severe quality control be maintained. However, it is necessary to order sufficiently in advance and store required quantity beforehand, since aggregates in this country are said to be short because of current demands of construction.

b) Cement

Cement is manufactured in accordance with the British Standards. Though its quality seems fair through previous performance, the same disposition as stated above to secure smooth supply shall be made because of current cement shortage.

c) Reinforcing Bar, Steel, Frames and Plywood:

Steel sheet piling and H-form steel are assumed to be imported and entirely consumed during the construction.

(d) Construction Equipment;

Every equipment except trucks, dump trucks and smaller size construction equipment that are commonly used domestically shall be imported.

(e) Labor:

Skilled labor relating to bridge construction is not available.

316 All prices are based on January, 1990 standard. Costs for real construction and economic analysis shall be reevaluated after selecting the Alternative.

8-B. TECHNICAL OPTIMIZATION

317 All concrete alternative schemes and four (4) out of nine (9) steel alternative schemes have been eliminated in the discussion of Section 7-E. And the remaining five (5) schemes were named alternatives A through E and compared on all such aspects as construction costs, and duration, workability, future maintenance and so on.

318 Features of respective alternatives are simply shown in Table 8-1. The information outlined in this table implies that altenative A shall be selected as the new Kafue Road Bridge.

319 Alternatives A and B consider a new bridge to construction on the existing alignment, and featured to take advantage of existing approach embankment that has been stable in service to traffic for a long period.
Since the old bridge as a matter of course will be dismantled, these alternatives will produce another economically advantageous facet if the old bridge is revived at another site.

320 Reconstruction spans for the alternatives A and B, and the alternatives C, D and E which are applicable to the new alignment are 950 m and 1900 m respectively. In case of the new alignment, the reconstruction span extends to the weigh bridge, requires re-routing of the telephone line alongside the road and necessitates land acquisition of a part of existing private property.

321 Construction costs for each alternative have been indicated by percentage based on preliminary estimated net construction costs that include required approach spans of respective alignment in addition to main bridge construction costs.

322 Alternatives A and B were found to be least expensive, while C and D are approximately 10 % higher notwithstanding they are of equivalent size to A. Alternative E is most expensive. In Alternatives, C, D and E, future settlement of the embankment was considered. Provision of approach spans for all the Alternatives A through D has no significant difference.

323 When the old bridge is required to be demolished in order not to adversely affect the new bridge, an supplementary cost for removal of the old bridge shall take place on Alternatives C through E.

324 There is no wide difference in construction time of the required alternatives. In fact, every alternative would require nearly 2-years. However, Alternatives A and B include demolition time of the existing bridge. If Alternatives C, D and E have to include removal of the

existing bridge, almost 4-months extension of construction time is anticipated.

325 The bridge length of Alternatives B and C is same as that of the existing bridge and construction cost of superstructure is relatively low. But, as water depth around abutments is great, work shall be carried out inside steel sheet pile cofferdams. The cofferdam construction would push up entire construction cost. Besides, this would require high technique for dewatering, since penetration of sheet piles is not too deep. As the filtration plant exists at 3.3 km off downstream of the bridge site, water pollution due to the interruption should be avoided.

326 Alternatives C, D and E (planned on the new alignment) have 8 m in average embankment depth. Therefore, particular care shall be taken to the settlement of embankment, if construction is completed within a short period.

327 Alternatives A, D and E are planned to set a longer bridge length because of economic aspect. This has resulted in an expansion of the river width. The river bed of water channel near the Bridge is deeply scoured in the past. It is manifest that scouring was brought by construction of the Kafue Road Bridge, judging from facts that other places including the Kafue Rail Bridge are not affected by scouring. It is expected, consequently, that an expansion of the river width will contribute to prevent the scouring of river bed.

328 In conclusion, Alternative A is technically the most feasible and recommendable bridge type to be considered. Sizes of side spans and individual structural elements and diameter of steel piles will be thoroughly reviewed in the course of the preliminary design.

8-C. DEMOLISHED OF EXISTING BRIDGE

329 The superstructure has been constructed for some forty (40) years since its original relocation from the Thames River. For the time being, any members except those damaged by vehicles collision seem to be well maintained. At least the main structural elements appear to be sound. Accordingly, revising of these elements after being

dismantled and relocating as necessary seem to be practical.

330 The superstructure has to be dismantled with due consideration to pier stability. Piers may be unstable since their foundation has poor setting on the bearing stratum.

331 As each structural element of superstructure is riveted, while field connections are bolted, dismantling is relatively easy. Elements shall be piece-marked and stored in the yard to be prepared for removal.

332 Subsequent to removal of the superstructure, demolition of piers and abutments will follow. Pier foundation will normally be removed up to the river bed.

Table 8-1 COMPARISON OF ALTERNATIVES

Alter-native	Alignment Corresponded	Spans and Structural Type	Length of Project Road	Construc-tion Cost	Construc-tion Period (Months)	Restriction of Pier Location	River Width	Workability	Others	Evalua-tion
A	Existing	40+43+43+40=166m 4-Spans Continuous Steel Plate Girder	0.95Km	○	23	Nil	165m	good	Entail dismantling of existing superstructure	◎
B	Existing	3×43=129m 3-Spans Continuous Steel Plate Girder	0.95Km	○	22	Nil	128m	Cofferdam and Sealing to leak water	do	○
C	New	3×43=129m 3-Spans Continuous Steel Plate Girder	1.90Km	△	23	To keep Stream Line	128m	do	Re-routing of Tel. Line. Req. care for settle-of embankment	○
D	New	25+3×43+25=179m 5-Spans Continuous Steel Plate Girder	1.90Km	△	24	do	168m	good	do	△
E	New	50+60+50=160m 3-Spans Continuous Steel Plate Girder	1.90Km	×	24	do	159m	good	do	△

Note; ◎ Excellent
○ Good
△ Fair
× Poor

CHAPTER 9

PRELIMINARY ENGINEERING DESIGN

CHAPTER 9 PRELIMINARY ENGINEERING DESIGN

9-A. SUMMARY OF STRUCTURAL DESIGN CONDITIONS

333 Structural design conditions shall be as summarized below.

Item	Unit	Design Standard
Design Speed	km/hr	100
Widths of Traffic Lane	m	3.35×2=6.7 m
Widths of Marginal Strip	m	0.3×2=0.6 m
Widths of Footpath	m	1.2×2=2.4 m
Crossfall of Carriageway	%	2.5
Crossfall of Footpath	%	2.0
Span Length	m	37.6m+43m+37.6m
Sofit Elevation	m	980.045
Live load		
T-Loading	Ton	8.2
L-Loading	-	L-20 or TT-43
Temperature Change	°C	0°C~45°C
Wind Velocity	m/sec	20 m/sec
Horizontal Seismic Coefficient	-	0.1
Utilities		
Water Main	kg/m	300
Power Line	kg/m	50
Telephone Line	kg/m	30
Thickness of Slab	cm	23.0
Thickness of Pavement	cm	7.0
Design Specifications	-	Specifications for Highway Bridge, 1990 Japan Road Association

9-B. PRELIMINARY ENGINEERING DESIGN

334 The preliminary engineering design was carried out for the bridge type selected during Phase I Study. The design also includes the approach roads.

Principal drawings and summary of quantities are as listed below:

(1) Site and Layout Plan : See Fig. 9-1.

(2) Framing Plan of Superstructure
: See Fig. 9-2.

(3) Primary Dimension of Substructure and Foundation
a. A1 : See Fig. 9-3
b. P1 : See Fig. 9-4.
c. P2 : See Fig. 9-5.
d. P3 : See Fig. 9-6.
e. A2 : See Fig. 9-7 and 9-8.

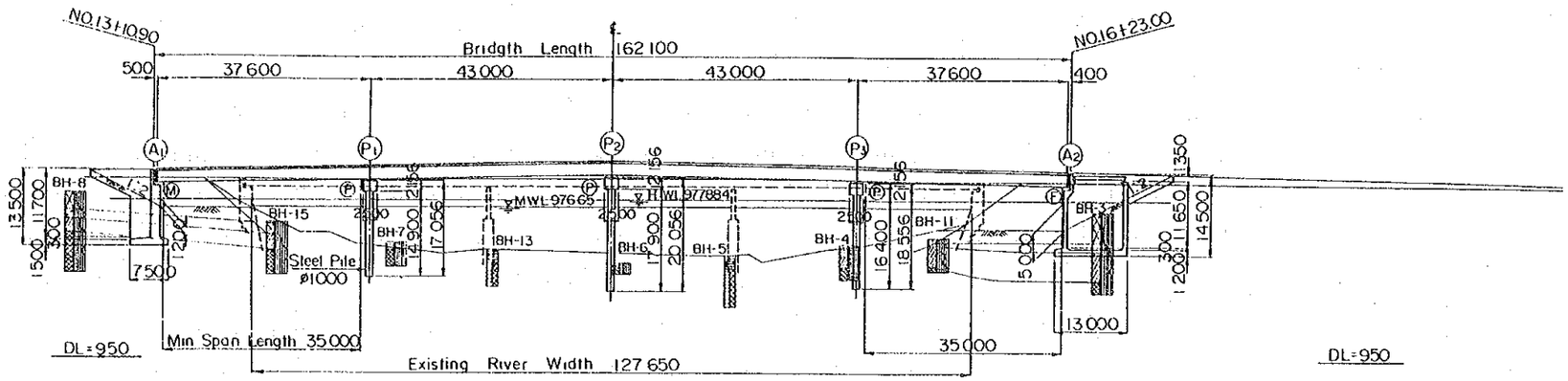
(4) Approach Roads : See Fig. 9-9 thru 9-11.

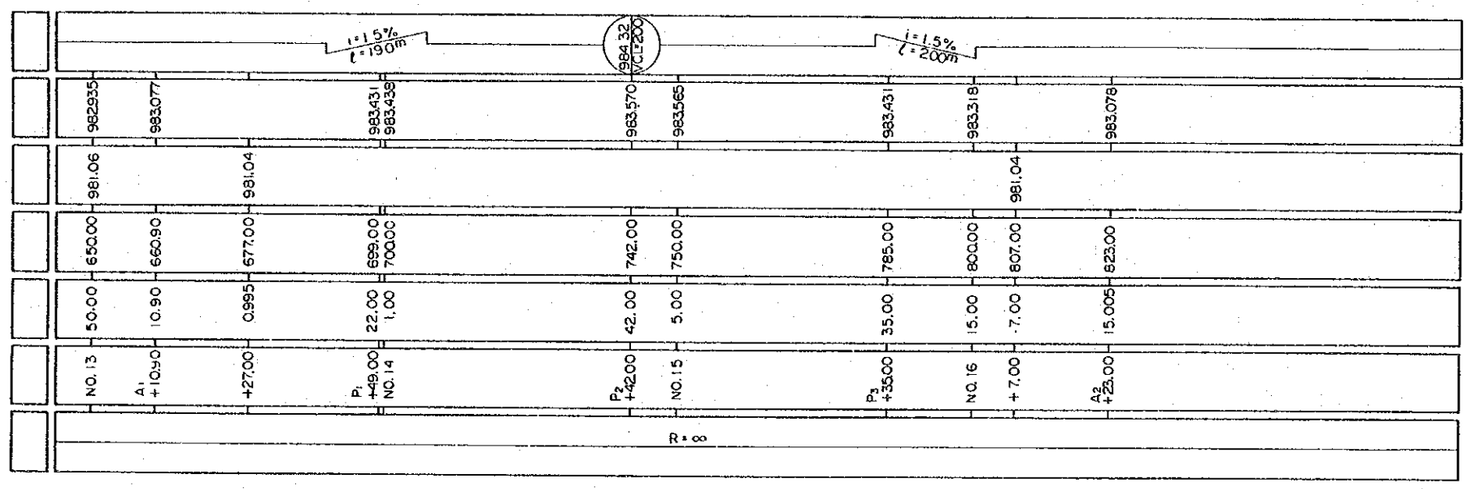
(5) Quantity of Superstructure
: See Table 9-1.

(6) Quantity of Substructure and Foundation
: See Table 9-2.

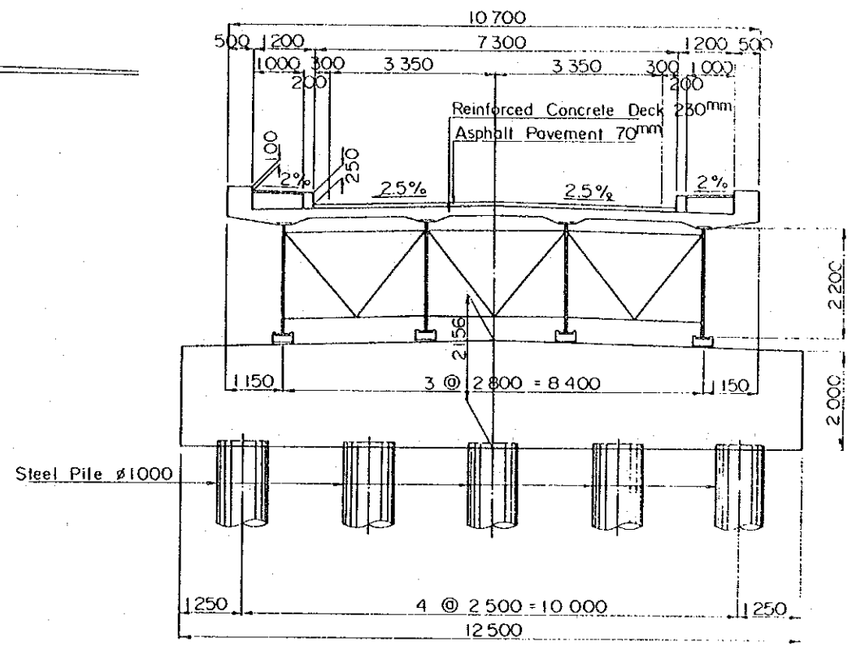
(7) Quantity of Approach Roads
: See Table 9-3.

ELEVATION





CROSS SECTION



PLAN

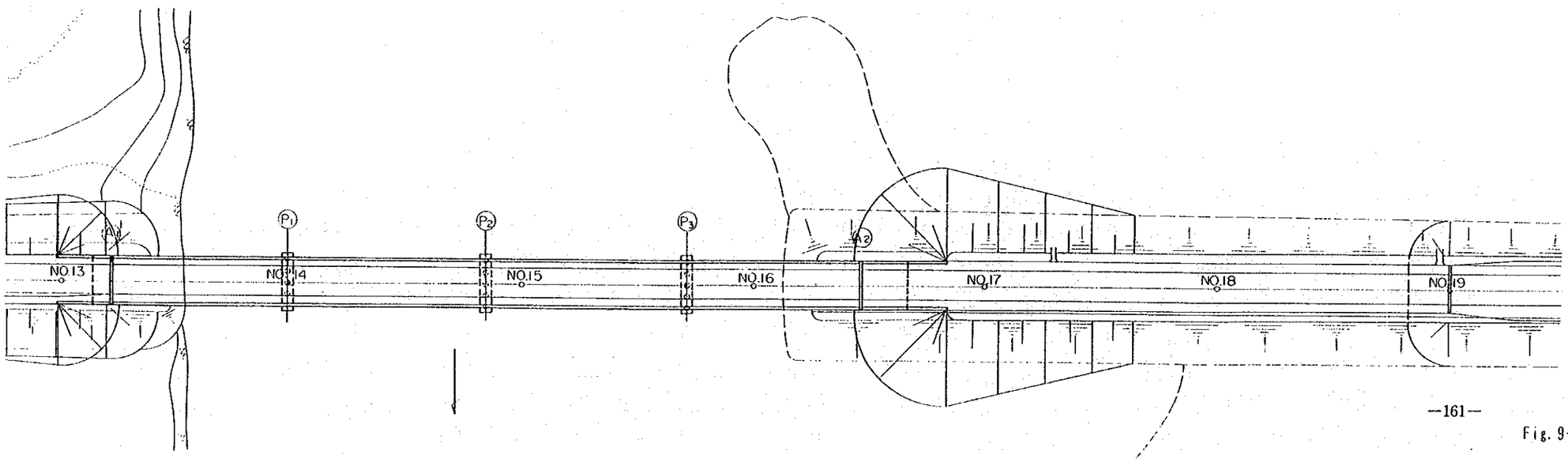
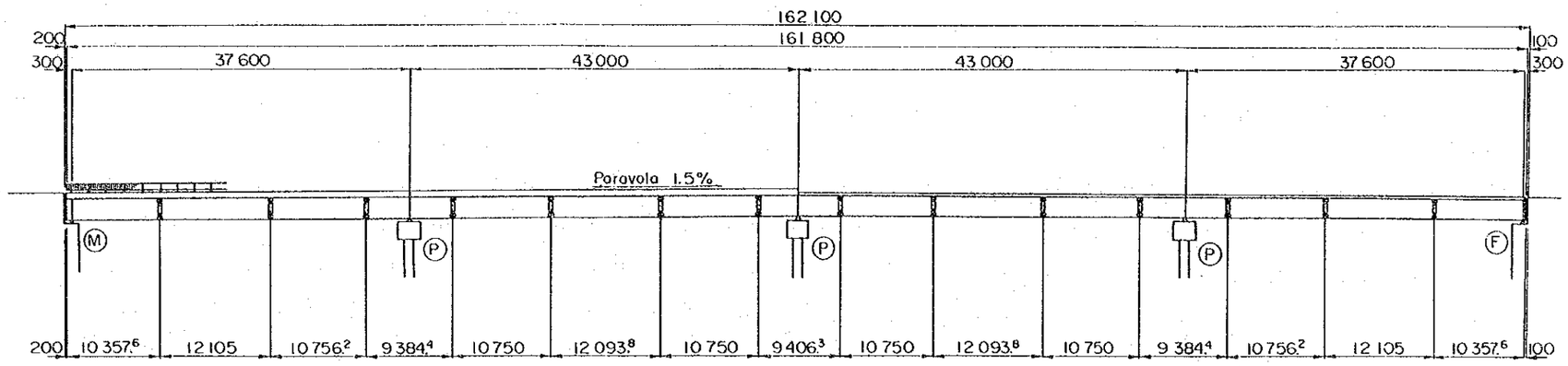
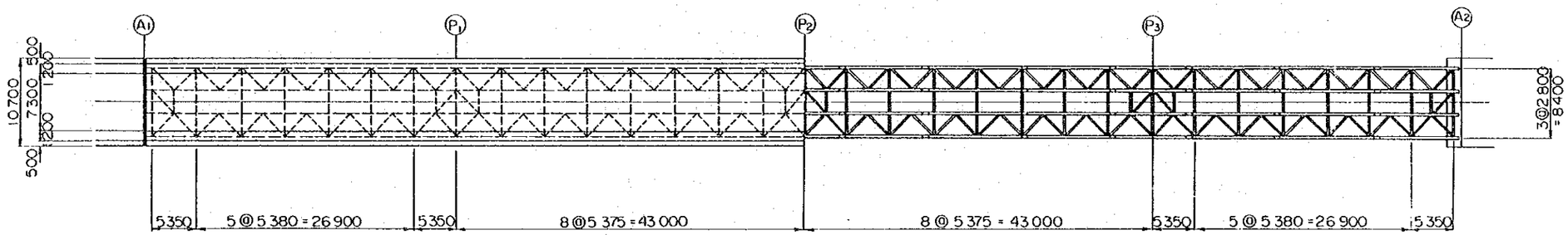


Fig. 9-1 Site and Layout Plan

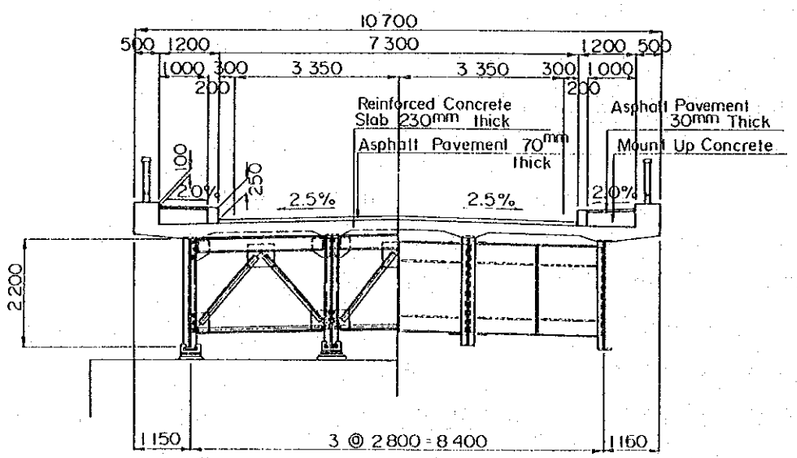
GENERAL ARRANGEMENT



PLAN



CROSS SECTION



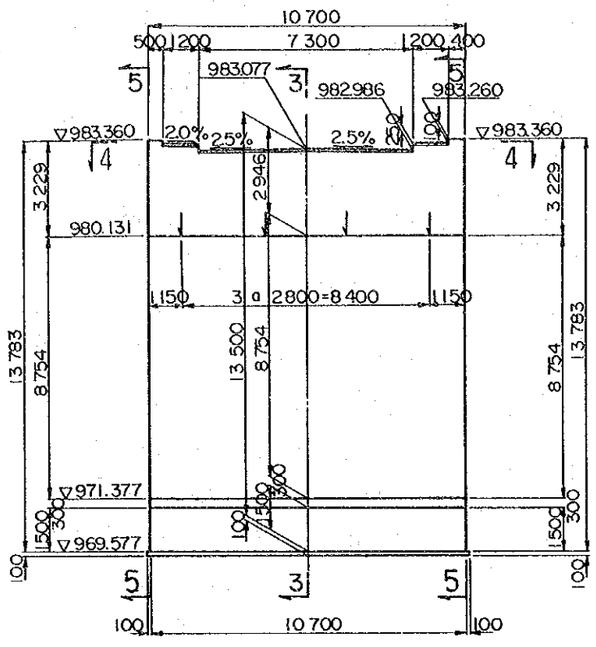
Design Condition

Class of Bridge	1st class
Type	4-span continuous non-composite girder
Length	162.100m
Span	37.600m+43.000m+43.000m+37.600m
Breadth	7.300m for carriageway 1.200m footpath
Live Load	T-20, L-20
Slab	reinforced concrete slab 230m thick
Pavement	asphalt pavement 70mm thick for carriageway 30mm thick for footpath

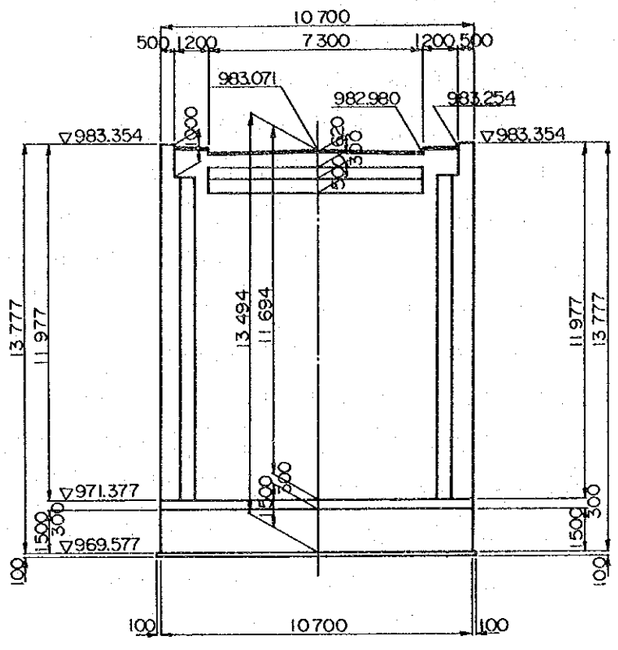
Fig. 9-2 Framing Plan of Superstructure

ABUTMENT (A1)

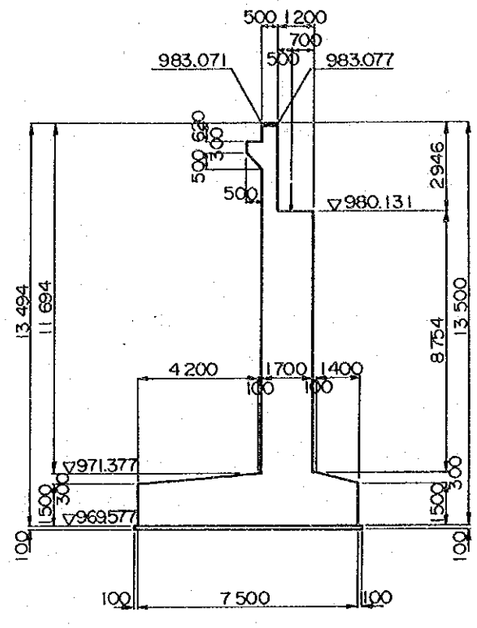
1 — 1



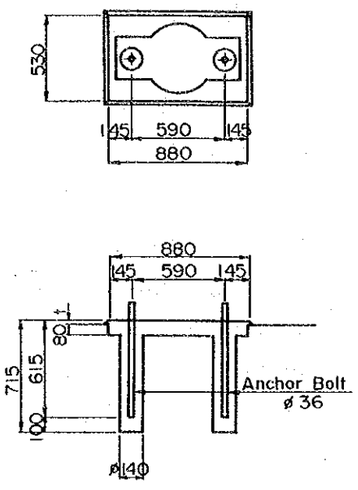
2 — 2



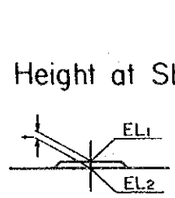
3 — 3



Box-Out Detail at Shoe Base

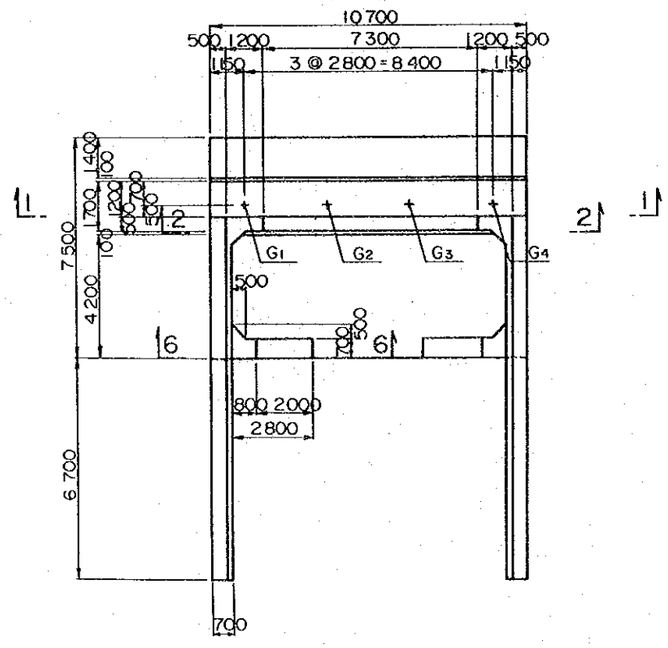


Mortar Height at Shoe Base

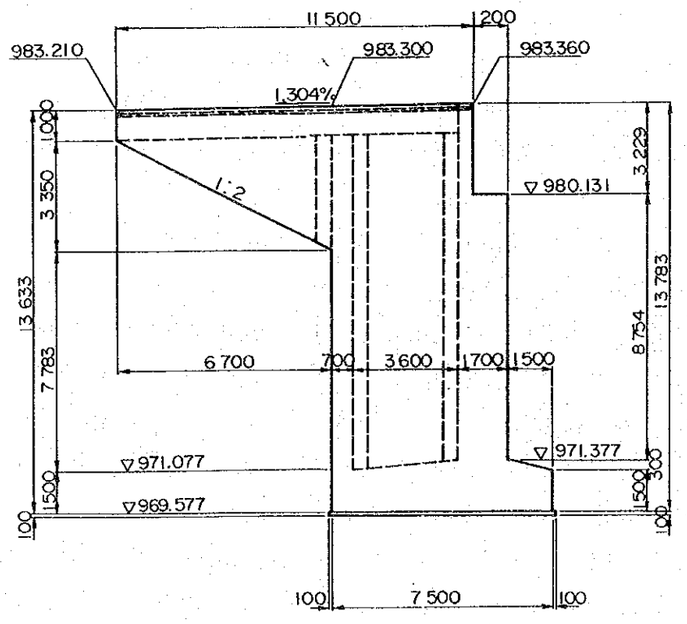


	G1	G2	G3	G4
EL1	980.155	980.225	980.225	980.155
t	24	94	94	24
EL	980.131	980.131	980.131	980.131

4 — 4



5 — 5



6 — 6

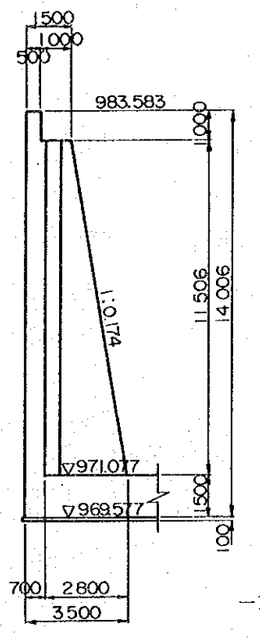
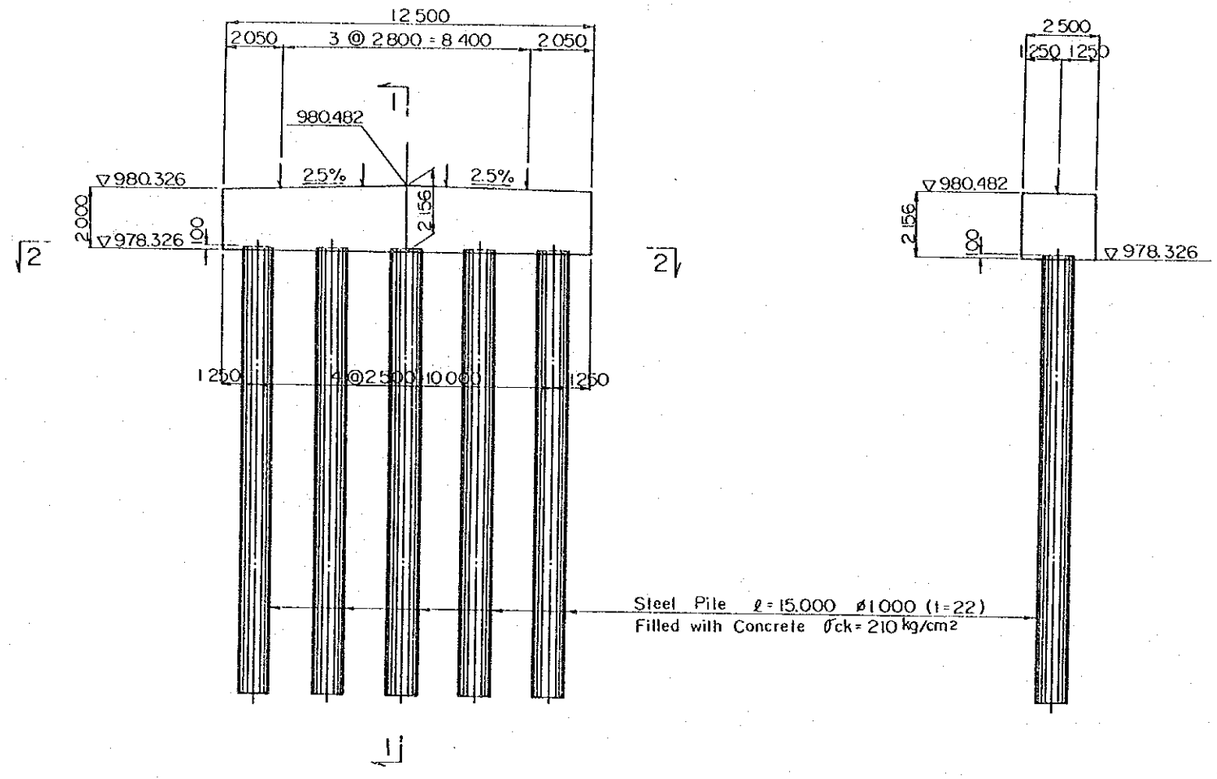
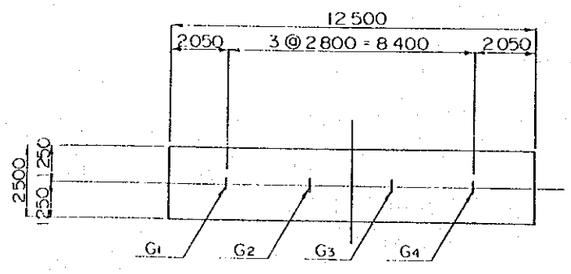


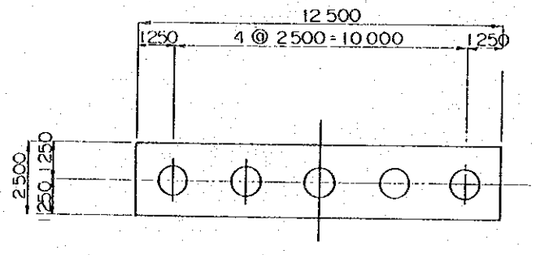
Fig. 9-3 Primary Dimension of Substructure and Foundation (A1)

PIER 1 (P1)

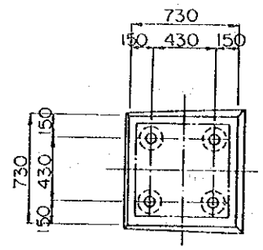


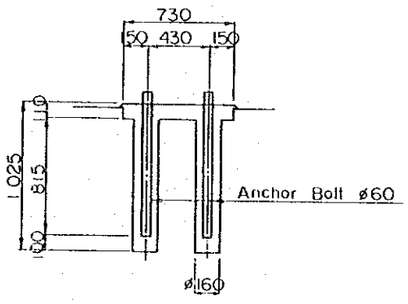


2 — 2

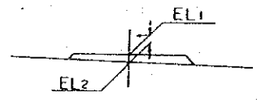


Box-Out Detail at Shoe Base





Mortar Height at Shoe Base

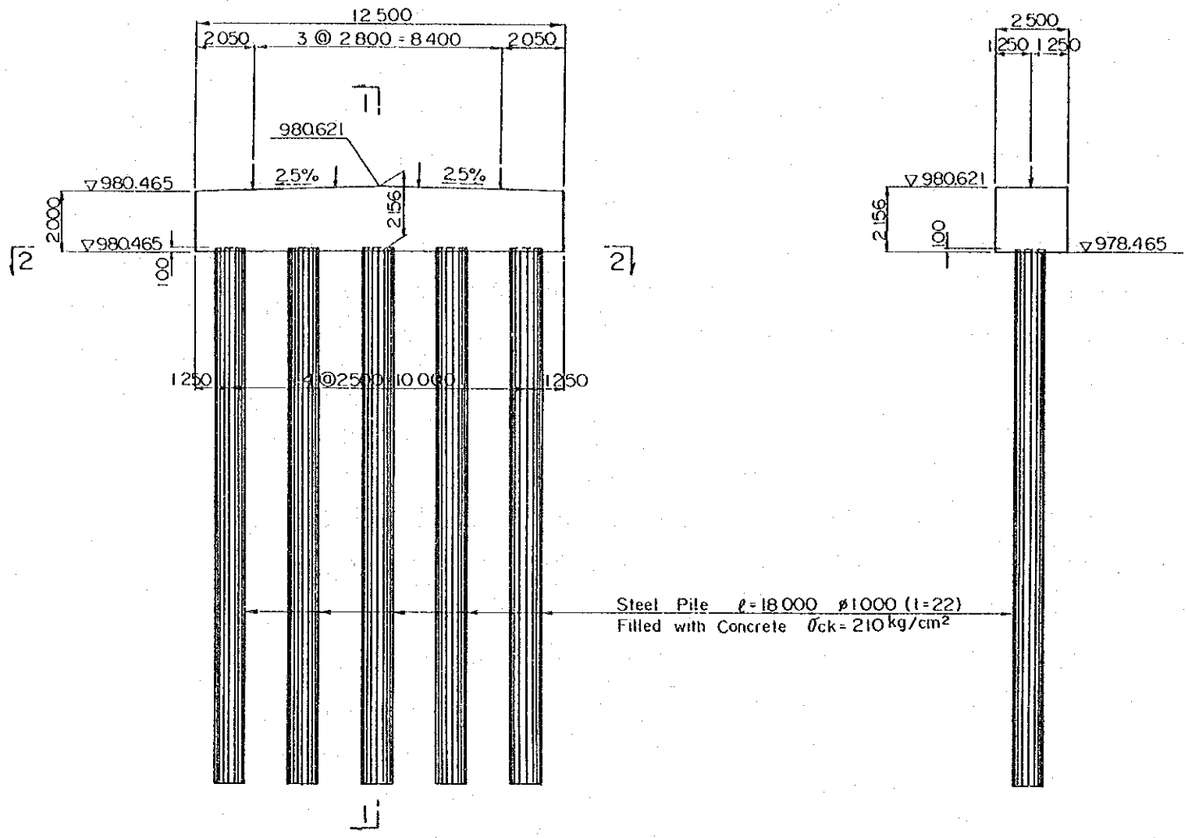


	G1	G2	G3	G4
EL1	980.407	980.477	980.477	980.407
I	30	30	30	30
EL2	980.377	980.447	980.447	980.377

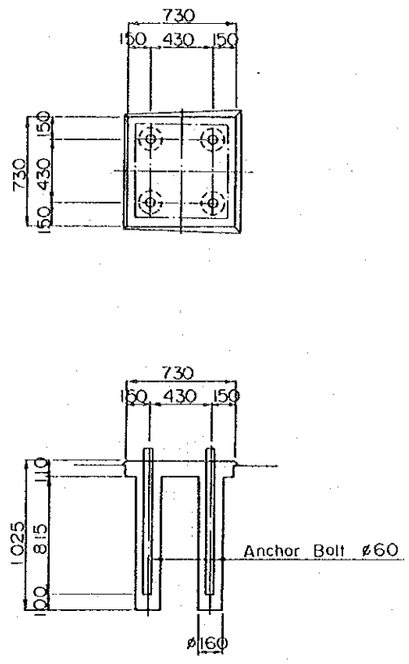
Fig. 9-4 Primary Dimension of Substructure and Foundation (P1)

PIER 2 (P2)

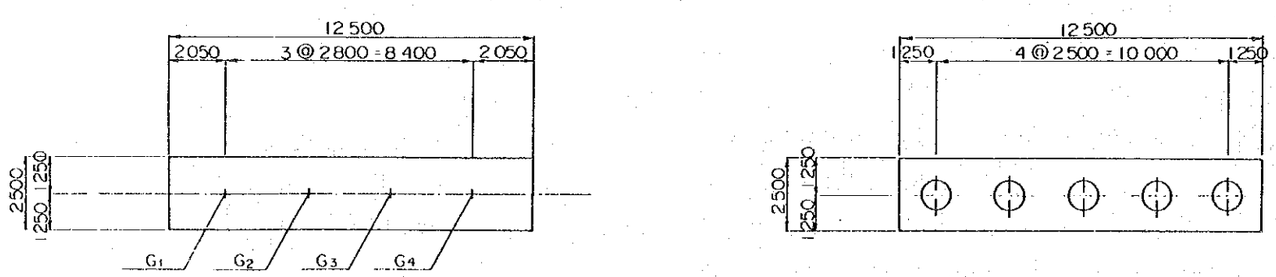
1 — 1



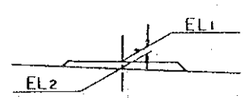
Box-Out Detail at Shoe Base



2 — 2



Mortar Hight at Shoe Base

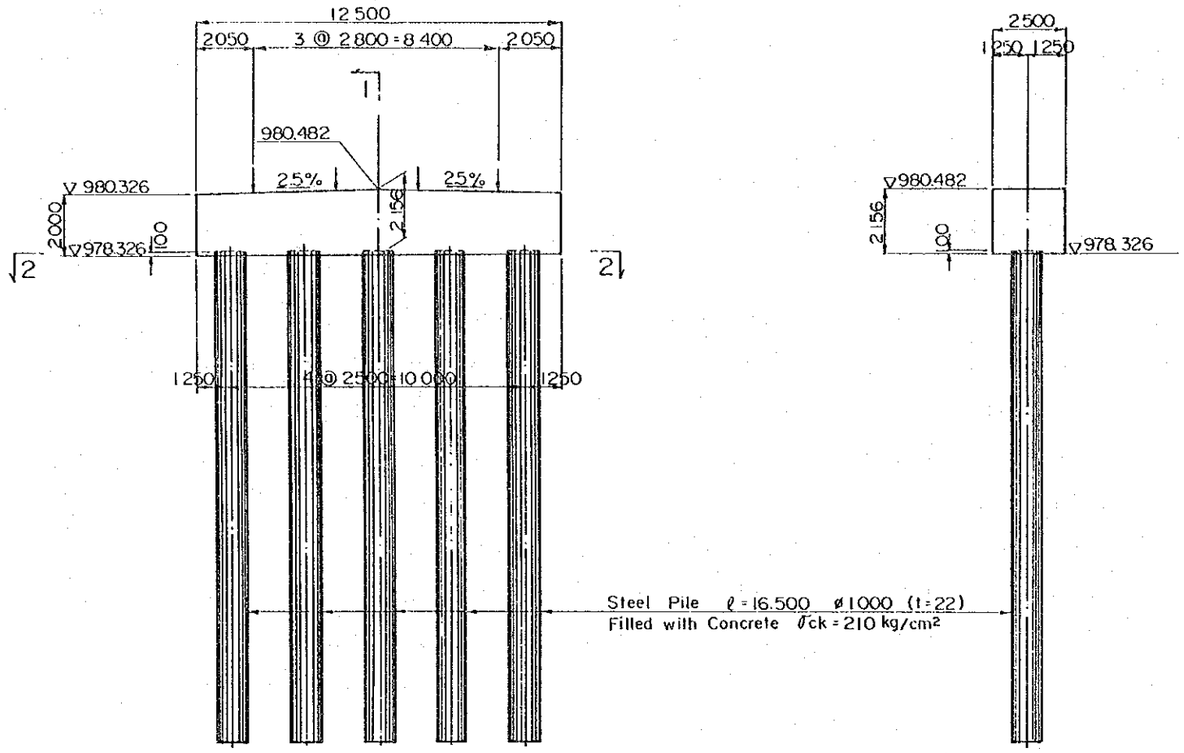


	G1	G2	G3	G4
EL1	980.546	980.616	980.616	980.546
1	30	30	30	30
EL2	980.516	980.586	980.586	980.516

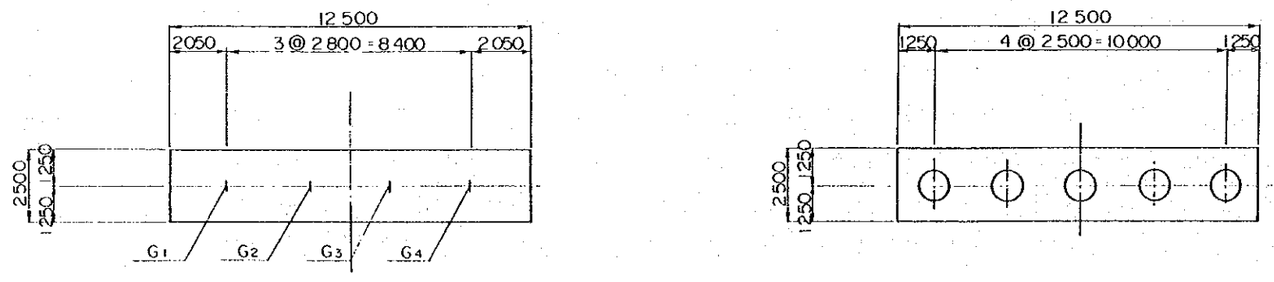
Fig. 9-5 Primary Dimension of Substructure and Foundation (P2)

PIER 3 (P3)

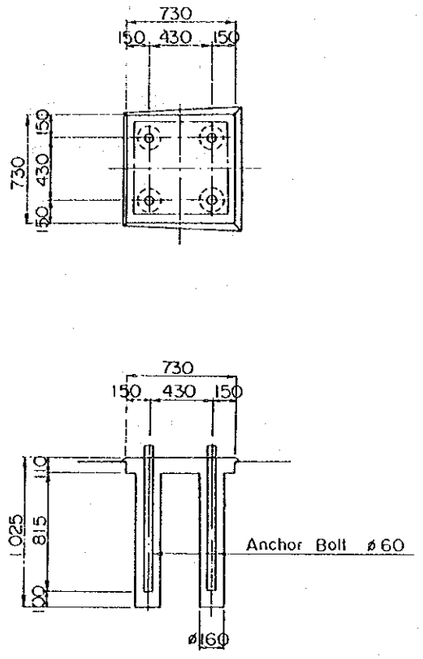
1 — 1



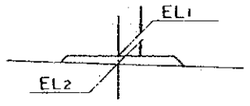
2 — 2



Box-Out Detail at Shoe Base



Mortar Height at Shoe Base

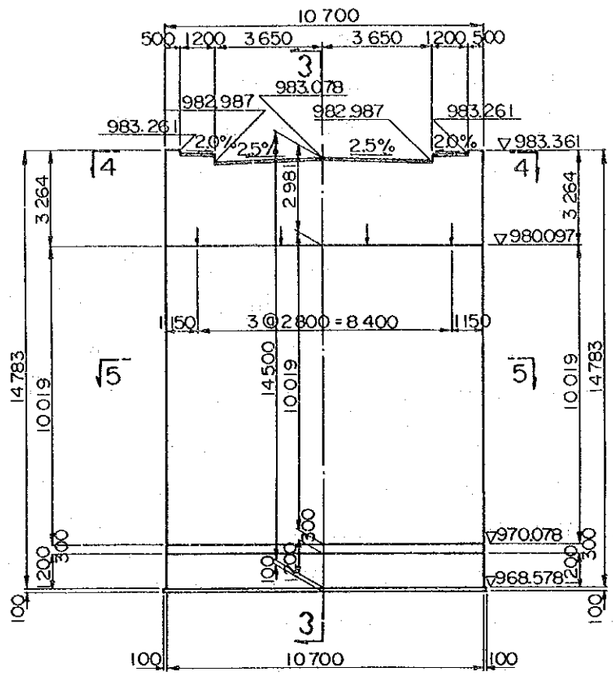


	G1	G2	G3	G4
EL1	980.407	980.477	980.477	980.407
t	30	30	30	30
EL2	980.377	980.447	980.447	980.377

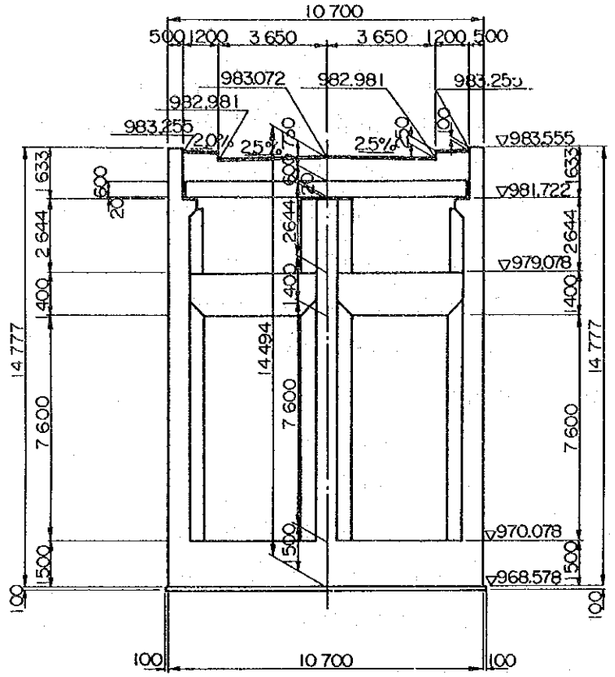
Fig. 9-6 Primary Dimension of Substructure and Foundation (P3)

ABUTMENT 2 (A2) 1 of 2

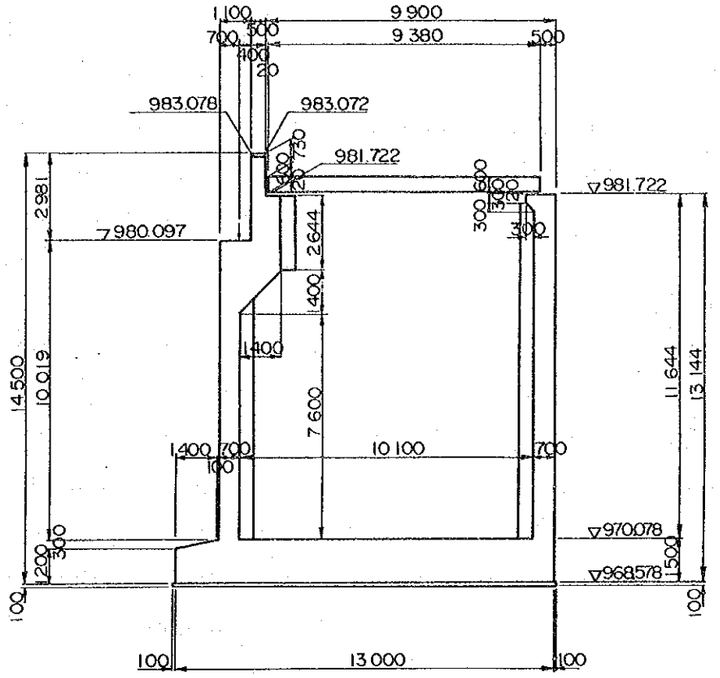
1 — 1



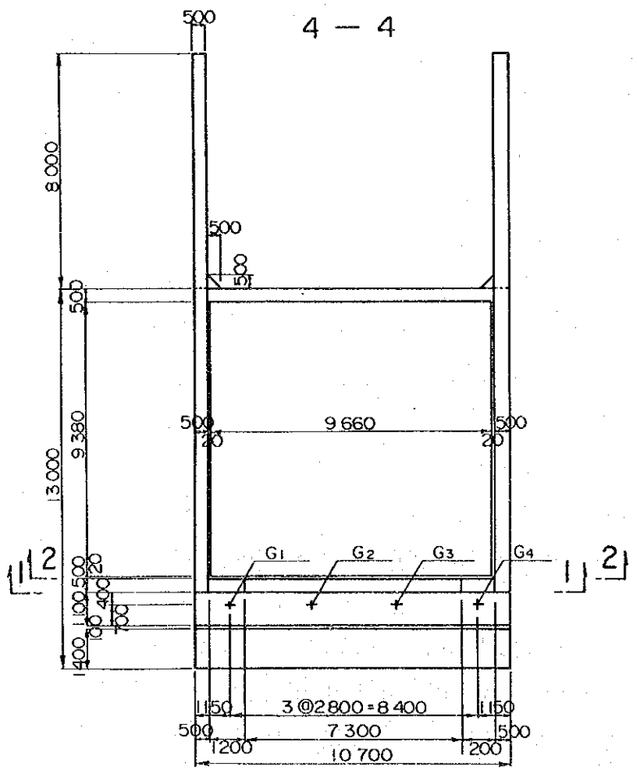
2 — 2



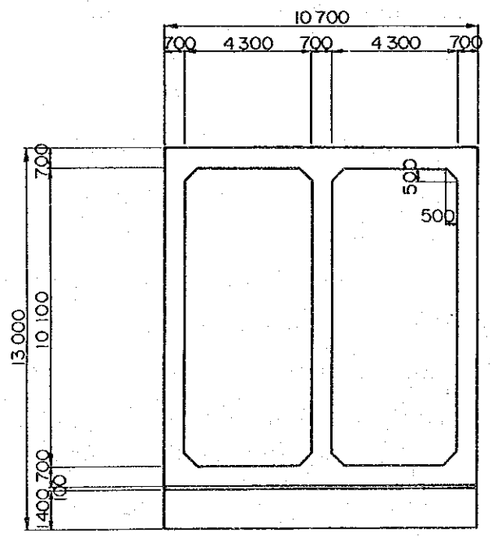
3 — 3



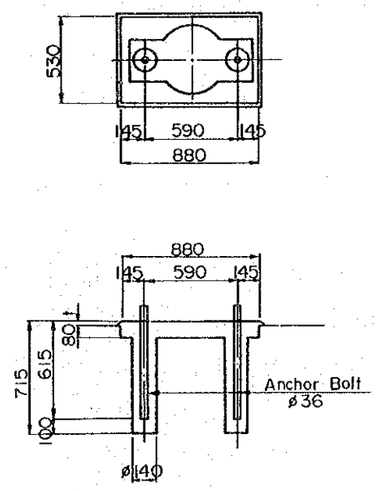
4 — 4



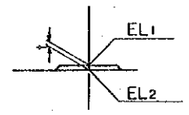
5 — 5



Box-Out Detail at Shoe Base



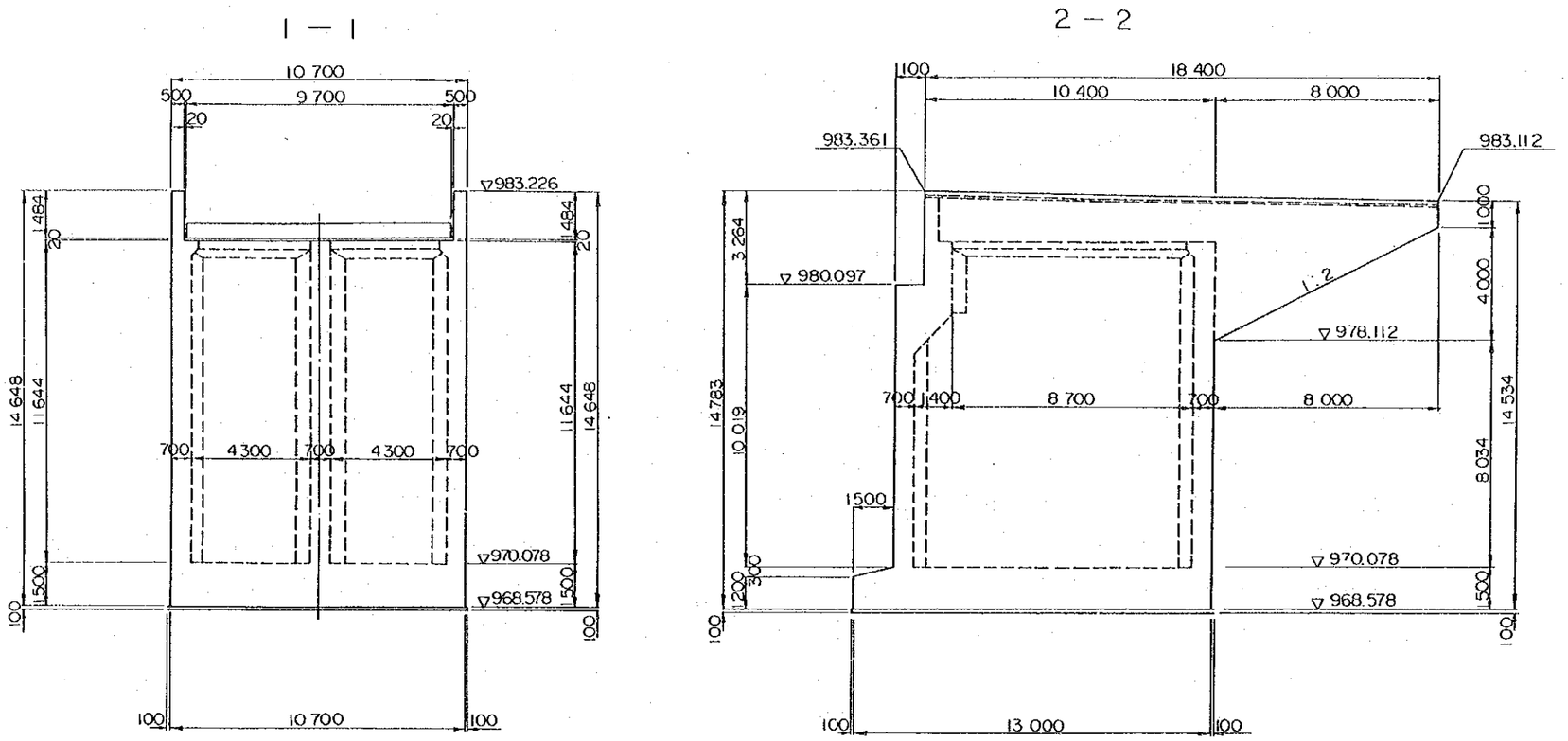
Mortar Height at Shoe Base



	G1	G2	G3	G4
EL1	980.121	980.191	980.191	980.121
t	24	94	94	24
EL2	980.097	980.097	980.097	980.097

Fig. 9-7 Primary Dimension of Substructure and Foundation (A2-1/2)

ABUTMENT 2 (A2) 2 of 2



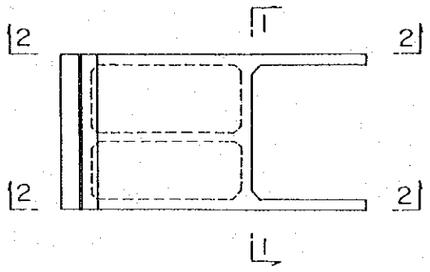
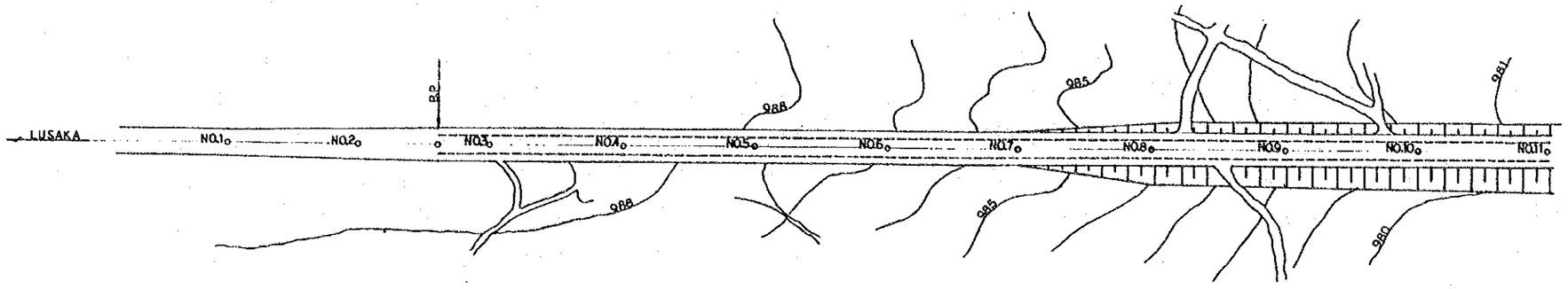
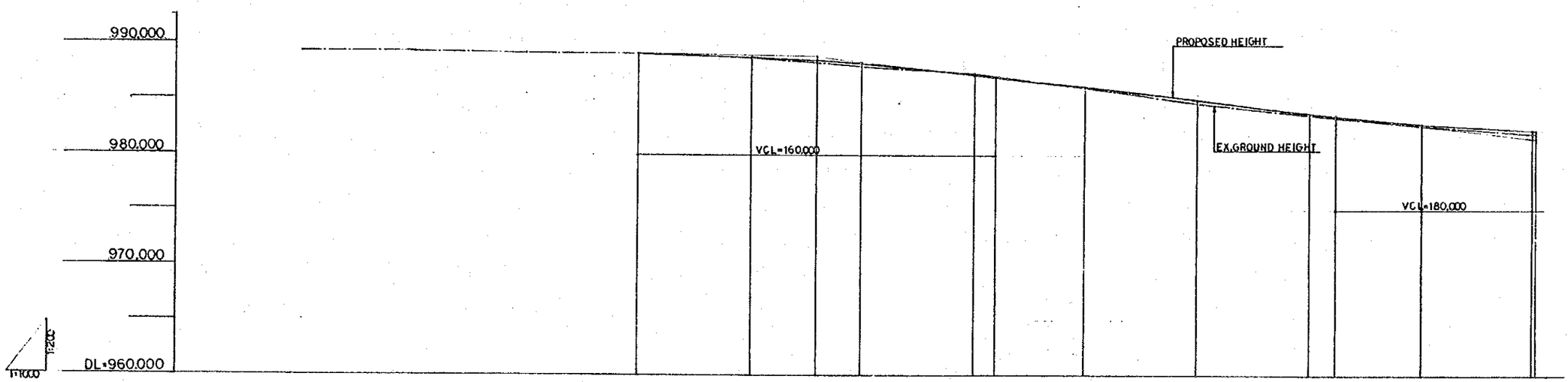


Fig. 9-8 Primary Dimension of Substructure and Foundation (A2-2/2)

PROFILE.(1)

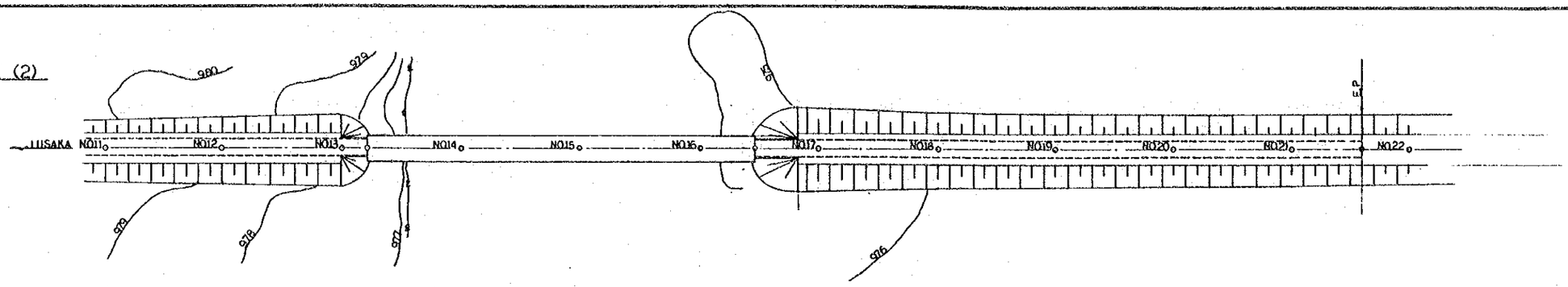




GRAND					983.140			983.004													981.470	
					i=0.17%																	
					l=80.000																	
BANKING					0.000			0.025			0.232			0.046			0.346			0.196			0.130			0.353
EXCAVATION													0.041									
PROPOSED HEIGHT					983.140			983.885			983.570		983.292	983.359		983.132	983.196			983.025			983.856			983.576			982.840			982.343	982.334
GROUND HEIGHT	982.250			983.310			983.150			983.140			983.880			983.050	987.400			986.150			984.680			983.666			982.710			981.990	
ACCUMULATED DISTANCE	0.000			50.000			100.000		130.000	150.000			200.000			250.000	300.000		310.000	350.000			400.000			450.000		462.000	500.000			550.000	552.000
DISTANCE	0.000			50.000			50.000		30.000	20.000			50.000			50.000	50.000		10.000	40.000			50.000			50.000		12.000	38.000			50.000	2.000
STATION	0			1			2		B.P 2+30	3			4			4+30	5		6	6+10			7			8		9	9+12			10			11	11+02
CURVE BAND	R=∞																					

Fig. 9-9 Approach Roads - Profile 1 of 2

PROFILE (2)



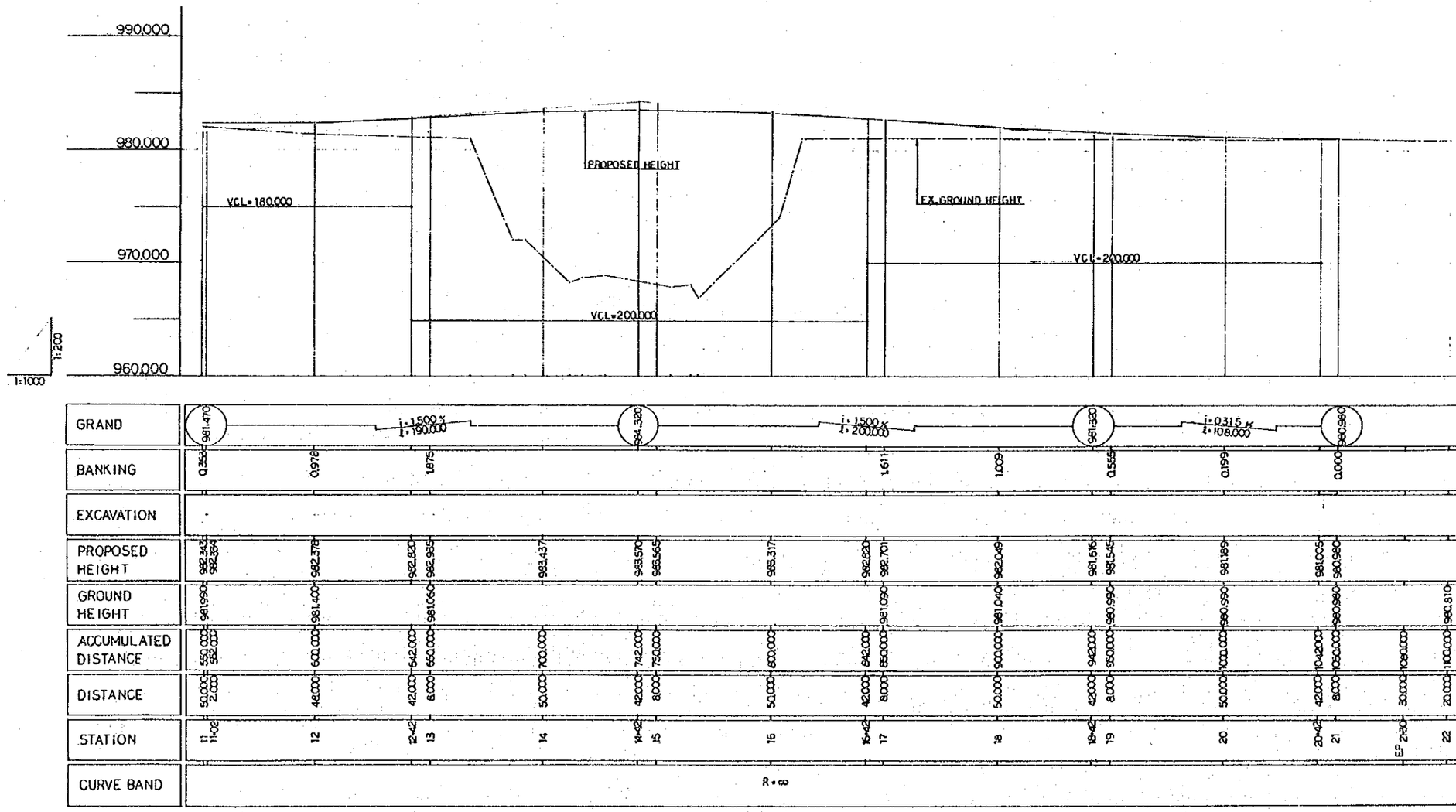
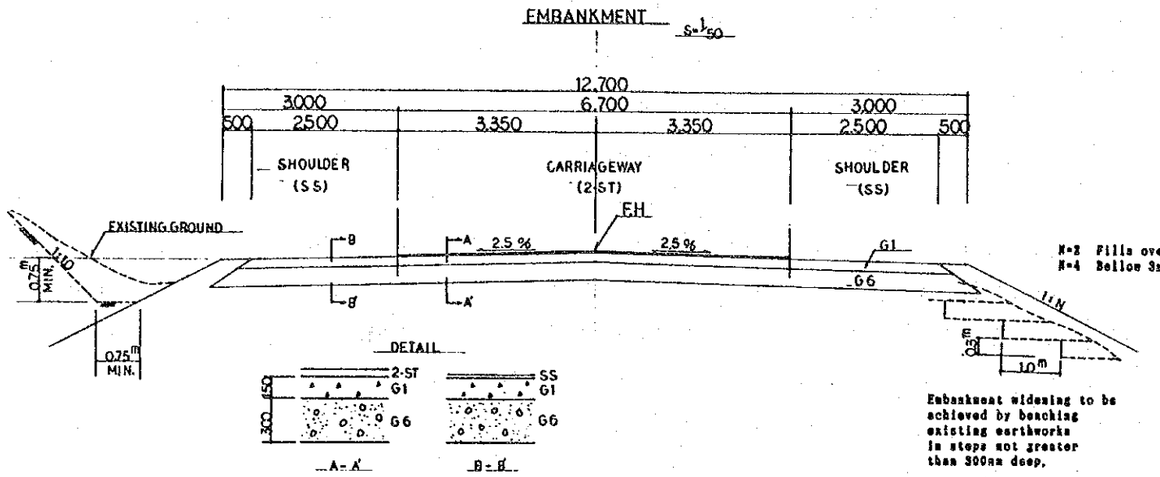
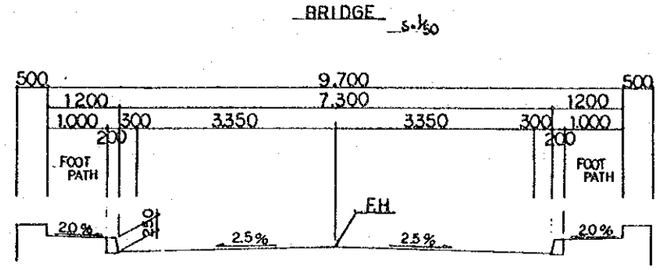


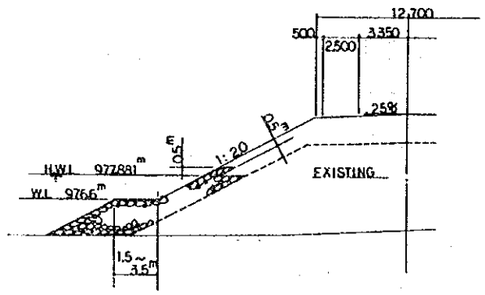
Fig. 9-10 Approach Roads - Profile 2 of 2



N=2 Fills over 3m in height
N=4 Bellow 3m in height

Embankment widening to be achieved by benching existing earthworks in steps not greater than 300mm deep.





TOE AND SLOPE PROTECTION FOR RIVER PORTION S=1/200

2-ST - Double bituminous surface treatment
First seal 80/100 pen bitumen @ 1.5 l/m2 10mm chipping @ 70 m2/m3
Second seal 80/100 pen bitumen @ 1.3 l/m2 13.2mm chipping @ 80m2/m3

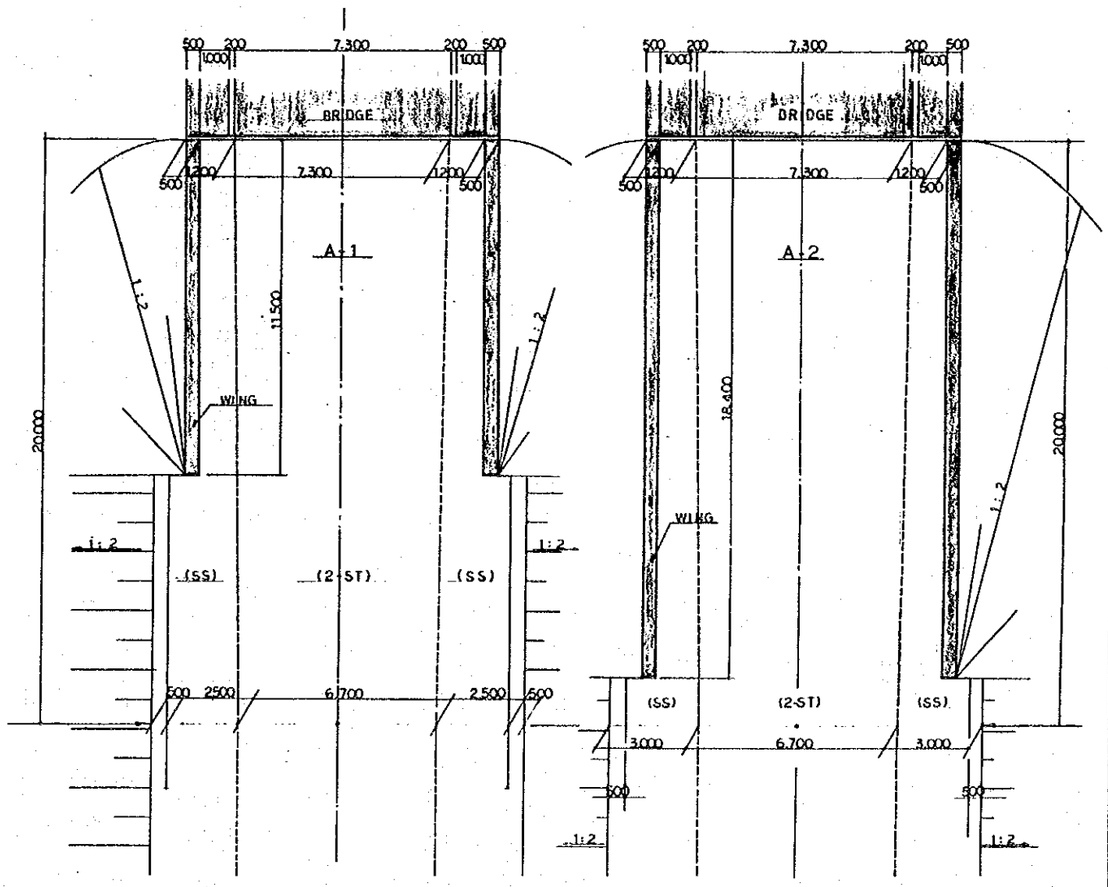
SS - Sand seal surface on shoulders
Seal 80/100 pen bitumen @ 1.0 l/m2
Crusher dust @ 120 m2/m3

G1 - Base course. Crushed stone road base and shoulder material PI>6, CBR<80

G6 - Sub-base course. Selected gravel sub-base PI>12, CBR<25

Notes;

1. Design based on 10 (Class 1A) and 5 (Class 1B) m.s.a.
2. Prime coat (where required) to be MC 30 cutback @ 1.0 l/m2
3. Tack coat (where required) to be K1-40 emulsion @ 0.6 l/m2
4. Cross section widths according to design standard
5. Existing base course material (after removal of bituminous surfacing) may be incorporated into the sub-base layer where required to match levels



DETAIL BETWEEN ROAD AND A-1, 2 ABUTMENT S=1/100

Fig. 9-11 Approach Roads - Cross Section & Road-Bridge Connection

Table 9-1 Quantity of Superstructure

(1) Steel Weight		
1) Main Structure		
Main Girder	258.8	ton
Cross beam	11.4	
Sway Bracing	12.8	
Lateral Bracing	10.0	
Bearing	10.5	
Sub total	303.5	ton
2) Accessary		
Expansion Joint	6.2	ton
Drainage System	8.4	
Hand Rail	13.2	
Sub total	27.8	ton
3) Total Steel Weight	331.3	ton
(2) Material Area		
1) Pavement Area		
Footpath (3.0 cm thick)	324.0	m^2
Carriageway (7.0 cm thick)	1181.0	m^2
2) Concrete		
Concrete Volume of slab	542.0	m^3
Concrete Volume of mount-up footpath	104.0	m^3
Mould Area	1915.0	m^2
Weight of Steel Reinforced Bar	98.6	ton
3) Painting Area	4834.0	m^2

Table 9-2 Quantity of Substructure and Foundation

(1) Footing and Shaft

Item	Type	Unit	Q'ty
concrete placement	Footing and shaft (σ_{CK}=210kg/cm^2)	m^3	1391.8
	Leveling (σ_{CK}=180 ")	m^3	22.8
Framework	Footing and shaft	m^2	2375.7
	Leveling	m^2	8.5
Work Platforms	H ≥ 8 m	m^2	1765.7
Supportings	H < 10 m	m^3	773.3
Reinforce-ment	SD30	kg	85067.5
Earthwork	Excavation	m^3	2971.1
	Surplus Soil	m^3	437.3
	Backfill	m^3	139.6

(2) Steel Pile

Item	Type	Unit	Q'ty
Steep pipe	ϕ1000×22 SKK41	kg	132980
Filled concrete	σ_{CK}=210 kg/cm^2	m^3	177.6

Table 9-3 Quantity of Approach Roads

Work Item		Quantity	Note
1. Excavation		1,467.0 m^3	
2. Embankment		8,048.6 m^3	
3. Step Excavation	(left)	640.0 m^3	
	(right)	1,100.0 m^3	
4. Reclamation	(left)	801.6 m^3	
	(right)	1,085.6 m^3	
5. Slope Protection	(left)	2,657.5 m^3	
	(right)	3,364.5 m^3	
6. Pavement			
6-1 Surface Course	(Roadway)	5,278.9 m^2	2ST(*1)
	(Shoulder)	3,939.5 m^2	SST(*2)
6-2 Base Course	(left)	3,597.0 m^2	
	(right)	3,625.5 m^2	
6-3 Subbase Course	(left)	3,208.5 m^2	
	(right)	3,241.0 m^2	

(Notes) 2ST : Double Surface Treatment
SST : Single Surface Treatment

9-C. CORROSION RESISTANCE

(1) Environment at Site

As is known well, Zambia is a land-locked country. The weather is genial and people enjoy refreshing breeze year around. Even during rainy season, rainfall hours in a day is relatively short. Besides, these exist no plants/shops that generate harmful sulfurous acid gas to corrosion.

For the conditions as mentioned, the site is geographically favored to corrosion resistance.

(2) Painting and Maintenance

Steel bridges, in general, are destined to require repainting. Though the site seems almost ideal from a standpoint of corrosion resistance, yet maintenance is more or less necessary. Among bridges inspected during a course of the Study, there was a bridge which has not been repainted for 16-years and still keeps sound painted surfaces.

Viewing the current financial difficulty of Zambia as a whole, it is essential to reduce maintenance costs as much as feasible.

(3) Application of Weathering Steel (Anti-Corrosion Steel)

(a) Weathering Steel:

One of the most effective device in reducing maintenance cost of steel bridges is an application of the weathering steel.

The weathering steel does not require any initial painting or repainting, since steel would produce fine rusty surface to protect steel from corrosion.

(b) Rust Stabilizing Coat:

Weathering steel has two (2) types of application, namely, steel without any coat (no paint application) and steel with rust stabilizing coat.

The greatest merit of the no paint application is economics as no kind of surface treatment is required. On the other hand, the no paint application has such disadvantages as stated below:

1. Appearances of steel surfaces are not always acceptable until the time when fine rust is produced and commence protecting surfaces.

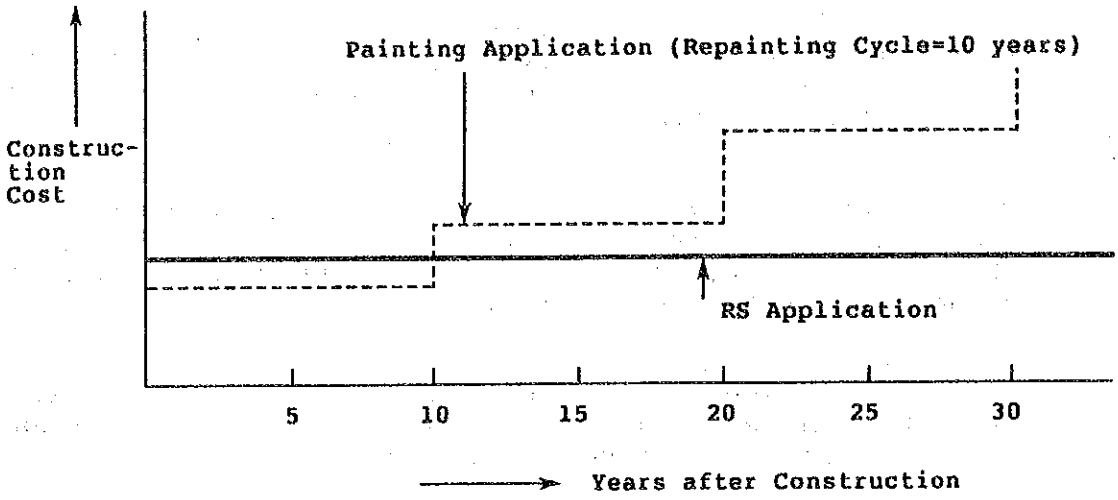
2. An initial flow-out of rust deteriorates such adjacent structures and facilities as concrete surfaces of substructure.

Considering the fact that steel structure would have to be oceantransported from outside the country and necessarily be contaminated by salt articles during the ocean-transportation, it is recommendable to use weathering steel with rust stabilizing coat. The application of the rust stabilizing coat is able to solve the above disadvantages that the no paint application is destined.

(c) Economical Comparison:

Weathering steel with rust stabilizing coat (hereinafter called RS application) is generally said fairly expensive comparing to ordinary painted steel.

Although initial cost of RS application upon completion of construction is more expensive, permanent cost including maintenance gives an economical advantage to the RS application.



A table that follows compares economics of both cases. (The comparison is based on nominal costs in Japan.)

(Unit: ¥/ton)

Evaluation Items	Painting Application	RS Application
Steel Price	-	+ 15,000
Painting/RS Coating	+51,000	+ 44,000
Repainting	+70,000/cycle	-
Total	+121,000	+59,000

As the result shows, the RS application turns to be less expensive than the painting application, once the first cycle of repainting is completed. Conclusively, the RS application is recommendable.

CHAPTER 10

IMPLEMENTATION PLAN

CHAPTER 10 IMPLEMENTATION PLAN

10-A. CONSTRUCTION CONDITION

1. The republic of Zambia is an inland country and does not have a port facility. The material and equipment required for the Project shall be disembarked at a port in a neighboring country. It will then be transported by land over a long distance through the neighboring country. Thus, for the Project's construction work, it is recommended that the least possible amount of construction material and equipment as possible be sent from Japan, and that Zambian material and equipment be used wherever possible.

2. Proper information, i.e. personnel of contractor, schedule of construction, may be necessary to be given to Army of Zambia.

3. During this Project, the traffic shall be secured. The safety measure and precaution shall be necessary when the traffic diversion or one way control is required.

4. During the construction, the water pollution shall be avoided. Harmful chemical material should not be allowed to be used and construction methods which might affect water clearances should be avoided.

5. In Zambia, rainy season starts from November.
Above term shall be considered in the project schedule.

10-B. IMPLEMENTATION METHOD

335 For the implementation of the Project a contractor shall perform the following servies:

(1) Construction schedule

1st year Contractor shall carry out Planning and Procurement, Diversion Work and Existing Bridge Demolition

2nd year Contractor shall carry out New Bridge Construction and Site Demolition Work

(2) Method of construction

- Bridge Dismantle — Bent pile method
- Bridge Erection — Bent pile method
- Temporary Bridge Pipe — Water jet & Vibro method
- Pier Pile — Pre-boring & Vibro method

10-C. PROCUREMENT PLAN

336 It will be required to use the construction material and equipment that is available in Zambia. Those which are not available locally will be shipped from Japan or third country. Table 10-1 shows the material and equipment and indicates the names of countries from where they are available.

Table 10-1 Construction Materials

The Republic of Zambia	Japan	Third Country
Sand	Steel Beam	Plywood
Gravel	Steel Plate	
Wood	Steel Bar	
	Steel Girder	
	Guard Rail	
	Hand Rail	
	Street Light	
	Concrete Admixture	
	Bridge Shoe	
	Bridge Expansion	
Construction Equipment:		
Asphalt Plant	Crawler Crane	
Asphalt Sprayor	Truck Crane	
Asphalt Finisher	Bulldozer	
Concrete Mixer	Vibration Roller	
	Tipper Lorry	
	Cram Shell Backet	
	Vibro Hammer	
	Water Jet Pump	
	Grouting Machine	
	Boring Machine	

Generator
Air Compressor
Submersible Pump
Submersible Sand Pump
Breaker
Hydraulic Giant Breaker

10-D. CONSTRUCTION SCHEDULE

337 The Project schedule is as shown in Table 10-2.

TABLE 10-2 PROJECT SCHEDULE

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
CONSULTANT SERVICES																												
CONTRACT	○																											
D/D	―	―	―	―																								
SUPERVISION					―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―	―
CONTRACTOR																												
CONTRACT				○																								
PREPARATION WORK					―	―	―	―	―																			
DIVERSION WORK									―	―	―	―	―	―	―												―	―
DEMOLITION WORK															―	―	―											
FOUNDATION WORK																	―	―	―	―	―	―						
GIRDER LAUNCHING																				―	―	―	―	―				
PAVING WORK																							―	―	―			
MISCELANEOUS WORK																									―	―	―	

10-E. COST ESTIMATE

338 An approximate project cost is summarized below:

	Total (million USD)	Foreign Currency (million USD)	Demestic Currency (millon KW)
1. Construction	12.0	8.6	134
(1) Direct Works	5.4	2.9	100
(2) Direct Temporary Works	0.4	0.3	3
(3) General Temporary Works	0.9	0.7	10
(4) Packaging & Transportation	2.7	2.7	-
(5) Fees, Expenses and Others	2.6	2.0	21
2. Design and Supervision	1.2	1.2	-
3. Total	13.2	9.8	134

Notes 1. 1 kw = 3.75 yen
2. 1 USD = 150 yen

CHAPTER 11

MAINTENANCE PROGRAM

CHAPTER 11 MAINTENANCE PROGRAM

339 Periodical inspection is a principle for bridge maintenance. And in case when extraordinary conditions are occasioned, it is imperative to investigate how they influenced on the bridge and to repair if the case may be.

Three (3) types of inspections that follow shall be implemented on the Kafue Road Bridge.

11-A. ORDINARY INSPECTION

340 Ordinary inspection of the bridge is principally done during ordinary inspection tour of roads and is mainly made by visual inspection. A frequency of the inspection shall be once in a month. And main inspection items shall be as follows;

(1) condition of bridge deck surfaces

deterioration and crack on road surfaces

(2) kerb and handrail

deformation and damage of handrail
crack on kerb

(3) condition of expansion joints

unusual sound and uncomfortable feeling which passengers perceive during drive

(4) condition of drainage

drain condition on road surfaces

(5) bridge connections

uneven and inequality settlement

(6) others

illegal exclusive use, obstacles, etc.

341 These inspections are to be implemented by Roads Department. Usual maintenance program that is kept implemented by Roads Department will satisfy these requirements.

11-B. REGULAR INSPECTION

342 Regular inspection must be periodically enforced to maintain the bridge in sound condition and required inspecting from both above and under bridge decks. A frequency of the inspection is once in five (5) years. Main items of the inspection are followings;

(1) condition of bridge deck surfaces

abrasion of pavement and crack on deck surfaces

(2) condition of kerb and handrail

deformation and damage

(3) condition of deck

crack on deck concrete

(4) condition of expansion joints

damage, deformation and crack at welded joints

(5) condition of bearings

piling of trash, earth and sand, corrosion of members and looseness of bolts

(6) condition of main girders and floorbeams

deformation and steel surfaces

(7) condition of substructure

settlement and slant of substructure, scour of foundation and river bed transformation

11-C. INSPECTION RECORDS

343 Judging from daily implementation being executed under control of Roads Department, it is believed inspection and maintenance program as delineated above shall include no major difficulties, provided Roads Department keeps current maintenance control and organization. As well, no extra maintenance budget will be anticipated to make ordinary and regular inspections, since these shall be implemented by visual inspections during regular roads maintenance patrol.

CHAPTER 12

SOCIO - ECONOMIC ASPECT OF THE PROJECT

12-A SOCIO - ECONOMIC ASPECT OF EXISTING KAFUE ROAD BRIDGE
12-B PROJECT ECONOMIC ANALYSIS

CHAPTER 12 SOCIO-ECONOMIC ASPECT OF PROJECT

12-A. SOCIO-ECONOMIC ASPECT OF EXISTING KAFUE ROAD BRIDGE

(1) Situation of Kafue Road Bridge in National Road Network

344 The Kafue road Bridge is located 56 Km south from Lusaka City. The road passing through the Kafue Road Bridge is a trunk line which joins Lusaka City and Southern Province in Zambia, and furthermore outside southern African countries (i.e. Zimbabwe, Botswana, and Mozambique).

345 The road diverges into two directions at the point of about 1.8 Km south from the Bridge (Kafue junction) ; i.e. one direction is from/to Zimbabwe and Botswana via Livingstone, another is from/to Zimbabwe via Chirundu.

346 The road through the Kafue junction to Livingstone is called T1 Road, which is connected with T2 Road at the Kafue junction.
T2 Road runs through Chirundu - Kafue junction - Lusaka - Kapiri Mposhi - Tunduma.

347 A road name "T" indicates a Inter-Territorial road, which ties Zambia's main cities around Lusaka City and forms an international road network with adjacent countries.

348 The Kafue road Bridge is situated on a trunk link in the national road network.

(2) Role of Kafue Road Bridge in External Trade

349 Table 12-1 shows a tend of transport volume (tons) of export and import by route/mode of Zambia in 1986, 1987 and 1988, which was compiled by Central Statistical Office.

305 Table 12-2 illustrates a summary of three year's (1986 - 1988) average of transport volume of export and import by route/mode, based on data of Table 12-1 above-mentioned.

Table 12-1

Transport Volume of Export/Import by Route/Mode

(1) Year of 1986,1987 and 1988 (Unit: ton)

Route/Mode of Transport	(a) Export									(b) Import								
	1986	(%)	(%)	1987	(%)	(%)	1988	(%)	(%)	1986	(%)	(%)	1987	(%)	(%)	1988	(%)	(%)
(1) By Road																		
1) Tanzania Border	6,755	1.2%	0.7%	31,813	15.7%	3.1%	7,409	2.6%	1.0%	49,528	30.3%	5.0%	37,514	12.4%	2.9%	18,943	13.5%	1.2%
2) Malawi Border	461,835	84.1%	48.9%	24,412	12.1%	2.4%	138,130	49.4%	18.5%	1,764	1.1%	0.2%	88,359	29.1%	6.7%	1,247	0.9%	0.1%
3) Zimbabwe Border	53,731	9.8%	5.7%	70,407	34.8%	6.9%	77,881	27.8%	10.4%	107,714	66.0%	10.9%	172,014	56.6%	13.1%	111,776	79.8%	7.3%
4) Botswana Border	5,519	1.0%	0.6%	5,674	2.8%	0.6%	37,326	13.3%	5.0%	3,363	2.1%	0.3%	3,851	1.3%	0.3%	4,994	3.6%	0.3%
5) Zaire Border	21,071	3.9%	2.2%	70,167	34.6%	6.8%	19,112	6.9%	2.6%	923	0.5%	0.2%	1,922	0.6%	0.1%	3,116	2.2%	0.3%
Total by Road	548,911	100%	58.1%	202,473	100%	19.8%	279,858	100%	37.5%	163,292	100%	16.6%	303,660	100%	23.1%	140,076	100%	9.2%
(2) By Rail																		
1) Tanzania Border	357,562	92.0%	37.8%	649,474	90.1%	63.6%	334,033	85.2%	44.8%	102,581	33.9%	10.4%	216,299	64.3%	16.5%	212,336	54.9%	13.9%
2) Zaire Border	5,450	1.4%	0.6%	15,058	2.1%	1.5%	12,648	3.2%	1.7%	48	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
3) Zimbabwe Border	25,439	6.6%	2.7%	56,367	7.8%	5.5%	45,576	11.6%	6.1%	200,019	66.1%	20.3%	120,163	35.7%	9.1%	174,568	45.1%	11.5%
Total by Rail	388,451	100%	41.1%	720,899	100%	70.6%	392,257	100%	52.6%	302,648	100%	30.7%	336,462	100%	25.6%	386,904	100%	25.4%
(3) Air	3,331		0.4%	2,867		0.3%	7,110		1.0%	11,441		1.2%	18,447		1.4%	35,308		2.3%
(4) Pipe Line	0		0.0%	0		0.0%	0		0.0%	506,778		51.5%	655,842		49.9%	962,665		63.1%
(5) Others	4,132		0.4%	95,307		9.3%	66,793		8.9%	77		0.0%	47		0.0%	141		0.0%
Grand Total	944,825		100%	1,021,546		100%	746,018		100%	984,236		100%	1,314,458		100%	1,525,094		100%

Data Source : Central Statistical Office, Zambia

Table 12-2

(2) Average of 3 Years (Unit: ton)

Route/Method of Transport	(a) Export			(b) Import			(c) Export & Import			
	Average	(%)	(%)	Average	(%)	(%)	Average	(%)	(%)	(%)
(1) By Road										(Exclude Pipe Line)
1) Tanzania Border	15,326	4.5%	1.7%	35,328	17.5%	2.8%	50,654	9.3%	2.3%	3.4%
2) Malawi Border	208,126	60.5%	23.0%	30,457	15.1%	2.4%	238,583	43.7%	11.0%	16.2%
3) Zimbabwe Border	67,340	19.6%	7.4%	130,501	64.5%	10.2%	197,841	36.2%	9.1%	13.5%
4) Botswana Border	16,173	4.7%	1.8%	4,069	2.0%	0.3%	20,242	3.7%	0.9%	1.4%
5) Zaire Border	36,783	10.7%	4.1%	1,987	0.9%	0.2%	38,770	7.1%	1.8%	2.6%
Total by Road	343,748	100%	38.0%	202,342	100%	15.9%	546,090	100%	25.1%	37.1%
(2) By Rail										
1) Tanzania Border	447,023	89.3%	49.4%	177,072	51.8%	13.9%	624,095	74.1%	28.6%	42.4%
2) Zaire Border	11,052	2.2%	1.2%	16	0.0%	0.0%	11,068	1.3%	0.5%	0.8%
3) Zimbabwe Border	42,461	8.5%	4.8%	164,917	48.2%	12.9%	207,378	24.6%	9.6%	14.1%
Total by Rail	500,536	100%	55.4%	342,005	100%	26.8%	842,541	100%	38.7%	57.3%
(3) Air	4,436		0.5%	21,732		1.7%	26,168		1.2%	1.8%
(4) Pipe Line	0		0.0%	708,428		55.6%	708,428		32.5%	-
(5) Others	55,410		6.1%	89		0.0%	55,499		2.5%	3.8%
Grand Total	904,130		100%	1,274,596		100%	2,178,726		100%	100%

Data Source : Central Statistical Office, Zambia

(a) General Feature :

351 According to Table 12-2, the followings can be observed as a general feature:

- Railway transport is an important mode in the country's external trade especially for export.
  Of routes in the railway mode, Tanzania Border route has a fair share. This is probably explained by an export transport of crude copper from Copper Belt area to Dar es Salaam port in Tanzania.

- Pipe line plays a critical role in the import of crude oil.

- Road transport shows a considerable share ratio, i.e. about 25% in all modes and about 37% in modes except pipe line for three year's average of export and import volume.

(b) Role of Kafue Road Bridge Corridor :

352 Of routes in the road mode, Zimbabwe Border route and Botswana Border routes are related to the Kafue Road Bridge corridor.

353 The total share of Zimbabwe and Botswana Border routes represents about 10% in all modes, and about 15% in modes except pipe line for three year's average volume of export and import. Moreover, this represents about 40% share only in road routes.

354 The said observation indicates that the Kafue Road Bridge corridor plays a respectable role of transport in the external trade.

(3) Situation in Future Road Network Program of Kafue Road Bridge

355 Fig. 12-1 shows a masterplan of future road network program of Preferential Trade Area for Eastern and Southern African States : PTA.

356 PTA is an organization for cooperation in development of overall economic activities among eastern and southern

African states, which was established at 1984. The headquarters is located at Lusaka City, and main member nations are Zambia, Tanzania, Zimbabwe, Botswana, Malawai, Ethiopia, Kenya, and etc.

357 Fig. 12-1 illustrates a schematic concept of masterplan of Trans Eastern Africa Highway and other trunk roads in PTA related area.

358 According to the illustration of road netwok masterplan, Trans Eastern Africa Highway is proposed to pass through the Kafue Road Bridge section.

(4) Importance of Kafue Road Bridge

359 Observations previously-mentioned in section (1) to (3) tell an important role of the Kafue Road Bridge both for national and international road transport network.

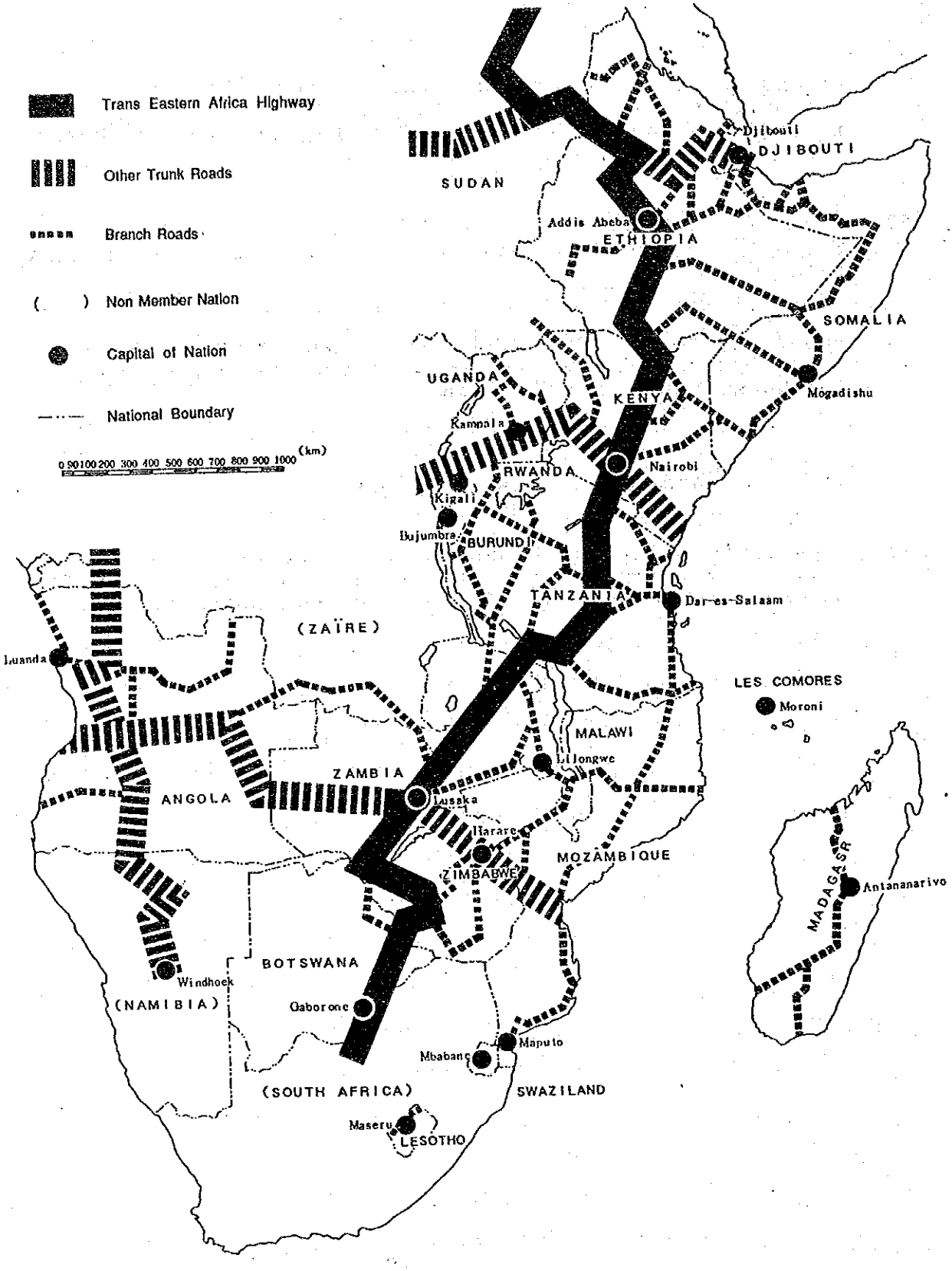


Fig. 12-1 Road Masterplan of PTA

Source : PTA Documents

12-B. PROJECT ECONOMIC ANALYSIS

(1) General

(a) Basic Assumption in Economic Analysis

360 According to the technical study results, the timing of becoming to be unserviceable condition of the existing Kafue Road Bridge is uncertain.

361 It can be confirmed that the existing bridge has a very long operation life time and a possibility of unsoundness of sub-structure, so that there will be some probability of collapse by some unforeseen forces which will lead to unserviceable condition of bridge.

362 In this economic analysis, concept of bridge unserviceability is assumed to be introduced with some probability.

(b) Assumption of Vehicle Traffic Related to Kafue Road Bridge

363 As observed previously in section 12-A, the existing Kafue Road Bridge plays a considerable role in both national and international road transport system.

364 Therefore, if the Kafue Road Bridge would become unserviceable for some structural reasons in near future, a critical effect on road transport system in Zambia will be foreseen.

365 As a matter of fact, in the case of bridge unserviceability, both internal and external vehicle traffics using the Kafue Road Bridge will be changed from the route via the Kafue Road Bridge into other routes (for example, conversion to Tanzania Border Route for external trades) and/or other modes.

366 And some portion of vehicle traffics which is expected to pass through the Kafue Road Bridge in a normal condition is assumed to be diverted to an alternative route, i.e. detour route.

(c) Assumption of Detour Route

367 As for detour route, there are some requirements to be considered counterplan, i.e. traffic control, traffic availability of road, improvement of road, improvement of pontoon facilities and etc.

368 For this economic analysis, however, it is assumed that although there are problems above-mentioned, detour routes

are available and requirements above are not regarded as a cost factor.

(d) Aim of Economic Analysis

369 A concept of bridge unserviceability and detour route are based on such assumptions as mentioned above, so that it is noted that this economic analysis aims to examine an impact in case of unserviceability of the existing Kafue Road Bridge rather than to measure economic feasibility of the Project.

(e) Assumption for Analysis

i) Project Life

The project life is assumed of to be 20 years.

ii) Construction Schedule

It is assumed that the construction schedule of new bridge is year 1991 to 1993, and opening year is year 1994.

iii) Exchange Rate

The assumed exchange rate is:

US$ 1 = Kwacha 40 = Yen 150 (Yen 1 = Kwacha 0.267)

(2) Estimation of Economic Benefit

(a) Economic Benefit of Project

370 Economic benefits of the Project consist of the following:

- Elimination of risk of bridge unserviceability (Increase of vehicle operating cost by diversion to detour route in case of bridge unserviceability)
- Reduction of waiting time of vehicle at approach points of bridge by improvement of lane width
- Increase of driving safety, driver's amenity and reduction of possibility of accident by improvement of lane width
- Employment creation of labour force during construction period

According to the implementation plan of construction, total Zambian manpower employed as labourer is expected to be approximately ..... man/month.

371 In this economic analysis, benefit of elimination of risk probability of bridge unserviceability is considered as a quantified benefit.

372 That is, an increase of vehicle operating cost by utilizing detour route compared with normal condition is regarded as benefit.
An effect of eliminating a risk of bridge unserviceability is embodied as a saving of vehicle operating cost.

(b) Saving of Vehicle Operating Cost

373 Benefit is estimated as a difference of vehicle operating cost between "With the Project" and "Without the Project". "With the Project" means a case of implementation of construction of new Kafue Road Bridge, and "Without the Project" means a case of no implementation of such a construction.

The benefit is assumed to be calculated as follows:

$$B = TRV \times DIS \times UPVOC$$

where:

B: Benefit of saving of vehicle operating cost

TRV: Estimated traffic volume by direction

DIS: Difference of distance between detour route and Kafue Road Bridge route by direction

UPVOC: Unit price of vehicle operating cost

(c) Traffic Volume by Direction

374 Table 12-3 shows a future estimated traffic volume by direction which pass through the Kafue Road Bridge corridor, based on the study result of traffic demand forecast. (refer to Chapter 3) Of these directions in Table 12-3, directions 1) to 4) are asssumed to be objective in this economic analysis.

Table 12-3 Traffic Volume by Direction
(Unit: Number of vehilce/day)

Direction \ year	1989	1992	2000
1) Lusaka - Southern Province	688	778	1,295
2) Kafue - Southern Province	219	249	400
3) Lusaka - Zimbabwe	39	44	176
4) Copperbelt - Southern Province	35	36	52
5) Others	130	112	203
Total	1,111	1,219	2,126

Note: "Others" includes traffic volumes related to other directions than 1) to 4) above.

Of these vehicle traffic volume, 50% is assumed to be diverted into detour routes.

(d) Estimation of Difference of Distance between Detour Route and Kafue Road Bridge Route

i) Assumption of Detour Route

In this economic analysis, as a detour route for the Kafue Road Bridge corridor, two alternative routes are assumed; i.e. Itezhi Tezhi Route and Chiawa Pontoon Route. Accordingly, economic analysis is made for these two cases.

ii) Difference of Distance

Based on assumption above, differences of distance between detour routes and the Kafue Road Bridge route are assumed as shown in Table 12-4.

Table 12-4 Difference of Distance by Direction

(Unit: Km)

Direction	Via Detour Route	Via Kafue Bridge	Difference of Distance
(a) Itezhi Tezhi Route			
1) Lusaka - Southern Province (Lusaka - Choma)	574	283	291
2) Kafue - Southern Province (Kafue - Choma)	618	239	379
3) Lusaka - Zimbabwe (Lusaka - Chrindu)	755	135	620
4) Copperbelt - Southern Prov. (Lusaka - Choma)	574	283	291
(b) Chiawa Pontoon Route			
1) Lusaka - Southern Province (Lusaka - Kafue junction)	225	55	170
2) Kafue - Southern Province (Kafue - Kafue junction)	269	11	258
3) Lusaka - Zimbabwe (Lusaka - Chrindu)	146	134	12
4) Copperbelt - Southern Prov. (Lusaka - Kafue junction)	225	55	170

Note: Name of place in ( ) indicates a point to measure distance.

(e) Unit Price of Vehicle Operating Cost

Table 12-5 shows an unit price of vehicle operating cost by vehicle type. Basic data and informations for unit price of vehicle operating cost were obtained by interview to car-dealers, trucking company and etc.

Table 12-5 Unit Price of Vehicle Operating Cost

(Unit: Kwacha per 1,000 Km)

Passenger Car	7,107
Truck/Lorry	15,280

Note: Refer to Appendix 12-1.

Table 12-6 shows a share ratio of vehicle type by year, based on the study result of traffic demand forecast.

Table 12-6 Share Ratio by Vehicle Type

Vehicle Type \ year	1989	1992	2000
Passenger Car	66.0%	67.6%	65.2%
Truck/Lorry	34.0%	32.4%	34.8%
Total	100.0%	100.0%	100.0%

Based on the share ratio by vehicle type, average unit prices of vehicle operating cost are obtained, and the result is shown in Table 12-7.

Table 12-7 Average Unit Price of Vehicle Operating Cost
(Unit: Kwacha per 1,000 Km)

\ year	1989	1992	2000
Average Unit Price of Vehicle Operating Cost	9,887	9,755	9,951

(f) Estimated Benefit

375 Based on the assumptions above (b) to (e), benefits of savinng of vehicle operating cost for each case by year are estimated as below (unit: million Kwacha):

	1992	2000
- Case of Itezhi Tezhi Route	638	1,185
- Case of Chiawa Pontoon Route	361	606

376 Values of intermediate years between year 1992 and 2000 are obtained by linear interpolation, and values after year 2001 are assumed to be fixed as that of year 2000.

(3) Economic Cost

(a) Construction Cost

377 In this analysis, the construction cost is assumed to be approximately 2 billion Yen, which is equivalent to about 534 million Kwacha.

378 Since the construction cost comprises almost foreign currency portion and the component of import duty and tax are already excluded from cost estimates, this estimatedconstruction cost in terms of market price is assumed as an economic cost.

379 The distribution of construction cost by year is assumed to be 30% in 1991, 40% in 1992 and 30% in 1993.

380 The life expectancy of bridge is assumed to be 50 years in this analysis. (The method of depreciation follows a straight line method.)
The project life of 20 years is a period for purpose of this analysis. Assets of bridge will continue to have value for a much longer period. So that, salvage value (undepreciated value) is assumed as a negative cost in the final year of the project life.

(b) Maintenance Cost

381 In this economic analysis, annual maintenance cost is assumed to be 1% of the construction cost.

(4) Economic Internal Rate of Return (EIRR)

(a) EIRR

382 Economic Internal Rate of Return (EIRR) is a value to satisfy the following equation:

$$\sum^{n} \frac{Bt-Ct}{(1+r)^{t}} = 0$$

where; Bt: Benefit in year t
Ct: Costs in year t
(Construction and maintenance costs)
t : Number of years
n : Calculation period
r : Value of EIRR

383 Based on the estimated benefit and the estimated construction and maintenance costs, EIRR is calculated as below (refer to Table 12-8):

- Case of Itezhi Tezhi Route: 80.1%

- Case of Chiawa Pontoon Route: 51.9%

(b) Evaluation

384 The calculation results of EIRR indicates that an impact of unserviceability of the Kafue Road Bridge is considerably heavy.

385 It can be recommended that in order to eliminate a risk of bridge unserviceability, a need of reconstruction of bridge is fairly high.

Table 12-8 Economic Analysis

(a) Case of Itezhi Tezhi Route

(Unit: million Kwacha)

Year	Benefit	Costruct. Cost	Maint. Cost	Net Cash Flow	EIRR
					80.11%
1991		160		-160	
1992		214		-214	
1993		160		-160	
1994	775		5	770	
1995	843		5	838	
1996	912		5	907	
1997	980		5	975	
1998	1048		5	1043	
1999	1117		5	1112	
2000	1185		5	1180	
2001	1185		5	1180	
2002	1185		5	1180	
2003	1185		5	1180	
2004	1185		5	1180	
2005	1185		5	1180	
2006	1185		5	1180	
2007	1185		5	1180	
2008	1185		5	1180	
2009	1185		5	1180	
2010	1185		5	1180	
2011	1185		5	1180	
2012	1185		5	1180	
2013	1185	-314	5	1494	

(b) Case of Chiawa Pontoon Route

(Unit: million Kwacha)

Year	Benefit	Costruct. Cost	Maint. Cost	Net Cash Flow	EIRR
					51.90%
1991		160		-160	
1992		214		-214	
1993		160		-160	
1994	392		5	387	
1995	422		5	417	
1996	453		5	448	
1997	484		5	479	
1998	514		5	509	
1999	545		5	540	
2000	606		5	601	
2001	606		5	601	
2002	606		5	601	
2003	606		5	601	
2004	606		5	601	
2005	606		5	601	
2006	606		5	601	
2007	606		5	601	
2008	606		5	601	
2009	606		5	601	
2010	606		5	601	
2011	606		5	601	
2012	606		5	601	
2013	606	-314	5	915	

CHAPTER 13

PROJECT EVALUATION AND CONCLUSION

CHAPTER 13 PROJECT EVALUATION AND CONCLUSION

(1) Basic Approach:

386 Principal approach in the feasibility study is, in general, to estimate and assess an impact of the project implementation. However, conventional way of the approach can only be practical to the scope of assessment that is tangible and able to indicate an amount of money.

387 A bulk of road projects are generally evaluated by direct and quantitative benefit for road users, namely, benefit brought by retrenchment of users' traffic time and operation cost on which a direct object of road construction is rested. And the project evaluation is made by economic analysis comprised of benefit-cost ratio and economic internal rate of return.

388 However, in such a case as reconstruction of the Kafue Road Bridge that is a sole bridge on a link of international trunk roads in the Southern region, consequence on society, economy and defense as well as impact to direct users is extremely large. In addition, it is complicated and troublesome to indicate the consequence by an amount of money. Needless to say, a direct affect due to the Kafue Road Bridge being unserviceable is awfully great, since a potential detour route is not fixed and is far. But, it is possible to quantify the affect.

389 On this project, increase of operation cost because of detouring is evaluated to be receivable benefit and used as one of indexes for the evaluation.

(2) Justification for Reconstructing the Kafue Road Bridge:

390 Some fifty (50) years has passed since the Kafue Road Bridge was initially constructed. Generally speaking, durable years of the bridge is exceeded.

391 Irrespective of the fact, each structural member of the superstructure is fairly sound, though a part of members is destroyed and lost, and these have to be remedied.

392 The width of the present Kafue Road Bridge is 6.1 m. And allowance between edges of carriageway and structural members of the bridge is narrow. Consequently, to pass each other on the bridge is unable for large-size vehicles and therefore, the present traffic condition is undesirable from a standpoint of traffic safety. On this particular road, a ratio of large-size vehicles is high and it is assumed that this trend will continuously maintained. From this point of view, too, the width seems insufficient.

393 The river bed of both up and downstream of the bridge is broadly scoured after construction. And this results in scarce footing of pier foundations into the bearing stratum and difficulty of piers' self-standing. Thus, piers are assumed to be in a condition that they may be collapsed at a sudden.

394 Reinforcing these piers is troublesome, since the water depth is 8-10 m and the river bed is composed of mud on which no bearing is expected and hard rock exposed underneath the mud. The reinforcement is anticipated to be more expensive than the replacement.

395 The southern road of the bridge has been rehabilitated, and the northern road is to be rehabilitated up until Lusaka. Therefore, the bridge will be a bottle-neck of the traffic, unless reconstructed.

396 To review comprehensively the above circumstance and from an engineering point of view, it is implied to replace the Kafue Road Bridge as quickly as possible.

(3) Engineering Future:

397 The new bridge is planned on the present location. Horizontal alignment is to be on the existing alignment, due to following reasons;

- The existing alignment is alomost ideal, and altering the location would make the alignment worse.

- The southern approach has higher embankment and is long. Most of the embankment has been constructed for 40-years and is stable.

- It is still less expensive to utilize the existing alignment, even though the existing bridge has to be demolished.

- Such indirect costs as relocation of telephone line and land compensation are not required.

398 Type and size of the new bridge is recommended as follows;

Type of Bridge	4-continuous span steel plate girder (deckbridge)	
Bridge Length	162 m	
Width	carriageway	7.3 m
	footpath	2 × 1 m
Span Length	37.6 m + 43 m + 43 m + 37.6 m	

399 The bridge length would become 22 m longer than the existing bridge. Likewise, the river width will be extended for approx. 20 m and turns out to be more favorable.

400 The weather and environment at Kafue region enable to recommend applying weathering steel. Application of the weathering steel will greatly reduce repainting cost that occupies most of maintenance cost of the bridge and accordingly, deduct the maintenance cost as a whole.

(4) Economic Evaluation:

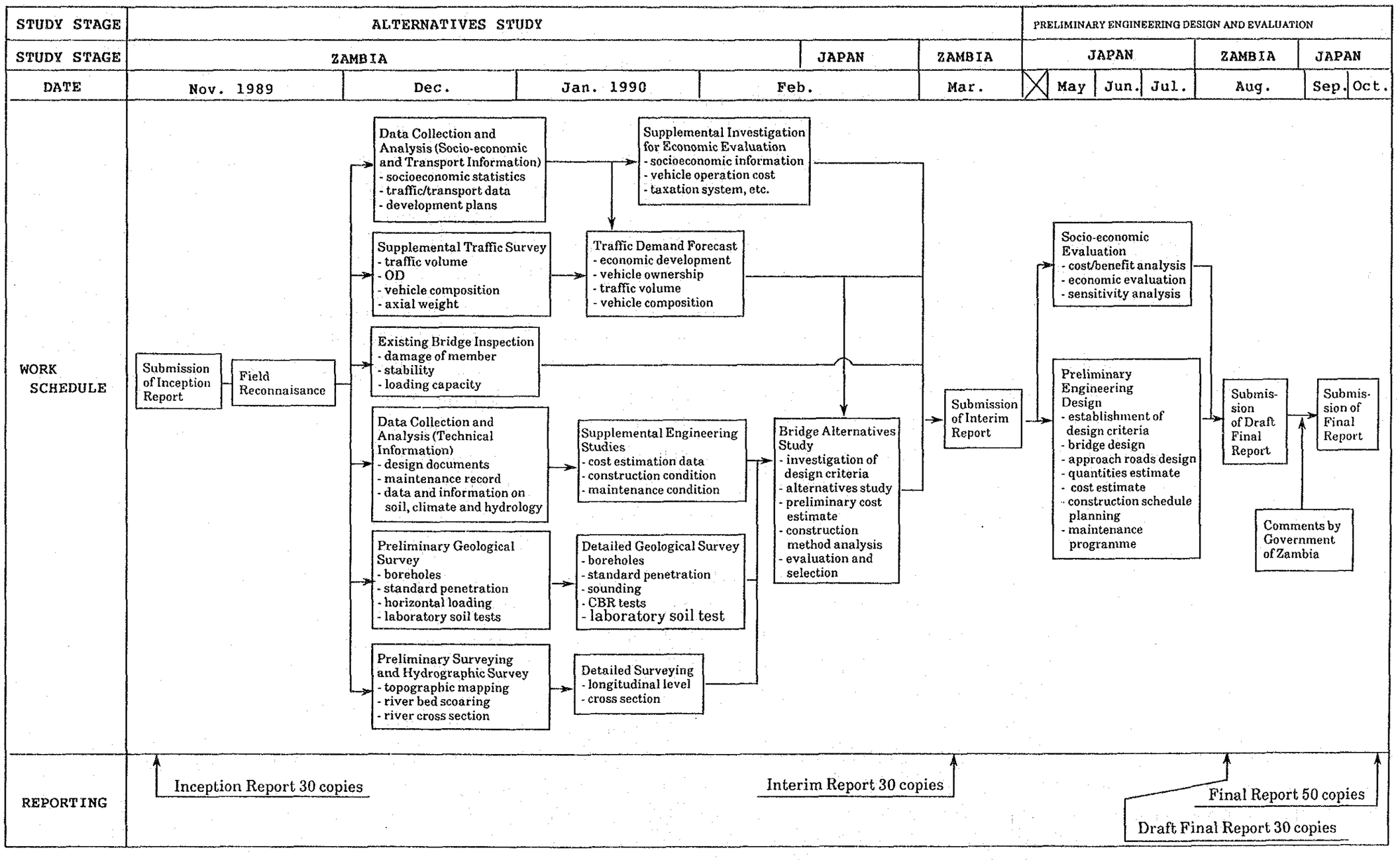
401 Once the present bridge becomes unserviceable, an impact is extremely large, and the risk of this is far beyond construction cost of the replacement.

(5) Conclusion:

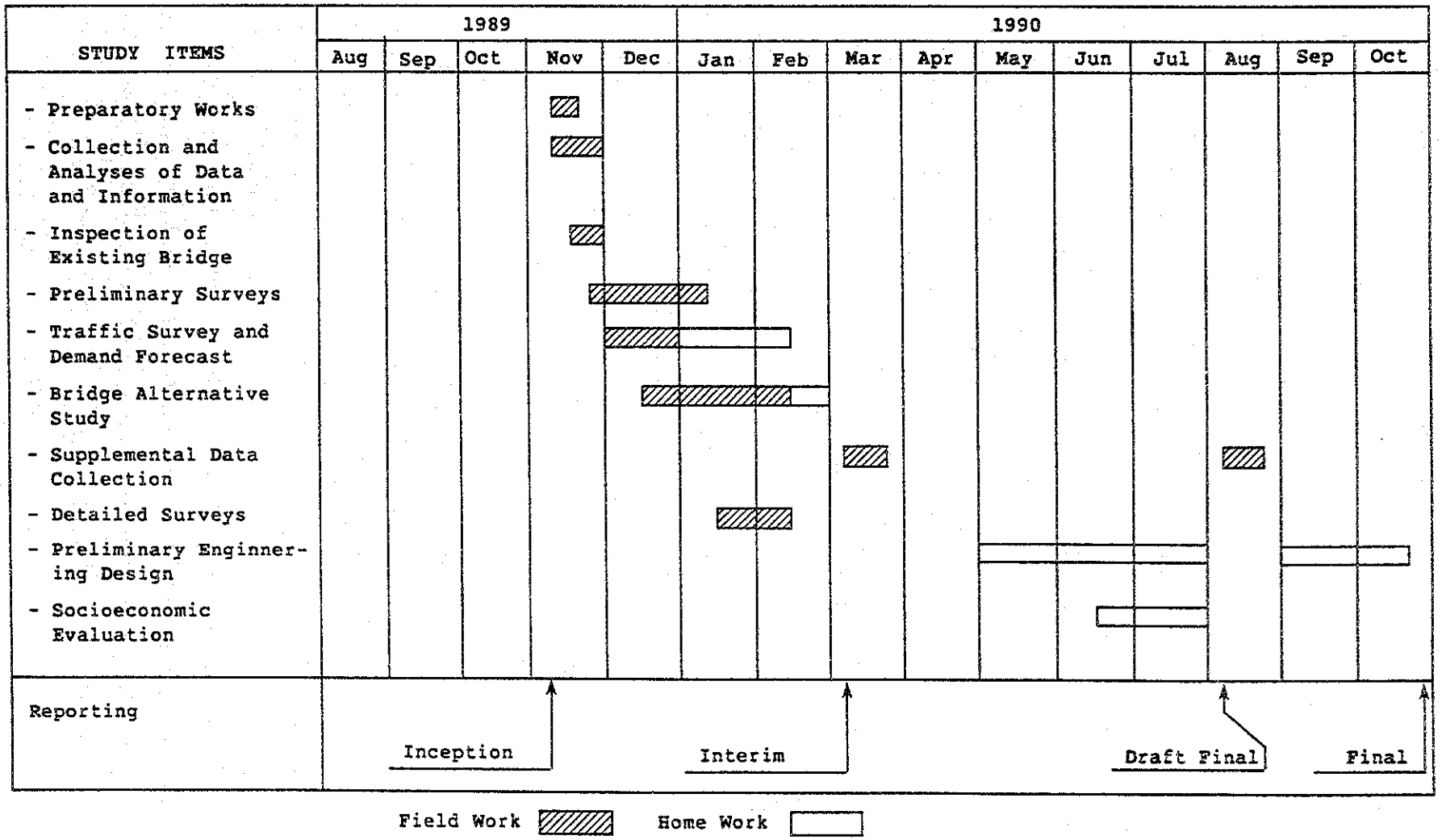
402 Based on the above discussion, and from standpoints of both engineering and economy, it is imperative to replace the Kafue Road Bridge as quickly as possible. In selecting the bridge type, features of Zambia as a land-locked country shall be wholly considered.

APPENDIX

APPENDIX 1-1 STUDY FLOW CHART



APPENDIX 1-2 STUDY SCHEDULE



APPENDIX-3

3-1 Daily Variation at Kafue Road Bridge

3-2 Results of Traffic Counting Survey

3-3 Results of Roadside O-D Survey

3-4 Instruction Manual of Traffic Survey

3-5 Future O-D Table 1992 and 2000

Appendix 3-1

Daily Variation at Kafue Road Bridge (From Lusaka) 11/Dec/89

	Time	P.Car	(%)	Truck	(%)	Trail	(%)	Bus	(%)	Total	(%)
7	7-8	8	2.4	2	2.0	4	3.8	0	0.0	14	2.6
8	8-9	10	3.1	7	7.0	6	5.7	1	11.1	24	4.4
9	9-10	12	3.7	3	3.0	4	3.8	0	0.0	19	3.5
10	10-11	25	7.6	6	6.0	10	9.5	0	0.0	41	7.6
11	11-12	19	5.8	7	7.0	10	9.5	0	0.0	36	6.7
12	12-13	20	6.1	10	10.0	6	5.7	0	0.0	36	6.7
13	13-14	22	6.7	9	9.0	6	5.7	1	11.1	38	7.0
14	14-15	25	7.6	7	7.0	8	7.6	1	11.1	41	7.6
15	15-16	29	8.9	9	9.0	7	6.7	0	0.0	45	8.3
16	16-17	36	11.0	9	9.0	9	8.6	0	0.0	54	10.0
17	17-18	36	11.0	11	11.0	2	1.9	0	0.0	49	9.1
18	18-19	26	8.0	6	6.0	9	8.6	1	11.1	42	7.8
19	19-20	15	4.6	2	2.0	8	7.6	0	0.0	25	4.6
20	20-21	4	1.2	0	0.0	1	1.0	1	11.1	6	1.1
21	21-22	7	2.1	0	0.0	3	2.9	0	0.0	10	1.8
22	22-23	3	0.9	0	0.0	1	1.0	0	0.0	4	0.7
23	23-24	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	24-01	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
1	1-2	1	0.3	1	1.0	0	0.0	0	0.0	2	0.4
2	2-3	1	0.3	0	0.0	0	0.0	0	0.0	1	0.2
3	3-4	1	0.3	0	0.0	1	1.0	1	11.1	3	0.6
4	4-5	2	0.6	0	0.0	0	0.0	2	22.2	4	0.7
5	5-6	9	2.8	3	3.0	2	1.9	1	11.1	15	2.8
6	6-7	16	4.9	8	8.0	8	7.6	0	0.0	32	5.9
	Total	327	100	100	100	105	100	9	100	541	100

(Source) Study Team
(Remark) 1.P.Car = Passenger Car + Van
2.Truck = 2Axle Truck + Others
3.Trail = Trailer + 3Axles Truck

Daily Variation at Kafue Road Bridge (To Lusaka) 11/Dec/89

	Time	P.Car	(%)	Truck	(%)	Trail	(%)	Bus	(%)	Total	(%)
7	7-8	18	4.9	0	0.0	5	5.3	1	12.5	24	4.2
8	8-9	19	5.2	7	6.6	12	12.8	0	0.0	38	6.6
9	9-10	28	7.6	9	8.5	2	2.1	1	12.5	40	7.0
10	10-11	29	7.9	5	4.7	10	10.6	0	0.0	44	7.7
11	11-12	29	7.9	6	5.7	3	3.2	0	0.0	38	6.6
12	12-13	16	4.4	6	5.7	8	8.5	2	25.0	32	5.6
13	13-14	19	5.2	9	8.5	3	3.2	1	12.5	32	5.6
14	14-15	28	7.6	10	9.4	7	7.4	0	0.0	45	7.8
15	15-16	34	9.3	6	5.7	8	8.5	1	12.5	49	8.5
16	16-17	29	7.9	7	6.6	3	3.2	0	0.0	39	6.8
17	17-18	19	5.2	9	8.5	5	5.3	0	0.0	33	5.7
18	18-19	23	6.3	4	3.8	4	4.3	1	12.5	32	5.6
19	19-20	22	6.0	4	3.8	4	4.3	0	0.0	30	5.2
20	20-21	14	3.8	5	4.7	3	3.2	0	0.0	22	3.8
21	21-22	7	1.9	0	0.0	5	5.3	0	0.0	12	2.1
22	22-23	6	1.6	0	0.0	2	2.1	0	0.0	8	1.4
23	23-24	4	1.1	1	0.9	1	1.1	0	0.0	6	1.0
24	24-01	2	0.5	0	0.0	0	0.0	0	0.0	2	0.3
1	1-2	0	0.0	0	0.0	2	2.1	0	0.0	2	0.3
2	2-3	0	0.0	2	1.9	0	0.0	0	0.0	2	0.3
3	3-4	1	0.3	2	1.9	0	0.0	0	0.0	3	0.5
4	4-5	1	0.3	3	2.8	2	2.1	0	0.0	6	1.0
5	5-6	2	0.5	1	0.9	4	4.3	1	12.5	8	1.4
6	6-7	17	4.6	10	9.4	1	1.1	0	0.0	28	4.9
	Total	367	100	106	100	94	100	8	100	575	100

(Source) Study Team
(Remark) 1.P.Car = Passenger Car + Van
2.Truck = 2Axle Truck + Others
3.Trail = Trailer + 3Axles Truck

Appendix 3-2 (1/3)

Result of Traffic Counting
Station; Kafue Bridge Date; 11/Dec/89
Direction;From Lusaka to Livingstone

Time	P.Car 1	Van 2	2Axle 3	3Axle 4	Trail 5	Bus(R) 6	Bus(S) 7	Others 8	1+2	3+4+5	6+7	8	Total	%
6-7														
7-8	2	6	1	2	2	0	0	1	8	5	0	1	14	2.6
8-9	3	7	6	0	6	1	0	1	10	12	1	1	24	4.4
9-10	4	8	3	0	4	0	0	0	12	7	0	0	19	3.5
10-11	15	10	4	1	9	0	0	2	25	14	0	2	41	7.6
11-12	8	11	2	1	9	0	0	5	19	12	0	5	36	6.7
12-13	7	13	9	1	5	0	0	1	20	15	0	1	36	6.7
13-14	7	15	8	0	6	1	0	1	22	14	1	1	38	7.0
14-15	13	12	7	0	8	1	0	0	25	15	1	0	41	7.6
15-16	12	17	9	0	7	0	0	0	29	16	0	0	45	8.3
16-17	9	27	9	0	9	0	0	0	36	18	0	0	54	10.0
17-18	8	28	10	0	2	0	0	1	36	12	0	1	49	9.1
18-19	5	21	5	1	8	1	0	1	26	14	1	1	42	7.8
19-20	6	9	2	0	8	0	0	0	15	10	0	0	25	4.6
20-21	0	4	0	0	1	1	0	0	4	1	1	0	6	1.1
21-22	2	5	0	0	3	0	0	0	7	3	0	0	10	1.8
22-23	1	2	0	0	1	0	0	0	3	1	0	0	4	0.7
23-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1-2	0	1	1	0	0	0	0	0	1	1	0	0	2	0.4
2-3	0	1	0	0	0	0	0	0	1	0	0	0	1	0.2
3-4	0	1	0	0	1	1	0	0	1	1	1	0	3	0.6
4-5	0	2	0	0	0	2	0	0	2	0	2	0	4	0.7
5-6	2	7	3	1	1	1	0	0	9	5	1	0	15	2.8
6-7	7	9	7	0	8	0	0	1	16	15	0	1	32	5.9
Total	111	216	86	7	98	9	0	14	327	191	9	14	541	100.0
(%)														

Result of Traffic Counting
Station; Kafue Bridge Date; 11/Dec/89
Direction;To Lusaka from Livingstone

Time	P.Car 1	Van 2	2Axle 3	3Axle 4	Trail 5	Bus(R) 6	Bus(S) 7	Others 8	1+2	3+4+5	6+7	8	Total	%
6-7														
7-8	6	12	0	3	2	1	0	0	18	5	1	0	24	4.2
8-9	10	9	7	0	12	0	0	0	19	19	0	0	38	6.6
9-10	8	20	8	0	2	1	0	1	28	10	1	1	40	7.0
10-11	9	20	4	0	10	0	0	1	29	14	0	1	44	7.7
11-12	4	25	4	0	3	0	0	2	29	7	0	2	38	6.6
12-13	8	8	5	0	8	2	0	1	16	13	2	1	32	5.6
13-14	8	11	9	0	3	1	0	0	19	12	1	0	32	5.6
14-15	14	14	9	1	6	0	0	1	28	16	0	1	45	7.8
15-16	15	19	5	0	8	1	0	1	34	13	1	1	49	8.5
16-17	14	15	7	0	3	0	0	0	29	10	0	0	39	6.8
17-18	8	11	8	1	4	0	0	1	19	13	0	1	33	5.7
18-19	12	11	3	0	4	0	1	1	23	7	1	1	32	5.6
19-20	5	17	3	0	4	0	0	1	22	7	0	1	30	5.2
20-21	7	7	4	0	3	0	0	1	14	7	0	1	22	3.8
21-22	1	6	0	0	5	0	0	0	7	5	0	0	12	2.1
22-23	2	4	0	0	2	0	0	0	6	2	0	0	8	1.4
23-24	1	3	1	0	1	0	0	0	4	2	0	0	6	1.0
24-1	2	0	0	0	0	0	0	0	2	0	0	0	2	0.3
1-2	0	0	0	0	2	0	0	0	0	2	0	0	2	0.3
2-3	0	0	1	0	0	0	0	1	0	1	0	1	2	0.3
3-4	0	1	2	0	0	0	0	0	1	2	0	0	3	0.5
4-5	0	1	3	0	2	0	0	0	1	5	0	0	6	1.0
5-6	0	2	1	0	4	1	0	0	2	5	1	0	8	1.4
6-7	6	11	10	0	1	0	0	0	17	11	0	0	28	4.9
Total	140	227	94	5	89	7	1	12	367	188	8	12	575	100.0
(%)														

Appendix 3-2 (2/3)

Result of Traffic Counting
Station; Great North Road (T4) Date; 12/Dec/89
DIRECTION:FROM LUSAKA TO COPPERBELT

Time	P.Car 1	Van 2	2Axle 3	3Axle 4	Trail 5	Bus(R) 6	Bus(S) 7	Others 8	1+2	3+4+5	6+7	8	Total	%
6-7	7	14	16	0	6	3	0	3	21	22	3	3	49	5.5
7-8	9	9	6	0	2	4	0	2	18	8	4	2	32	3.6
8-9	9	14	12	0	4	7	4	1	23	16	11	1	51	5.8
9-10	6	26	8	0	3	2	1	4	32	11	3	4	50	5.6
10-11	20	23	13	1	9	1	2	5	43	23	3	5	74	8.4
11-12	17	30	17	0	6	4	2	2	47	23	6	2	78	8.8
12-13	21	30	15	2	1	4	1	8	51	18	5	8	82	9.3
13-14	15	27	11	0	5	1	0	14	42	16	1	14	73	8.2
14-15	15	27	16	0	5	5	0	3	42	21	5	3	71	8.0
15-16	20	32	20	0	5	3	0	6	52	25	3	6	86	9.7
16-17	16	42	12	1	9	3	0	8	58	22	3	8	91	10.3
17-18	21	36	14	0	13	2	0	10	57	27	2	10	96	10.8
18-19	5	12	5	0	7	0	0	1	17	12	0	1	30	3.4
19-20	3	5	2	0	1	0	0	3	8	3	0	3	14	1.6
20-21	1	0	5	0	2	0	0	1	1	7	0	1	9	1.0
21-22									0	0	0	0	0	0.0
22-23									0	0	0	0	0	0.0
23-24														
24-1														
1-2														
2-3														
3-4														
4-5														
5-6														
6-7														
Total	185	327	172	4	78	39	10	71	612	254	49	71	886	100
(%)														

Result of Traffic Counting
Station; Great North Road (T4) Date; 12/Dec/89
Direction;To Lusaka From Copperbelt

Time	P.Car 1	Van 2	2Axle 3	3Axle 4	Trail 5	Bus(R) 6	Bus(S) 7	Others 8	1+2	3+4+5	6+7	8	Total
6-7	2	4	12	0	7	0	0	7	6	19	0	7	32
7-8	12	9	7	0	3	1	0	5	21	10	1	5	37
8-9	21	29	12	0	4	2	0	8	50	16	2	8	76
9-10	20	23	13	0	1	2	0	5	43	14	2	5	64
10-11	12	26	11	0	4	3	0	2	38	15	3	2	58
11-12	7	24	11	0	7	1	0	5	31	18	1	5	55
12-13	12	19	10	0	2	7	0	2	31	12	7	2	52
13-14	12	19	12	0	3	6	0	2	31	15	6	2	54
14-15	15	15	11	0	1	5	0	2	30	12	5	2	49
15-16	18	22	12	0	2	0	0	1	40	14	0	1	55
16-17	21	22	19	0	6	0	0	5	43	25	0	5	73
17-18	21	22	17	0	4	5	1	3	43	21	6	3	73
18-19	10	17	8	0	0	2	1	1	27	8	3	1	39
19-20	10	27	6	0	1	0	2	1	37	7	2	1	47
20-21	6	7	0	0	2	0	0	1	13	2	0	1	16
21-22													
Total	199	285	161	0	47	34	4	50	484	208	38	50	780

Appendix 3-2 (3/3)

Result of Traffic Counting
Station; Kafue Road Brdge Date; 14/Dec/89
DIRECTION:FROM LUSAKA TO LIVINGSTONE Cloudy/Rain

Time	P.Car	Van	2Axle	3Axle	Trail	Bus(R)	Bus(S)	Others					
	1	2	3	4	5	6	7	8	1+2	3+4+5	6+7	8	Total	%
6-7	1.0	4.0	0.0	0.0	10.0	1.0	0.0	0.0	5.0	10.0	1.0	0.0	16.0	2.8
7-8	2.0	6.0	7.0	0.0	5.0	1.0	0.0	0.0	8.0	12.0	1.0	0.0	21.0	3.7
8-9	6.0	12.0	5.0	0.0	2.0	2.0	0.0	1.0	18.0	7.0	2.0	1.0	28.0	4.9
9-10	9.0	18.0	4.0	0.0	3.0	0.0	2.0	1.0	27.0	7.0	2.0	1.0	37.0	6.5
10-11	12.0	15.0	6.0	1.0	3.0	1.0	0.0	4.0	27.0	10.0	1.0	4.0	42.0	7.4
11-12	6.0	16.0	8.0	0.0	8.0	1.0	0.0	3.0	22.0	16.0	1.0	3.0	42.0	7.4
12-13	9.0	21.0	5.0	0.0	11.0	0.0	0.0	3.0	30.0	16.0	0.0	3.0	49.0	8.6
13-14	8.0	8.0	9.0	1.0	7.0	0.0	0.0	0.0	16.0	17.0	0.0	0.0	33.0	5.8
14-15	5.0	11.0	7.0	1.0	6.0	0.0	0.0	2.0	16.0	14.0	0.0	2.0	32.0	5.6
15-16	9.0	15.0	11.0	0.0	8.0	0.0	0.0	0.0	24.0	19.0	0.0	0.0	43.0	7.5
16-17	11.0	21.0	15.0	0.0	6.0	0.0	0.0	4.0	32.0	21.0	0.0	4.0	57.0	10.0
17-18	7.0	29.0	10.0	0.0	4.0	0.0	1.0	2.0	36.0	14.0	1.0	2.0	53.0	9.3
18-19	10.0	26.0	3.0	0.0	8.0	0.0	0.0	0.0	36.0	11.0	0.0	0.0	47.0	8.2
19-20	0.0	6.0	2.0	0.0	0.0	1.0	0.0	1.0	6.0	2.0	1.0	1.0	10.0	1.8
20-21	1.0	4.0	2.0	0.0	3.0	0.0	0.0	0.0	5.0	5.0	0.0	0.0	10.0	1.8
21-22	0.0	1.0	1.0	0.0	3.0	0.0	0.0	0.0	1.0	4.0	0.0	0.0	5.0	0.9
22-23	1.0	2.0	4.0	0.0	1.0	0.0	0.0	0.0	3.0	5.0	0.0	0.0	8.0	1.4
23-24	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	2.0	1.0	0.0	0.0	3.0	0.5
24-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-2	1.0	2.0	0.0	0.0	2.0	0.0	0.0	0.0	3.0	2.0	0.0	0.0	5.0	0.9
2-3	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.4
3-4	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.4
4-5	6.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0	10.0	1.0	0.0	0.0	11.0	1.9
5-6	2.0	7.0	3.0	0.0	1.0	0.0	0.0	2.0	9.0	4.0	0.0	2.0	15.0	2.6
6-7									0.0	0.0	0.0	0.0	0.0	0.0
Total	107.0	229.0	104.0	3.0	93.0	9.0	3.0	23.0	336.0	200.0	12.0	23.0	571.0	100.0
(%)														

Result of Traffic Counting
Station; Kafue Road Brdge Date; 14/Dec/89
DIRECTION:TO LUSAKA FROM LIVINGSTONE Cloudy/Rain

Time	P.Car	Van	2Axle	3Axle	Trail	Bus(R)	Bus(S)	Others					
	1	2	3	4	5	6	7	8	1+2	3+4+5	6+7	8	Total	%
6-7	3.0	14.0	4.0	1.0	5.0	0.0	0.0	1.0	17.0	10.0	0.0	1.0	28.0	5.0
7-8	6.0	22.0	7.0	1.0	8.0	1.0	0.0	0.0	28.0	16.0	1.0	0.0	45.0	8.1
8-9	8.0	19.0	9.0	0.0	7.0	0.0	0.0	2.0	27.0	16.0	0.0	2.0	45.0	8.1
9-10	9.0	16.0	7.0	0.0	3.0	0.0	0.0	3.0	25.0	10.0	0.0	3.0	38.0	6.8
10-11	4.0	17.0	8.0	0.0	2.0	0.0	0.0	3.0	21.0	10.0	0.0	3.0	34.0	6.1
11-12	3.0	17.0	6.0	1.0	4.0	1.0	1.0	5.0	20.0	11.0	2.0	5.0	38.0	6.8
12-13	9.0	11.0	5.0	0.0	3.0	1.0	0.0	2.0	20.0	8.0	1.0	2.0	31.0	5.6
13-14	8.0	12.0	4.0	0.0	20.0	2.0	0.0	1.0	20.0	24.0	2.0	1.0	47.0	8.4
14-15	8.0	7.0	6.0	0.0	9.0	1.0	1.0	1.0	15.0	15.0	2.0	1.0	33.0	5.9
15-16	9.0	11.0	3.0	1.0	9.0	0.0	0.0	1.0	20.0	13.0	0.0	1.0	34.0	6.1
16-17	1.0	12.0	4.0	0.0	9.0	3.0	0.0	1.0	13.0	13.0	3.0	1.0	30.0	5.4
17-18	13.0	19.0	4.0	0.0	5.0	1.0	0.0	1.0	32.0	9.0	1.0	1.0	43.0	7.7
18-19	10.0	15.0	2.0	0.0	8.0	3.0	0.0	1.0	25.0	10.0	3.0	1.0	39.0	7.0
19-20	7.0	10.0	3.0	0.0	3.0	0.0	0.0	0.0	17.0	6.0	0.0	0.0	23.0	4.1
20-21	1.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	0.9
21-22	2.0	5.0	0.0	0.0	3.0	0.0	0.0	0.0	7.0	3.0	0.0	0.0	10.0	1.8
22-23	4.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	5.0	2.0	0.0	0.0	7.0	1.3
23-24	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.2
24-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-2	1.0	1.0	1.0	0.0	2.0	0.0	0.0	0.0	2.0	3.0	0.0	0.0	5.0	0.9
2-3	0.0	1.0	0.0	0.0	3.0	0.0	0.0	0.0	1.0	3.0	0.0	0.0	4.0	0.7
3-4	1.0	1.0	2.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	4.0	0.7
4-5	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.4
5-6	0.0	4.0	2.0	0.0	5.0	0.0	0.0	0.0	4.0	7.0	0.0	0.0	11.0	2.0
6-7														
Total	107.0	219.0	79.0	4.0	111.0	13.0	2.0	22.0	326.0	194.0	15.0	22.0	557.0	100.0
(%)														

Appendix 3-3 (1/6)

Origin	Vehicle Type				
Zone	Total	cars	Truck,	Bus,	No Answer
1. Lusaka City Urban Area	295 (100.0%)	182 (61.7%)	113 (38.3%)	0 (.0%)	0 (.0%)
2. Kafue Area	92 (100.0%)	68 (73.9%)	24 (26.1%)	0 (.0%)	0 (.0%)
3. Chilanga	3 (100.0%)	1 (33.3%)	2 (66.7%)	0 (.0%)	0 (.0%)
4. Lusaka West	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	4 (100.0%)	2 (50.0%)	2 (50.0%)	0 (.0%)	0 (.0%)
6. Southern Province	390 (100.0%)	274 (70.3%)	111 (28.5%)	5 (1.3%)	0 (.0%)
7. Eastern Province	2 (100.0%)	1 (50.0%)	1 (50.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
9. Kapiri Area	7 (100.0%)	4 (57.1%)	3 (42.9%)	0 (.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	7 (46.7%)	7 (46.7%)	1 (6.7%)	0 (.0%)
12. Northwestern province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
14. Nothern province	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
15. Luapula	3 (100.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
16. Botswana	5 (100.0%)	4 (80.0%)	1 (20.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	29 (100.0%)	12 (41.4%)	15 (51.7%)	2 (6.9%)	0 (.0%)
18. Kenya Tanzania	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)
19. Malawi	4 (100.0%)	1 (25.0%)	3 (75.0%)	0 (.0%)	0 (.0%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	7 (100.0%)	1 (14.3%)	6 (85.7%)	0 (.0%)	0 (.0%)
22. Angola	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	6 (100.0%)	4 (66.7%)	2 (33.3%)	0 (.0%)	0 (.0%)
24. Namibia	3 (100.0%)	0 (.0%)	3 (100.0%)	0 (.0%)	0 (.0%)
25. Swazcland	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	573 (65.4%)	295 (33.7%)	8 (.9%)	0 (.0%)

Destination					
	Total	cars	Truck,	Bus	No Answer
1. Lusaka City Urban Area	311 (100.0%)	220 (70.7%)	89 (28.6%)	2 (.6%)	0 (.0%)
2. Kafue Area	80 (100.0%)	57 (71.3%)	21 (26.3%)	2 (2.5%)	0 (.0%)
3. Chilanga	6 (100.0%)	5 (83.3%)	1 (16.7%)	0 (.0%)	0 (.0%)
4. Lusaka West	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	3 (100.0%)	1 (33.3%)	2 (66.7%)	0 (.0%)	0 (.0%)
6. Southern Province	379 (100.0%)	257 (67.8%)	121 (31.9%)	1 (.3%)	0 (.0%)
7. Eastern Province	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
9. Kapiri Area	5 (100.0%)	2 (40.0%)	2 (40.0%)	1 (20.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	8 (53.3%)	6 (40.0%)	1 (6.7%)	0 (.0%)
12. Northwestern province	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
14. Nothern province	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
15. Luapula	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
16. Botswana	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	38 (100.0%)	11 (28.9%)	27 (71.1%)	0 (.0%)	0 (.0%)
18. Kenya Tanzania	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)
19. Malawi	11 (100.0%)	8 (72.7%)	2 (18.2%)	1 (9.1%)	0 (.0%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	12 (100.0%)	0 (.0%)	12 (100.0%)	0 (.0%)	0 (.0%)
22. Angola	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	8 (100.0%)	2 (25.0%)	6 (75.0%)	0 (.0%)	0 (.0%)
24. Namibia	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
25. Swazcland	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	573 (65.4%)	295 (33.7%)	8 (.9%)	0 (.0%)

Appendix 3-3 (2/6)

Origin	Loaded Materials							
	Total	1. Empty	2. Agricultural	3. Mineral goods	4. Chemical production	5. Industrial products	6. Miscellaneous	7. 無回答
1. Lusaka City Urban Area	295 (100.0%)	248 (84.1%)	10 (3.4%)	3 (1.0%)	5 (1.7%)	23 (7.8%)	6 (2.0%)	0 (.0%)
2. Kafue Area	92 (100.0%)	84 (91.3%)	2 (2.2%)	1 (1.1%)	0 (.0%)	5 (5.4%)	0 (.0%)	0 (.0%)
3. Chilanga	3 (100.0%)	1 (33.3%)	2 (66.7%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
4. Lusaka West	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	4 (100.0%)	1 (25.0%)	0 (.0%)	0 (.0%)	1 (25.0%)	1 (25.0%)	1 (25.0%)	0 (.0%)
6. Southern Province	390 (100.0%)	302 (77.4%)	16 (4.1%)	51 (13.1%)	2 (.5%)	16 (4.1%)	3 (.8%)	0 (.0%)
7. Eastern Province	2 (100.0%)	1 (50.0%)	1 (50.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
9. Kapiri Area	7 (100.0%)	6 (85.7%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (14.3%)	0 (.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	8 (53.3%)	1 (6.7%)	0 (.0%)	2 (13.3%)	2 (13.3%)	2 (13.3%)	0 (.0%)
12. Northwestern province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
14. Nothern province	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
15. Luapula	3 (100.0%)	2 (66.7%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (33.3%)	0 (.0%)
16. Botswana	5 (100.0%)	3 (60.0%)	0 (.0%)	0 (.0%)	0 (.0%)	2 (40.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	29 (100.0%)	12 (41.4%)	3 (10.3%)	3 (10.3%)	3 (10.3%)	8 (27.6%)	0 (.0%)	0 (.0%)
18. Kenya Tanzania	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
19. Malawi	4 (100.0%)	1 (25.0%)	2 (50.0%)	1 (25.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	7 (100.0%)	5 (71.4%)	0 (.0%)	2 (28.6%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
22. Angola	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	6 (100.0%)	3 (50.0%)	0 (.0%)	0 (.0%)	0 (.0%)	3 (50.0%)	0 (.0%)	0 (.0%)
24. Namibia	3 (100.0%)	0 (.0%)	0 (.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
25. Swaziland	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	688 (78.5%)	37 (4.2%)	64 (7.3%)	13 (1.5%)	61 (7.0%)	13 (1.5%)	0 (.0%)

Appendix 3-3 (3/6)

Destination	Loaded Materials							
	Total	1. Empty	2. Agricultural	3. Mineral goods	4. Chemical production	5. Industrial products	6. Miscellenieous	7. 無回答
1. Lusaka City Urban Area	311 (100.0%)	238 (76.5%)	16 (5.1%)	42 (13.5%)	0 (.0%)	13 (4.2%)	2 (.6%)	0 (.0%)
2. Kafue Area	80 (100.0%)	65 (81.3%)	1 (1.3%)	9 (11.3%)	1 (1.3%)	4 (5.0%)	0 (.0%)	0 (.0%)
3. Chilanga	6 (100.0%)	4 (66.7%)	0 (.0%)	1 (16.7%)	0 (.0%)	0 (.0%)	1 (16.7%)	0 (.0%)
4. Lusaka West	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	3 (100.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
6. Southern Province	379 (100.0%)	322 (85.0%)	10 (2.6%)	2 (.5%)	7 (1.8%)	31 (8.2%)	7 (1.8%)	0 (.0%)
7. Eastern Province	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
9. Kapiri Area	5 (100.0%)	2 (40.0%)	1 (20.0%)	1 (20.0%)	0 (.0%)	1 (20.0%)	0 (.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	9 (60.0%)	2 (13.3%)	0 (.0%)	2 (13.3%)	2 (13.3%)	0 (.0%)	0 (.0%)
12. Northwestern province	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
14. Nothern province	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)
15. Luapula	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
16. Botswana	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	38 (100.0%)	27 (71.1%)	6 (15.8%)	3 (7.9%)	0 (.0%)	0 (.0%)	2 (5.3%)	0 (.0%)
18. Kenya Tanzania	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)
19. Malawi	11 (100.0%)	5 (45.5%)	0 (.0%)	2 (18.2%)	3 (27.3%)	1 (9.1%)	0 (.0%)	0 (.0%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	12 (100.0%)	1 (8.3%)	1 (8.3%)	3 (25.0%)	0 (.0%)	7 (58.3%)	0 (.0%)	0 (.0%)
22. Angola	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	8 (100.0%)	7 (87.5%)	0 (.0%)	1 (12.5%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
24. Namibia	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
25. Swaziland	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	688 (78.5%)	37 (4.2%)	64 (7.3%)	13 (1.5%)	61 (7.0%)	13 (1.5%)	0 (.0%)

Appendix 3-3 (4/6)

Fig. ? Classification of Vehicle

Origin of Trips	Vehicle Type					Vehicle Type				
	Total	1. 乗用	2. 貨物	3. バス	4. 無回答	Total	1. 乗用	2. 貨物	3. バス	4. 無回答
1. Lusaka City Urban Area	295 (100.0%)	182 (61.7%)	113 (38.3%)	0 (.0%)	0 (.0%)	311 (100.0%)	220 (70.7%)	89 (28.6%)	2 (.6%)	0 (.0%)
2. Kafue Area	92 (100.0%)	68 (73.9%)	24 (26.1%)	0 (.0%)	0 (.0%)	80 (100.0%)	57 (71.3%)	21 (26.3%)	2 (2.5%)	0 (.0%)
3. Chilanga	3 (100.0%)	1 (33.3%)	2 (66.7%)	0 (.0%)	0 (.0%)	6 (100.0%)	5 (83.3%)	1 (16.7%)	0 (.0%)	0 (.0%)
4. Lusaka West	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	4 (100.0%)	2 (50.0%)	2 (50.0%)	0 (.0%)	0 (.0%)	3 (100.0%)	1 (33.3%)	2 (66.7%)	0 (.0%)	0 (.0%)
6. Southern Province	390 (100.0%)	274 (70.3%)	111 (28.5%)	5 (1.3%)	0 (.0%)	379 (100.0%)	257 (67.8%)	121 (31.9%)	1 (.3%)	0 (.0%)
7. Eastern Province	2 (100.0%)	1 (50.0%)	1 (50.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)
9. Kapiri Area	7 (100.0%)	4 (57.1%)	3 (42.9%)	0 (.0%)	0 (.0%)	5 (100.0%)	2 (40.0%)	2 (40.0%)	1 (20.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	7 (46.7%)	7 (46.7%)	1 (6.7%)	0 (.0%)	15 (100.0%)	8 (53.3%)	6 (40.0%)	1 (6.7%)	0 (.0%)
12. Northwestern province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
14. Nothern province	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
15. Luapula	3 (100.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
16. Botswana	5 (100.0%)	4 (80.0%)	1 (20.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	29 (100.0%)	12 (41.4%)	15 (51.7%)	2 (6.9%)	0 (.0%)	38 (100.0%)	11 (28.9%)	27 (71.1%)	0 (.0%)	0 (.0%)
18. Kenya Tanzania	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)
19. Malawi	4 (100.0%)	1 (25.0%)	3 (75.0%)	0 (.0%)	0 (.0%)	11 (100.0%)	8 (72.7%)	2 (18.2%)	1 (9.1%)	0 (.0%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	7 (100.0%)	1 (14.3%)	6 (85.7%)	0 (.0%)	0 (.0%)	12 (100.0%)	0 (.0%)	12 (100.0%)	0 (.0%)	0 (.0%)
22. Angola	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	6 (100.0%)	4 (66.7%)	2 (33.3%)	0 (.0%)	0 (.0%)	8 (100.0%)	2 (25.0%)	6 (75.0%)	0 (.0%)	0 (.0%)
24. Namibia	3 (100.0%)	0 (.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
25. Swazcland	2 (100.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	573 (65.4%)	295 (33.7%)	8 (.9%)	0 (.0%)	876 (100.0%)	573 (65.4%)	295 (33.7%)	8 (.9%)	0 (.0%)

Appendix 3-3 (5/6)

Origin of Trips	Trip Purpose									
	Total	1. To work	2. Business	3. To hose	4. Shopping	5. Entertainment	6. To school	7. Social Visit	8. Others	9. 無回答
1. Lusaka City Urban Area	295 (100.0%)	17 (5.8%)	172 (58.3%)	2 (.7%)	9 (3.1%)	70 (23.7%)	0 (.0%)	13 (4.4%)	10 (3.4%)	2 (.7%)
2. Kafue Area	92 (100.0%)	3 (3.3%)	53 (57.6%)	4 (4.3%)	4 (4.3%)	16 (17.4%)	0 (.0%)	3 (3.3%)	7 (7.6%)	2 (2.2%)
3. Chilanga	3 (100.0%)	0 (.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
4. Lusaka West	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	4 (100.0%)	0 (.0%)	2 (50.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	2 (50.0%)	0 (.0%)	0 (.0%)
6. Southern Province	390 (100.0%)	33 (8.5%)	230 (59.0%)	16 (4.1%)	3 (.8%)	76 (19.5%)	2 (.5%)	26 (6.7%)	4 (1.0%)	0 (.0%)
7. Eastern Province	2 (100.0%)	0 (.0%)	1 (50.0%)	0 (.0%)	1 (50.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	2 (100.0%)	0 (.0%)
9. Kapiri Area	7 (100.0%)	0 (.0%)	5 (71.4%)	0 (.0%)	0 (.0%)	1 (14.3%)	0 (.0%)	1 (14.3%)	0 (.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	0 (.0%)	8 (53.3%)	0 (.0%)	1 (6.7%)	4 (26.7%)	0 (.0%)	1 (6.7%)	1 (6.7%)	0 (.0%)
12. Northwestern province	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)
14. Nothern province	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
15. Luapula	3 (100.0%)	0 (.0%)	2 (66.7%)	0 (.0%)	0 (.0%)	1 (33.3%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
16. Botswana	5 (100.0%)	0 (.0%)	2 (40.0%)	0 (.0%)	0 (.0%)	2 (40.0%)	0 (.0%)	1 (20.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	29 (100.0%)	0 (.0%)	18 (62.1%)	0 (.0%)	0 (.0%)	3 (10.3%)	0 (.0%)	7 (24.1%)	0 (.0%)	1 (3.4%)
18. Kenya Tanzania	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
19. Malawi	4 (100.0%)	0 (.0%)	4 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	7 (100.0%)	0 (.0%)	6 (85.7%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (14.3%)	0 (.0%)	0 (.0%)
22. Angola	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	6 (100.0%)	0 (.0%)	4 (66.7%)	0 (.0%)	0 (.0%)	1 (16.7%)	0 (.0%)	1 (16.7%)	0 (.0%)	0 (.0%)
24. Namibia	3 (100.0%)	0 (.0%)	3 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
25. Swaziland	2 (100.0%)	0 (.0%)	1 (50.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (50.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	53 (6.1%)	519 (59.2%)	22 (2.5%)	19 (2.2%)	174 (19.9%)	2 (.2%)	58 (6.6%)	24 (2.7%)	5 (.6%)

Appendix 3-3 (6/6)

Destination of Trips	Trip Purpose									
	Total	1. To work	2. Business	3. To home	4. Shopping	5. Entertainment	6. To school	7. Social Visit	8. Others	9. 無回答
1. Lusaka City Urban Area	311 (100.0%)	23 (7.4%)	187 (60.1%)	9 (2.9%)	2 (.6%)	62 (19.9%)	1 (.3%)	24 (7.7%)	3 (1.0%)	0 (.0%)
2. Kafue Area	80 (100.0%)	10 (12.5%)	40 (50.0%)	7 (8.8%)	1 (1.3%)	16 (20.0%)	1 (1.3%)	4 (5.0%)	1 (1.3%)	0 (.0%)
3. Chilanga	6 (100.0%)	1 (16.7%)	3 (50.0%)	0 (.0%)	1 (16.7%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (16.7%)	0 (.0%)
4. Lusaka West	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
5. Lusaka East	3 (100.0%)	0 (.0%)	2 (66.7%)	0 (.0%)	0 (.0%)	1 (33.3%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
6. Southern Province	379 (100.0%)	19 (5.0%)	215 (56.7%)	6 (1.6%)	11 (2.9%)	90 (23.7%)	0 (.0%)	16 (4.2%)	18 (4.7%)	4 (1.1%)
7. Eastern Province	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
8. Mumbwa Area	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
9. Kapiri Area	5 (100.0%)	0 (.0%)	3 (60.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	2 (40.0%)	0 (.0%)	0 (.0%)
10. Serenje Area	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
11. Copperbelt Province	15 (100.0%)	0 (.0%)	10 (66.7%)	0 (.0%)	0 (.0%)	1 (6.7%)	0 (.0%)	4 (26.7%)	0 (.0%)	0 (.0%)
12. Northwestern province	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
13. Western Province	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
14. Nothern province	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
15. Luapula	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
16. Botswana	1 (100.0%)	0 (.0%)	1 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
17. Zimbabwe	38 (100.0%)	0 (.0%)	29 (76.3%)	0 (.0%)	4 (10.5%)	1 (2.6%)	0 (.0%)	4 (10.5%)	0 (.0%)	0 (.0%)
18. Kenya Tanzania	2 (100.0%)	0 (.0%)	2 (100.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
19. Malawi	11 (100.0%)	0 (.0%)	6 (54.5%)	0 (.0%)	0 (.0%)	1 (9.1%)	0 (.0%)	3 (27.3%)	0 (.0%)	1 (9.1%)
20. Mozambique	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
21. Zaire	12 (100.0%)	0 (.0%)	11 (91.7%)	0 (.0%)	0 (.0%)	1 (8.3%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
22. Anghla	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
23. Republic of South Africa	8 (100.0%)	0 (.0%)	6 (75.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	1 (12.5%)	1 (12.5%)	0 (.0%)
24. Namibia	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
25. Swazcland	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)	0 (.0%)
26. Total	876 (100.0%)	53 (6.1%)	519 (59.2%)	22 (2.5%)	19 (2.2%)	174 (19.9%)	2 (.2%)	58 (6.6%)	24 (2.7%)	5 (.6%)

TRAFFIC SURVEY
INSTRUCTION MANUAL

DECEMBER, 1989

JICA STUDY TEAM

FOR

KAFUE ROAD BRIDGE RECONSTRUCTION PROJECT

3-4 INSTRUCTION MANUAL OF TRAFFIC SURVEY

PART(1)

1. Introduction

In response to the request made by the Government of Zambia for the Kafue Road Bridge Construction Project, the Government of Japan has sent a team to carry out the feasibility study on it.

The Government of Zambia will have been finished the fourth five years development plan (1985-89) in this year. The New Fifth 5-years Plan (1990-94) will start the next year which has to develop efficiently the agricultural and non-mining industries.

In the field of "Transportation", it can be said following two viewpoints.

(1) The development of appropriate agricultural structure depend upon the well balanced infrastructure development, especially road network structure.

(2) Zambia, due to an inland country, the sections of international roads in outside countries has always some potentiality of anxiety for national-security. From this point of view, road sections in Zambia should be well developed improved as well.

Kafue Road Bridge is one of strategically important points for Zambia from above mentioned viewpoints. This study should analyze that Kafue Road Bridge is necessary to reconstruct new bridge instead of present bridge from engineering point of view and its economic feasibility.

This traffic survey will provide data/information to the study team to enable decision making on future implementation of the proposed project. That is, the obtained data/information of traffic characteristics by the traffic survey will be utilized to forecast the future traffic volume and to study an economic feasibility. Those data can be utilized also by Zambian Government on the other purposes such as formulating a plan of road improvement/construction etc.

2. Purpose of this traffic survey

In order to analyze the feasibility of Kafue Road Bridge Construction Project, it is necessary to ascertain the origin and destination of vehicle trip and the details of the characteristics of vehicle movements at this bridge.

The obtained data/information about vehicle movements will be examined to analyze the existing road network and to make up a plan to meet the traffic demand in future.
With the results of this survey, the traffic volume, nature and characteristics of existing vehicle trips can be determined. Hence, results of the survey offer useful data not only for this bridge construction planning but also for the comprehensive regional planning.

3. Outline of the Survey

3.1 Content of the survey

This survey consists of two parts;

(a) Interviewing

(b) Traffic counting

In the interviewing survey, vehicles passing through the survey station will be interviewed during each hour from 6:00 am. to 6:00 pm.. In traffic counting, all the vehilces passing through the station during the 24 hours period beginning at 6:00 am. will counted on an hourly basis according to the vehicle type.

3.2 Survey Station

Survey stations are selected as follows;

(1) O-D Survey ----- Kafue Road Bridge (11/Dec.)

(2) Traffic count -- a) Kafue Road Bridge (11/Dec.)
b) Fringe of Lusaka urban area on T4 near air port, point No.ZO105 by Road Department Survey (12/Dec.)
c) Fringe of Lusaka urban area on T2

near Motomoto, point No.ZT28 by Road Department Survey (12/Dec.)

3.3 Interviewing

(a) Questionnaire for interviewing are as follows;

1. Origin of the trip
2. Destination of the trip
3. Purpose of the trip
4. Number of passengers
   (in case of a passenger car/van)
5. Kinds of loaded goods
6. Tonnage of loaded goods
   (in case of a truck/lorry)

(b) Procedure

In the interviewing survey, all of the vehicles passing through the survey stations will be interviewed during the survey period.

The average interviewing time is expected to be less than 3 minutes.

This O-D survey is conducted for 12 hours beginning at 6:00 a.m.

The personnel involved for each station is as follows;

Director of the traffic survey
Counterpart from Road Department
Supervisor
Group leader of interviewers
Interviewers
Counters
Personnel for urgent communication
Policemen
Defence officer if necessary

The number of personnels is shown in Table 3.1.
Also the organization chart is shown in Figure 3.1.

Policemen are assigned to stop and guide the vehicle. The supervisor and policemen should watch that the survey is carried out smoothly and safety.

Supervisor and two group leaders (at both direction of traffic flow) should be engaged to watch the progress of the survey.

Interviewers should take care of traffic accidents and troubles due to the survey is carried out along the roadside at the survey station.

3.4 Notice of interviewing

It must be emphasised here that the co-operation of the public is entirely voluntary. If any driver refuses to answer the questions, he/she will be allowed to leave the group of interviewing vehicles as far as he can avoid any traffic accidents.

Interviewers should mention that the following vehicles should be excluded for interview.

1) Ambulances
2) Fire engines
3) Post office vans
4) Police cars
5) Security vehicles
6) Armed service vehicles
7) Buses on regular route
8) VIP cars with/without an escorts of policement
9) Forklift and road construction vehicles
10) Ox-carts
11) Motor cycles

It should be mentioned the governmental car/truck should be interviewed except above mentioned vehicle types.

3.5 Traffic Counting

(a) Purpose of traffic Counting

When it will have heavy rain or traffic delay will be induced by the O-D survey, the survey should be stopped until such condition is cleared. The hourly result of such condition has not gained complete data. In such case, it should be estimated the whole-hourly-data using by the result of traffic counting. Therefore, the traffic counting survey has an important purpose to get the total volume of each hour and whole day in order to enlarge the results of sampling data to exact each one hour vehicle volume.

(b) Classification of vehicle type

Vehicle type is classified in this study as follows;

1) Passenger car
2) Van, Pick-up, Landrover, Landcrusor and Caravan
3) Lorry/Truck: two axles
4) Lorry/Truck: three axles and more
5) Lorry/Truck: draw-bar-trailer
6) Bus: regular route bus
7) Bus: sight-seeing bus or private-use bus
8) Others: army-vehicles, construction-vehilce, police car, emergency-vehilce etc.

(c) Procedure

Group of two or three persons, stationed by the road-side will perform assigned functions. They count the traffic volume by means of a counting sheet. Supervisor should check their records/informations collected.

The function of the counting person are only counting an information on the number of vehicles passing by, the type of vehilces and direction which is heading for. In every hour, the total number of vehicles by type is recorded in a given form. The location of these groups will be at the back of the line of interviewers for the O-D survey. The counting will commence from 6:00 am. to 6:00 pm.

4. Explanation of questionnaires

4.1 Procedure of interviewing

The interview should commence with an introductory greeting:

"Good Morning/Afternoot Sir/Madam. We are carrying out a traffic survey, would you please answer some questions about the usage of your vehilce."

(a) Origin of the trip

Ask the driver the origin of this trip i.e. the place he/she started this journey.
Record the name of province, city or village or major facilities.

Ex. Where do you come from of this trip?

(b) Destination of the trip

Ask the driver where he/she will close his/her journey.
Record the name of province, city and village.

Ex. Where do you want to go?

(c) Purpose of the trip

Ask the driver the purpose of this trip and mark the corresponding number according to the categories lists in the questionnaire sheet.

(d) Number of passengers (in case of passenger car/van)

Ask the driver the number of passenger of who boarded his/her vehilce for this trip, put the figure to the column. If she/he is not sure of the exact numbers, ask him/her to give the approximate number. In the case where there is no other passenger, put "0"(zero) into the corresponding column (i.e. to exclude driver himself/herself).

6. Definition of Trip

6.1 Origin and Destination of trip are most important questions in this questionnaire.

Simply saying, origin of trip means the starting place to drive of this trip. That is, Origin means the last place where the driver starts to move the vehilce up to this station. Destination means the ending place where the driver will stop the moving passing through the survey station.

Origin and Destination should be recorded clearly the name of place. (1) Name of Province, city or village
If it will be difficult, following names can be recorded instead of place. (2) The major facilities such as:

- Air port
- Governmental facilities
- Big factory
- National park
- Lake or river or bridge etc.

PART(2)

1. Manners as an interviewer

This survey is most important part in the traffic planning. Results of the survey are fully depend on the individual interviewer's effort. We have many excellent methods to analyze and a superior computing machine to calculate. But, if the data taken from the survey have not been complete, we can not get the right result from the analysis.
Therefore, the interviewer should always have the intention to trace actual activities. For that reasons mentioned above:

(a) It is necessary to understand the content of the survey in detail. When someone asks a question, the interviewer should always be able to answer it.

(b) The interviewer should carry out the survey according to the instruction. Do not modify or interpret the terms based upon your own judgement or assumption.

(c) Observe the rules and schedule strictly. For example, interviewer must gather punctually at the meeting place on the specified time/data.

(d) During the actual survey, interviewer should take care of diction and manner.

(e) During the actual survey, interviewer must follow the direction of the policemen.

(f) Interviewer should ask the advice of the supervisors whenever the unknown or unexpected matter will happen.

2. Attention

2.1 Check

Every interviewer should check their own marked questionnaire sheet in the rest of interviewing.
In the checking, every interviewer should examine the next point.

(1) The station No., sheet No., time of the interviewing
(2) Name of interviewer and supervisor
(3) Is there any blank in the answering column?
Especially Origin and Destination.
(4) Is there no mistake in the making in every column?

Every interviewer should make these checking as early as possible and while your memories are still clear.

2.2 Attention

It must be emphasized here again that the co-operation of the public is entirely voluntary. If any driver refuse to answer the questions, it will be allowed to leave the group of interviewing vehicles as far as he can avoid any accidents.

3. Appendix

3.1 Type of Vehicles

Interviewers should identify the kind of vehicles as follows:

(1) Passenger car
Private saloon owned by private owner
Saloon owned by company or governmental bodies.

(2) Van, Pickup, Landrover and Landcrusor
Usual van with utilities for persons and goods
Small size truck and Jeep, Landrover, Landcrusor

(3) Lorry; two axles
Truck with front and rear wheel

(4) Lorry: three axles and more
Truck with front wheel and more than two rear wheels

(5) Lorry; draw-bar-trailer
Driver and engine (that is tractor) are separated with trailer by bar.

(6) Bus; Regular route bus
Usual public bus which operated on regular routes

(7) Bus; Sight-seeing bus and private bus
Sight-seeing bus which operated unregularly
Private owned bus which transport own shop or companies including rental car

(8) Others
Army vehicles, Ambulance, Fire engine, Police car, Petro tank, Construction vehicle, Refrigerator, etc.

3.2 Trip Purpose

(1) To work (going to work)
Going to work-place of driver
Sending other person to his work place

(2) Business (business engagement)
Selling insurance, transporting goods to customer. Delivering materials, going to meeting or other business

(3) To home
Going back home from work, shopping, etc.

(4) Shopping (to go shopping/marketing)
going to market, shops and other shopping places for the purpose of buying fish, vegetables, clothes and etc.

(5) Entertainment (For foods/entertainment)

(6) To School
Studying, or sending children to school.

(7) Social visit
Social gathering, visiting relatives, going to air port and other private purpose.

TRAFFIC COUNTING SHEET

JICA STUDY TEAM
Date 11 DEC,1989

Station No.	Direction from to	Name of surveyor	Name of Survisor	Sheet No.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
6 - 7															
7 - 8															
8 - 9															
10 - 11															
11 - 12															
12 - 13															
13 - 14															
14 - 15															
15 - 16															
16 - 17															
17 - 18															
Sub total															
Total															

ROADSIDE OD SURVEY QUESTIONAIR DATE 1989

STATION NO.	TIME: TO	DIRECTION FROM TO	NAME OF INTERVIEWER	NAME OF SUPERVISOR	SHEET NO:

No.	TYPE OF CAR	Origin	Destinition	Loaded Goods	Loaded Tonage	ONLY FOR PASSENGER CAR PURPOSE	PASSENGER
1.	1.Passenger car 2.Van,Landcrusor 3.Lorry;2 axles 4.Lorry;3 axles 5.Lorry;trailer and tracter 6.Bus;Regular 7.Bus;Sightseeing 8.Others ( )	1.Lusaka city 2.Kafue city 3.Livingston 4.Copperbelt 5.Zimbabwe ( )	1.Lusaka city 2.Kafue city 3.Livingston 4.Copperbelt 5.Zimbabwe ( )	Loaded Goods 1. 2. 3.	Loaded Tonage 1. ton 2. ton 3. ton	1.to work 2.Bussiness 3.Shopping 4.Entertainment 5.To home 6.To school 7.Social visit 8.Other	DRIVER + ( ) PERSON
2.	1. 2. 3. 4. 5. 6. 7. 8. ( )			1. 2. 3.	1. ton 2. ton 3. ton	1 3 5 7 2 4 6 8	DRIVER + ( ) PERSON
3.	1. 2. 3. 4. 5. 6. 7. 8. ( )			1. 2. 3.	1. ton 2. ton 3. ton	1 3 5 7 2 4 6 8	DRIVER + ( ) PERSON
4.	1. 2. 3. 4. 5. 6. 7. 8. ( )			1. 2. 3.	1. ton 2. ton 3. ton	1 3 5 7 2 4 6 8	DRIVER + ( ) PERSON
5.	1. 2. 3. 4. 5. 6. 7. 8. ( )			1. 2. 3.	1. ton 2. ton 3. ton	1 3 5 7 2 4 6 8	DRIVER + ( ) PERSON

VEHICLE TYPE

1. Passenger car
2. Van, Pickup, Landcrusor, Landrover
3. Lorry; 2 axles
4. Lorry; 3 axles
5. Lorry; trailer and tracter
6. Bus; Regular route bus
7. Bus; Sightseeing bus
8. Others

Vehicle Type	5	10	15	20	Total
( )					
( )					
( )					
( )					

JICA STUDY TEAM

THE FEASIBILITY STUDY ON Kafue Road Bridge PROJECT

TRAFFIC VOLUME SURVEY

Sheet No. _____

STATION No. _____

SURVEYOR NAME _____

CHECKED BY _____

DIRECTION { FROM / TO } LUSAKA

TIME FROM ___:___ TO ___:___ AM PM

DATE 11 DEC. 1989

Vehicle Type	5	10	15	20	Total
( )					
( )					
( )					
( )					
( )					