS (km)			
				2.0	4.2	5.2	5.6
a	Structural steel	SS41	t	27,023	51,567	67,929	67,929
		SM50	t	15,183	28,986	38,188	38,188
		SM58	t	24,671	47,099	62,051	62,051
	Cast steel (shoe)		t	1,592	2,786	3,582	3,582
	Reinforced concrete (slab)		m^3	1,056	2,015	2,655	2,655
	Form		m^2	2,541	4,851	6,391	6,391
	Asphalt pavement		m^2	16,898	32,259	42,500	42,500
b	Structural steel	SS41	t	41,884	79,913	105,265	105,265
		SM50	t	20,542	39,217	51,667	51,667
		SM58	t	29,099	55,553	73,189	73,189
	Cast steel (shoe)		t	2,600	4,550	5,850	5,850
	Reinforced concrete (slab)		m^3	2,534	4,838	6,374	6,374
	Form		m^2	3,696	7,056	9,296	9,296
	Asphalt pavement		m^2	33,795	64,518	85,000	85,000

Table VI-8 Total weight of steel of superstructure

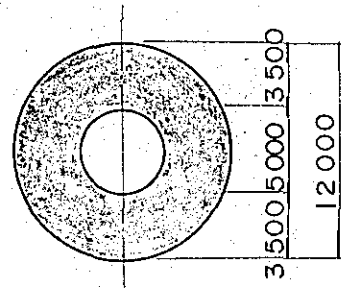
(ton)

Case	Span (m)	Distance between guide banks			
		2.0 km	4.2 km	5.2 km	5.6 km
a	100	16,230	34,054	42,018	45,412
	150	22,823	47,251	57,023	61,908
	250	43,050	91,281	110,881	110,881
	350	68,469	130,438	171,750	171,750
b	100	21,705	45,403	56,394	60,793
	150	30,311	62,734	75,704	82,188
	250	67,880	143,901	174,791	174,791
	350	94,125	179,233	235,971	235,971

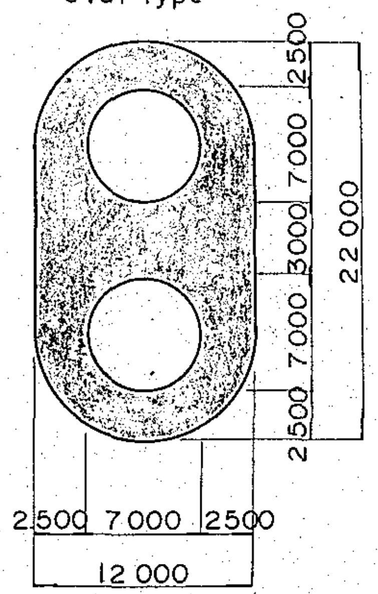
Table VI-9-1 BAHADURABAD SITE



Circular type

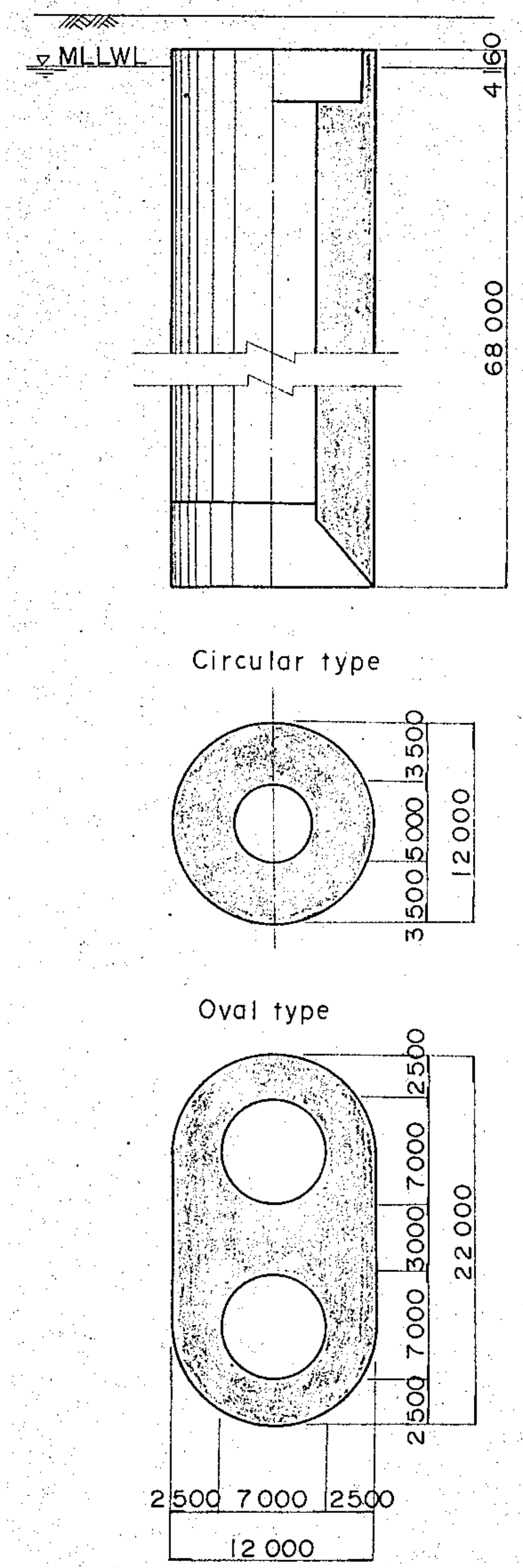


Oval type



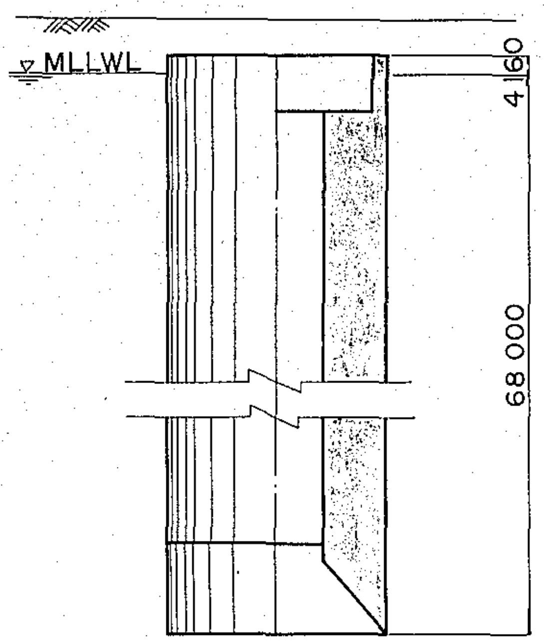
Case of bridge		Unit	Case a				Case b			
Shape of well			Circular type		Oval type		Oval type			
Span length		m	L = 100	L = 150	L = 250	L = 350	L = 100	L = 150	L = 250	L = 350
Per one well	Concrete Body	m3	715	715	715	715	1 100	1 100	1 100	1 100
	Concrete Top slab	〃	339	339	699	699	699	699	699	699
	Concrete Bottom slab	〃	452	452	932	932	932	932	932	932
	Concrete Wall	〃	6 542	6 542	10 929	10 929	10 929	10 929	10 929	10 929
	Excavation	〃	8 431	8 431	17 377	17 377	17 377	17 377	17 377	17 377
	Volume of wells	Empm3	7 917	7 917	16 317	16 317	16 317	16 317	16 317	16 317
B = 5.6 km	Number of wells	each	55	37	22	16	55	37	22	16
	Concrete Body	m3	39 330	26 460	15 730	11 440	60 550	40 700	24 200	17 600
	Concrete Top slab	〃	18 650	12 540	15 380	11 180	38 450	25 860	15 380	11 180
	Concrete Bottom slab	〃	24 860	16 720	20 500	14 910	51 260	34 480	20 500	14 910
	Concrete Wall	〃	359 810	242 050	240 440	174 860	601 100	404 370	240 440	174 860
	Excavation	〃	463 710	311 950	382 290	278 030	955 740	642 950	382 290	278 030
	Volume of wells	Empm3	435 440	292 930	358 970	261 070	897 440	603 730	358 970	261 070
B = 4.2 km	Number of wells	each	41	28	18	12	41	28	18	12
	Concrete Body	m3	29 320	20 020	12 870	8 580	45 100	30 800	19 800	13 200
	Concrete Top slab	〃	13 900	9 490	12 580	8 390	28 660	19 570	12 580	8 390
	Concrete Bottom slab	〃	18 530	12 660	16 780	11 180	38 210	26 100	16 780	11 180
	Concrete Wall	〃	268 220	183 180	196 722	131 150	448 090	306 010	196 720	131 150
	Excavation	〃	345 670	236 070	312 790	208 520	712 460	486 560	312 790	208 520
	Volume of wells	Empm3	324 600	221 680	293 710	195 800	669 000	456 880	293 710	195 800
B = 2.0 km	Number of wells	each	29	13	8	6	29	13	8	6
	Concrete Body	m3	20 740	9 300	5 720	4 290	31 900	14 300	8 800	6 600
	Concrete Top slab	〃	9 830	4 410	5 590	4 190	20 270	9 090	5 590	4 190
	Concrete Bottom slab	〃	13 110	5 880	7 460	5 590	27 030	12 120	7 460	5 590
	Concrete Wall	〃	189 720	85 050	87 430	65 570	316 940	142 080	87 430	65 570
	Excavation	〃	244 500	109 600	139 020	104 260	503 930	225 900	139 020	104 260
	Volume of wells	Empm3	229 590	102 920	130 540	97 902	473 190	212 120	130 540	97 900

Table VI-9-2 GABARGAON SITE

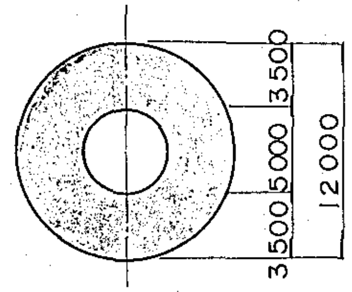


Case of bridge			Unit	Case a				Case b			
Shape of well				Circular type		Oval type		Oval type			
Span length			m	L = 100	L = 150	L = 250	L = 350	L = 100	L = 150	L' = 250	L = 350
Per one well	Concrete	Body	m^3	715	715	715	715	1 100	1 100	1 100	1 100
		Top slab	"	339	339	699	699	699	699	699	699
		Bottom slab	"	452	452	932	932	932	932	932	932
		Wall	"	6 729	6 729	11 241	11 241	11 241	11 241	11 241	11 241
	Excavation		"	8 687	8 687	17 904	17 904	17 904	17 904	17 904	17 904
	Volume of wells		Empm^3	8 143	8 143	16 783	16 783	16 783	16 783	16 783	16 783
B = 5.6 km	Number of wells		each	51	34	22	16	51	34	22	16
	Concrete	Body	m^3	36 470	24 310	15 730	11 440	56 100	37 400	24 200	17 600
		Top slab	"	17 290	11 530	15 380	11 180	35 650	23 770	15 380	11 180
		Bottom slab	"	23 050	15 370	20 500	14 910	47 530	31 690	20 500	14 910
		Wall	"	343 180	228 790	247 300	179 860	573 290	282 190	247 300	179 860
	Excavation		"	443 040	295 360	393 890	286 460	913 100	608 740	393 890	286 460
	Volume of wells		Empm^3	415 290	276 860	369 230	268 530	855 930	570 620	369 230	268 530
B = 4.2 km	Number of wells		each	41	28	18	12	41	28	18	12
	Concrete	Body	m^3	29 320	20 020	12 870	8 580	45 100	30 800	19 800	13 200
		Top slab	"	13 900	9 490	12 580	8 390	28 660	19 570	12 580	8 390
		Bottom slab	"	18 530	12 660	16 780	11 180	38 210	26 100	16 780	11 180
		Wall	"	275 890	188 410	202 340	134 890	460 880	314 750	202 340	134 890
	Excavation		"	356 170	243 240	322 270	214 850	734 060	501 310	322 270	214 850
	Volume of wells		Empm^3	333 860	228 000	369 230	201 400	688 100			
B = 2.0 km	Number of wells		each	29	13	8	6	29	13	8	6
	Concrete	Body	m^3	20 740	9 300	5 720	4 290	31 900	14 300	8 800	6 600
		Top slab	"	9 830	4 410	5 590	4 190	20 270	9 090	5 590	4 190
		Bottom slab	"	13 110	5 880	7 460	5 590	27 030	12 120	7 460	5 590
		Wall	"	195 140	87 480	89 930	67 450	325 990	146 130	89 930	67 450
	Excavation		"	251 920	112 930	143 230	107 420	519 220	232 750	143 232	107 424
	Volume of wells		Empm^3	236 150	105 860	134 260	100 700	486 710	218 180	134 260	100 700

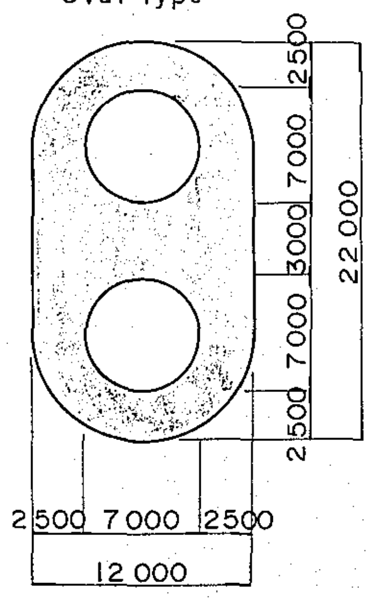
Table VI-9-3 SIRAJGANJ SITE



Circular type

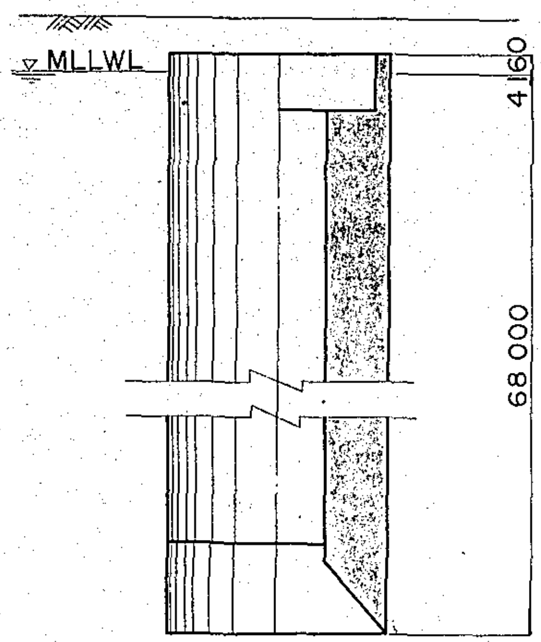


Oval type

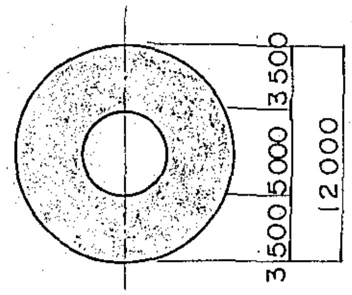


Case of bridge			Unit	Case a				Case b			
Shape of well				Circular type		Oval type		Oval type			
Span length			m	L = 100	L = 150	L = 250	L = 350	L = 100	L = 150	L = 250	L = 350
Per one well	Concrete	Body	m3	715	715	715	715	1 100	1 100	1 100	1 100
		Top slab	"	339	339	699	699	699	699	699	699
		Bottom slab	"	452	452	932	932	932	932	932	932
		Wall	"	6 355	6 355	10 617	10 617	10 617	10 617	10 617	10 617
	Excavation		"	8 161	8 161	16 820	16 820	16 820	16 820	16 820	16 820
	Volume of wells		Empm3	7 691	7 691	15 851	15 851	15 851	15 851	15 851	15 851
B = 5.6 km	Number of wells		each	55	37	22	16	55	37	22	16
	Concrete	Body	m3	39 330	26 460	15 730	11 440	60 550	40 700	24 200	17 600
		Top slab	"	18 650	12 540	15 380	11 180	38 450	25 860	15 380	11 180
		Bottom slab	"	24 860	16 720	20 500	14 910	51 260	34 480	20 500	14 910
		Wall	"	349 530	235 140	233 570	169 870	583 940	392 830	233 570	169 870
	Excavation		"	448 860	301 960	370 040	269 120	925 100	622 340	370 040	269 120
	Volume of wells		Empm3	423 010	284 570	348 720	253 620	871 810	586 490	348 720	253 620
B = 4.2 km	Number of wells		each	41	28	18	12	41	28	18	12
	Concrete	Body	m3	29 320	20 020	12 870	8 580	45 100	30 800	19 800	13 200
		Top slab	"	13 900	9 490	12 580	8 390	28 660	19 570	12 580	8 390
		Bottom slab	"	18 530	12 660	16 780	11 180	38 210	26 100	16 780	11 180
		Wall	"	260 560	177 940	191 110	127 400	435 300	297 280	191 110	127 400
	Excavation		"	334 600	228 510	302 760	201 840	689 620	470 960	302 760	201 840
	Volume of wells		Empm3	315 330	215 350	285 320	190 210	649 890	443 830	285 320	190 210
B = 2.0 km	Number of wells		each	29	13	8	6	29	13	8	6
	Concrete	Body	m3	20 740	9 300	5 720	4 290	31 900	14 300	8 800	6 600
		Top slab	"	9 830	4 410	5 590	4 190	20 270	9 090	5 590	4 190
		Bottom slab	"	13 110	5 880	7 460	5 590	27 030	12 120	7 460	5 590
		Wall	"	184 300	82 620	84 940	63 700	307 890	138 020	84 940	63 700
	Excavation		"	236 670	106 090	134 560	100 920	487 780	218 660	134 560	100 920
	Volume of wells		Empm3	223 040	99 980	126 810	95 110	459 680	206 060	126 810	95 110

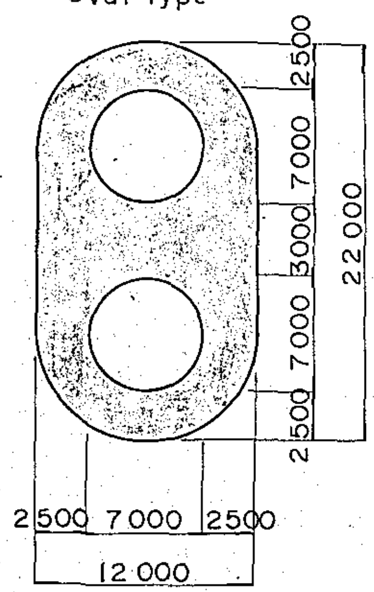
Table VI-9-4 NAGARBARI SITE



Circular type



Oval type



Case of bridge			Unit	Case a				Case b			
Shape of well				Circular type		Oval type		Oval type			
Span length			m	L = 100	L = 150	L = 250	L = 350	L = 100	L = 150	L' = 250	L = 350
Per one well	Concrete	Body	m3	715	715	715	715	1 100	1 100	1 100	1 100
		Top slab	"	339	339	699	699	699	699	699	699
		Bottom slab	"	452	452	932	932	932	932	932	932
		Wall	"	7 290	7 290	12 178	12 178	12 178	12 178	12 178	12 178
	Excavation		"	9 286	9 286	19 139	19 139	19 139	19 139	19 139	19 139
	Volume of wells		Empm3	8 822	8 822	18 182	18 182	18 182	18 182	18 182	18 182
B = 5.6 km	Number of wells		each	51	34	22	16	51	34	22	16
	Concrete	Body	m3	36 470	24 310	15 730	11 440	56 100	37 400	24 200	17 600
		Top slab	"	17 290	11 530	15 380	11 180	35 650	23 770	15 380	11 180
		Bottom slab	"	23 050	15 370	20 500	14 910	47 530	31 690	20 500	14 910
		Wall	"	371 790	247 860	267 920	194 850	621 080	414 050	267 920	194 850
	Excavation		"	473 590	315 720	421 060	306 220	976 090	650 730	421 060	306 220
	Volume of wells		Empm3	499 920	299 950	400 000	290 910	449 920	299 950	400 000	290 910
B = 4.2 km	Number of wells		each	41	28	18	12	41	28	18	12
	Concrete	Body	m3	29 320	20 020	12 870	8 580	45 100	30 800	19 800	13 200
		Top slab	"	13 900	9 490	12 580	8 390	28 660	19 570	12 580	8 390
		Bottom slab	"	18 530	12 660	16 780	11 180	38 210	26 100	16 780	11 180
		Wall	"	298 890	204 120	219 200	146 140	499 300	340 980	219 200	146 140
	Excavation		"	380 730	260 010	344 500	229 670	784 700	535 890	344 500	229 670
	Volume of wells		Empm3	361 700	247 020	327 280	218 180	361 700	247 020	327 280	218 180
B = 2.0 km	Number of wells		each	29	13	8	6	29	13	8	6
	Concrete	Body	m3	20 740	9 300	5 720	4 290	31 900	14 300	8 800	6 600
		Top slab	"	9 830	4 410	5 590	4 190	20 270	9 090	5 590	4 190
		Bottom slab	"	13 110	5 880	7 460	5 590	27 030	12 120	7 460	5 590
		Wall	"	211 410	94 770	97 424	73 070	353 160	158 310	97 420	73 070
	Excavation		"	269 290	120 720	153 110	114 830	555 030	248 807	153 110	114 830
	Volume of wells		Empm3	255 840	114 690	145 460	109 090	527 280	236 370	145 460	109 090

Table VI-9-5 The total list of construction materials of well foundations in Case a

Span (m)	Dist. Btw. G.B (km)	Items	Unit	Proposed site			
				Bahadurabad	Gabargaon	Sirajganj	Nagarbari
L= 100	2.0	R.C S.W	m^3 Emp. m^3	233,400 244,500	238,820 251,920	227,980 236,670	255,090 269,290
	4.2	R.C S.W	m^3 Emp. m^3	329,970 345,670	337,640 356,170	322,310 334,600	360,640 380,730
	5.2	R.C S.W	m^3 Emp. m^3	— —	419,990 443,040	— —	448,600 473,590
	5.6	R.C S.W	m^3 Emp. m^3	442,650 463,710	— —	432,370 448,860	— —
L= 150	2.0	R.C S.W	m^3 Emp. m^3	104,640 109,600	107,070 112,930	102,210 106,090	114,360 120,720
	4.2	R.C S.W	m^3 Emp. m^3	225,350 236,070	230,580 243,240	220,110 228,510	246,290 260,010
	5.2	R.C S.W	m^3 Emp. m^3	— —	280,000 295,360	— —	299,070 315,720
	5.6	R.C S.W	m^3 Emp. m^3	297,770 311,950	— —	290,860 301,960	— —
L = 250	2.0	R.C S.W	m^3 Emp. m^3	106,200 139,020	108,700 143,230	103,710 134,560	116,194 153,110
	4.2	R.C S.W	m^3 Emp. m^3	238,952 312,790	244,570 322,270	233,340 302,760	261,430 344,500
	5.2	R.C S.W	m^3 Emp. m^3	— —	298,910 393,890	— —	319,530 421,060
	5.6	R.C S.W	m^3 Emp. m^3	292,050 382,290	— —	285,180 370,040	— —
L= 350	2.0	R.C S.W	m^3 Emp. m^3	79,640 104,260	81,520 107,420	77,770 100,920	87,140 114,830
	4.2	R.C S.W	m^3 Emp. m^3	159,300 208,520	163,040 214,850	155,550 201,840	174,290 229,670
	5.2	R.C S.W.	m^3 Emp. m^3	— —	217,390 286,460	— —	232,380 306,220
	5.6	R.C S.W	m^3 Emp. m^3	212,390 278,030	— —	207,400 269,120	— —

R.C. Reinforced Concrete
S.W. Sinking of Wells

Table VI-9-6 The total list of construction materials of well fandations in Case b

Span (m)	Dist. Btw. G.B (km)	Items	Unit	Proposed site			
				Bahadurabad	Gabargaon	Sirajganj	Nagarbari
L= 100	2.0	R.C	m^3	396,140	405,190	387,090	432,360
		S.W	Emp. m^3	503,930	519,220	487,780	555,030
	4.2	R.C	m^3	560,060	572,850	547,270	611,270
		S.W	Emp. m^3	712,460	734,060	689,620	784,700
	5.2	R.C	m^3	——	712,570	——	760,360
		S.W	Emp. m^3	——	913,100	——	976,090
	5.6	R.C	m^3	751,360	——	734,150	——
		S.W	Emp. m^3	955,740	——	925,100	——
L= 150	2.0	R.C	m^3	177,590	181,640	173,530	193,890
		S.W	Emp. m^3	225,900	232,750	218,660	248,807
	4.2	R.C	m^3	382,480	391,220	373,750	417,450
		S.W	Emp. m^3	486,560	501,310	470,960	535,890
	5.2	R.C	m^3	——	375,050	——	506,910
		S.W	Emp. m^3	——	608,740	——	650,730
	5.6	R.C	m^3	505,410	——	493,870	——
		S.W	Emp. m^3	642,950	——	622,340	——
L= 250	2.0	R.C	m^3	109,280	111,780	106,790	119,270
		S.W	Emp. m^3	139,020	143,230	134,560	153,110
	4.2	R.C	m^3	235,880	251,500	240,270	268,360
		S.W	Emp. m^3	312,790	322,270	302,760	344,500
	5.2	R.C	m^3	——	307,380	——	328,000
		S.W	Emp. m^3	——	393,890	——	421,060
	5.6	R.C	m^3	300,520	——	293,650	——
		S.W	Emp. m^3	382,290	——	370,040	——
L= 350	2.0	R.C	m^3	81,950	83,830	80,080	89,450
		S.W	Emp. m^3	104,260	107,424	100,920	114,830
	4.2	R.C	m^3	163,920	167,660	160,170	178,910
		S.W	Emp. m^3	208,520	214,850	201,840	229,670
	5.2	R.C	m^3	——	223,550	——	238,540
		S.W	Emp. m^3	——	286,460	——	306,220
	5.6	R.C	m^3	218,550	——	21,3560	——
		S.W	Emp. m^3	278,030	——	269,120	——

R.C. Reinforced Concrete
S.W. Sinking of Wells

2-2-2. Multi-pile-foundation.

The quantity of works for multi-pile foundation at each one of four sites for every type of superstructure and each distance between guide banks were estimated for case a and b.

The quantity for the pile of diameter 2 m is seen in Tables VI-10-1～4 and the one for the pile of diameter 3 m is seen in Tables VI-11-1～4.

Figs. VI-12-1, 2, show the relations between the weight of steel piles and the span of superstructure for case a and b. From the relations, it was found that the total metal weight of multi-pile foundation for pile of diameter 2 m and needless to compare the costs, superiority of the pile of diameter 3 m was proved. Therefore, the investigation on the multi-pile foundation is made only for the one of pile of diameter 3.0 m hereinafter.

3. Approaches.

The materials for the embankment of approaches are selected earth, dredged sand, pitching stone and sodding. The quantity of them is shown in Table VI-12.

In case b, the viaduct was planned. The quantity of materials for the viaduct is shown in Table VI-13.

Table VI-10-1 Bahadurabad Site

Diameter of pile	2000 mm
Thickness of plate	40 mm

	Case		Unit	Case a				Case b			
	Span length			L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.6 km	Number of fixed piers		each	19	13	12	9	19	13	12	9
	Number of Movable piers		"	36	24	10	7	36	24	10	7
	Concrete	body	m^3	37,400	44,400	33,000	27,500	47,720	59,400	36,600	34,400
		footing	"	120,450	104,900	77,060	111,760	145,220	178,240	126,590	165,760
	Number of piles		each	770	818	610	841	1,142	1,338	976	1,246
	Total length of piles		m	57,750	61,350	45,750	63,080	85,650	100,350	73,200	93,450
	Total weight of piles		t	111,630	118,590	88,430	121,930	165,560	193,980	141,500	180,640
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3		42,000	27,000	25,800		50,400	32,400	29,400
		footing	"		132,160	94,080	134,400		198,020	141,980	154,560
	Number of piles		each		1,030	686	1,008		1,456	1,080	1,152
	Total length of piles		m		83,950	55,910	82,150		118,660	88,020	93,890
	Total weight of piles		t		162,280	108,070	158,800		229,370	170,140	181,490
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-10-2 Gabargaon Site

Diameter of pile	2000^{mm}
Thickness of plate	40^{mm}

Case			Unit	Case a				Case b			
Span length				L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.2 km	Number of fixed piers		each	18	12	12	9	18	12	12	9
	Number of Movable piers		"	33	22	10	7	33	22	10	7
	Concrete	body	m^3		51,000	33,000	34,400		61,200	39,600	39,200
		footing	"		160,380	114,690	179,200		240,450	173,540	206,080
	Number of piles		each		1,250	916	1,344		1,768	1,320	1,536
	Total length of piles		m		99,380	72,820	106,850		140,560	104,940	122,110
	Total weight of piles		t		192,100	140,790	206,540		271,700	202,850	236,040
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3		45,000	32,400	25,800		50,400	37,800	29,400
		footing	"		163,460	141,980	168,960		220,860	201,600	194,300
	Number of piles		each		1,260	1,080	1,236		1,680	1,512	1,440
	Total length of piles		m		107,100	91,800	105,060		142,800	128,520	122,400
	Total weight of piles		t		207,020	177,450	203,080		276,030	248,430	236,600
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-10-3 Sirajganj Site

Diameter of pile	2000 mm
Thickness of plate	40 mm

Case			Unit	Case a				Case b			
Span length				L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.6 km	Number of fixed piers		each	19	13	12	9	19	13	12	9
	Number of Movable piers		"	36	24	10	7	36	24	10	7
	Concrete	body	m^3	37,400	44,400	33,000	27,500	47,720	59,400	36,600	34,400
		footing	"	120,450	104,900	77,060	111,760	145,220	178,240	126,590	165,760
	Number of piles		each	770	818	610	841	1,142	1,338	976	1,246
	Total length of piles		m	58,910	62,580	46,670	64,340	87,360	102,360	74,660	95,320
	Total weight of piles		t	113,870	120,970	90,210	124,370	168,870	197,860	144,320	184,250
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3		45,000	32,400	25,800		50,400	37,800	29,400
		footing	"		163,460	141,980	168,960		220,860	201,600	194,304
	Number of piles		each		1,260	1,080	1,236		1,680	1,512	1,440
	Total length of piles		m		105,210	90,180	103,210		140,280	126,250	120,240
	Total weight of piles		t		203,370	174,320	199,500		271,160	244,040	232,420
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-10-4 Nagarbari Site

Diameter of pile	2000 mm
Thickness of plate	40 mm

	Case		Unit	Case a				Case b			
	Span length			L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.2 km	Number of fixed piers		each	18	12	12	9	18	12	12	9
	Number of Movable piers		"	33	22	10	7	33	22	10	7
	Concrete	body	m^3		51,000	33,000	34,400		61,200	39,600	39,200
		footing	"		160,380	114,690	179,200		240,450	173,540	206,080
	Number of piles		each		1,250	836	1,344		1,768	1,320	1,536
	Total length of piles		m		100,630	67,300	108,190		142,320	106,260	123,650
	Total weight of piles		t		194,520	130,090	209,130		275,100	205,400	239,020
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3		45,000	32,400	25,800		50,400	37,800	29,400
		footing	"		163,460	141,980	168,960		220,860	201,600	194,304
	Number of piles		each		1,260	1,080	1,236		1,680	1,512	1,440
	Total length of piles		m		108,360	92,880	106,300		144,480	130,030	123,840
	Total weight of piles		t		209,460	179,540	205,480		279,280	251,350	239,380
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-11-1 Bahadurabad Site

Diameter of pile	3000 mm
Thickness of plate	60 mm

B	Case		Unit	Case a				Case b			
	Span length			L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.6 km	Number of fixed piers		each	19	13	12	9	19	13	12	9
	Number of Movable piers		"	36	24	10	7	36	24	10	7
	Concrete	body	m^3	30,800	33,600	26,400	27,200	43,760	44,400	31,800	27,200
		footing	"	89,640	96,770	91,580	104,540	165,460	144,720	125,930	161,570
	Number of piles		each	258	248	210	242	294	348	288	384
	Total length of piles		m	18,060	17,360	14,700	16,940	20,580	24,360	20,160	26,880
	Total weight of piles		t	78,560	75,516	63,950	73,690	89,520	105,970	87,700	116,930
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3	32,680	25,500	21,600	20,400	37,720	33,600	29,700	20,400
		footing	"	112,210	73,440	75.170	91,080	141,700	110,690	117,612	121,180
	Number of piles		each	219	198	192	196	247	294	272	288
	Total length of piles		m	16,640	15,050	14,590	14,900	18,770	22,340	20,670	21,890
	Total weight of piles		t	72,380	65,470	63,470	64,820	81,650	97,180	89,910	95,220
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-11-2 Gabargaon Site

Diameter of pile	3000 mm
Thickness of plate	60 mm

B	Case		Unit	Case a				Case b			
	Span length			L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.2 km	Number of fixed piers		each	18	12	12	9	18	12	12	9
	Number of Movable piers		"	33	22	10	7	33	22	10	7
	Concrete	body	m^3	40,440	30,900	26,400	27,200	46,920	40,800	26,400	27,200
		footing	"	152,930	88,990	91,580	120,580	176,260	134,210	106,660	161,570
	Number of piles		each	273	240	234	260	309	356	332	384
	Total length of piles		m	20,070	17,640	17,200	19,110	22,710	26,170	24,400	28,220
	Total weight of piles		t	87,300	76,730	74,820	83,130	98,790	113,840	106,140	122,760
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3	28,000	33,600	29,700	20,400	28,000	38,100	29,700	20,400
		footing	"	106,700	96,770	117,610	99,790	106,700	168,700	135,430	121,180
	Number of piles		each	288	234	252	240	288	396	328	288
	Total length of piles		m	22,750	18,490	19,910	18,960	22,750	31,280	25,910	22,750
	Total weight of piles		t	98,960	80,430	86,610	82,480	98,960	136,070	112,710	98,960
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-11-3 Sirajganj Site

Diameter of pile	3000^{mm}
Thickness of plate	60^{mm}

	Case		Unit	Case a				Case b			
	Span length			L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5.6 km	Number of fixed piers		each	19	13	12	9	19	13	12	9
	Number of Movable piers		"	36	24	10	7	36	24	10	7
	Concrete	body	m^3	30,800	33,600	26,400	27,200	43,760	44,400	31,800	27,200
		footing	"	89,640	96,770	91,580	104,540	165,460	144,720	125,930	161,570
	Number of piles		each	258	248	210	242	294	348	288	384
	Total length of piles		m	18,190	17,480	14,810	17,060	20,730	24,530	20,300	27,070
	Total weight of piles		t	79,120	76,060	64,400	74,220	90,160	106,720	88,320	117,760
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3	32,680	25,500	21,600	20,400	37,720	33,600	29,700	20,400
		footing	"	112,210	73,440	75,170	91,078	141,700	110,690	117,612	121,180
	Number of piles		each	288	234	252	240	288	396	328	288
	Total length of piles		m	22,460	18,250	19,660	18,720	22,460	30,890	25,580	22,460
	Total weight of piles		t	97,700	79,390	85,520	81,430	97,700	134,330	111,270	97,700
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Table VI-11-4 Nagarbari Site

Diameter of pile	3000 mm
Thickness of plate	60 mm

Case			Unit	Case a				Case b			
Span length				L=100	L=150	L=250	L=350	L=100	L=150	L=250	L=350
B = 5. km	Number of fixed piers		each	18	12	12	9	18	12	12	9
	Number of Movable piers		"	33	22	10	7	33	22	10	7
	Concrete	body	m^3	40,440	30,900	26,400	27,200	46,920	40,800	26,400	27,200
		footing	"	152,930	88,990	91,580	120,580	176,260	134,210	106,660	161,570
	Number of piles		each	273	240	234	260	309	356	332	384
	Total length of piles		m	20,480	18,000	17,550	19,500	23,180	26,700	24,900	28,800
	Total weight of piles		t	89,090	78,300	76,340	84,830	100,830	116,150	108,320	125,280
B = 4.2 km	Number of fixed piers		each	14	10	10	7	14	10	10	7
	Number of Movable piers		"	27	18	8	5	27	18	8	5
	Concrete	body	m^3	28,000	33,600	29,700	20,400	28,000	38,100	29,700	20,400
		footing	"	106,700	96,770	117,610	99,790	106,700	168,700	135,430	121,180
	Number of piles		each	288	234	252	240	288	396	328	288
	Total length of piles		m	23,330	18,950	20,410	19,440	23,330	32,080	26,570	23,330
	Total weight of piles		t	101,490	82,430	88,780	84,560	101,490	139,550	115,580	101,490
B = 2.0 km	Number of fixed piers		each	7	5	5	4	7	5	5	4
	Number of movable piers		"	12	8	3	2	12	8	3	2
	Concrete	body	m^3								
		footing	"								
	Number of piles		each								
	Total length of piles		m								
	Total weight of piles		t								

Fig. VI-12-1 Total weight of steel pipe used for multi-pile foundation in Case a

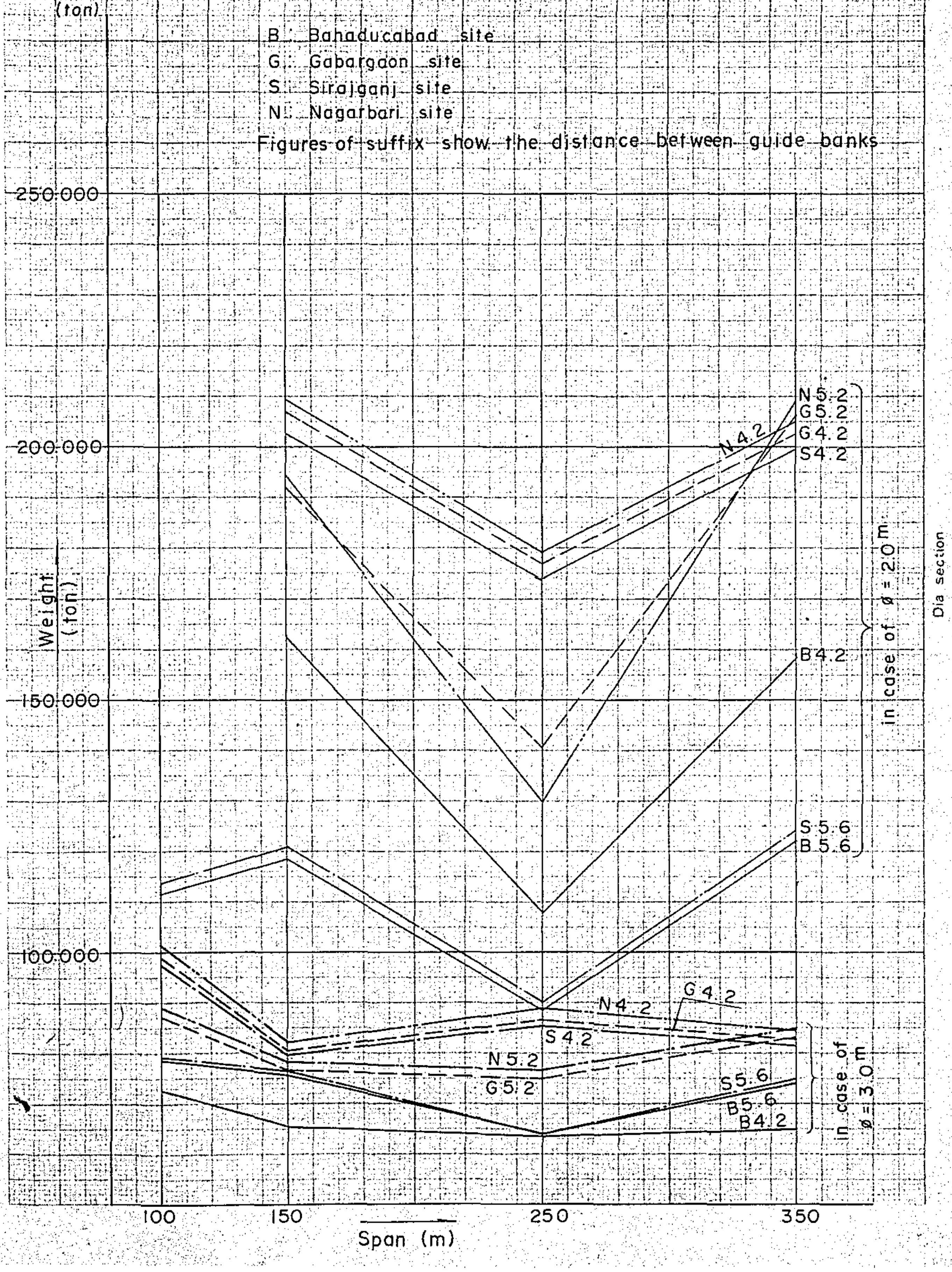


Fig VI-12-2 Total weight of steel pipe used for multi-pile foundation in Case b

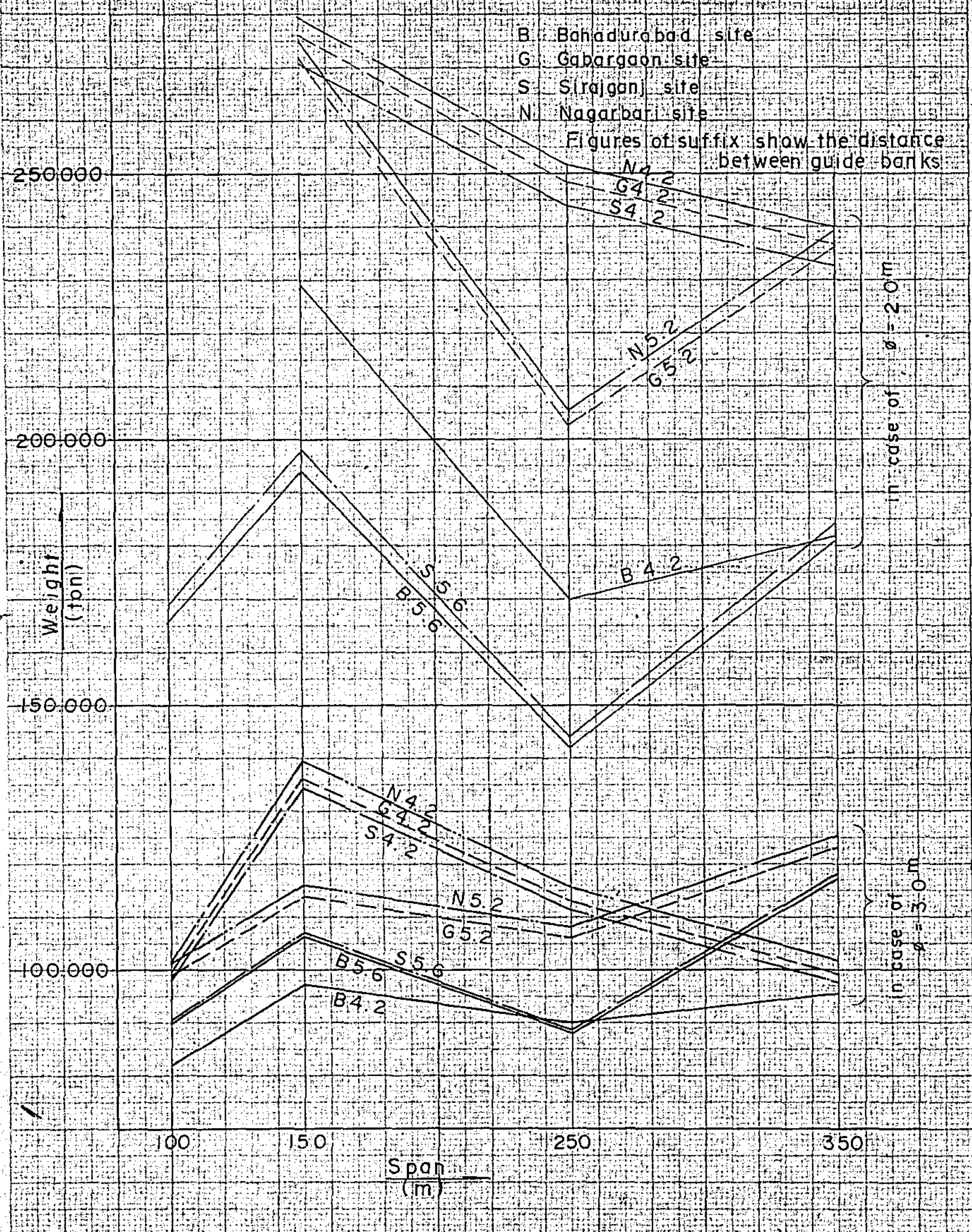


Table VI-12 List of materials used for embankment in approach

		Case a				Case b			
Items		Selected earth	Dredged sand	Pitching stone	Sodding	Selected earth	Dredged sand	Pitching stone	Sodding
Unit		10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3
Bahadurabad	2.0 Km	1,740	1,250	212	247	2,561	1,750	212	247
	4.2 "	1,740	1,699	314	359	2,561	2,379	314	359
	5.6 "	1,740	2,357	385	459	2,561	3,300	385	459
Gabargaon	2.0 "	1,740	1,069	224	253	2,561	1,497	224	253
	4.2 "	1,740	1,930	338	388	2,561	2,702	338	388
	5.2 "	1,740	2,585	393	484	2,561	3,619	293	484
Sirajganj	2.0 "	1,740	1,555	208	249	2,561	2,177	208	249
	4.2 "	1,740	2,246	375	412	2,561	3,144	375	412
	5.6 "	1,740	3,137	453	521	2,561	4,392	453	521
Nagarbari	2.0 "	1,740	2,051	278	313	2,561	2,871	278	313
	4.2 "	1,740	2,920	400	442	2,561	4,088	400	442
	5.2 "	1,740	3,713	457	521	2,561	5,198	457	521

Table VI-13 List of materials used for elevated bridge of approach in Case b

	Items	Unit	Quantities	Remarks
Superstructure	Structural steel	ton	7,404	SM53, SS41
	Cast iron	"	276	Shoe
	Reinforced concrete	m^3	9,260	Slab
	Asphalt pavement	m^2	27,504	
Substructure	Structural steel	ton	2,504	SM53, SS41
	Reinforced concrete	m^3	26,000	
	Steel pipe pile	ton	5,600	600

4. Term of construction works.

Term of construction works for Jamuna Bridge Project was estimated approximately at seven years which consists of two years for preparation and five years for main construction works. In order to execute the works within seven years, special effort for speed and schedule of the works is required because the works are big and need a lot of materials and equipment.

The most convenient period for transportation of the materials is the rainy season from June to October while the period is not convenient for the construction works itself.

The workable hours in a day are mine hours from 8:00 to 17:00 in the season from November to February the next year and are eleven hours from 7:00 to 18:00 in March, April, September and October except rainy season (May Aug.). For the works of substructure 24 hours work by a few shifts is needed.

The bridge construction work itself, is scheduled to complete within six years including one year for the preparation.

The foundations are to be constructed first and after the completion of the piers the superstructures are to be elected one by one.

5. Construction method and equipment.

5-1. Transportation.

Khulna port is expected to be used to unload the materials and equipment from abroad while Chittagong port may be used for unloading of a part of them.

Transportation by railway doesn't answer the purpose because an increase of goods waggons and an improvement of rail gage are needed to supplement the shortage of waggons and to avoid loading or unloading arise from difference of rail gages.

Transportation by road doesn't answer also the purpose because there are few roads which available during rainy season and have enough bearing strength for the heavy load, in addition, because of limitation of ferry capacity.

After all, transportation by river was adopted. For this purpose, loading places which loading can be done at any season in a year at proposed site and access roads connect the site with existing roads were planned.

5-2. Substructure.

Construction works of the well foundation are divided into two kinds of works, one is on land and the other is under the water. And the works under the water is divided also two kinds, one is for the case of the depth of water more than five meters and the other one for shallow case.

When the depth of water is larger than five meter, metallic floating caisson method will be adopted while island method will be available for the shallow case.

The floating caisson is to be sunk to the designed spot after concreting.

Sinking of the well foundation should be done during a dry season and construction speed of pier which is to be constructed after the completion of top slab of the well must be controled so as to keep the level of pier head higher than water level at any time to secure the dry work.

Level of top surface of the island in water should be higher than the water level during a dry season, even at the beginning and the end of rainy season, taking the executing period into consideration.

On land, island method might be needed also according to circumstances taking execution period into consideration.

Ordinary method of excavation by tripod derrick crane and clamshell grabbing crane is not available in this case because the well length which is to be excavated is over 70 m and the excavation must be done as quick as possible. Therefore, the excavation methods by the excavator with large diameter and the reverse circulation equipment were adopted.

For execution of works of multi-pile-foundation, piling of steel piles with large diameter and placing of top slab concrete are essential. For the works on the river, a large piling barge should be used and it is advisable to set a steel frame in the water and connect them with the steel plates which serve as bottom form for the top slab and make use of them as a guide for piling in order to secure the correct position of piles.

For the works on land, a channel for the barge should be excavated along the bridge line and the piling is to be executed by the barge.

Main equipments for the works of substructure are as follows.

large diameter excavators (reverse circulation system)
tripod derrick cranes
compressors
submerged pumps
crane trucks
concrete pump trucks
barges
pump dredgers
large pile driving boats
semi-automatic welders
concrete mixing plants
aggregate plants
bulldozers

Fig. VI-13 shows outline of the excavator with large diameter and its reverse circulation system.

5-3. Superstructure

Erection of superstructure on land and river where the water is shallow and its speed is not so fast is planned to be executed by bent erection method.

The cantilever erection method is to be applied to other places.

Fig. VI-14 shows an example of the erection method for the case of 250 m span length.

Main equipment for the works of superstructure are as follows.

travelling crane
tower crane
floating crane
crawler crane
bulldozer
generators
deck barges

Fig VI-13 Excavation method used reverse circulation

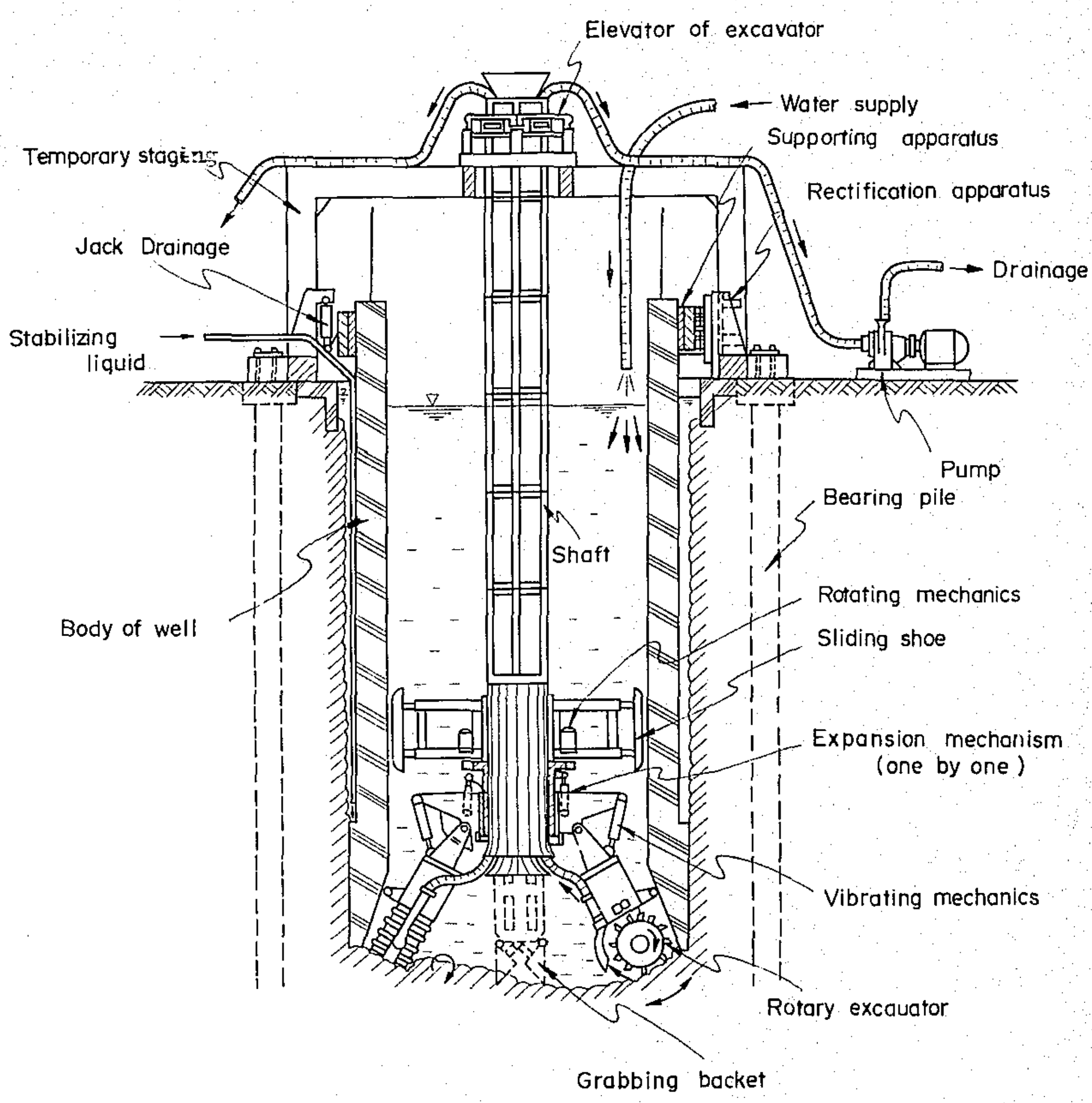
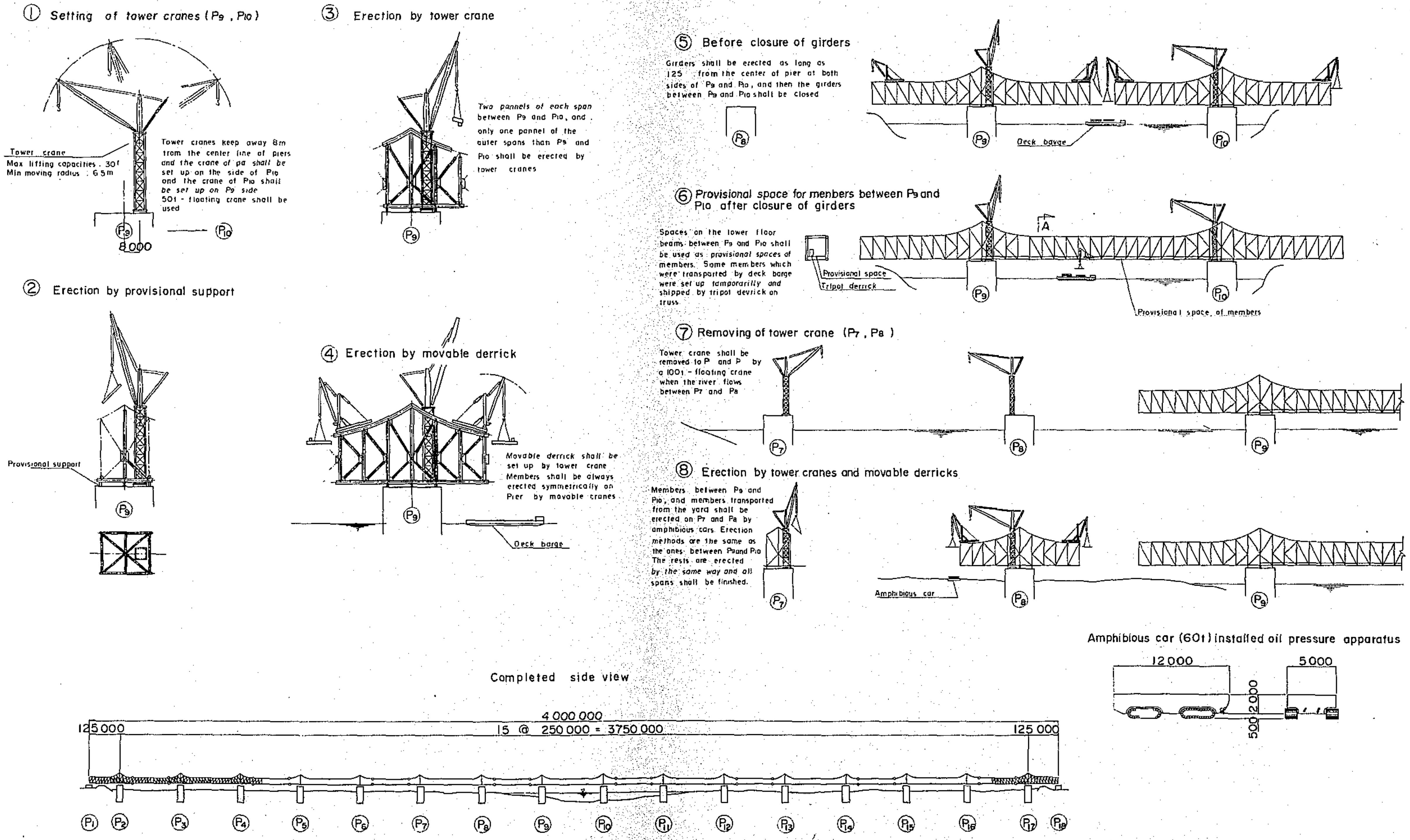


Fig. Ⅵ - 14 Cantilever erection method in case of span of 250m

Condition All the year round the river flows between P9 and P10 of piers



6. Controversial points on construction works.

6-1. Points on preparation.

(a) A lot of materials and equipment must be unloaded at Kuluna port and transported by goods waggons to the site. Therefore, a large capacity of unloading facilities and yards are needed at Kuluna port and the site.

(b) Concrete mixing plants should be prepared and located at the most convenient places for the works which require the material of concrete. Aggregate plants are also needed.

(c) As a lot of fuel is consumed for the construction equipment and generators, a large capacity of fueling stations are required at both sides of the river.

(d) For the purpose of making inspection of and repairs on all kinds of the construction equipment, a large scale of motorpools are required at both sides of the river.

(e) Other than the facilities mentioned above, accomodations for the laborers, and the facilities for water supply, drainage, electric power supply and heliport and others must be prepared as a base of the construction works. The base should be constructed so as not to submerged during floods.

6-2. Points on temporary works.

(a) The temporary roads for construction works must be prepared to connect the site with the base. However as the roads will be submerged and broken by floods during rainy season, they must be reconstructed once in a year at least.

(b) Temporary piers for barges must be constructed at a spot in the construction site which water flows in a year.

These temporary piers should be assembled by prefabricated members so as to be able to withdraw from the spot to prevent any loss or breakage of the piers when a flood accured.

(c) Dockyards for the steel caissons of the well foundation must be prepared. The dockyards should not be lost by flood.

(d) Setup of the steel frame, the bent for superstructure, the supporting frame and the form should be simple and they must be able to take into pieces and to assembled again easily providing for floods.

6-3. Points on main construction works.

(a) The construction works must be executed in a hurry and the construction equipment with high efficiency should be used. Making simplify the structure and mechanizing the works, reduction of the construction term must be achieved.

(b) As almost all works are tube executed in parallel during dry season and the quantity of the works is very large, the job sites might be congested with laborers and equipment. Therefore, the management of these laborers and equipment is not ignored.

(c) Abundant labourers should be used as much as possible and modern construction equipment should be used only for the works which the labourers can not handle.

7. Pier protection against scour .

The Jamuna River Bridge is designed on the basis of the guide bank system and the river beds at proposed sites for guide bank types A, B and C are very deep in water as seen in Fig. VI-15. If the well were not protected against scoure, designed length of the well might be more than 100 m taking the elevation of bearing strata and the sinking method into consideration. The well foundation of 100 m length is not only economical but also difficult to sink. Therefore the well foundation should be protected against scoure to secure enough embedded length in the ground.

The pier protection methods investigated by the River Training Team are described below.

7-1. Range of pier protection.

7-1-1. Gales' proposal.

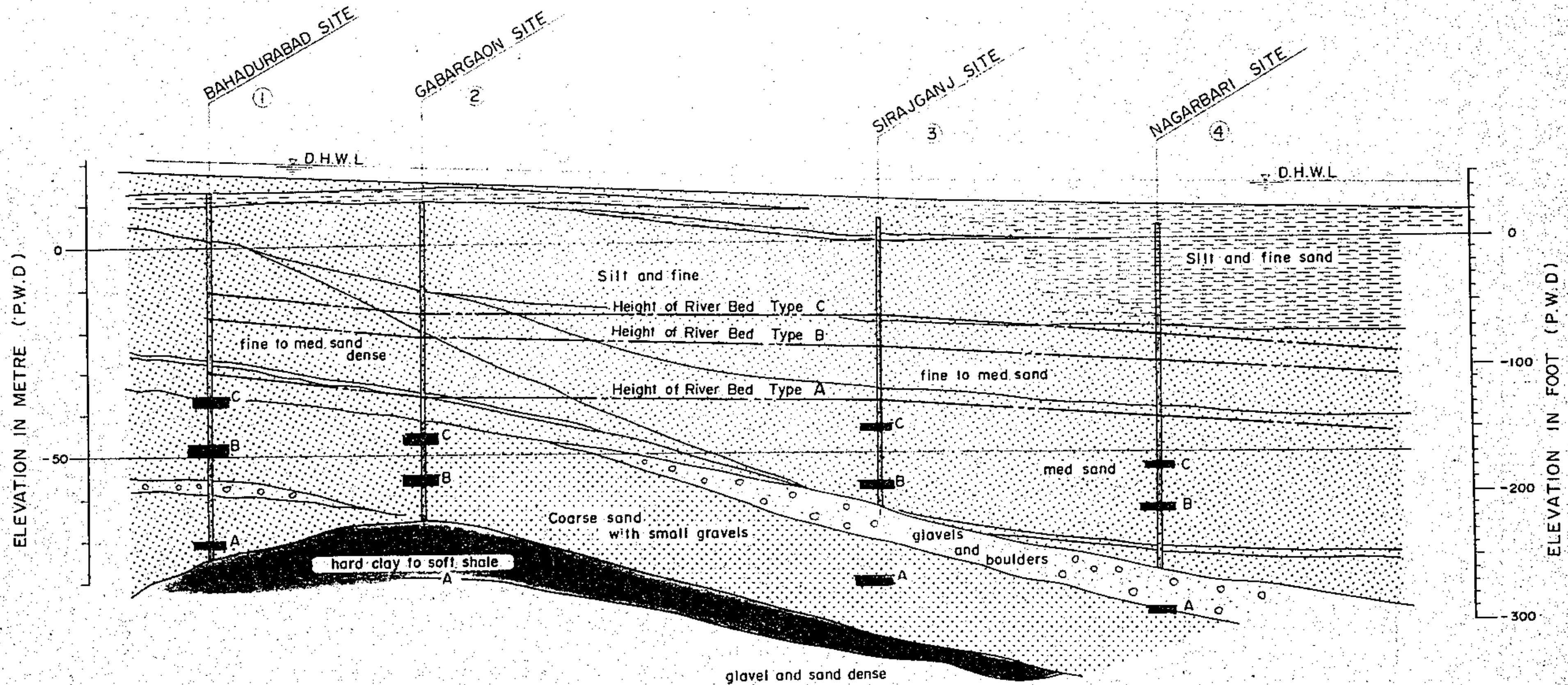
R.R. Gales proposed an range of pier protection on condition that stream strikes pier diagonally. In this proposal, a scatter of rubbles caused by scouring of the river bed was investigated as in Fig. VI-16.

7-1-2. Studies of Ishizaki and Homma.

Katsuyoshi Ishizaki and Katsuichi Homma (129 GB) made a wide range experimental study and obtained the results as seen in Figs. VI-17, 18.

In these Figures, the following notations are used:

Fig. VI -15 Profile of Foundation including River Bed Condition



A : Height of river bed after scouring as 12.0m-Pier-Width for the guide bank Type A.
B : " " Type B.
C : " " Type C.

Fig. VI-16

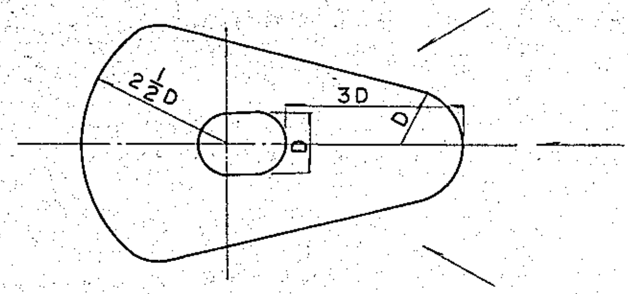


Diagram of Pier - Apron

Fig. VI-17

The relation between q'/q and x/r.

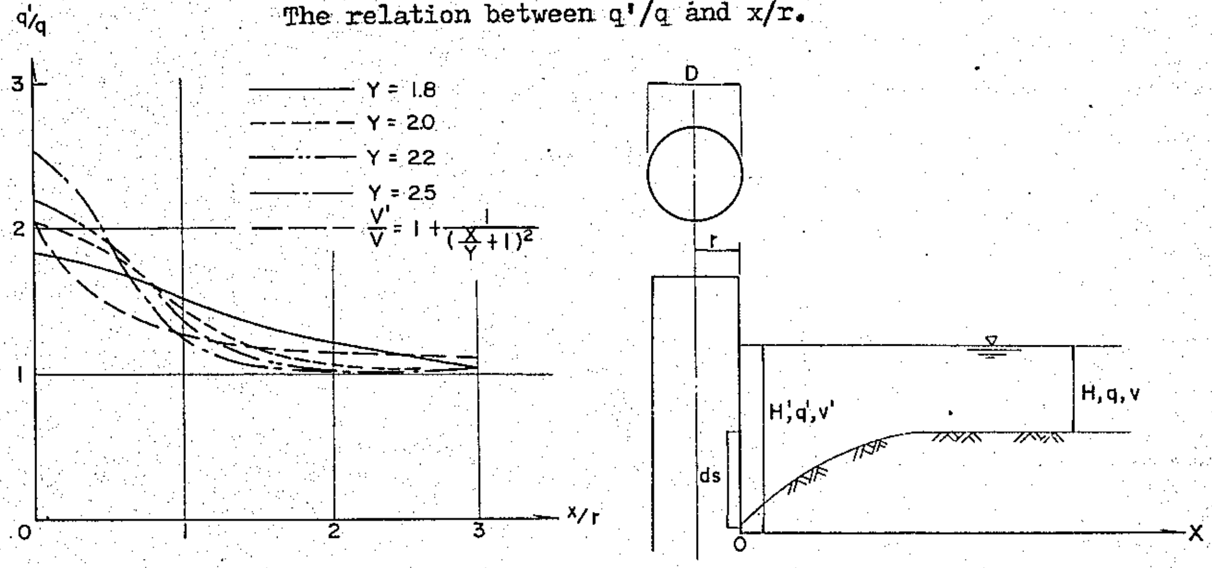
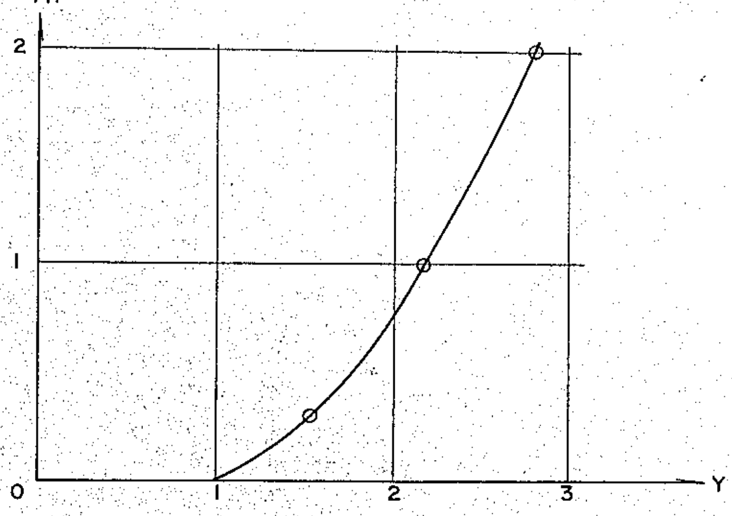


Fig. VI-18

The relation between ds/H and z.



H : water depth without scour.

q : discharge per unit width.

v : mean velocity in the normal water depth.

x : distance from sidewall of pier.

y : radius of cylindrical pier.

d_s : **scouring depth at sidewall of pier (X=0).**

H', q', v' : water depth, discharge per unit width respectively after scoring.

z : value of q'/q at sidewall of pier (x=o).

D : diameter of cylindrical pier.

Fig. VI-17 shows the relation between q'/q and x/r and Fig. VI-18 shows the relation between d_s/H and z.

As seen in Fig. VI-17, $q'/q > 1$ for conditions $x/r < z$ or $x < D$. Therefore, the area which is encircled with distance D from sidewall of the pier is judged as enough protection range against scouring taking scatter of the rubbles into consideration.

7-1-3. Present aspect of Hardinge bridge.

According to the survey on the protection rubbles for Hardinge bridge piers, it is reported that the rubbles are scattered within a range which is encircled with distance 2D from sidewall of the pier.

7-2. Protection work.

The theoretical diameter and weight of the rubbles for protection against the scouring estimated from the water velocity and scouring depth are very large.

However, stones smaller than theoretical one are available for all practical purposes provided that good maintenance and enough supply are secured.

At least, for the foundations which may be hit by stream even in a dry season, rubble-mounds at the protection area are needed. The depth of the rubble-mound is about $3.0^m \sim 3.5^m$. But this mound may sink and scatter with lowering of river bed elevation introduced by construction of guide banks and scouring arose by increased river water in rainy season. Therefore, periodical measuring for the scouring should be made and rubbles must be supplied if necessary. In order to execute these works a proper organization for the maintenance works should be set up and the stock yards for the rubbles should be prepared.

When a dangerous scouring for the foundation should happen because of shift of talweg, the organization should stands ready to dump the rubbles into the spot.

CHAPTER VII

ROUGH ESTIMATE OF CONSTRUCTION COSTS

1. Estimating bases of construction costs.

In estimate of construction costs, costs of general facilities such as living quarters, motor pool, fuel storage, material storage, cargo-handling facilities at the sites and electric power supply system, water and drainage equipment for these, are excluded.

Next items were considered.

(a) General unit prices were studied based on the result of price researches at the end of March of 1974.

(b) Repayment of main construction machinery shall be finished during the working period and there is no remaining prices.

(c) According to the investigation of the first stage of the Quarry Study Team, the unit prices at stock yards of the four sites are as follows.

Bahadurabad	6	TK/ft^3
Gabargaon	6.3	"
Sirajganj	7	"
Nagarbari	7.4	"

(d) Unit prices of basic materials for construction are so follows.

Structural steel	2,200	TK/t	79,000	yen/t	(in Japan)
Deformed bar	2,080	"	75,000	"	(")
Metal sheet pile	1,610	"	58,000	"	(")
Light sheet pile	1,720	"	62,000	"	(")
Cement	321	"	11,500	"	(")
Sand	448	TK/100 cft	5,700	yen/m^3	(at site)
Gravel	700	"	8,500	"	(at site)

2. Rough estimate of construction costs.

2-1. Superstructure.

Details of the rough estimated construction costs of each span length of superstructure inclusive by the case of a and b about 2.0^{Km}, 4.2^{Km}, 5.2^{Km}, and 5.6^{Km} of guide bank distances, are shown in Tables VII-1~2. The tables content prices of cast steel, fabrication costs, costs of erection, pavement cost, and reinforcing concrete costs respectively.

In Table VII-3, total costs about each item of these table collectively and construction cost per unit weight of steel are shown.

The costs of superstructures, are shown by guide bank types and totalized by application of the corresponding costs for each type of guide banks for each proposed site.

2-2. Substructure.

Total costs of substructures are affected by conditions of the proposed sites and totalized by the corresponding types of guide bank and each span length of substructure at each site.

As for well foundation, costs of reinforced concrete and sinking work and excavation were summarized and these total, costs were shown in Table VII-4-1 about the case a and in Table VII-4-2 about the case b. As for multi-pile-foundation, costs of reinforced concrete and steel pipe pile were summarized and these total costs were shown in Table VII-5-1 about the case a and in Table VII-5-2 about the case b.

In this estimate, the diameter of the steel pile is 3.0^m and the case of 3.0^m of diameter is preferable than the case of 2.0^m as stated in "CHAPTER VI 2 Quantity of works".

Furthermore it is estimated the transportation costs of substructure at 2.0% besides these costs. But the case of 2.0^{Km} of guide bank distance was excluded because the case of over 4.0^{Km} is better according to "The Report of River Training Work".

2-3. Approaches

The costs of each site and distance between guide banks were totalized about the case a and b, and these results are shown in Table VII-6.

Table VII-1-1 Rough estimation of construction costs of superstructure

Case a Span length L=100m

($\times 10^8$ YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	4.7	9.8	12.1	13.0
	SM50	83,000¥/t	6.6	13.9	17.2	18.6
	SM58	98,000¥/t	-	-	-	-
Cast steel (shoe)		500,000¥/t	2.4	4.9	5.3	6.6
Fabrication		150,000¥/t	23.6	49.6	61.4	66.1
Erection	Cantilever	360,000¥/t	58.4	73.6	75.6	73.6
	Bent	260,000¥/t	-	35.4	54.6	64.9
Subtotal			95.7	187.2	226.2	242.8
Asphalt pavement		1,000¥/m^2	0.1	0.3	0.4	0.4
Reinforced concrete		70,000¥/m^3	3.1	6.5	8.0	8.7
Subtotal			3.2	6.8	8.4	9.1
Total			98.9	194.0	234.6	251.9
Transportation costs		150,000¥/t	24.3	51.1	63.0	68.1
Grand total			123.2	245.1	297.6	320.0

Table VII-1-2 Rough estimation of construction costs of superstructure

Case a Span length L=150m

(10^8 YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	4.5	9.3	11.2	12.1
	SM50	83,000¥/t	9.2	19.1	23.0	25.0
	SM58	95,000¥/t	3.7	7.6	9.2	10.0
Cast steel (shoe)		500,000¥/t	2.6	5.3	6.3	6.9
Fabrication		150,000¥/t	33.5	69.3	83.6	90.8
Erection	Cantilever	360,000¥/t	82.2	102.0	102.6	100.3
	Bent	260,000¥/t	-	49.1	74.1	88.5
Subtotal			135.7	261.7	310.0	333.6
Asphalt pavement		1,000¥/m^2	0.2	0.3	0.4	0.4
Reinforced concrete		70,000¥/m^3	3.2	6.7	8.1	8.8
Subtotal			3.4	7.0	8.5	9.2
Total			139.1	268.7	318.5	342.8
Transportation costs		150,000¥/t	34.2	70.9	85.5	92.9
Grand total			173.3	339.6	404.0	435.7

Table VII-1-3 Rough estimation of construction costs of superstructure

Case a Span length L=250m

($\times 10^8$ YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	12.1	25.7	31.3	31.3
	SM50	83,000¥/t	6.8	14.5	17.6	17.6
	SM58	98,000¥/t	13.5	28.6	34.7	34.7
Cast steel (shoe)		500,000¥/t	4.3	8.7	10.4	10.4
Fabrication		150,000¥/t	63.3	134.3	163.2	163.2
Erection	Cantilever	360,000¥/t	155.0	197.2	199.6	199.6
	Bent	260,000¥/t	-	94.9	144.1	144.1
Subtotal			255.0	503.9	600.9	600.9
Asphalt pavement		2,000¥/m^2	0.3	0.7	0.8	0.8
Reinforced concrete		70,000¥/m^3	0.7	1.5	1.8	1.8
Subtotal			1.0	2.2	2.6	2.6
Total			256.0	506.1	603.5	603.5
Transportation costs		150,000¥/t	64.6	136.9	166.3	166.3
Grand total			320.6	643.0	769.8	769.8

Table VII-1-4 Rough estimation of construction costs of superstructure

Case a Span length L=350m

(x10^8 YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	16.2	30.9	40.8	40.8
	SM50	83,000¥/t	12.6	24.1	31.7	31.7
	SM58	98,000¥/t	24.2	46.2	60.8	60.8
Cast steel (shoe)		500,000¥/t	8.0	13.9	17.9	17.9
Fabrication		150,000¥/t	100.3	191.5	252.3	252.3
Erection	Cantilever	360,000¥/t	246.5	281.7	309.2	309.2
	Bent	260,000¥/t	-	135.7	223.3	223.3
Subtotal			407.8	724.0	936.0	936.0
Asphalt pavement		2,000¥/m^2	0.3	0.6	0.9	0.9
Reinforced concrete		70,000¥/m^3	0.7	1.4	1.9	1.9
Subtotal			1.0	2.0	2.8	2.8
Total			408.8	726.0	938.8	938.8
Transportation costs		150,000¥/t	102.7	195.7	257.6	257.6
Grand total			511.5	921.7	1,196.4	1,196.4

Table VII-2-1 Rough estimation of construction costs of superstructure

Case b Span length L=100m

($x10^8$ YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	5.8	12.0	15.1	16.2
	SM50	83,000¥/t	7.5	15.8	19.5	21.0
	SM58	98,000¥/t	2.2	4.7	5.8	6.3
Cast steel (shoe)		500,000¥/t	3.5	7.2	9.0	10.0
Fabrication		150,000¥/t	31.5	65.9	81.9	88.2
Erection	Cantilever	360,000¥/t	78.1	98.1	101.5	98.5
	Bent	260,000¥/t		47.2	73.3	86.9
Subtotal			128.6	250.9	306.1	327.1
Asphalt pavement		1,000¥/m^2	0.3	0.6	0.8	0.8
Reinforced concrete		70,000¥/m^3	6.8	14.2	17.6	19.0
Subtotal			7.1	14.8	18.4	19.8
Total			135.7	265.7	324.5	346.9
Transportation costs		150,000¥/t	32.6	68.1	84.6	91.2
Grand total			168.3	333.8	409.1	438.1

Table VII-2-2 Rough estimation of construction costs of superstructure

Case b Span length L=150m

(x10^8 YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	6.5	13.5	16.2	17.6
	SM50	83,000¥/t	7.9	16.3	19.6	21.3
	SM58	98,000¥/t	8.8	18.1	21.9	23.8
Cast steel (shoe)		500,000¥/t	5.4	11.0	13.3	14.4
Fabrication		150,000¥/t	43.9	90.8	109.6	119.0
Erection	Cantilever	360,000¥/t	109.1	135.5	136.3	133.1
	Bent	260,000¥/t	-	65.2	98.4	117.5
Subtotal			181.6	350.4	415.3	446.7
Asphalt pavement		1,000¥/m^2	0.3	0.6	0.8	0.8
Reinforced concrete		70,000¥/m^3	7.2	15.0	18.1	19.7
Subtotal			7.5	15.6	18.9	20.5
Total			189.1	366.0	434.2	467.2
Transportation costs		150,000¥/t	45.5	94.1	113.6	123.3
Grand total			234.6	460.1	547.8	590.5

Table VII-2-3 Rough estimation of construction costs of superstructure

Case b Span length L=250m

($\times 10^8$ YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	20.8	44.1	53.6	53.6
	SM50	83,000¥/t	11.2	23.7	28.8	28.8
	SM58	98,000¥/t	17.9	37.9	46.1	46.1
Cast steel (shoe)		500,000¥/t	7.9	15.7	18.8	18.8
Fabrication		150,000¥/t	99.5	211.1	256.5	256.5
Erection	Cantilever	360,000¥/t	244.4	310.8	314.6	314.6
	Bent	260,000¥/t	-	149.7	227.2	227.2
Subtotal			401.7	793.0	945.6	945.6
Asphalt pavement		2,000¥/m^2	0.6	1.4	1.7	1.7
Reinforced concrete		70,000¥/m^3	1.7	3.6	4.3	4.3
Subtotal			2.3	5.0	6.0	6.0
Total			404.0	798.0	951.6	951.6
Transportation costs		150,000¥/t	101.8	215.9	262.2	262.2
Grand total			505.8	1,013.9	1,213.8	1,213.8

Table VII-2-4 Rough estimation of construction costs of superstructure

Case b Span length L=350m

($\times 10^8$ YEN)

ITEMS		UNIT PRICE	DISTANCE BETWEEN GUIDE BANKS			
			2.0 km	4.2 km	5.2 km	5.6 km
Structural steel	SS41	60,000¥/t	25.1	47.9	63.2	63.2
	SM50	83,000¥/t	17.0	32.6	42.9	42.9
	SM58	98,000¥/t	28.5	54.4	71.7	71.7
Cast steel (shoe)		500,000¥/t	13.0	22.8	29.3	29.3
Fabrication		150,000¥/t	137.3	262.0	345.2	345.2
Erection	Cantilever	360,000¥/t	338.9	387.1	424.7	424.7
	Bent	260,000¥/t	-	186.4	306.8	306.8
Subtotal			559.8	993.2	1,283.8	1,283.8
Asphalt pavement		2,000¥/m^2	0.7	1.3	1.7	1.7
Reinforced concrete		70,000¥/m^3	1.8	3.4	4.5	4.5
Subtotal			2.5	4.7	6.2	6.2
Total			562.3	997.9	1,290.0	1,290.0
Transportation costs		150,000¥/t	141.2	268.8	354.0	354.0
Grand total			703.5	1,266.7	1,644.0	1,644.0

Table VII-3 The list of rough estimated construction costs of superstructure

	Case	Span (m)	Distance between guide banks (km)			
			2.0	4.2	5.2	5.6
Total costs of construction ($\times 10^8$ YEN)	a	100	123.2	245.1	297.6	320.0
		150	173.3	339.6	404.0	435.7
		250	320.6	643.0	769.8	769.8
		350	511.5	921.7	1,196.4	1,196.4
	b	100	168.3	333.8	409.1	438.1
		150	234.6	460.1	547.8	590.5
		250	505.8	1,013.9	1,213.8	1,213.8
		350	703.5	1,266.7	1,644.0	1,644.0
Costs of unit weight ($\times 10^4$ YEN/t)	a	100	76	72	71	70
		150	76	72	71	70
		250	74	70	69	69
		350	75	71	70	70
	b	100	78	74	73	72
		150	77	73	72	72
		250	74	70	69	69
		350	75	71	70	70

Table VII-4-1 Rough estimate of construction costs of well foundations in Case a

Span (m)	Dist. btw. GB (Km)	Items	Unit	Proposed site Bahadurabad	Gabargaon	Sirajganj	Nagarbari
L = 100	4.2	R.C S.W	10^8 YEN "	138.6 320.8	141.8 330.5	135.4 310.5	151.5 353.3
		Total	" 10 crore TK	459.4 12.8	472.3 13.1	445.9 12.4	504.8 14.0
	5.2 or 5.6	R.C S.W	10^8 YEN	185.9 430.3	176.4 411.1	181.6 416.5	188.4 439.5
		Total	" 10 crore TK	616.2 17.1	587.5 16.3	598.1 16.6	627.9 17.4
L = 150	4.2	R.C S.W	10^8 YEN "	94.6 219.1	96.8 225.7	92.4 212.1	103.4 241.3
		Total	" 10 crore TK	313.7 8.7	322.5 9.0	304.5 8.5	344.7 9.6
	5.2 or 5.6	R.C S.W	10^8 YEN "	125.1 289.5	117.6 274.1	122.2 280.2	125.6 293.0
		Total	" 10 crore TK	414.6 11.5	391.7 10.9	402.4 11.2	418.6 11.6
L = 250	4.2	R.C S.W	10^8 YEN "	100.4 290.3	102.7 299.1	98.0 281.0	109.8 319.7
		Total	" 10 crore TK	390.7 10.9	401.8 11.2	379.0 10.5	429.5 11.9
	5.2 o5 5.6	R.C S.W	10^8 YEN "	122.7 354.8	125.5 365.5	119.8 343.4	134.2 390.7
		Total	" 10 crore TK	477.5 13.3	491.0 13.6	463.2 12.9	524.9 14.6
L = 350	4.2	R.C S.W	10^8 YEN "	66.9 193.5	68.5 199.4	65.3 187.3	73.2 213.1
		Total	" 10 crore TK	260.4 7.2	267.9 7.4	252.6 7.0	286.3 8.0
	5.2 or 5.6	R.C S.W	10^8 YEN "	89.2 258.0	91.3 265.8	87.1 249.7	97.6 284.2
		Total	" 10 crore TK	347.2 9.6	357.1 9.9	336.8 9.4	381.8 10.6

R.C. Reinforced Concrete
S.W. Sinking of Wells

Table VII-4-2 Rough estimate of construction costs of well foundation in Case b

Span (m)	Dist.btw.GB (Km)	Items	Unit	Proposed site: Bahadurabad	Gabargaon	Sirajganj	Nagarbari
L = 100	4.2	R.C	10^8 YEN	235.2	240.6	229.9	256.7
		S.W	"	661.2	681.2	640.0	728.2
		Total	"	896.4	921.8	869.9	984.9
			10crore TK	24.9	25.6	24.2	27.4
	5.2 or 5.6	R.C	10^8 YEN	315.6	299.3	308.3	319.4
		S.W	"	886.9	847.4	858.5	905.8
		Total	"	1,202.5	1,146.7	1,166.8	1,225.2
			10crore TK	33.4	31.9	32.4	34.0
L = 150	4.2	R.C	10^8 YEN	160.6	164.3	157.0	175.3
		S.W	"	451.5	465.2	437.1	497.3
		Total	"	612.1	629.5	594.1	672.6
			10crore TK	17.0	17.5	16.5	18.7
	5.2 or 5.6	R.C	10^8 YEN	212.3	157.5	207.4	212.9
		S.W	"	596.7	564.9	577.5	603.9
		Total	"	809.0	722.4	784.9	816.8
			10crore TK	22.5	20.1	21.8	22.7
L = 250	4.2	R.C	10^8 YEN	99.1	105.6	100.9	112.7
		S.W	"	290.3	299.1	281.0	319.7
		Total	"	389.4	404.7	381.9	432.4
			10crore TK	10.8	11.2	10.6	12.0
	5.2 or 5.6	R.C	10^8 YEN	126.2	129.1	123.3	137.8
		S.W	"	354.8	365.5	343.4	390.7
		Total	"	481.0	494.6	466.7	528.5
			10crore TK	13.4	13.7	13.0	14.7
L = 350	4.2	R.C	10^8 YEN	68.8	70.4	67.3	75.1
		S.W	"	193.5	199.4	187.3	213.1
		Total	"	262.3	269.8	254.6	288.2
			10crore TK	7.3	7.5	7.1	8.0
	5.2 or 5.6	R.C	10^8 YEN	91.8	93.9	89.7	100.2
		S.W	"	258.0	265.8	249.7	284.2
		Total	"	349.8	359.7	339.4	384.4
			10crore TK	9.7	10.0	9.4	10.7

R.C. Reinforced Concrete
S.W. Sinking of Wells

Table VII-5-1 Rough estimate of construction costs of multi-pile foundation in Case a

Span (m)	Dist. btw. GB (Km)	Items	Unit	Proposed site: Bahadurabad	Gabargaon	Sirajganj	Nagarbari
L = 100	4.2	R.C	10^8 YEN	145.0	134.8	145.0	134.8
		Steel pile	"	420.0	573.2	566.3	587.1
		Total	"	565.0	708.0	711.3	721.9
			10crore TK	15.7	19.7	19.8	20.1
	5.2 or 5.6	R.C	10^8 YEN	120.5	193.3	120.5	193.3
		Steel pile	"	457.9	507.4	461.1	517.3
		Total	"	578.4	700.7	581.6	710.6
			10crore TK	16.1	19.5	16.2	19.7
L = 150	4.2	R.C	10^8 YEN	99.0	130.5	99.0	130.5
		Steel pile	"	380.0	465.7	460.0	476.7
		Total	"	479.0	596.2	559.0	607.2
			10crore TK	13.3	16.6	15.5	16.9
	5.2 or 5.6	R.C	10^8 YEN	130.5	120.0	130.5	120.0
		Steel pile	"	440.2	446.0	443.3	454.6
		Total	"	570.7	566.0	573.8	574.6
			10crore TK	15.9	15.7	15.9	16.0
L = 250	4.2	R.C	10^8 YEN	96.7	147.4	96.7	147.4
		Steel pile	"	369.0	501.5	495.4	513.4
		Total	"	465.7	648.9	592.1	660.8
			10crore TK	12.9	18.0	16.4	18.4
	5.2 or 5.6	R.C	10^8 YEN	118.1	118.1	118.1	118.1
		Steel pile	"	372.8	435.0	375.2	443.3
		Total	"	490.9	553.1	493.3	561.4
			10crore TK	13.6	15.4	13.7	15.6
L = 350	4.2	R.C	10^8 YEN	111.4	120.2	111.4	120.2
		Steel pile	"	376.2	477.7	471.8	489.0
		Total	"	487.6	597.9	583.2	609.2
			10crore	13.5	16.6	16.2	16.9
	5.2 or 5.6	R.C	10^8 YEN	131.7	147.9	131.7	147.9
		Steel pile	"	429.3	483.2	432.3	492.6
		Total	"	561.0	631.1	564.0	640.5
			10crore TK	15.6	17.5	15.7	17.8

R.C. Reinforced Concrete

Table VII-5-2 Rough estimate of construction costs of multi-pile foundation in Case b

Span (m)	Dist.btw.GB (Km)	Items	Unit	Proposed site: Bahadurabad	Gabargaon	Sirajganj	Nagarbari
L = 100	4.2	R.C	10^8 YEN	282.3	182.0	242.3	182.0
		Steel pile	"	639.2	773.8	764.5	792.5
		Total	"	881.5	995.8	1,006.8	974.5
			10crore TK	24.5	26.6	28.0	27.1
	5.2 or 5.6	R.C	10^8 YEN	282.6	301.2	282.6	301.2
		Steel pile	"	704.3	774.8	709.2	790.3
		Total	"	986.9	1,076.0	991.8	1,091.5
			10crore TK	27.4	29.9	27.6	30.3
L = 150	4.2	R.C	10^8 YEN	144.3	206.9	144.3	206.9
		Steel pile	"	563.8	787.9	778.6	807.1
		Total	"	708.1	994.8	922.9	1,014.0
			10crore TK	19.7	27.6	25.6	28.2
	5.2 or 5.6	R.C	10^8 YEN	189.0	175.0	189.0	175.0
		Steel pile	"	617.8	661.7	621.9	674.4
		Total	"	806.8	836.7	810.9	849.4
				22.4	23.2	22.5	23.6
L = 250	4.2	R.C	10^8 YEN	147.4	165.2	147.4	165.2
		Steel pile	"	521.6	652.8	644.9	668.5
		Total	"	669.0	818.0	792.3	833.7
			10crore TK	18.6	22.7	22.0	23.2
	5.2 or 5.6	R.C	10^8 YEN	157.6	133.1	157.6	133.1
		Steel pile	"	511.3	616.9	514.7	628.9
		Total	"	668.9	750.0	672.3	762.0
			10crore TK	18.6	20.8	18.7	21.2
L = 350	4.2	R.C	10^8 YEN	141.7	141.7	141.7	141.7
		Steel pile	"	552.6	573.2	566.3	587.0
		Total	"	694.3	714.9	708.0	728.7
			10crore TK	19.3	19.9	19.7	20.2
	5.2 or 5.6	R.C	10^8 YEN	188.8	188.8	188.8	188.8
		Steel pile	"	681.5	713.6	686.1	727.4
		Total	"	870.3	902.4	874.9	916.2
			10crore TK	24.2	25.1	24.3	25.4

R.C. Reinforced Concrete.

Table VII-6 Rough estimate of construction casts for approaches

(10^8 YEN)

Case	Site proposed for bridge construction	Distance btw. guide banks	Earth work by dredging	Earth work for embankment	Lifted bridge	Total
a	Bahadurabad	4.2 Km	49	90	–	139
		5.6 "	53	90	–	143
	Gabargaon	4.2 "	53	90	–	143
		5.2 "	57	90	–	147
	Sirajganj	4.2 "	53	90	–	147
		5.6 "	69	90	–	159
	Nagarbari	4.2 "	89	90	–	179
		5.2 "	53	90	–	183
b	Bahadurabad	4.2 Km	51	133	94	278
		5.6 "	56	133	94	283
	Gabargaon	4.2 "	56	133	94	283
		5.2 "	60	133	94	287
	Sirajganj	4.2 "	66	133	94	293
		5.6 "	72	133	94	299
	Nagarbari	4.2 "	93	133	94	320
		5.2 "	98	133	94	325

CHAPTER VIII

SELECTION OF THE MOST SUITABLE TYPE OF STRUCTURE AND ORDER OF EVALUATION AT PROPOSED SITES

1. Procedures of selection of the most suitable type of structure and span length.

In CHAPTER VII, costs of super structure and two types of well and multi-pile-foundation about substructure were estimated roughly, based on the four proposed sites of Bahadurabad, Gabargaon, Sirajganj and Nagarbari, the four span lengths of 100^m, 150^m, 250^m and 350^m, and the three guide bank types of 2.0^{Km}, 4.2^{Km} and 5.2^{Km} or 5.6^{Km} about each proposed site. As above mentioned, about the optimum type of superstructures, three span steel continuous truss bridges for 100^m and 150^m and steel cantilever truss bridges for 250^m and 350^m were the most suitable type of superstructures.

As for substructure, there were compared on merits of well and multi-pile-foundation and the best type of substructure was determined.

And next, we can obtain the optimum span length by comparison of total costs of super and substructures based on each type of guide banks and span length at each proposed site.

2. Selection of the type of substructures.

For the purpose of comparison between well and multi-pile foundation, the costs of well foundation shown in Table VII-4-1~2 and the cost of multi-pile foundation shown in Table VII-5-1~2 were illustrated in Fig. VIII-1-1~4, Fig. VIII-2-1~4 on each proposed site and the case a and b respectively.

According to these graphs, in the case a, it is evident that well foundations are more economical than multi-pile-foundation among the four proposed sites and every spans. But both costs are nearly equal in the case of 5.6^{Km} of guide bank distance and 100^{m} in span length at Bahadurabad and Sirajganj. And it is worth notice that the difference of costs of both types of the foundation in 4.2^{Km} of the guide bank distance are rather more than in 5.2^{Km} or 5.6^{Km}.

In the case of b, as the same dimension for well section was used even in different span of bridge, costs of well foundation decreased in proportion to the numbers of wells by decreasing of the numbers of wells in long span.

In multi-pile foundation there was not much differences among the costs of various spans, and total costs was not always in proportion to the difference of span length.

As in the case a, well foundations are more economical than multi-pile-foundations in most cases but on the contrary, in type of 5.2^{Km} or 5.6^{Km} in guide bank, multi-pile-foundations are more economical than well foundations in the case of 100^{m} in span length.

From above studies about foundation types, the result that well foundations would be proper in the case a and in most cases b well foundation would be superior, was reduced.

Fig.VIII-1-1 The relation between costs and span of substructure in Case a at Bahadurabad site

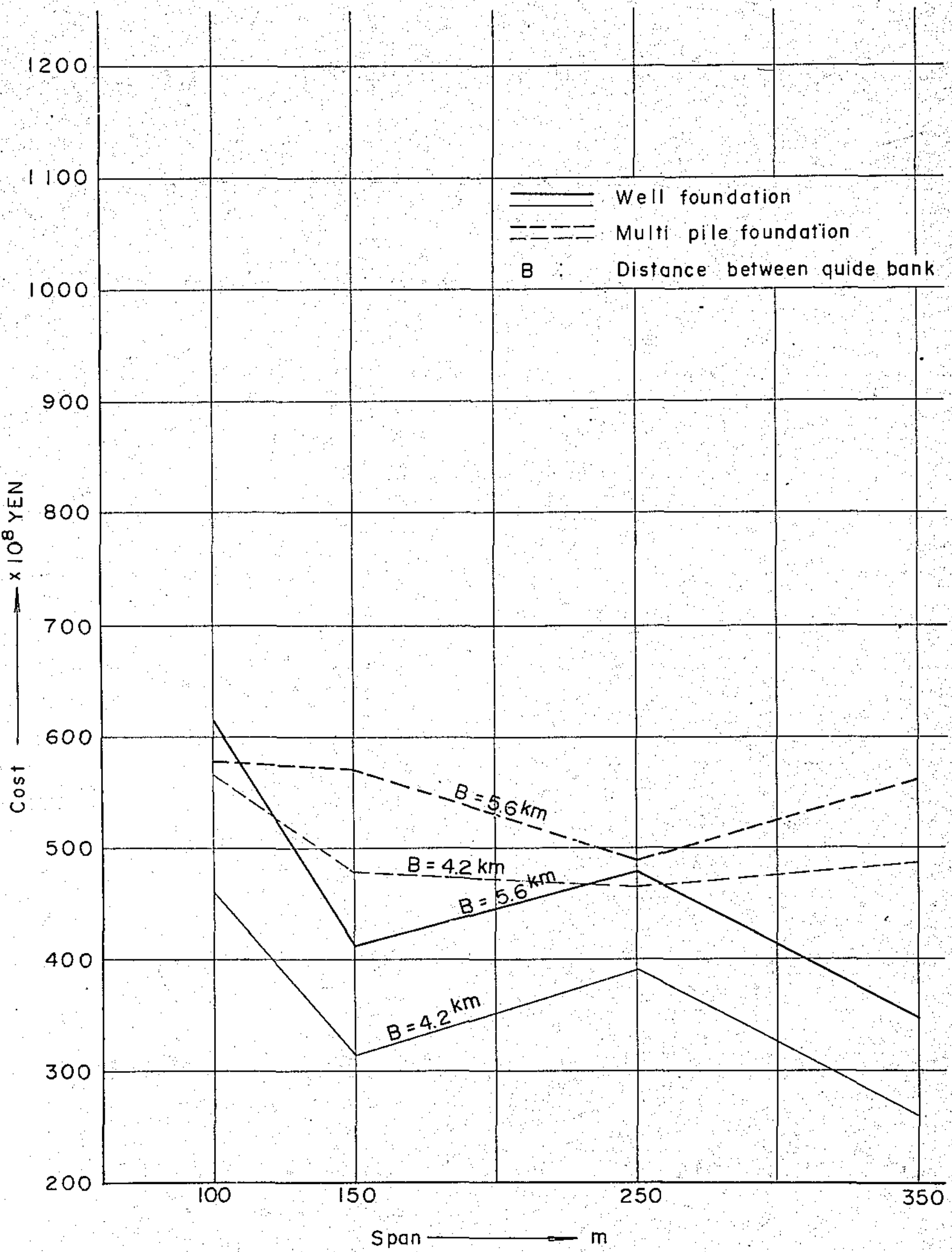


Fig.VIII-1-2 The relation between costs and span of substructure in Case a at Gabargaon site

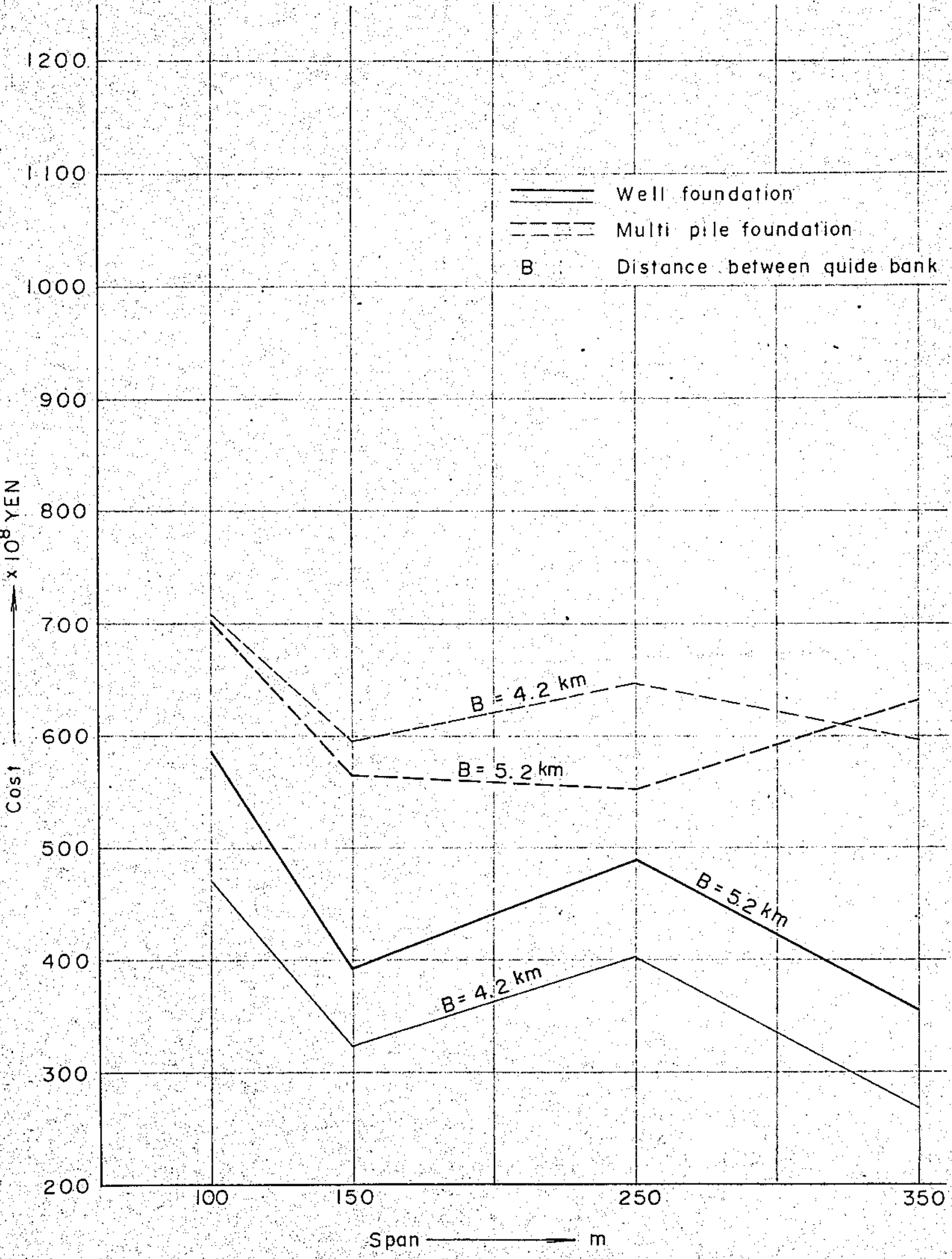


Fig.VIII-1-3 The relation between costs and span of substructure in Case a at Sirajganj site

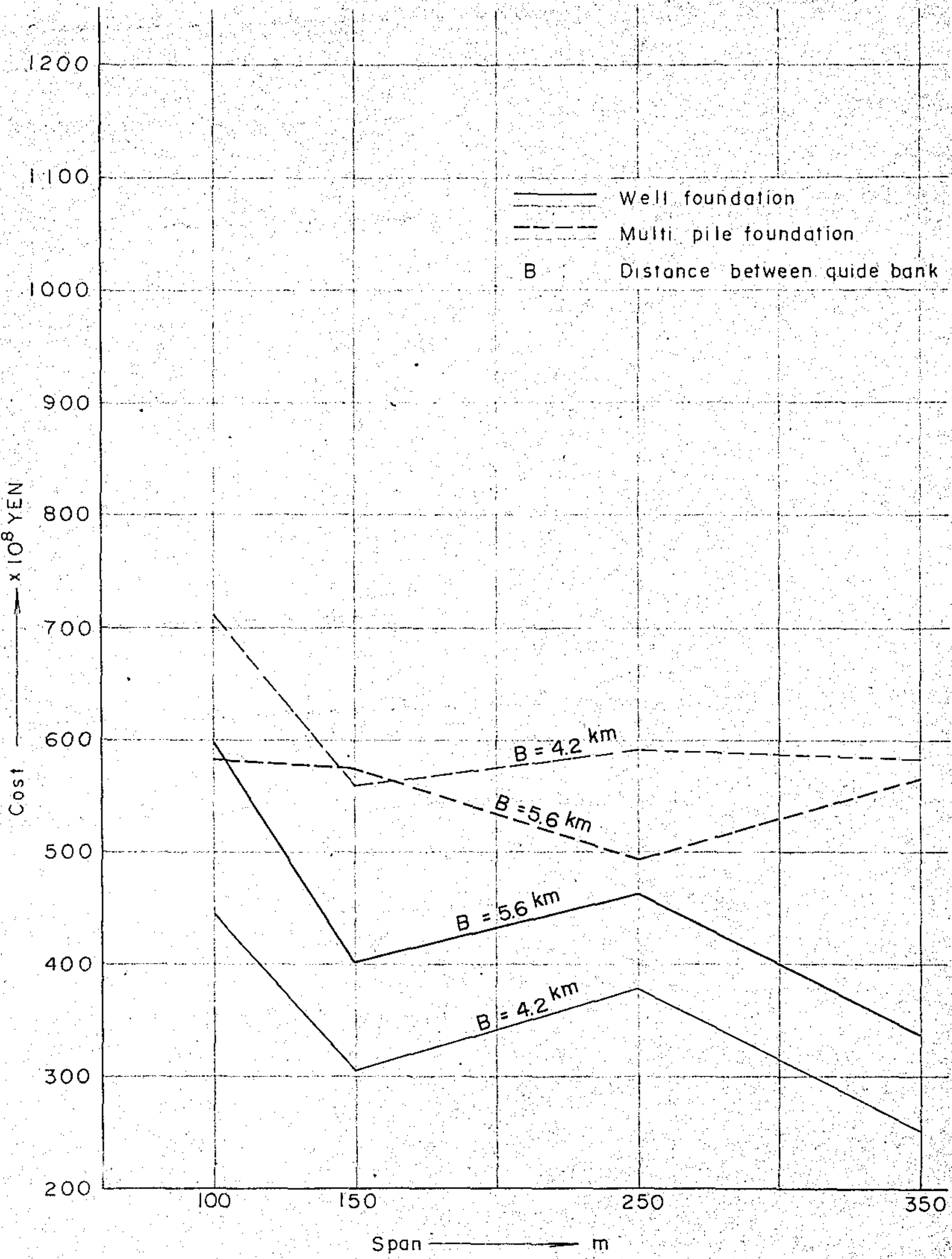


Fig.VIII-1-4 The relation between costs and span of substructure in Case a at Nagarbari site

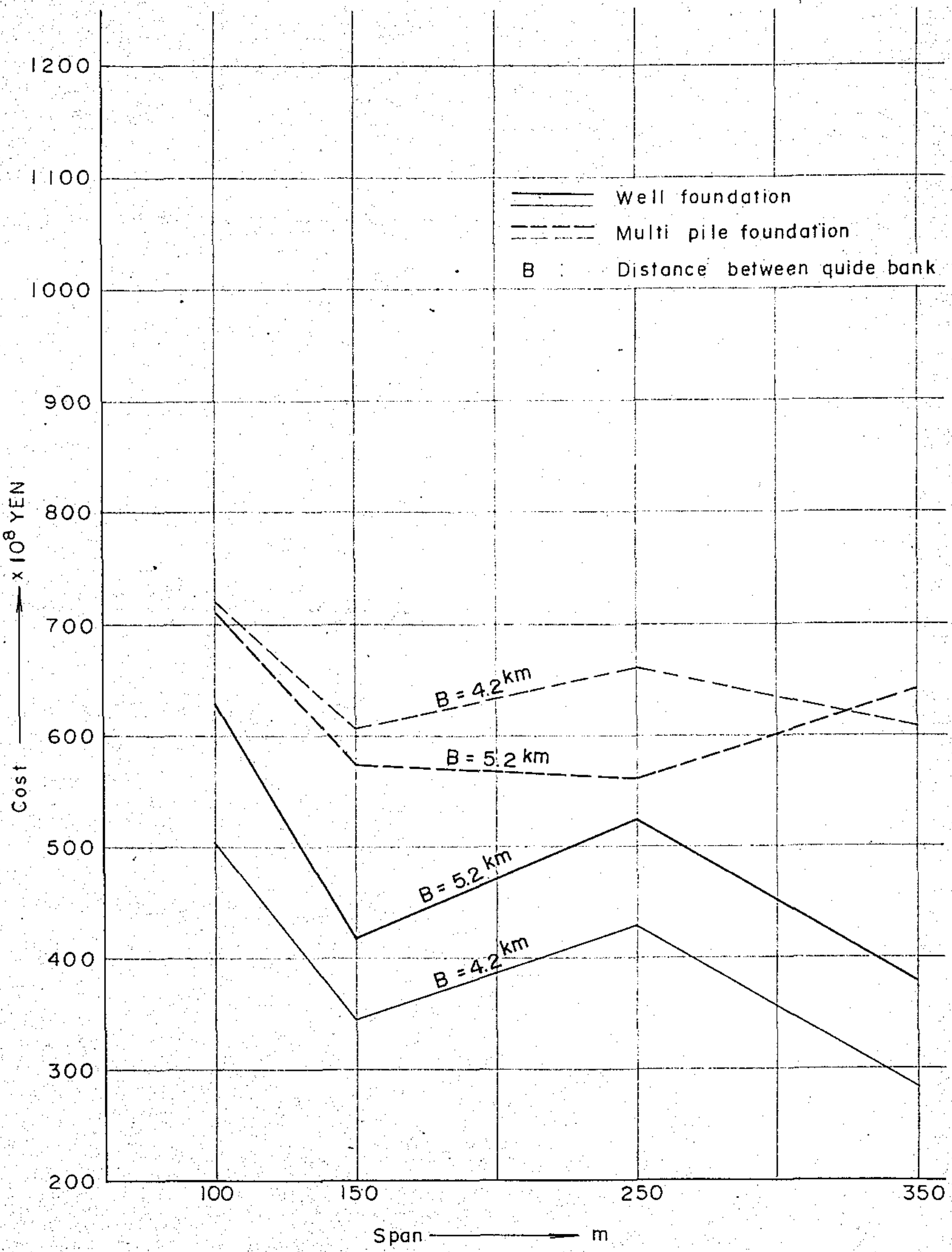


Fig.VIII-2-1 The relation between costs and span of substructure in Case b at Bahadurabad site

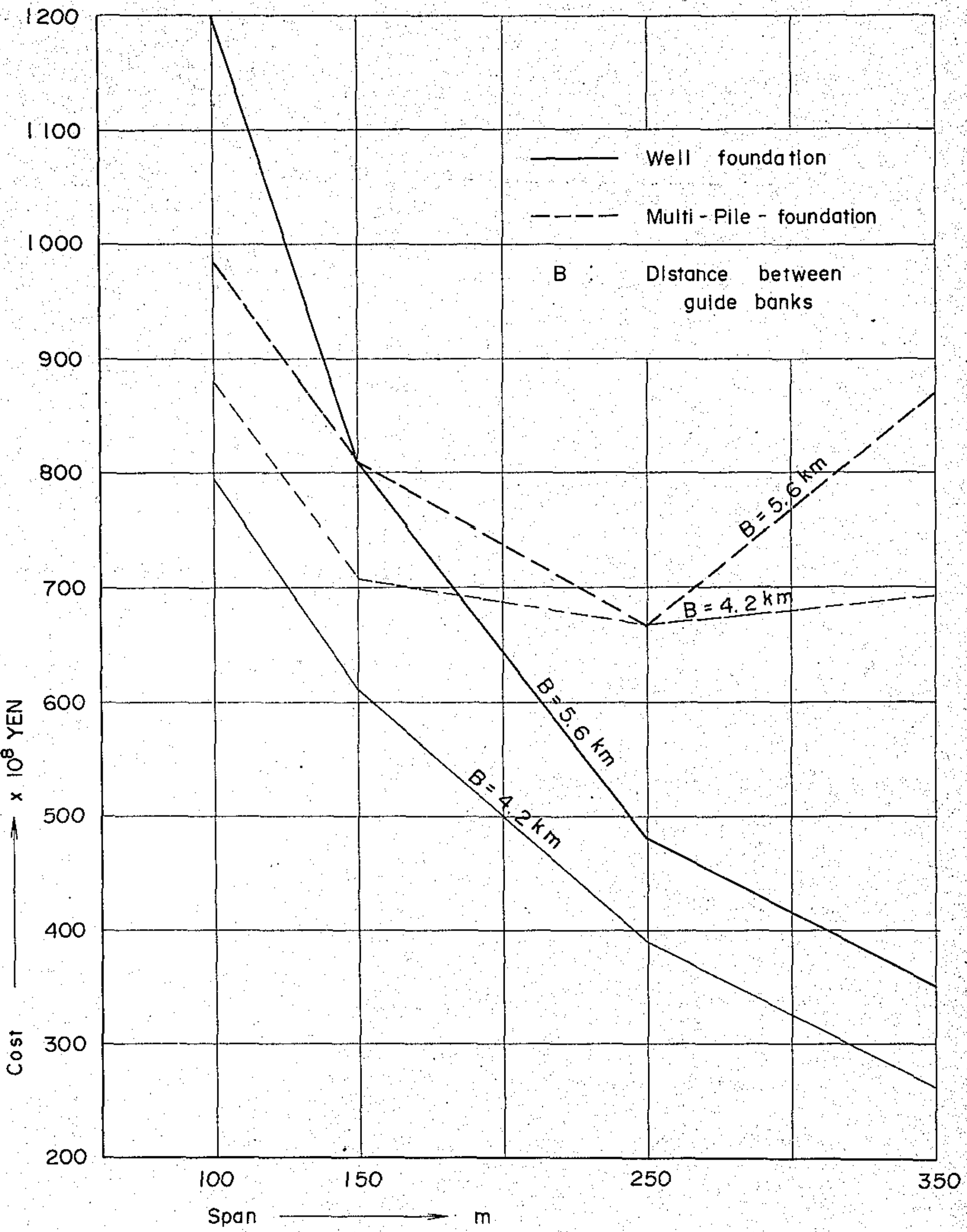


Fig.VIII-2-2 The relation between costs and span of substructure in Case b at Gabargaon site

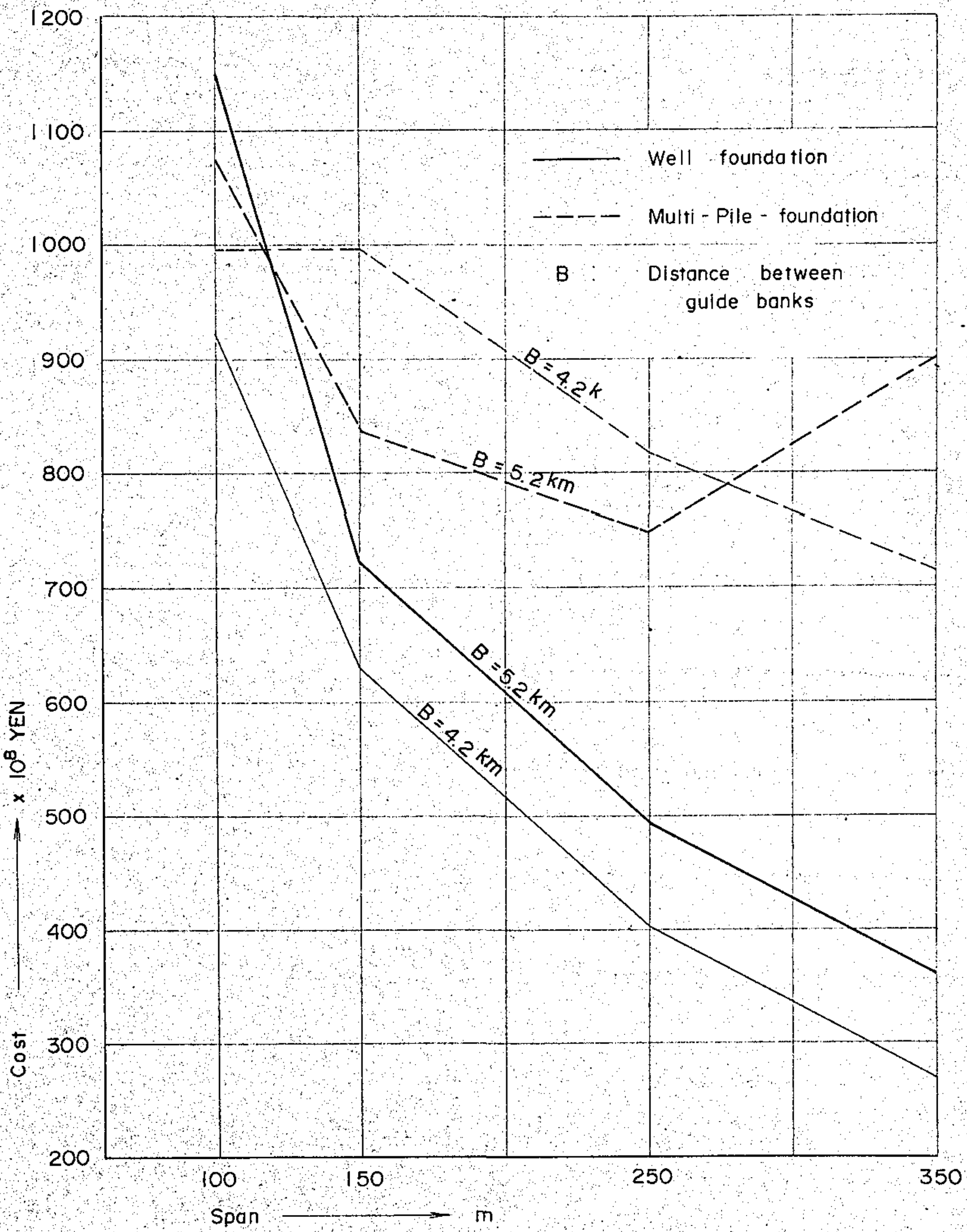


Fig.VIII-2-3 The relation between costs and span of substructure in Case b at Sirajganj site

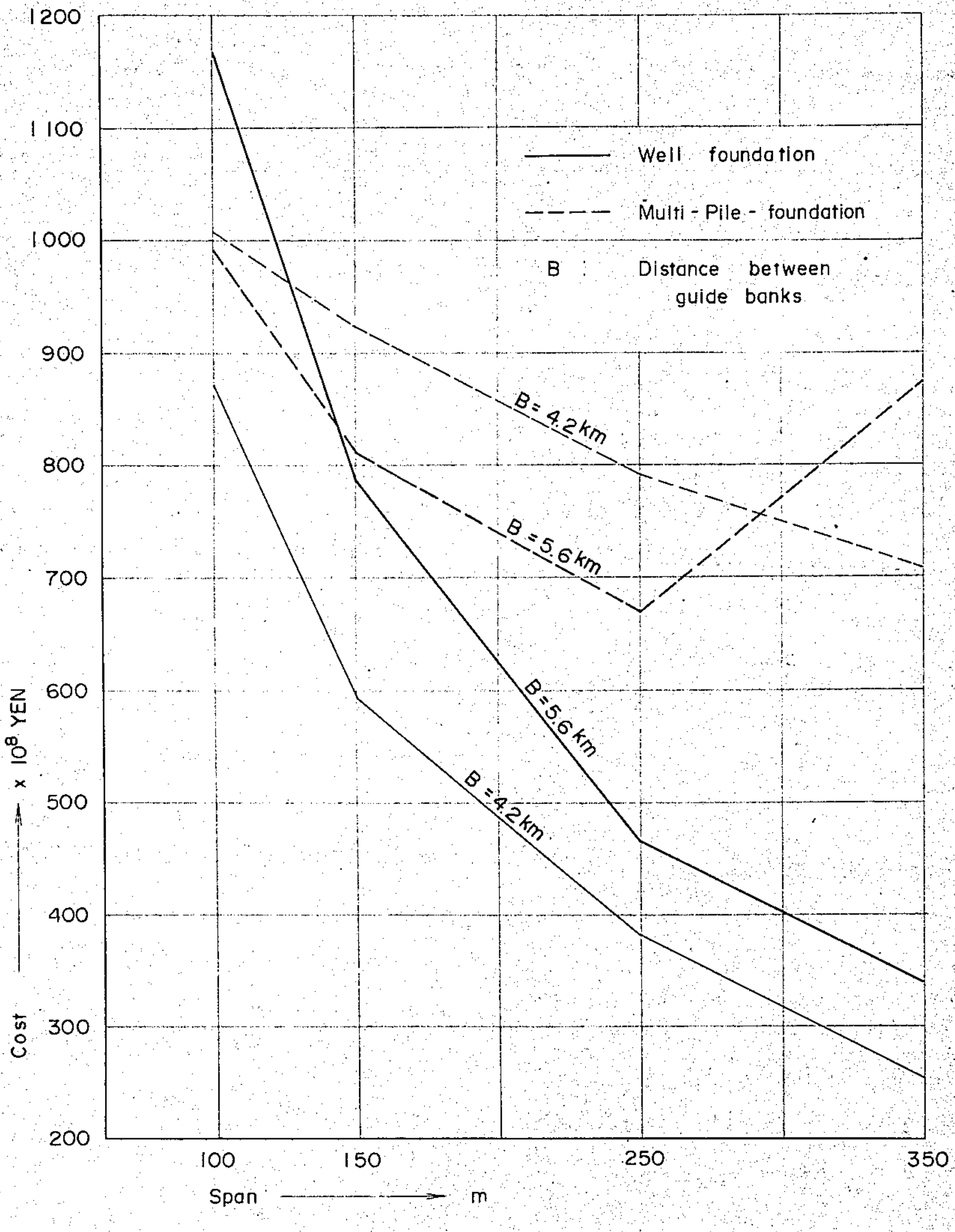
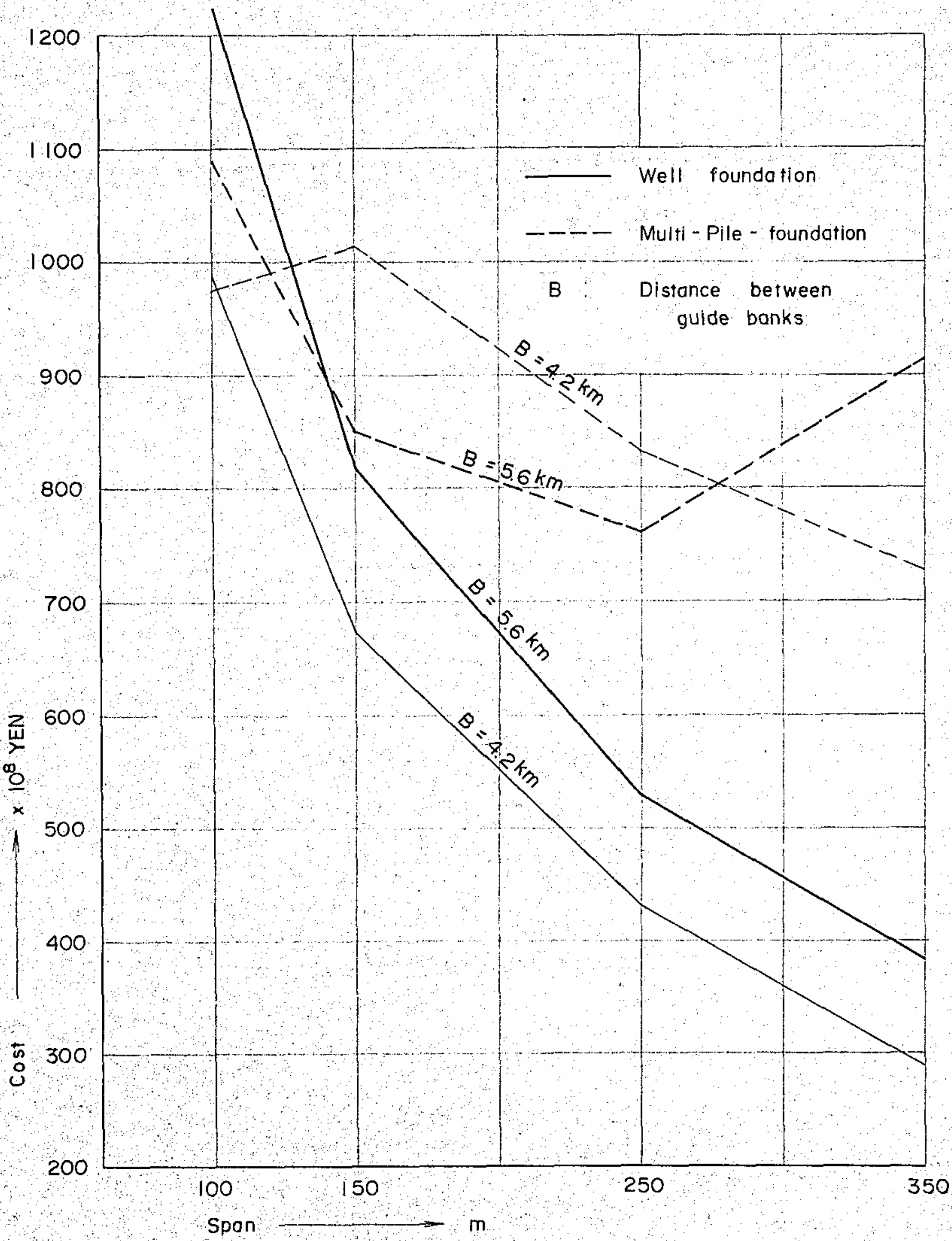


Fig. VIII-2-4 The relation between costs and span of substructure in Case b at Nagarbari site



3. Decisions of the optimum span length and total construction costs.

Generally speaking, on the graph, costs of superstructure in ordinate and span length in abscissa, costs of superstructure increase extremely in accordance with the increase of its span length.

As for substructure, a individual scale of foundation will be enlarged in accordance with the increment of span length, but increasing rate of the total costs of substructure is less than it of superstructure. Now considering a multi-spans bridge having the constant bridge length, total costs of superstructure increase in accordance with the increment of span length of bridge but the total costs of substructure decrease in a slow curve gradually because the number of piers decrease due to increment of span length.

Adding up both costs, this curve tends to convex downward generally. This means that the span length corresponding to the bottom point of the curve is the most economical one. Therefore, we will call this the optimum span length.

We have been studied about bridges having four types of spans, and Fig. VIII-3-1～4 in the case a and Fig. VIII-4-1～4 in the case b were procured.

Apparently from the upper graphs, about 150^m of span length was decided as the most economical in the case a and b and in each proposed bridge site.

In these cases, a type of superstructure is a three span continuous truss and a type of substructure is a well foundation. Consequently, at the first stage of the study, three span continuous truss of 150^m of span length was adopted as the basis of the selection of site as the optimum span length. Figs. VIII-5-1～4 show the general view of four types of bridge in the case of 4.2^{Km} (2.6 miles) of width of guide bank. According to the classification of Fig. II-4, the total costs of construction in only a scope of the Jamuna River Bridge are shown in Table VIII-1, and in this table the total costs contain costs of super and substructure, approach road and transportation about each case, each site and each guide bank type respectively. In this case, a superstructure of the main bridge is a three span continuous steel truss and a substructure is a well foundation.

Fig. VIII-3-1 The relation between construction costs and span of bridge with well foundation in Case a

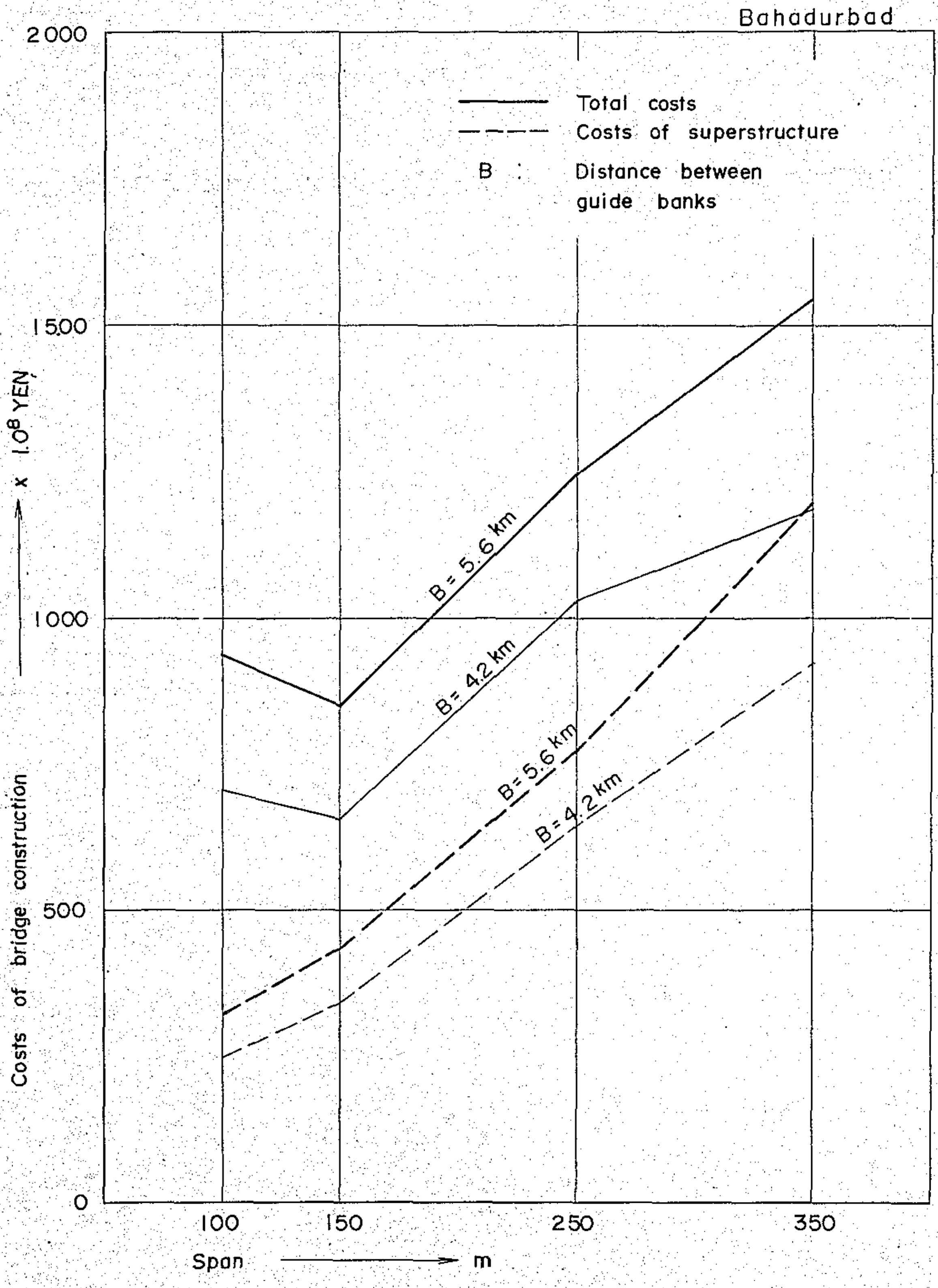


Fig. VIII-3-2 The relation between construction costs and span of bridge with well foundation in Case a

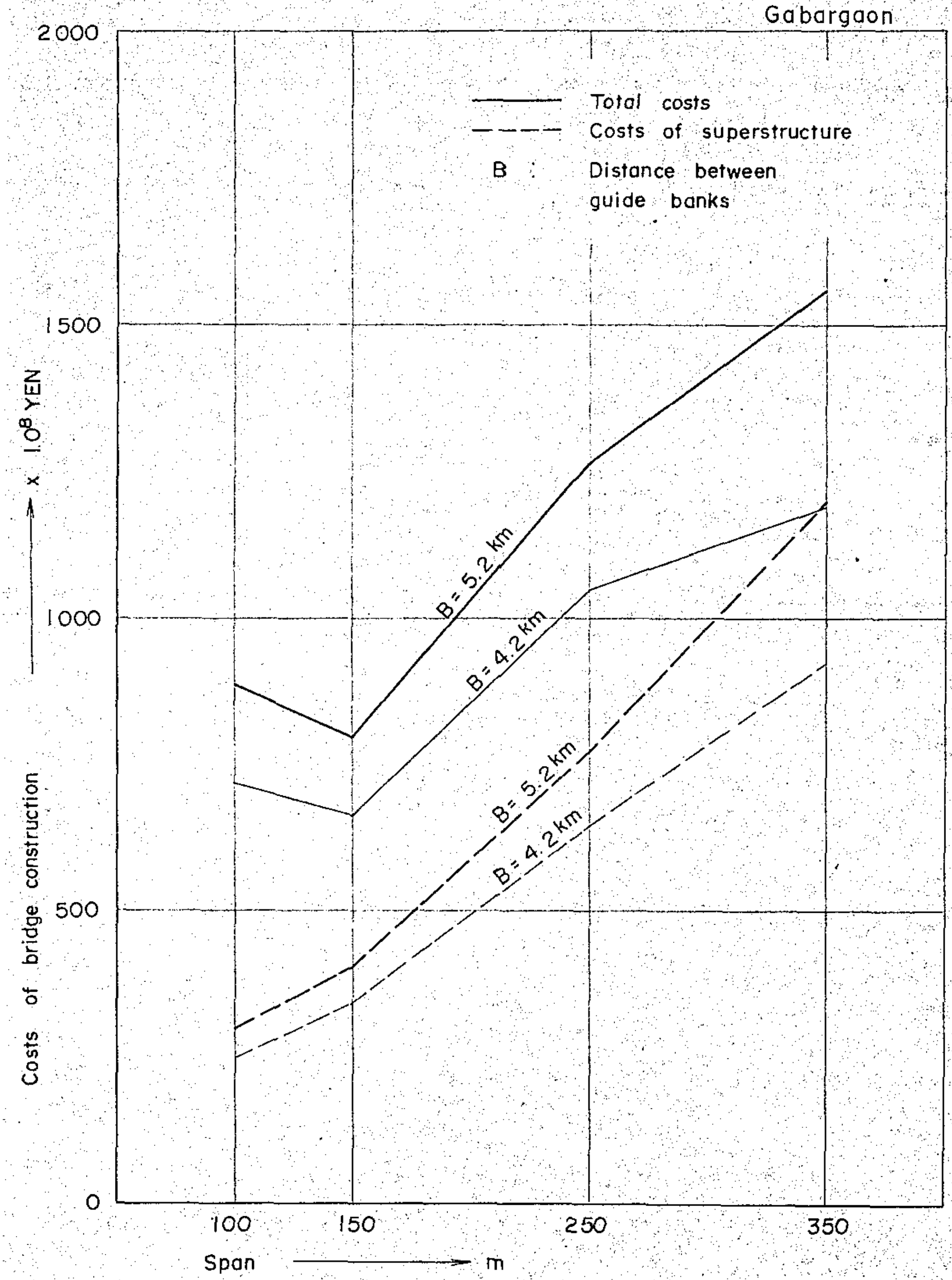


Fig. VIII-3-3 The relation between construction costs and span of bridge with well foundation in Case a

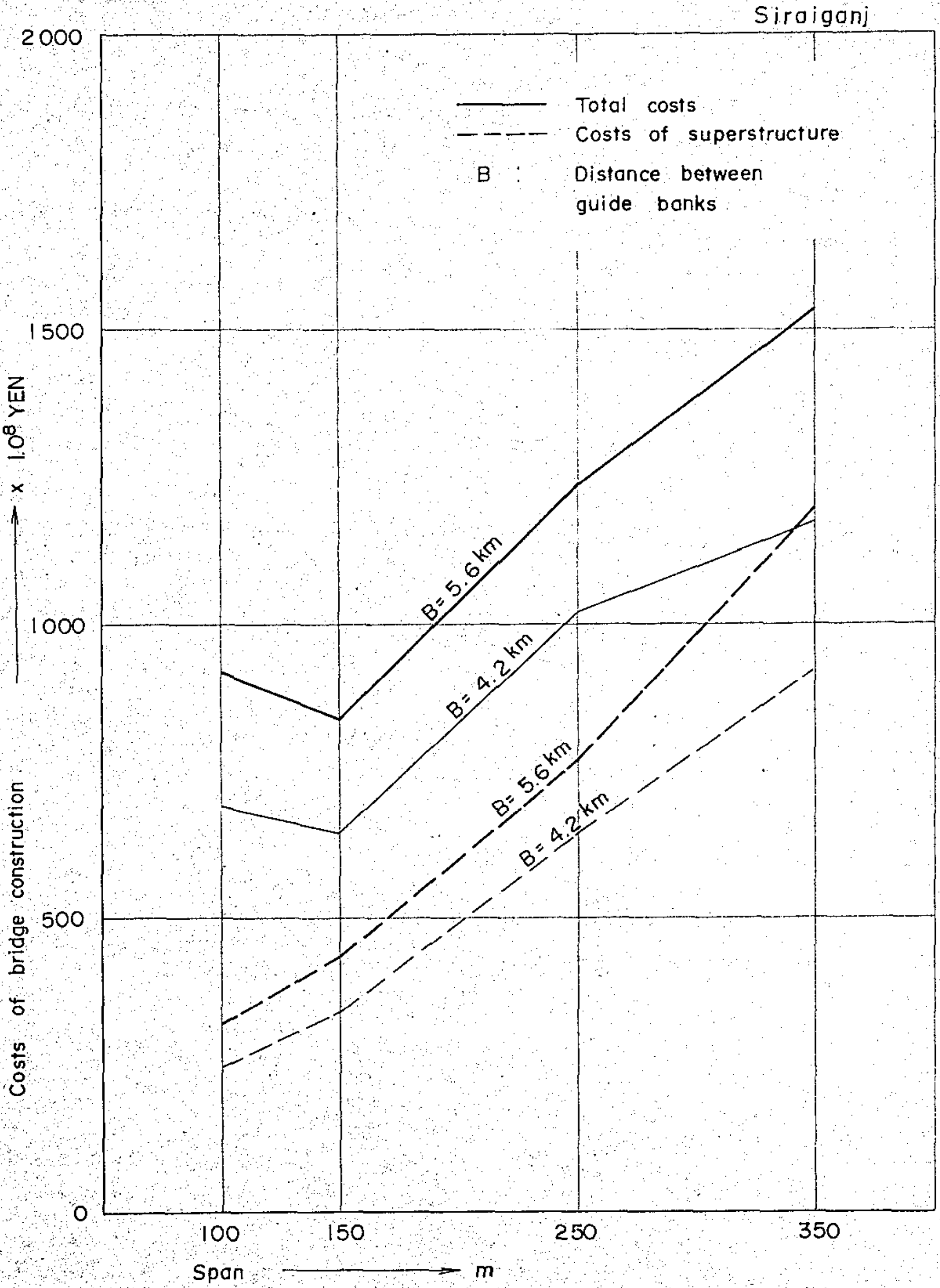


Fig. VIII-3-4 The relation between construction costs and span of bridge with well foundation in Case a

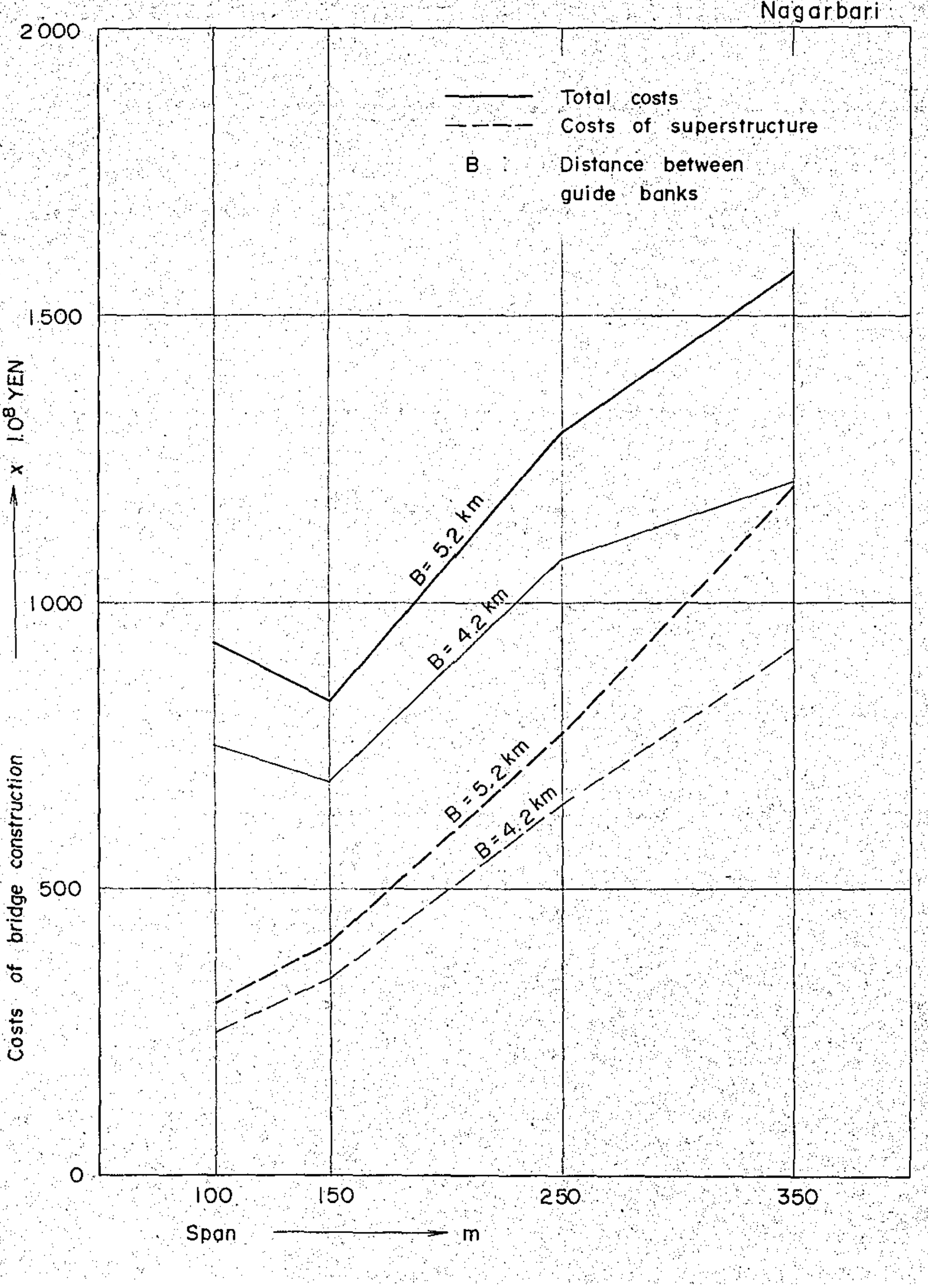


Fig. VIII-4-1 The relation between construction costs and span of bridge with well foundations in Case b

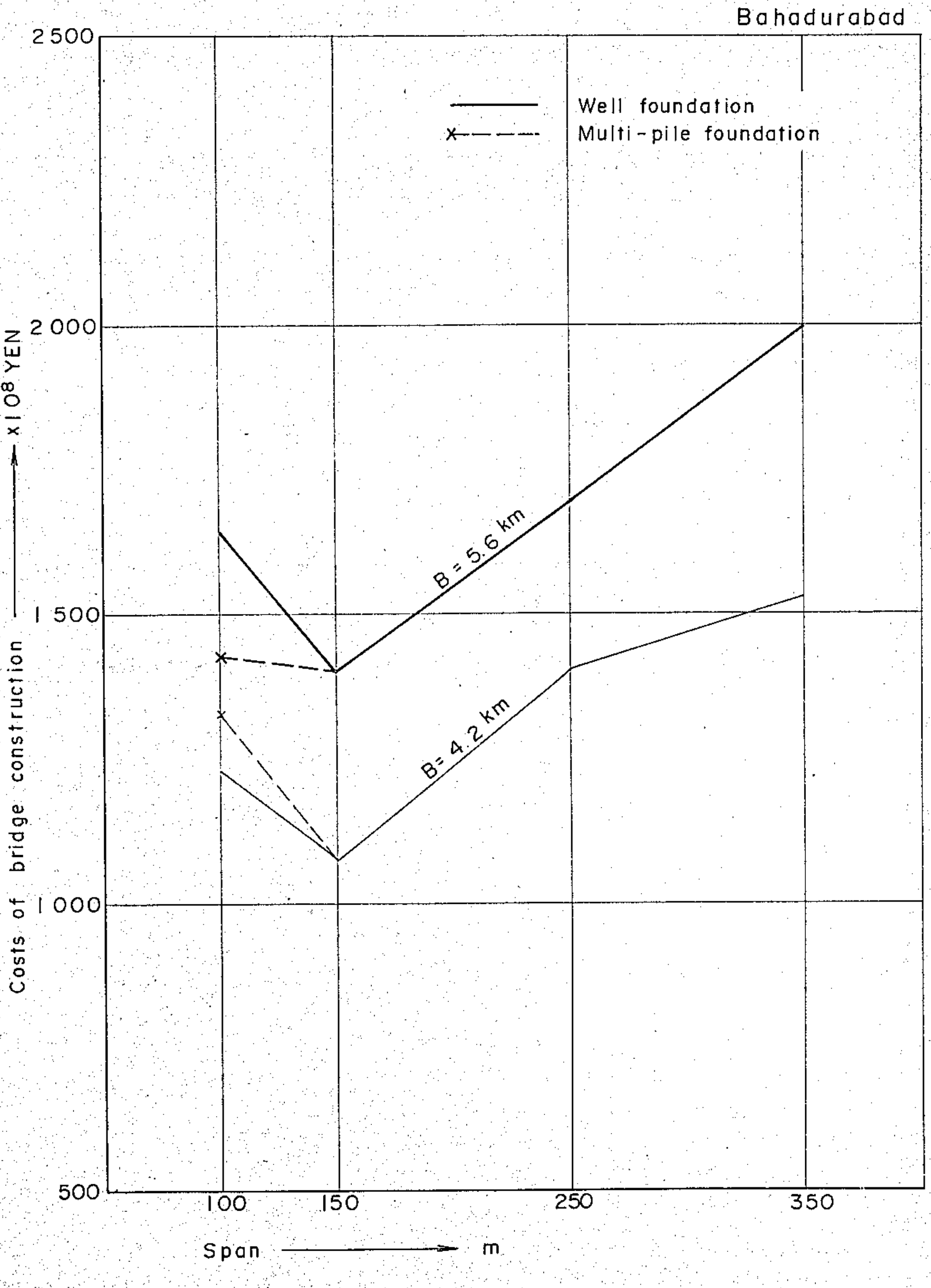


Fig. VIII-4-2 The relation between construction costs and span of bridge with well foundations in Case b

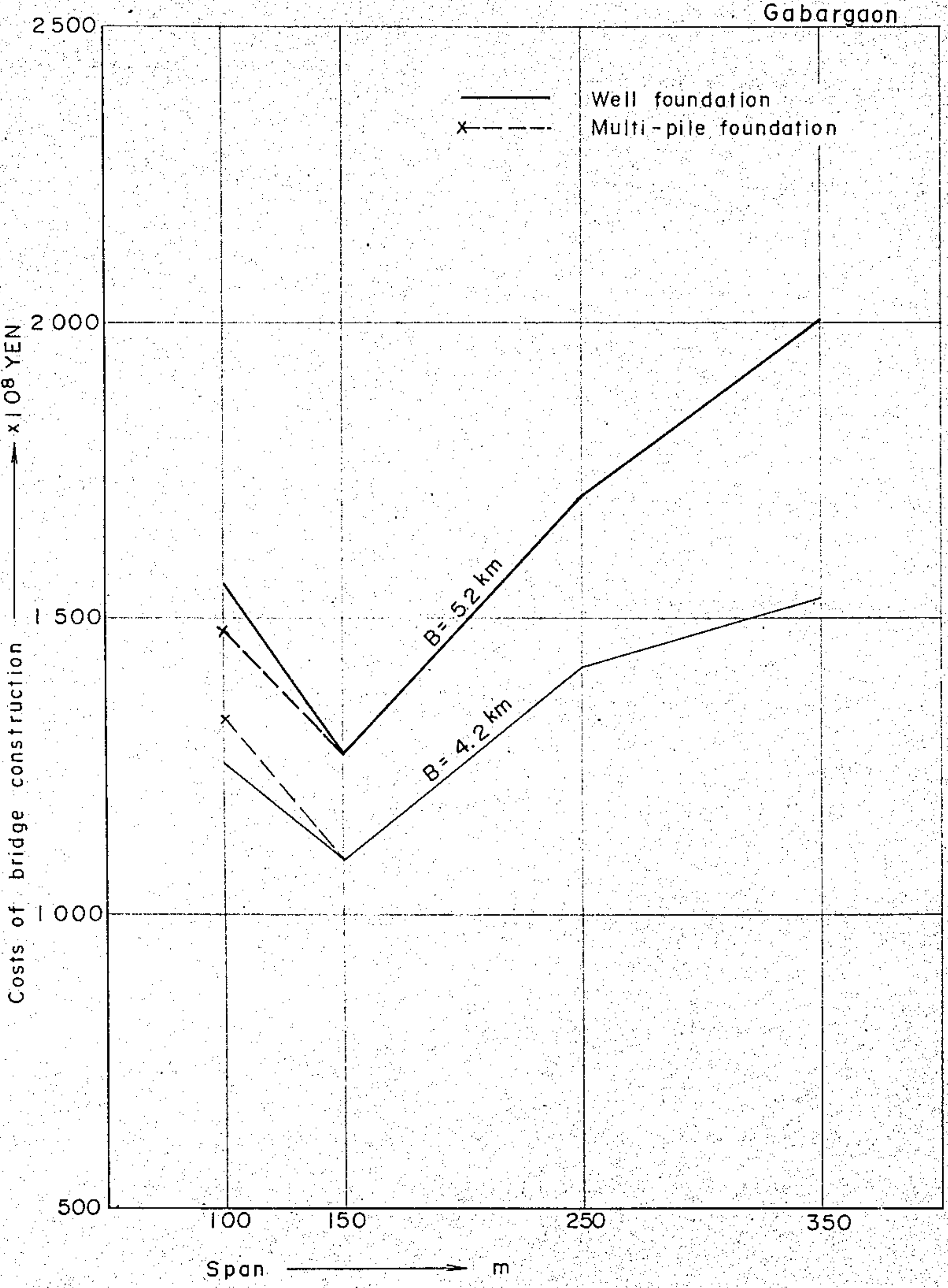


Fig. VIII-4-3 The relation between construction costs and span of bridge with well foundations in Case b

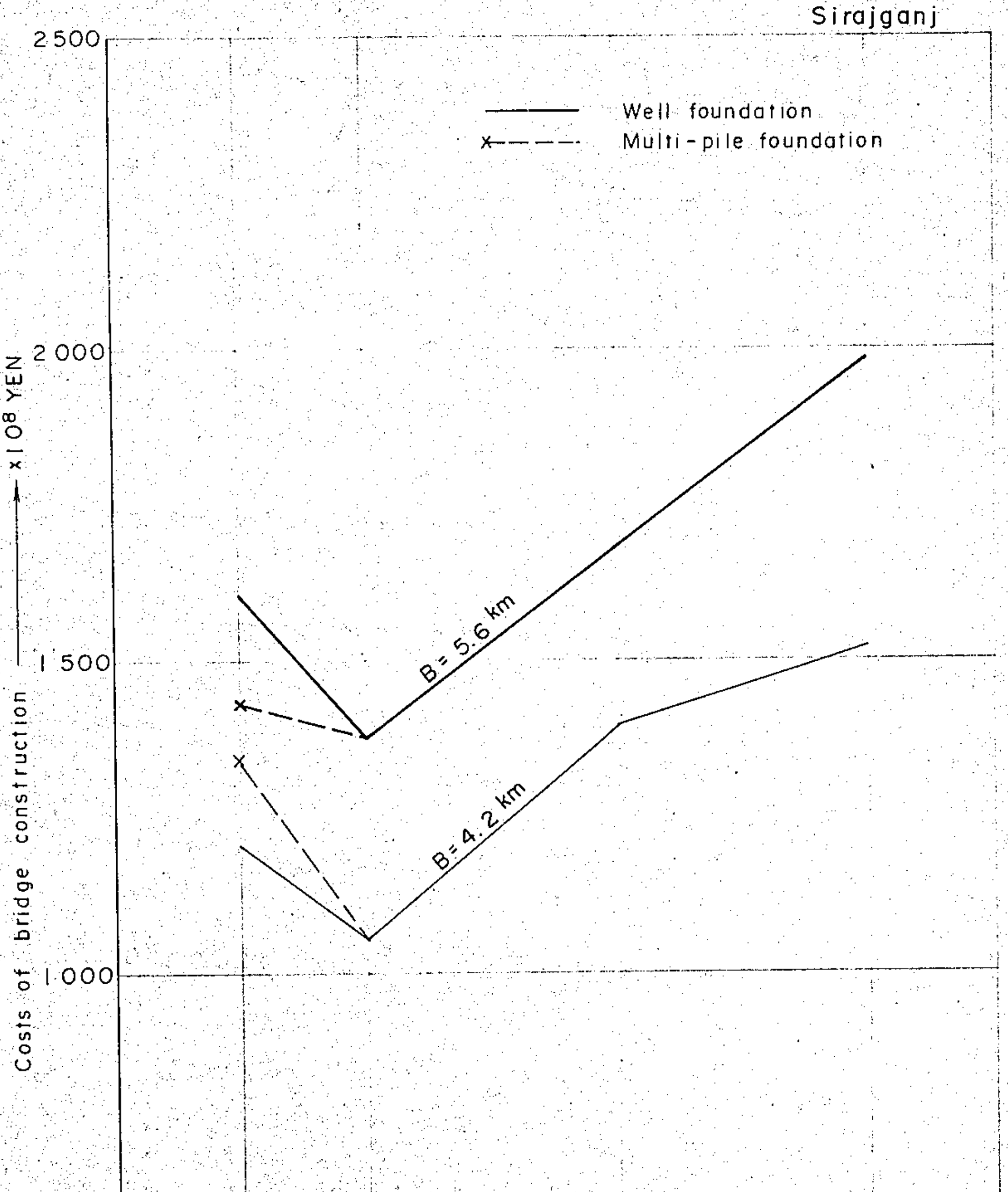
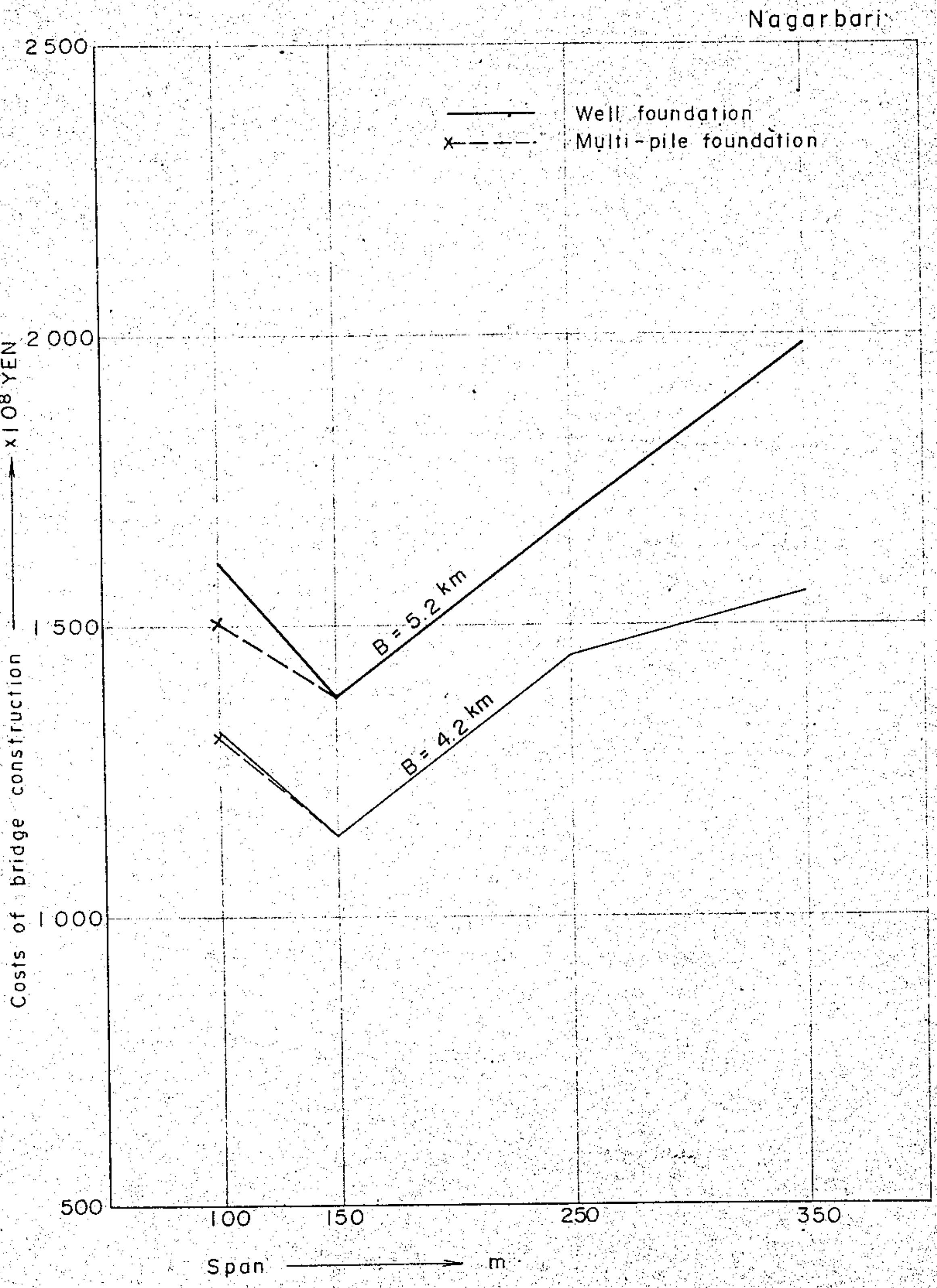


Fig. VIII-4-4 The relation between construction costs and span of bridge with well foundations in Case b



4. Order of evaluation of proposed sites.

The total costs of construction according to the most suitable type of structure and span length at each proposed site were shown in Table VIII-1. The order of evaluation of proposed sites to be obtained from this table, is as in Table VIII-2.

Table VIII-1 Rough estimate of bridge construction costs

(10^8 in YEN)

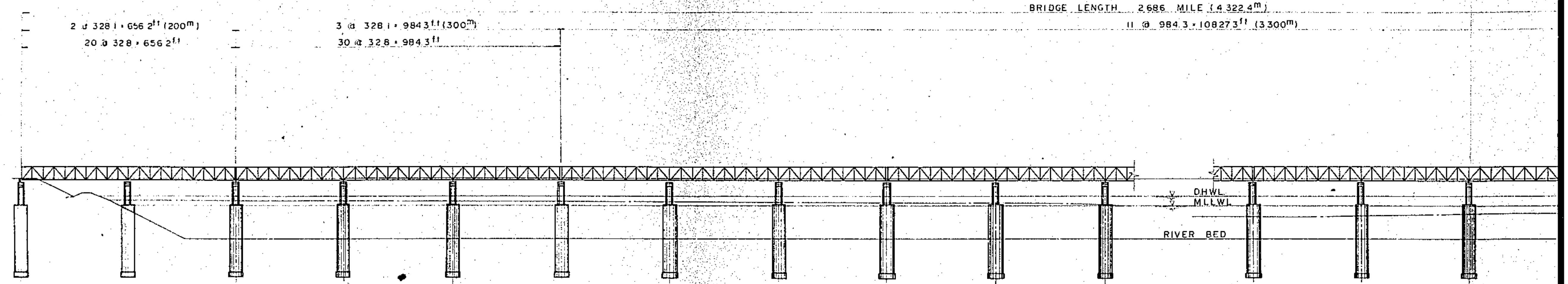
Case	Site proposed for bridge const.	Distance btw. guide banks	Super-structure	Sub-structure	Approach Road	Subtotal	Transpor-tation costs	Total
a	Bahadurabad	4.2 km 5.6 km	269 343	314 415	139 143	722 901	83 108	805 1,009
	Gabargaon	4.2 km 5.2 km	269 319	323 392	143 147	735 858	84 101	819 959
	Sirajganj	4.2 km 5.6 km	269 343	305 402	147 159	721 904	81 102	802 1,008
	Nagarbari	4.2 km 5.2 km	269 319	345 419	179 183	793 921	85 103	878 1,024
b	Bahadurabad	4.2 km 5.6 km	366 467	612 809	278 283	1,256 1,559	163 208	1,419 1,767
	Gabargaon	4.2 km 5.2 km	366 434	630 722	283 287	1,279 1,443	158 230	1,437 1,673
	Sirajganj	4.2 km 5.6 km	366 467	594 785	293 299	1,253 1,551	167 214	1,420 1,765
	Nagarbari	4.2 km 5.2 km	366 434	673 817	320 325	1,359 1,576	149 211	1,508 1,787

Table VIII-2 Evaluation of the proposed sites in regard to bridge construction costs

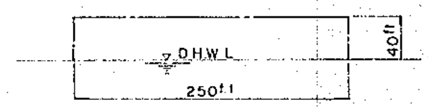
Case	a		b	
Site \ Distance btw. guide banks	4.2 km	5.2 km or 5.6 km	4.2 km	5.2 km or 5.6 km
Bahadurabad	2	3	2	3
Gabargaon	3	1	3	1
Sirajganj	1	2	1	2
Nagarbari	4	4	4	4

Fig. VIII-5-1 GENERAL VIEW OF JAMUNA RIVE
RAIL-CUM-HIGWAY
CONTINUOUS TRUSS
DISTANCE BETWEEN GUIDE BANKS 2.6

PROFILE SCALE 1:4000

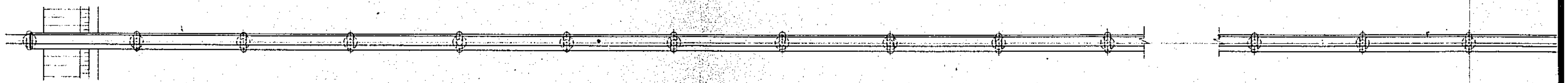


NAVIGATION CLEARANCE SCALE



PLAN SCALE 1:4000

CASE- a



CASE- b

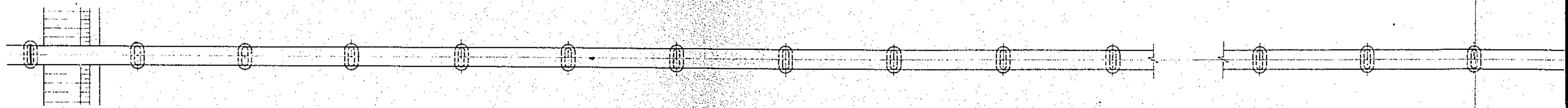


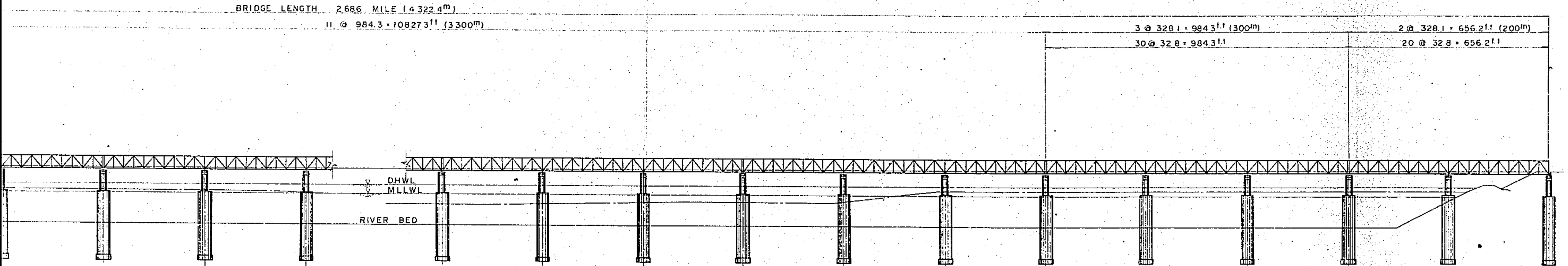
Fig. VIII-5-1 GENERAL VIEW OF JAMUNA RIVER BRIDGE

RAIL-CUM-HIGWAY

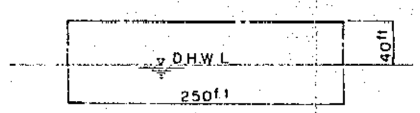
CONTINUOUS TRUSS

DISTANCE BETWEEN GUIDE BANKS 2.610 MILE (4.2 KM)

PROFILE SCALE 1:4000

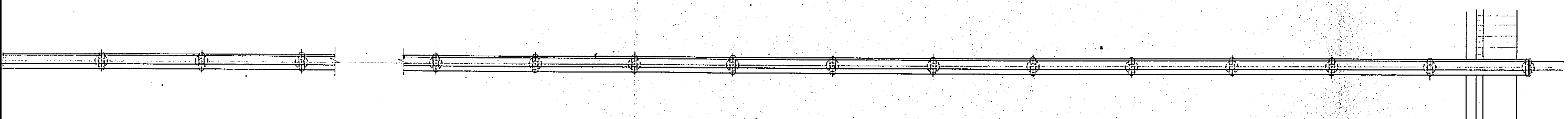


NAVIGATION CLEARANCE SCALE 1:2000

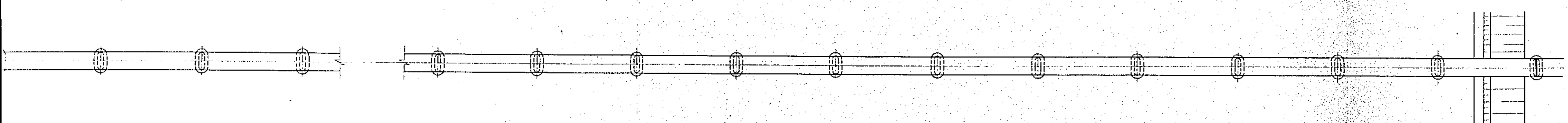


PLAN SCALE 1:4000

CASE-a

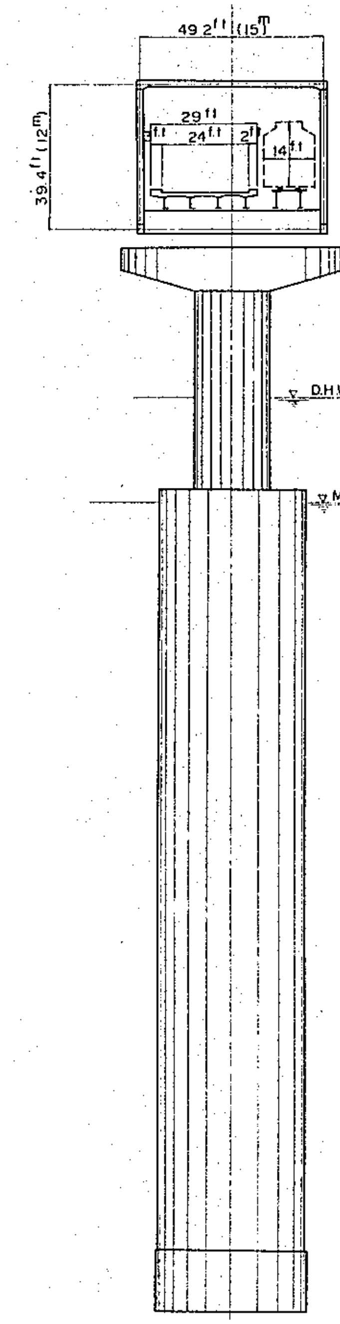


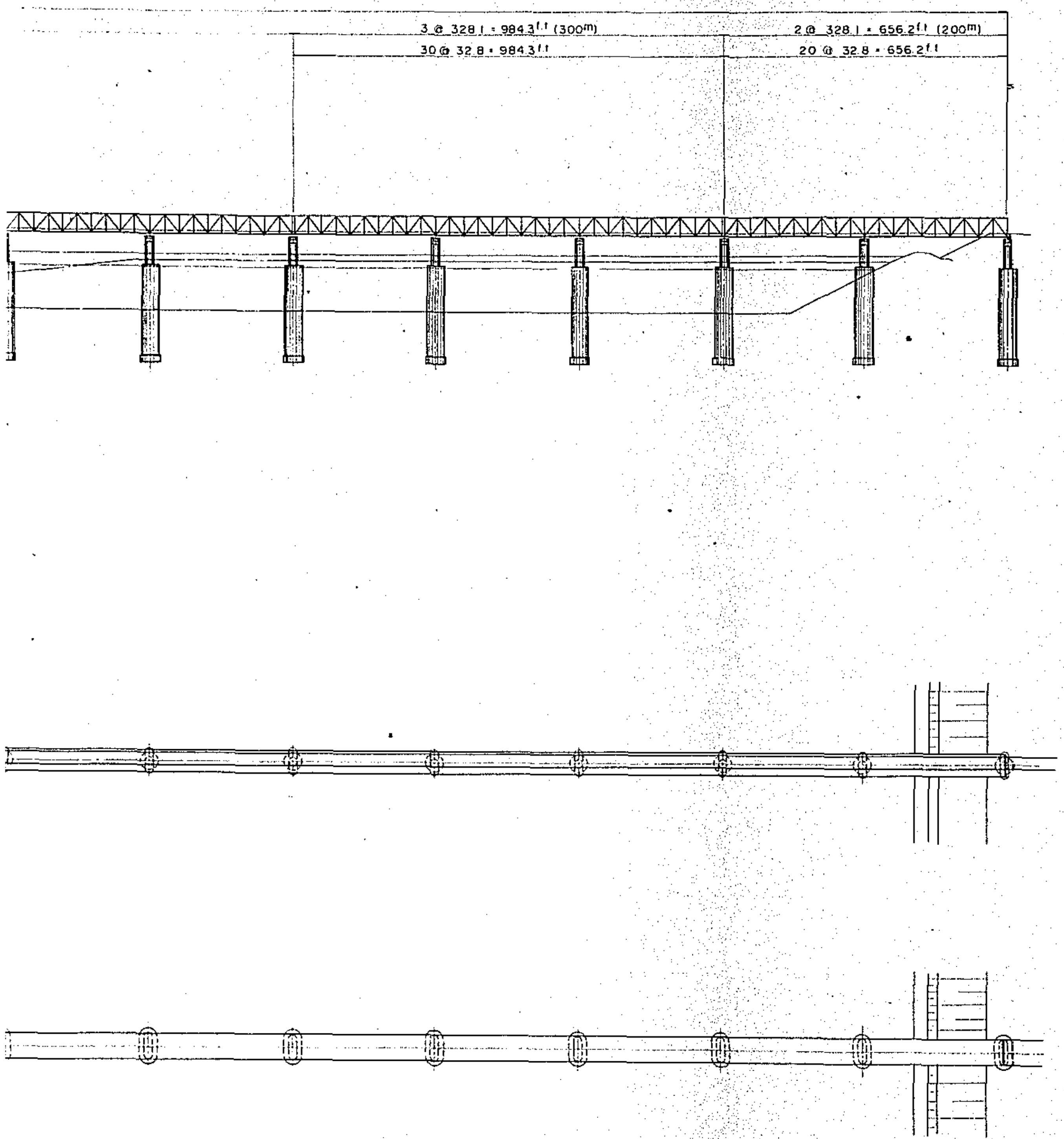
CASE-b



TYPICAL C

CASE-a





TYPICAL CROSS SECTION SCALE 1:600

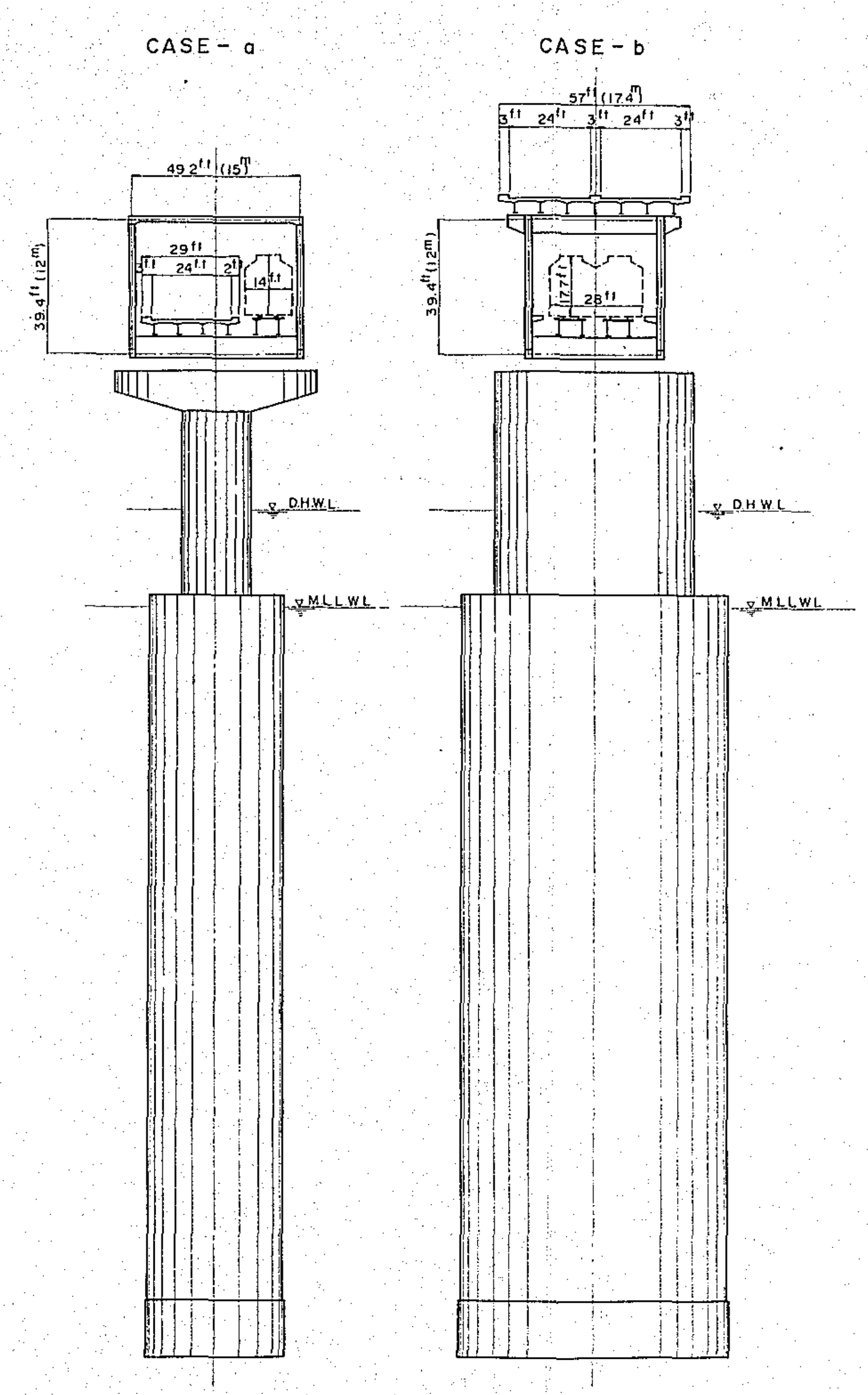


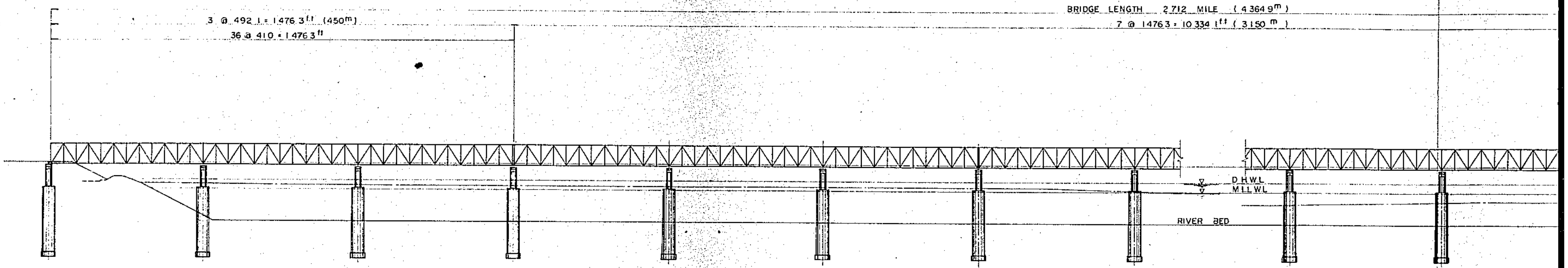
Fig. VIII-5-2 GENERAL VIEW OF JAMUNA RIVER B

(RAIL - CUM - HIGHWAY)

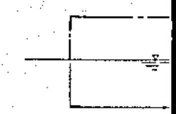
CONTINUOUS TRUSS

DISTANCE BETWEEN GUIDE BANKS 2610 MILE (4.2

PROFILE SCALE 1:4000

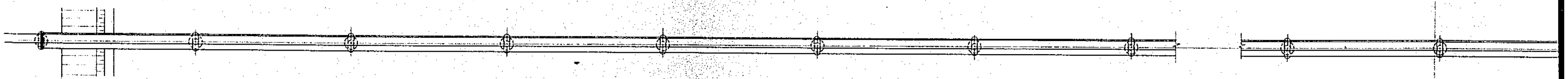


NAVIGATION



PLAN SCALE 1:4000

CASE - a



CASE - b

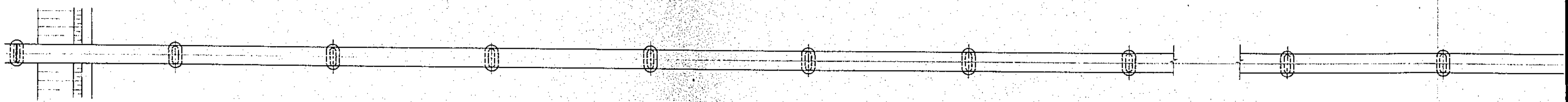


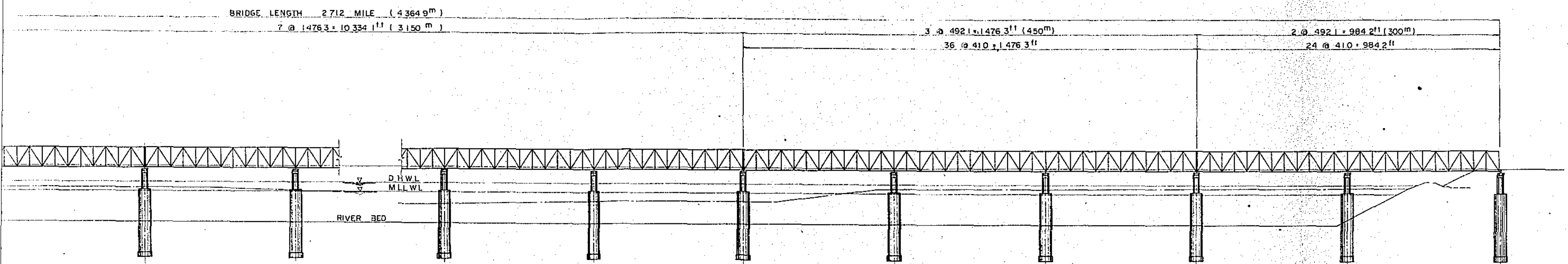
Fig. VIII-5-2 GENERAL VIEW OF JAMUNA RIVER BRIDGE

(RAIL - CUM - HIGHWAY)

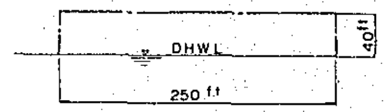
CONTINUOUS TRUSS

DISTANCE BETWEEN GUIDE BANKS 2.610 MILE (4.2 KM)

PROFILE SCALE 1:4000

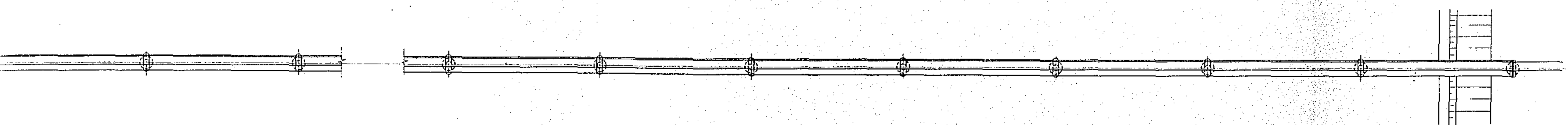


NAVIGATION CLEARACE SCALE 1:2000

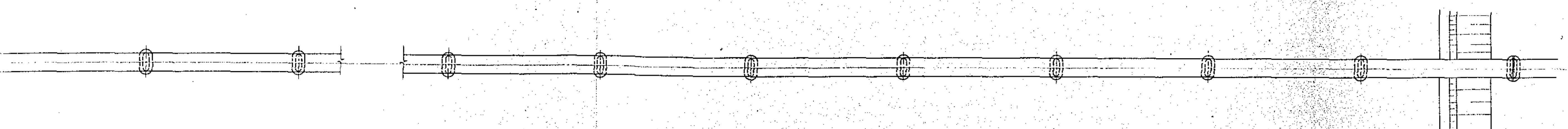


PLAN SCALE 1:4000

CASE - a

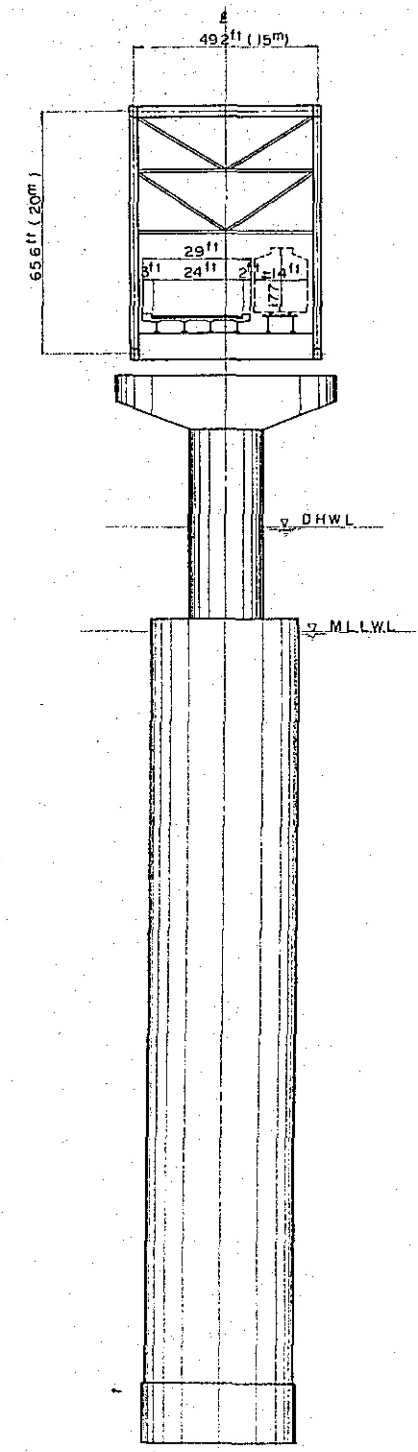


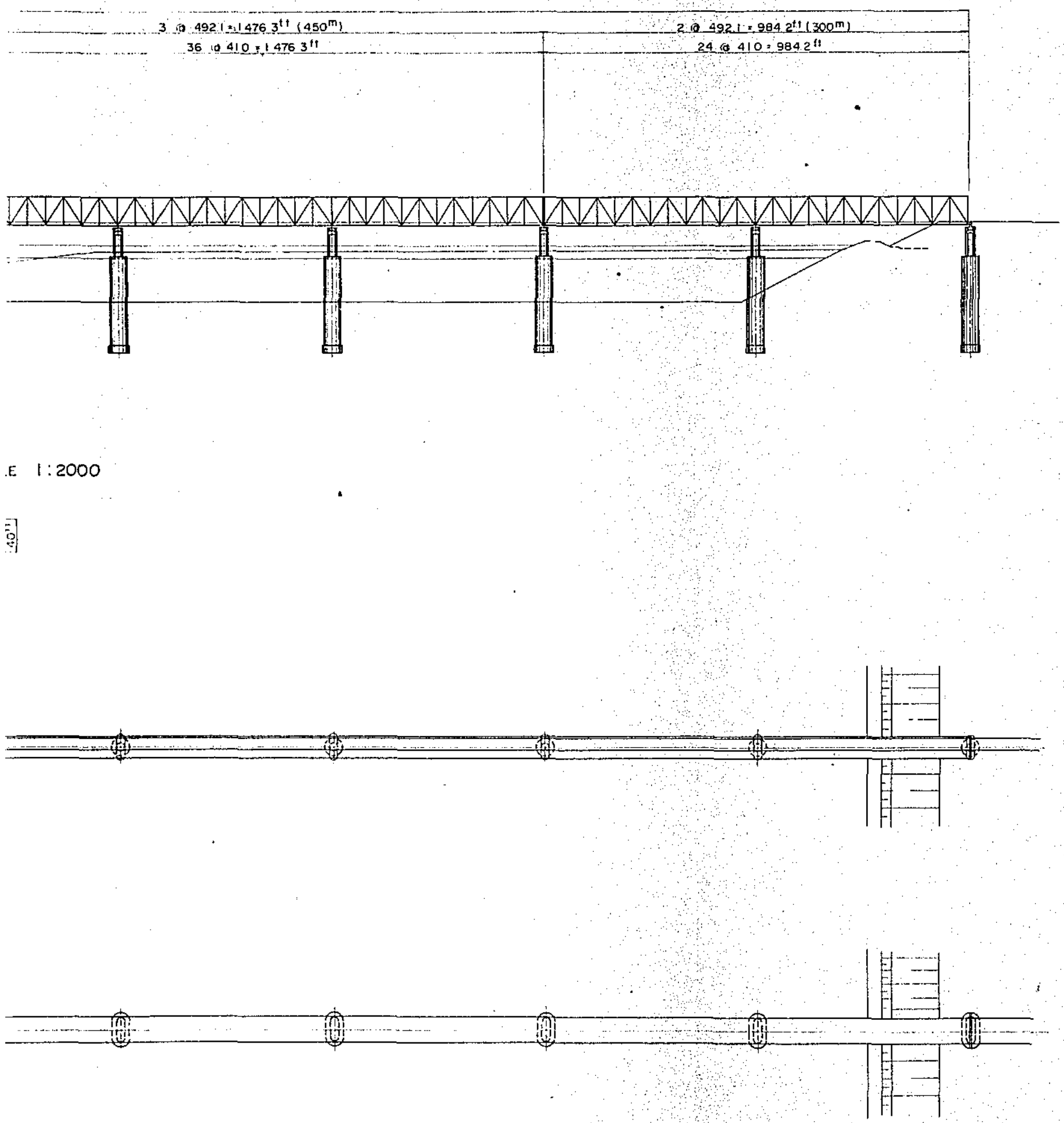
CASE - b



TYPCAL CROSS SE

CASE - a





.E 1:2000

TYPCAL CROSS SECTION SCALE 1:600

CASE - a

CASE - b

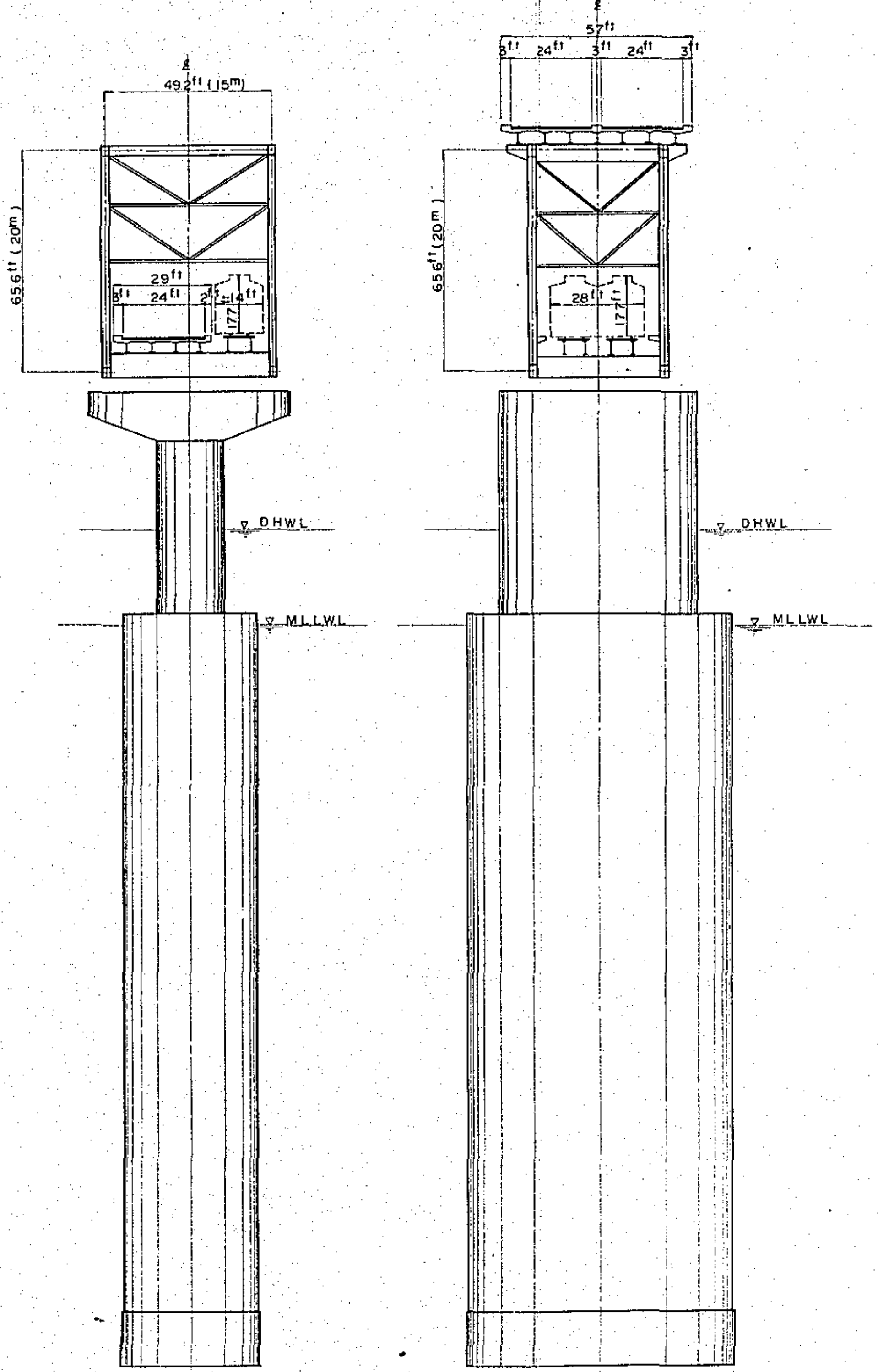


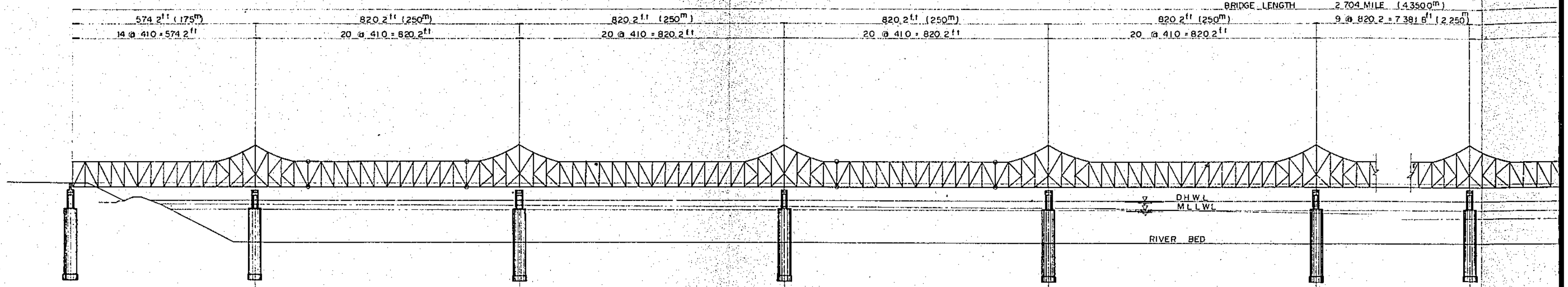
Fig. VIII-5-3 GENERAL VIEW OF JAMUNA RIVE

(RAIL - CUM - HIGHWAY)

CANTILEVER

DISTANCE BETWEEN GUIDE BANKS 2610

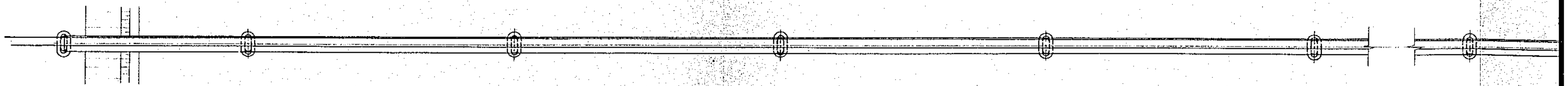
PROFILE SCALE 1 : 4000



NAVIGAT

PLAN SCALE 1 : 4000

CASE - a



CASE - b

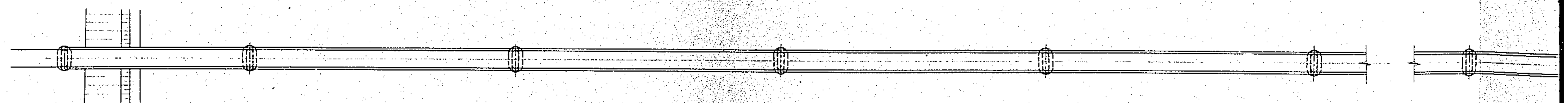
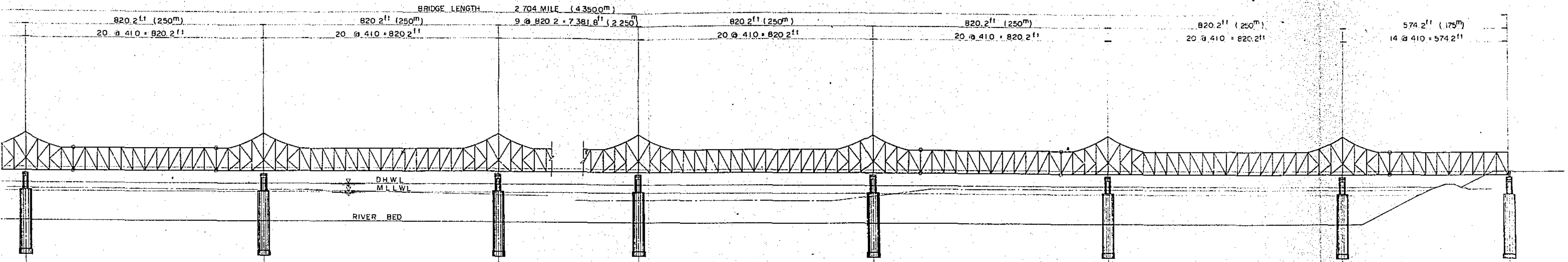


Fig. VIII-5-3 GENERAL VIEW OF JAMUNA RIVER BRIDGE
(RAIL - CUM - HIGHWAY)

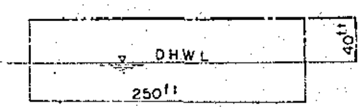
CANTILEVER

DISTANCE BETWEEN GUIDE BANKS 2.610 MILE (4.2KM).

PROFILE SCALE 1:4000

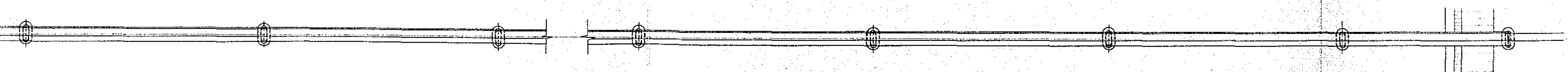


NAVIGATION CLEARANCE SCALE 1:2000

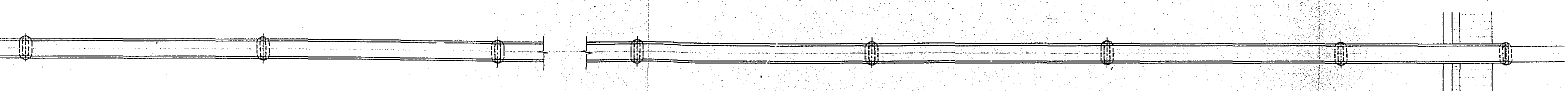


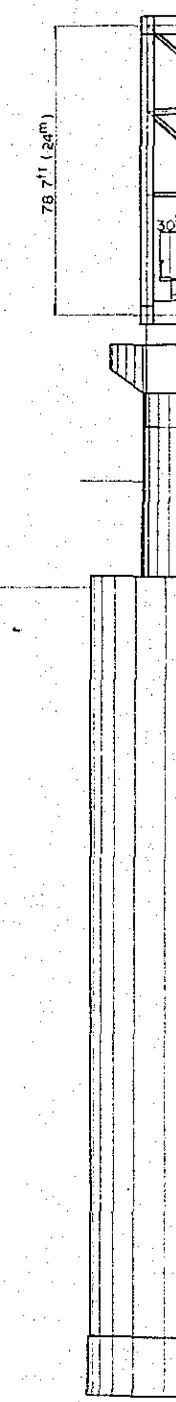
PLAN SCALE 1:4000

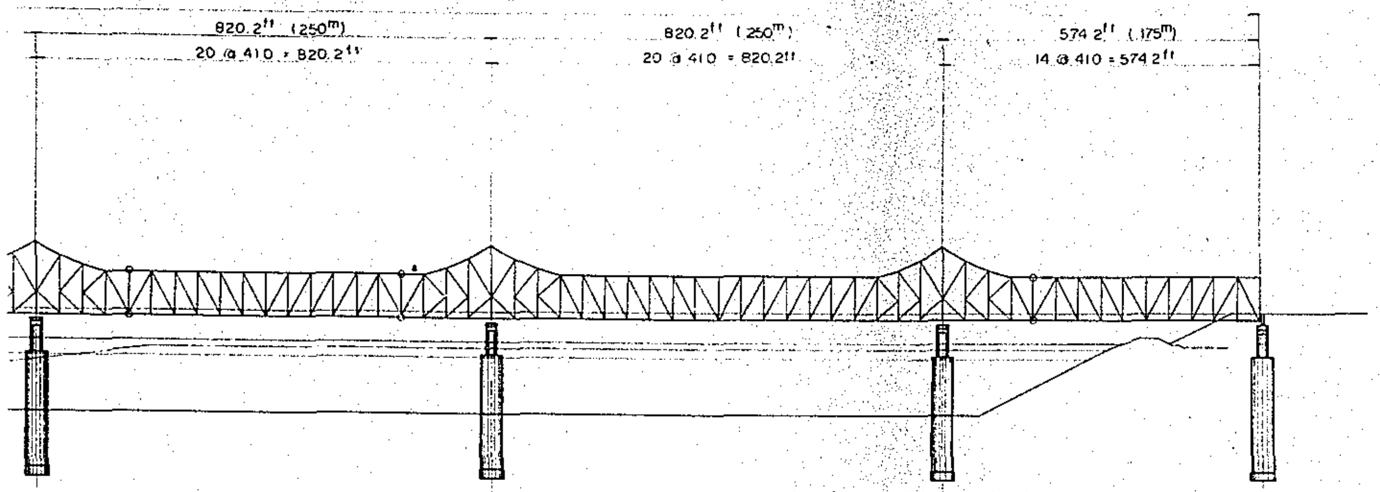
CASE - a



CASE - b







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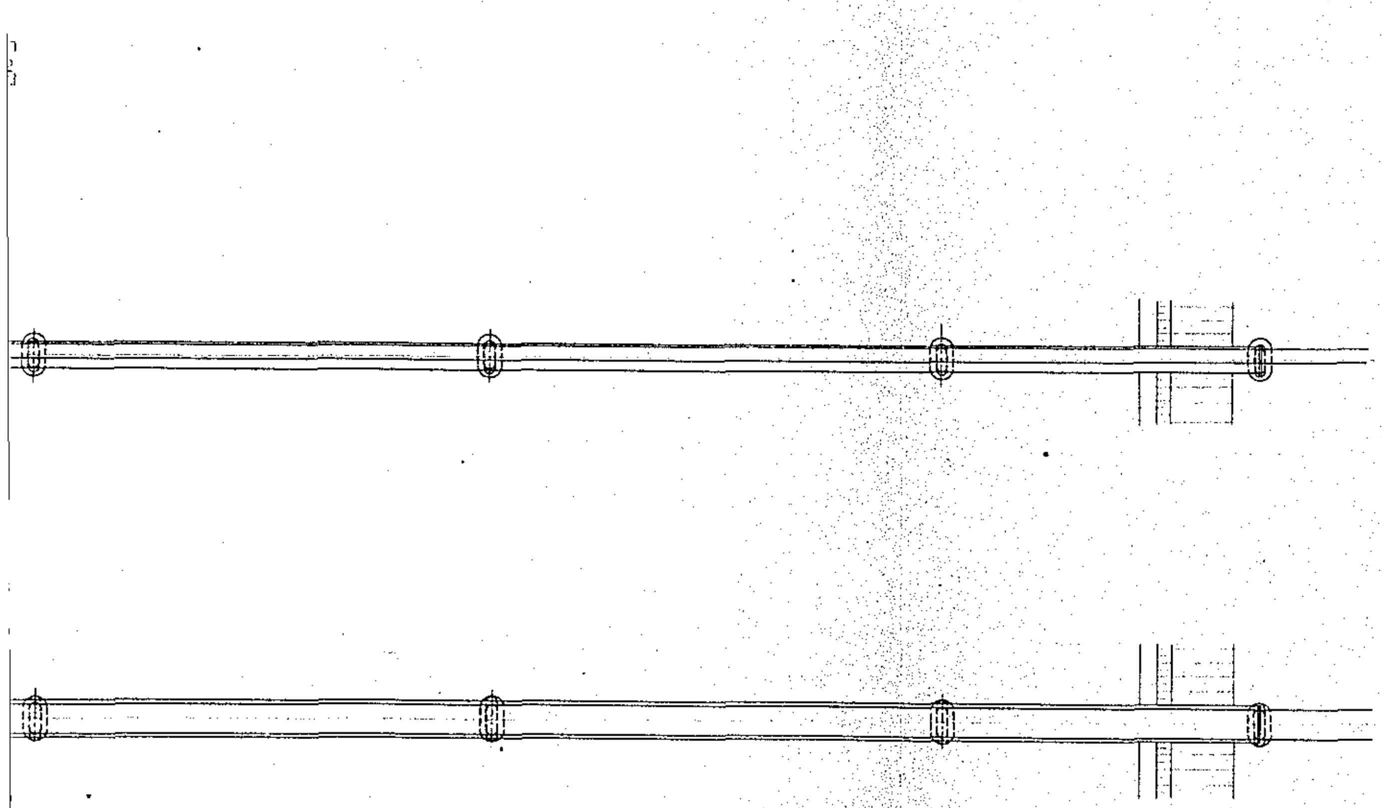


TYPICAL CROSS SECTION SCALE 1:600

CASE - a

CASE - b

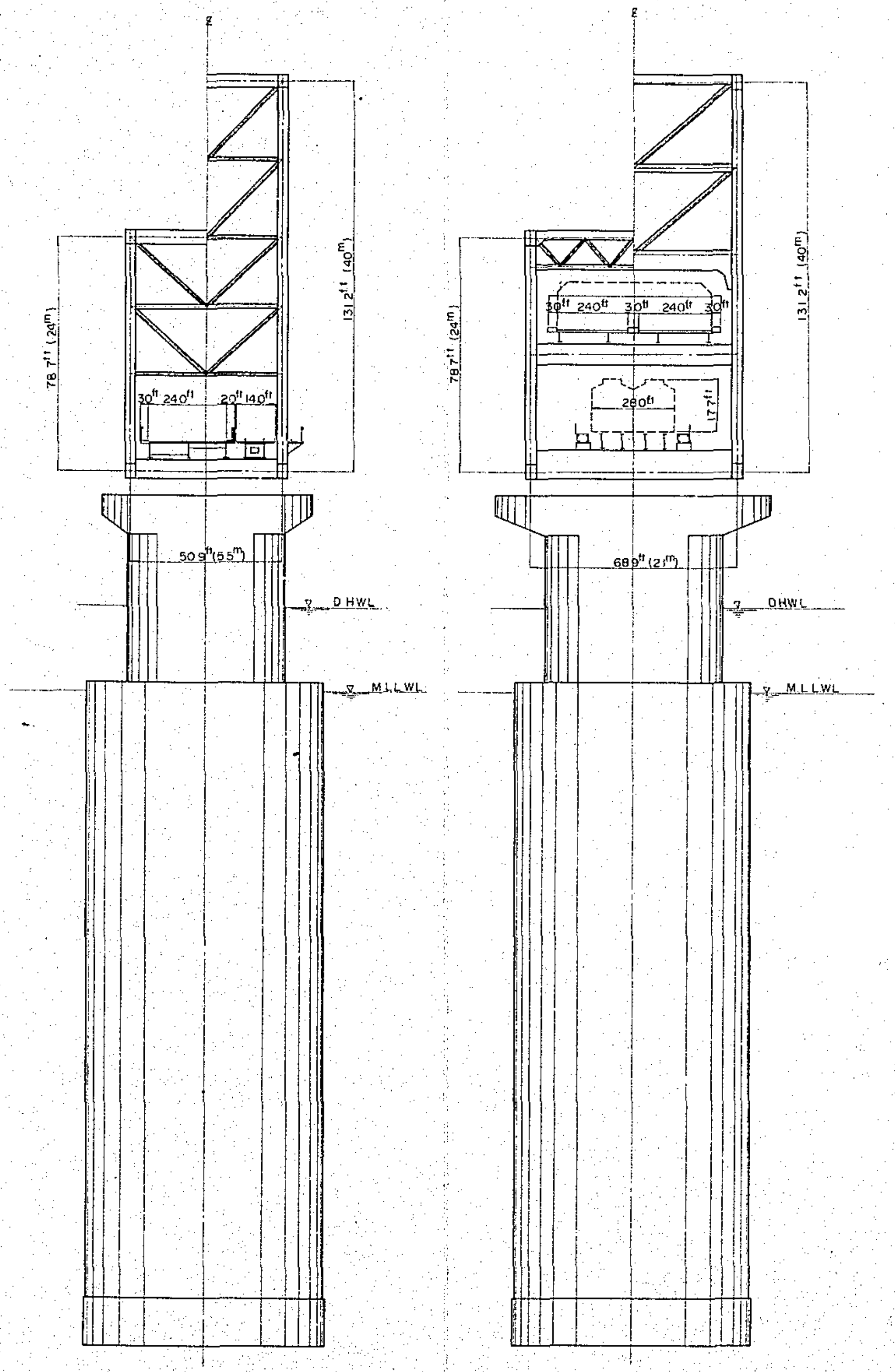


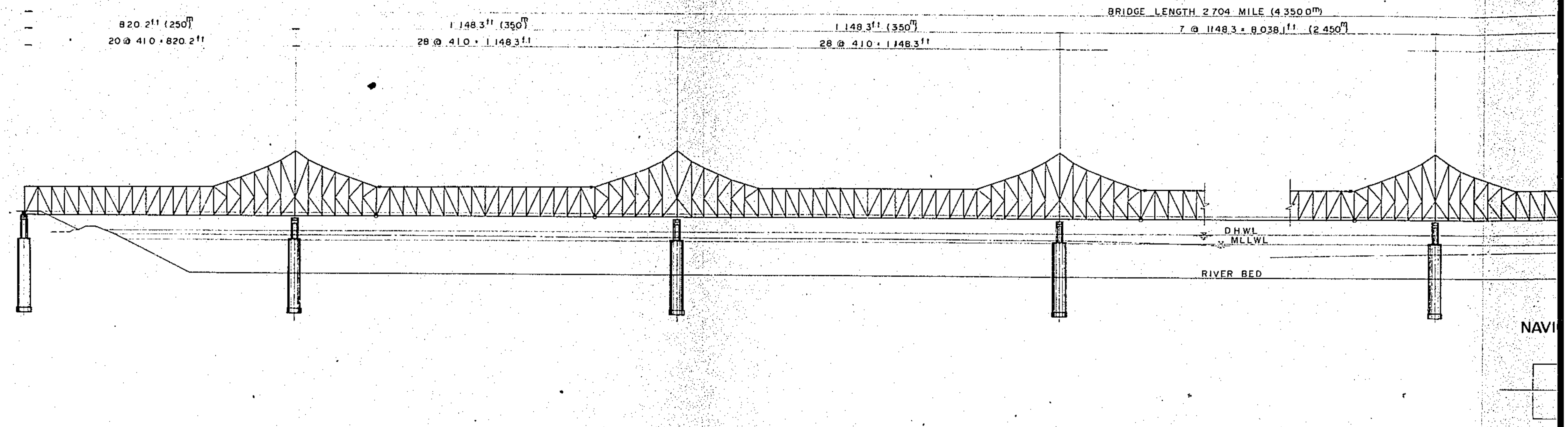
Fig. VIII-5-4 GENERAL VIEW OF JAMUNA RIVER

(RAIL-CUM-HIGHWAY)

CANTILEVER TRUSS

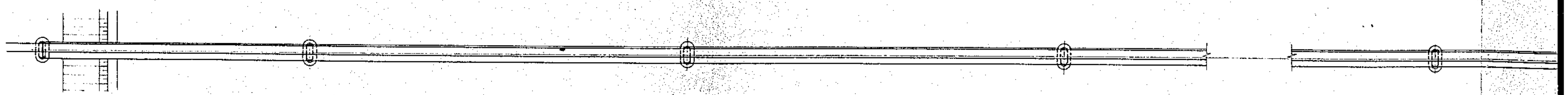
DISTANCE BETWEEN GUIDE BANKS 2610 M

PROFILE SCALE 1:4000



PLAN SCALE 1:4000

CASE - a



CASE - b

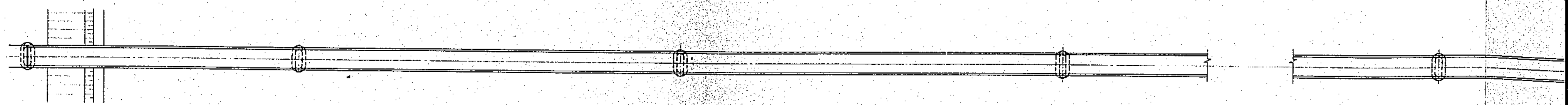


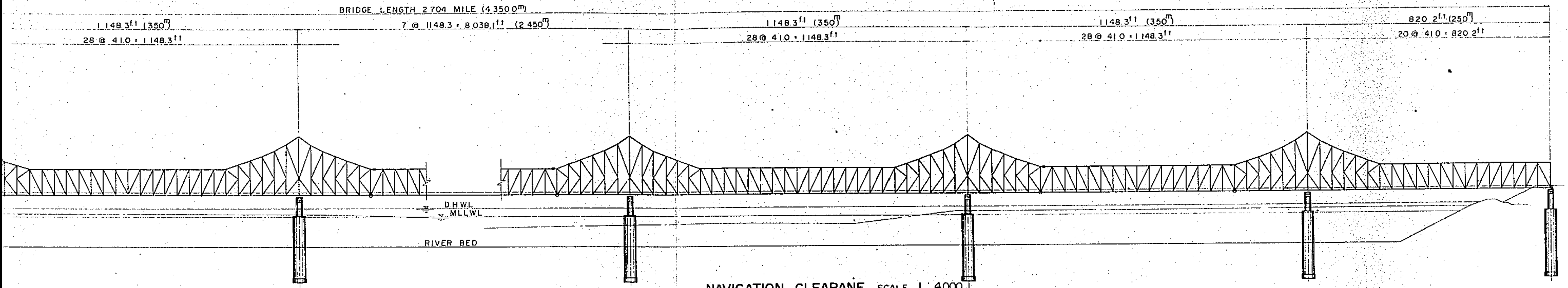
Fig. VIII -5-4 GENERAL VIEW OF JAMUNA RIVER BRIDGE

(RAIL- CUM- HIGHWAY)

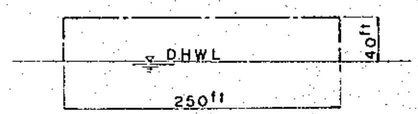
CANTILEVER TRUSS

DISTANCE BETWEEN GUIDE BANKS 2.610 MILE (4.2 KM)

PROFILE SCALE 1 : 4000

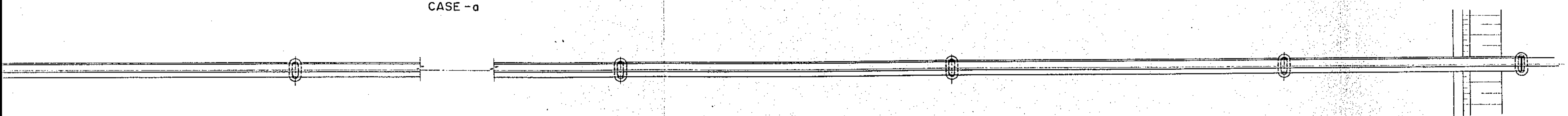


NAVIGATION CLEARANE SCALE 1 : 4000

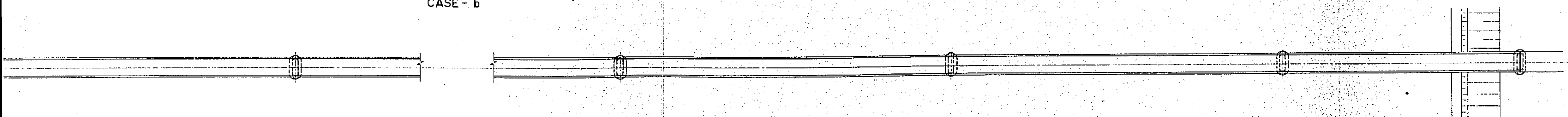


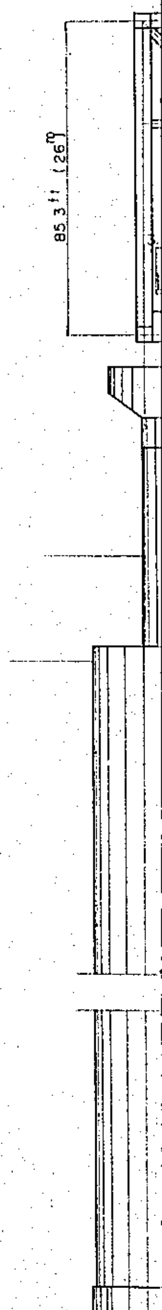
PLAN SCALE 1 : 4000

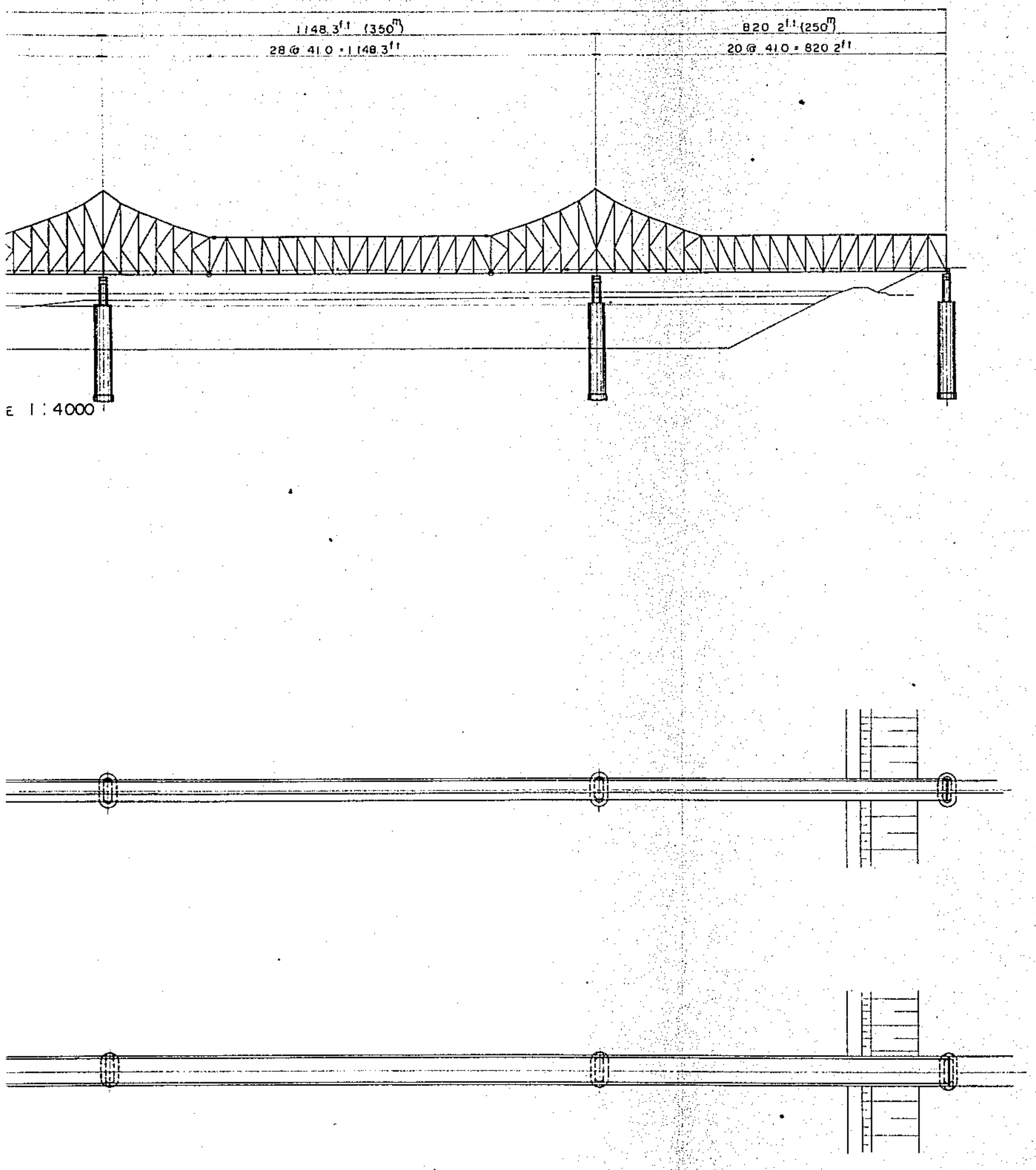
CASE - a



CASE - b

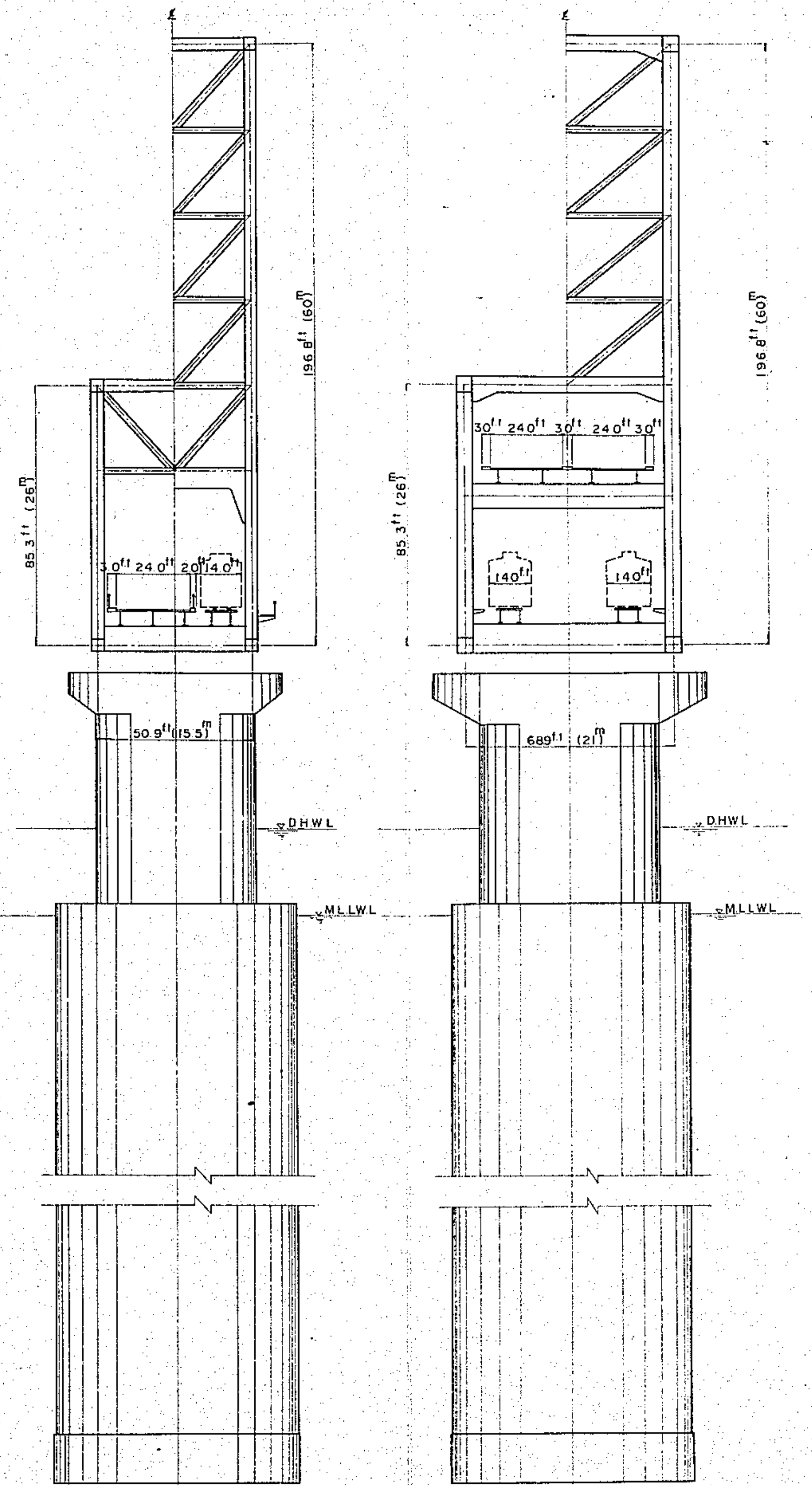






TYPICAL CROSS SETION SCALE 1:600

CASE - a CASE - b



CHAPTER IX

BRIDGES IN THE DOMAIN OF ACCESS PART

Bridges over 300 ft in span included in the domain of railway and highway access were shown in Table II-1, Table II-2 and as for the type of superstructure of these bridges, we adopted the prestressed concrete bridges. Composition of span was decided by the next two factors. These factors are navigation clearance of river to be crossed and minimization of total construction cost of bridge. In the latter factor, composition of span is affected by the well or pile foundation. As stated above, the well foundation was adopted for the place where local scour seems to be expected and the pile foundation was adopted for the other sites. In the access part, railway bridge and highway bridge were treated independently.

Types and composition of span of bridge included in railway access are shown in Table IX-1 and those in highway access are in Table IX-2.

The rough estimate of construction costs for these types and composition of span of bridges were shown in Table IX-3 for railway access and Table IX-4 for highway access respectively.

The left part of access part at Sirajganj site must cross one of offtakes of the Dhaleswari river. Therefore, this offtake should be closed and the other downward offtake should be dredged, and these necessary costs were estimated in the costs of highway access part. These costs are roughly 19 hundred million yen for closing works and 44 hundred million yen for dredging works and the total makes 63 hundred million yen.

Table. IX-1 Miscellaneous Data of Bridge (≧100m) in the Domain of Railway Access (in mater)

Name of Site	Name of Bridge	Side of River Bank	Total Bridge Length (m)	Span Length (m)	Type of Superstructure	Type of Sub-Structure
1 BAHADURABAD	1 - A	Right	300	9 @ 33	P.C. Simple - G	R.C. Pile
	1 - B		200	6 @ 33	"	"
	2 - A	Right	100	3 @ 33	"	"
	2 - B		100	3 @ 33	"	"
	2 - C		150	5 @ 30	"	"
2 GABARGAON	2 - D		100	3 @ 33	"	"
	2 - E	Left	400	7 @ 57	P.C. 3-Cont. Box-G	Open Caisson
	2 - F		150	7 @ 21	P.C. Simple - G	R.C. Pile
	2 - G		150	7 @ 21	"	"
	3 - A	Left	100	5 @ 20	"	"
	3 - B		200	10 @ 20	"	"
3 SIRAJGANJ	3 - C		100	5 @ 20	"	"
	3 - D		200	6 @ 33	"	"
	3 - E		300	9 @ 33	"	"
	3 - F		300	9 @ 33	"	"
	4 - A	Right	100	5 @ 20	"	"
	4 - B		200	10 @ 20	"	"
	4 - C		600	30 @ 20	"	"
	4 - D		300	5 @ 60	P.C. 3-Cont. Box-G	Open Caisson
4 NAGARBARI	4 - E	Left	200	10 @ 20	P.C. Simple - G	R.C. Pile
	4 - F		1 150	20 @ 57.5	P.C. 3-Cont. Box-G	Open Caisson
	4 - G		100	5 @ 20	P.C. Simple - G	R.C. Pile
	4 - H		250	5 @ 50	P.C. 3-Cont. Box-G	Open Caisson
	4 - I		150	3 @ 50	"	"

(note) P.C. : Prestressed Concrete   3-Cont. : 3-Span Continuous
R.C. : Reinforced Concrete   G : Girder

Table IX-2 Miscellaneous Data of Bridge (≧100m) in the Domain of Highway Access (in meter)

Name of Site	Name of Bridge	Side of River Bank	Total Bridge Length (m)	Span Length (m)	Type of Superstructure	Type of Sub-structure
1 BAHADURABAD	1 - 1	Right	300	9 @ 33	P.C. Simple - G	R.C. Pile
	1 - 2	"	200	6 @ 33	"	"
	1 - 3	Left	100	5 @ 20	R.C. Simple - G	"
2 GABARGAON	2 - 1	Right	100	3 @ 33	P.C. Simple - G	"
	2 - 2	"	300	9 @ 33	"	"
	2 - 3	Left	100	5 @ 20	R.C. Simple - G	"
	2 - 4	"	400	7 @ 57	P.C. 7-Cont. Box - G	Open Caisson
	2 - 5	"	100	5 @ 20	R.C. Simple - G	R.C. Pile
3 SIRAJGANJ	3 - 1	"	150	7 @ 21	R.C. Simple - G	R.C. Pile
4 NAGARBARI	4 - 1	Right	600	10 @ 60	P.C. 3-Cont. Box-G	Open Caisson
	4 - 2	"	300	15 @ 20	R.C. Simple - G	R.C. Pile
	4 - 3	Left	200	10 @ 20	"	"
	4 - 4	"	100	5 @ 20	"	"

(note)
P.C. : Prestressed Concrete
R.C. : Reinforced Concrete
3-Cont. : 3 Span Continuous
G. : Girder
* : Rail-cum - Highway Bridge

Table IX-3 Rough Estimated Cost of Bridge Constructions in the Domain of Railway Access

Site Proposed for Br. Const.	Name of Bridge	Name of the River	Total Bridge Length (m)	Cost (x 10^6 YEN)			Unit Price YEN/m
				Super Structure	Sub-Structure	Amount	
Bahadurabad	1-A	Bangali	300	240	150	390	1,320,000
	1-B	Bangali	200	160	110	270	
Gabargaon	2-A	Hurasagar	100	80	60	140	1,390,000
	2-B	Karatoya	100	80	60	140	
	2-C	Bangali	150	120	80	200	
	2-D	Bangali	100	80	60	140	
	2-E	Chatal	400	330	350	680	
	2-F		150	90	60	150	
	2-G		150	90	60	150	
Sirajganj	3-A	Lohatang	100	60	40	100	1,210,000
	3-B	Furjani	200	120	80	200	
	3-C	Bansi	100	60	40	100	
	3-D		200	160	110	270	
	3-E	Turag	300	240	150	390	
	3-F	Tungi	300	240	150	390	
Nagarbari	4-A	Chikunai	100	60	40	100	2,010,000
	4-B	Rukunai	200	120	80	200	
	4-C	Baral	600	350	230	580	
	4-D	Hurasagari	300	540	360	900	
	4-E	Old-Dhaleswari	200	120	80	200	
	4-F	Dhaleswari	1,150	2,100	1,400	3,500	
	4-G		100	60	40	100	
	4-H	Bansi	250	210	140	350	
	4-I	Turag	150	120	90	210	

Table IX-4 Rough Estimated Cost of Bridge Constructions in the Domain of Highway Access

Site proposed for Br. Const.	Name of Bridge	Name of the River	Total Bridge Length (m)	Cost ($x\ 10^6$ YEN)			UNIT PRICE YEN/m
				Super Structure	Sub-Structure	Amount	
Bahadurabad	1-1	Bangali	300	180	100	280	970,000
	1-2	Bangali	200	120	70	190	
	1-3		100	53	52	110	
Gabargaon	2-1	Karatoya	100	59	50	110	1,530,000
	2-2	Bangali	300	180	120	300	
	2-3		100	53	52	110	
	2-4	Chatal	400	450	450	900	
	2-5		100	53	52	110	
Sirajganj	3-1		150	89	56	150	1,000,000
Nagarbari	4-1	Hurasagar	600	680	650	1,330	1,620,000
	4-2		300	160	140	300	
	4-3	Old-Dhaleswari	200	110	90	200	
	4-4	Old-Dhaleswari	100	53	52	110	

ANNEX-1 Contents of Accumulated Data

NO	DATA	SOURCE	GIVEN LENT BUY	REMARKS
1	Roads and Highways Directnate Schedule of Rate for Construction of BRIDGE	Road & Highways M.O.C.	Given	
2	Roads and Highways Directnate Schedule of Rate for Road Works	"	"	
3	Monthly Rainfall Statement on Sirajganj at 1973.		"	
4	Daily Report Sheets MITSUI-OHBAYASHI J.V.	OHBAYASHI Office	"	
5	Report of the National Pay Commission		Buy	
6	Plan and Profile of Dacca-Aricha Highway Bridge. Mirpur Br. Bangshi Br. Kaliganga Br.	R.&H. M.O.C.	Given	
7	Sinking Record of Caisson of KALIGANGA Br.	"	"	
8	Sinking Report of No.4 Caisson of Sitarakya Br.	OHBAYASHI office	"	
9	Road Map of Bangladesh scale 1 inch=8 miles	R & H M.O.C.	"	
10	Bangladesh Land & People		Buy	
11	1st 5 years Plan		"	
12	General Rules and Schedules for Working of the Chittagong Port (Railway) from January 1959	Chittagong Port Trust	Buy	
13	Manual of Standard Bridge Design (East Pakistan)		"	
14	Power Development in Bangladesh		Given	
15	Law of Evidence & Limitation		Buy	
16	Constitutional Law in Bangladesh		"	
17	Law of Tort		"	
18	Interim Report on Remedial Works Required to Harding Bridge & King George V Br.	Jamuna Br, Survey Office	Given	

NO	DATA	SOURCE	GIVEN LENT BUY	REMARKS
19	Re-Openning of King George V Bridge over the Megnna	Jamuna Br. Survey Of.	Given	
20	The Harding Bridge over the Lower Ganges at Sara	Bangladesh Railway (Paksey)	"	—
21	Modorn Road Construction Procedures	R&H, M.O.C.	"	
22	Bangladesh Consultants Limited		"	Consultin Firm
23	Associated Consulting Engineers Ltd.		"	"
24	Prachi Prakaushali Sangstha Limited		"	"
25	Prakaushali Sangsad Limited		"	"
26	Messrs Rahman & Associated Ltd.		"	"
27	Engineering Consultants & Associated Ltd.		"	"
28	Brixton & Brixton Ltd. Consulting Engineers		"	"
29	Bureau of Consulting Engineers LTD.		"	"
30	Associated Architects and Engineers Ltd.		"	"
31	Bangladesh Survey Organization Ltd.		"	Land Survey
32	The Engineers Ltd.		"	Construction Firm
33	Bengal Development Corporation Ltd.		"	"
34	Stonevill Engineers Ltd.		"	"
35	National Builders & Engineers Ltd.		"	"
36	Delta Constructions Ltd.		"	"
37	Harding Bridge-Section of Scouring Taken at Centre Line from July to December 1973	Bridge Engineer, West Paksey	"	

ANNEX-2

BANGLADESH RAILWAY.

No.XEN/J/G/74. Dated:- 28 - 1 - 1974.

From:- XEN/J.B.S/Dacca. To:- The Director,
Jamuna Bridge Survey/DA.

Sub:- Confirmation of Datas.

Mr. Tezuka, Leader of Bridge Planning Team wanted confirmation of the following datas in connection with designing of Bridge Girders of proposed Jamuna Bridge.

1. Bridge Girders to be designed as per Main Line loading of Indian Railway Bridge Code.

2. All structures to be designed keeping the provision of Electrification in future.

The above Datas are hereby confirmed.

Executive Engineer,
Jamuna Bridge Survey,
Bangladesh Railway, Dacca.

Copy to ENC/CRB for information. Since the Team wanted the confirmation of the above Datas by 31.1.74, so the undersigned confirmed the above Datas on behalf of Bangladesh Railway.

Sd/-

Executive Engineer,
Jamuna Bridge Survey,
Bangladesh Railway, Dacca.

ANNEX - 3

MATTERS TO BE DETERMINED PRIOR TO
THE PLANNING OF THE JAMUNA RIVER BRIDGE

THE FEASIBILITY STUDY TEAM

The Feasibility Study Team for the Jamuna River Bridge Construction Project wishes to obtain a consent of the Government of Bangladesh on the following items.

I. Measuring Units

Metric System will be applied to all engineering quantities except some important quantities which will be converted in Foot-Pound System.

II. Bridge Specifications

The following specifications will be applied to the design of the Jamuna River Bridge.

1. Superstructure.

(a) Highway Bridge.

(1) Loads.

All loads to be used for design will be specified by the Standard Specifications for Highway Bridges adopted by AASHO.

(2) Construction gauge.

The construction gauge will be specified by the Standard Specifications for Highway Bridges adopted by AASHO.

(3) Structures.

All structures will be designed by the Standard Specifications for Highway Bridges adopted by the Japan Road Association.

(4) Materials.

All materials to be used for design will be specified by the Japanese Industrial Standard.

(b) Railway Bridge.

(1) Loads

All loads to be used for design will be specified by the Bridge Code for Indian Railways.

(2) Construction gauge.

The construction gauge will be specified by the Bridge Code for Indian Railways.

(3) Structures.

All structures will be designed by the Standard Specifications for Railway Bridges adopted by the Japan Society of Civil Engineers.

(4) Materials.

Same as above.

(c) Highway/Railway Bridge.

(1) Loads.

All loads to be used for the design of highway floor will be specified by the Standard Specifications for Highway Bridge adopted by AASHO.
All loads to be used for the design of railway floor will be specified by the Bridge Code for Indian Railways.

(2) Construction gauge.

The construction gauge for highway part will be specified by the Standard Specifications for Highway Bridges adopted by AASHO, and, for railway part, will be specified by the Bridge Code for Indian Railways.

(3) Structures.

All structures will be designed by the Standard Specifications for Highway Bridges adopted by the Japan Road Association except railway floor system.
The railway floor system will be designed by the Standard Specifications for Railway Bridges adopted by the Japan Society of Civil Engineers.

(4) Materials.

Same as above.

b. Substructure.

All substructures will be designed by the Standard Specifications for Reinforced Concrete adopted by the Japan Society of Civil Engineers.

MINUTES OF THE MEETING HELD BETWEEN THE JAPANESE FEASIBILITY STUDY TEAM FOR THE JAMUNA BRIDGE PROJECT AND THE RAILWAY DEPARTMENT, GOVERNMENT OF BANGLADESH.

****

The following members from the Japanese Feasibility Study Team and the Railway Department held the meeting on 8th August, 1973 in the chamber of Joint Secretary and discussed the matters to be determined prior to the planning of the Jamuna River Bridge according to the Agenda (ANNEX attached herewith) presented by the Study Team.

The matters mentioned in the Agenda were agreed between both the parties with the following addendum :

MEMBERS FROM FEASIBILITY STUDY TEAM:

1. Dr. S. Inose : Leader.
2. Mr. I. Kawasaki : Adviser to the team.
3. Mr. I. Iizuka : "
4. Dr. S. Sato : Member of the team.
5. Mr. J. Doihara : Director of the Jamuna Bridge Survey Office.

MEMBERS FROM RAILWAY DEPARTMENT:

1. Mr. Ahmed Ibrahim : Additional Secretary.
2. Mr. M.A.Ghafour : Member/Engineering, Railway Board.
3. Mr. M. Rahman : Engineer-in-chief, Railway.
4. Mr. Syed Hossain : Bridge Engineer.

1. The gauge length to be used for design shall be 5' 6".

2. The Japanese Study Team will present the following copies to the Railway Department for reference translating some important articles into English :

   a. The Standard Specifications for Railway Bridges adopted by the Japan Society of Civil Engineers.

   b. The Standard Specifications for Reinforced Concrete adopted by the Japan Society of Civil Engineers.

c. The Japanese Industrial Standard for structural steel.

The Japanese Feasibility Study Team for Jamuna River Bridge Construction.

Leader Shizuo Inose
Dr. S. INOSE.

The Railway Department, Government of Bangladesh.

Leader M. A. Ghafur
(Mr A. Ghafur.)
Member(Engineering),
Bangladesh Rly Board,
Rail Bhaban, Ramna,
Dacca.

MINUTES OF THE MEETING HELD BETWEEN THE JAPANESE FEASIBILITY STUDY TEAM FOR THE JAMUNA BRIDGE PROJECT AND THE ROADS AND HIGHWAYS DIRECTORATE, GOVERNMENT OF BANGLADESH.

****

The following members from the Japanese Feasibility Study Team and the Roads and Highways Directorate, Government of Bangladesh held a meeting on 9th August, 1973 in the chamber of Deputy Chief Engineer, Roads and Highways Directorate, Government of Bangladesh and discussed the matters to be determined prior to the planning of the Jamuna River Bridge according to the Agenda (ANNEX attached herewith) presented by the Study Team.

The matters mentioned in the Agenda were agreed between both the parties except the following :

MEMBERS FROM FEASIBILITY STUDY TEAM:

1. Dr. S. Inose : Leader.
2. Mr. I. Kawaraki : Adviser to the team.
3. Mr. I. Iizuka : "
4. Dr. S. Sato : Member of the team.
5. Mr. J. Ebihara : Director of the Jamuna Bridge Survey Office.

MEMBERS FROM ROADS & HIGHWAYS DIRECTORATE:

1. Mr. Md. Shafiullah : Deputy Chief Engineer.
2. Mr. Anwar Hossain : Executive Engineer.
3. Mr. A. Samad : Senior Structural Designer.

1. Article a. Superstructure in the Agenda

(a) Highway Bridge

(1) Loads

Live load to be used for design will be specified by the I.R.C. Standard Vehicle Class A.

(2) Construction gauge

The construction gauge will be specified by I.R.C.

(c) Highway/Railway Bridge

(1) Loads

Live load to be used for design of highway floor will be specified by I.R.C. Standard Vehicle Class A.

(2) Construction gauge

The construction gauge for highway part will be specified by I.R.C.

2. The Japanese Study Team will present the following copies to the Roads and Highways Directorate for reference translating some important articles into English.

a. The standard specifications for Highway Bridges adopted by the Japan Road Association.

b. The standard specifications for Reinforced Concrete adopted by the Japan Society of Civil Engineers.

c. The Japanese Industrial Standard for structural steel.

Dr. S. INOSE
Leader of the
Japanese Feasibility Study
Team for Jamuna River Bridge
Project.

MD. SHAMSUL[illegible]
Deputy Chief Engineer,
Roads & Highways Directorate
Government of Bangladesh.
Dacca.

ANNEX - 4

P. 226

Grams: AUTHORITY
Phones: 245251-55

বাংলাদেশ অভ্যন্তরীণ নৌ-পরিবহন কর্তৃপক্ষ

BANGLADESH INLAND WATER TRANSPORT AUTHORITY

ডি, আই, টি, ভবন (শাখা)
পোষ্ট বক্স ৭৬, ঢাকা-২
বাংলাদেশ

DIT BUILDING (ANNEXE)
POST BOX 76, DACCA-2
BANGLADESH

Memo.No.CE/JB/J-AID/ 3950 Dated: ~~January~~ Feb' 5, 1974.

Mr. Junji Ebihara,
Director, Jamuna Bridge Survey Office,
732, Dhanmondi R.A., Road No.19,
Dacca-5.

Sub : Jamuna Bridge - Minimum horizontal and vertical clearances to meet navigational requirements.

Ref : Your letter No.BIWTA-II/341/74 dated 20.1.74 addressed to Chairman, BIWTA.

Dear Sir,

The undersigned is directed to refer to your above mentioned letter addressed to Chairman, BIWTA and to inform that the following are the minimum navigational requirements in so far as the proposed rail-cum-road bridge across the Jamuna is concerned:

1. Minimum horizontal clearance between two piers ... 250(two hundred and fifty) feet.

2. Minimum vertical clearance under the soffit of the girders ... 40 (forty) feet.

(Anwar Hossain)
Secretary.

Memo.No.CE/JB/J-AID/ Dated: ~~January~~ Feb' 5, 1974.

Copy forwarded for information to :-

1. Secretary to the Govt. of the People's Republic of Bangladesh, Ministry of Shipping, IWT & Aviation, Bangladesh Secretariat, Dacca-2.
2. Secretary to the Govt. of the People's Republic of Bangla[desh] Ministry of Communications, Bangladesh Secretariat, Dacca