4.2.2 Vertical Alignment

1) R. de Francia Avenue

In the corridor R. de Francia Av. / Ygatimî Av., between Colón Avenue and the connecting bridge, the slope changes in a comparatively short distance. The greatest slope is the one located between Brasil and Rojas Silva Streets, which is 6.8%. This value is inside the established limits for a design speed of 60 km/h with respect to the maximal longitudinal slope and vertical curves of minimal ratio. Therefore, it has been adopted as a structure which fits to the current one, without introducing corrections on the vertical alignment.

2) Connecting Bridge

The four main lanes destined for fast circulation will be elevated through the viaduct. Therefore, it has been planned in such way to keep the 5.0m vertical clearance on the spaces destinated for the secondary streets, on the R. de Francia Avenue section, as well as, on the Eusebio Ayala Avenue section.

According to the AASHTO standards, the minimal ratio of vertical curves for a 60 km/hour design speed is about 2,500m for the convex surface, and around 2,100m for the concave surface. The end corresponding to Eusebio Ayala Avenue was designed employing these values, in order to have continuous vertical curves, resulting in the maximum vertical slope of 4.24%. On the other hand, on the end corresponding to R. de Francia Avenue, the 5.25% current street slope was used.

3) Eusebio Ayala Avenue

This artery presents a relatively gentle slope, where the maximal slope of 4.13% exists on the section between Kubitscheck and Choferes del Chaco Avenues. On the other hand, the section between Rca. Argentina and De la Victoria Avenues, and the one corresponding to Fernando de la Mora Municipality have slopes of 0.4% and 0.3% respectively. These values are lower than the necessary drainage slope, and therefore, floods occur. Consequently, it has been planned to elevate the road surface from 0.5m to 1m or more than the present height.

The overflowed areas along Eusebio Ayala Avenue, indicated on the Storm Water drainage Project of Asunción and its Metropolitan Area of 1987, constitute those sections which have gentle slopes and low areas such as:

- New intersection with Gral. Santos Avenue
- New intersection with Choferes del Chaco Avenue
- New intersection with Boggiani Avenue

Concerning the low areas, the storm water which concentrates in those areas will be drained away through the construction of a perpendicular drainage channel to Eusebio Ayala Avenue. Therefore, this aspect was not considered in the vertical alignment.

In the section of the viaduct of Eusebio Ayala Avenue, the same AASHTO standard value employed for the connecting viaduct Eusebio Ayala - R. de Francia Avenues were adopted for the vertical curves. It was suggested to give a greater continuity of vertical curves in the planning, in order to reduce the distance of the approach section, resulting in Rca. Argentina Avenue intersection having a greater slope of 5.45%, but globally it varies around 5%.

4) Madame Lynch Avenue

The actual section between Eusebio Ayala and Choferes del Chaco Avenues has a slope of 0.5% - 2.0%, where an Itay Creek branch flows beside the avenue. For the design of the vertical alignment it has been planned to have a height which will ensure the minimal difference of 4 meters with respect to the channel bed (the planned height of the channel is 3.6m).

5) España Avenue Extension

The beginning height will be fixed up to the actual street level, and the intersection with the rail road will be on the same level. Consequently at the intersection with Paraguarí Street it does not allow adopting of gentle slopes. So, the vertical curve has been adopted in order to lighten the said slope. The alternative of the grade separation with the box culvert implementation of Paraguari Street was not adopted, due to the short distance up to the junction with México Street and the resulting steep slope.

4.3 PAVEMENT DESIGN

4.3.1 Pavement Design Standards

1) Zonal Coefficient

The zonal coefficient of Asunción City will be determined as 1.0, since there are no great variation of climate during the whole year, assuming that it will not produce any notable effects on the structure.

2) Service Index

The service index is the service grade in respect to the street traffic. Consequently, it will be determined as 2.5, taking into account that the streets in the Study will have the function of arterial streets.

3) Traffic Volume and Axial Load

A 20 year traffic volume from the opening year (1992) will be employed. Concerning the traffic volume increase, the estimated growth rate for the years 1992 to 2000 period will be adopted. Trucks and buses are classified as heavy vehicles. The distribution of axial load according to the AASHTO standard will be employed for the calculation (the average axial load is of about 4 tons for single axis of trucks), assuming vehicle weight of 5 tons.

4.3.2 Pavement Composition of Current Streets

The currently employed pavement types in Paraguay are classified as follows:

a. Multilayer asphalt pavement
b. Telford-base pavement
c. Empedrado
d. Adoquinado pavement
e. Asphalt layer over empedrado pavement

The multilayer asphalt pavement is currently employed on the National Roads, which are under MOPC jurisdiction, but still has not been implemented in Asunción City.

Empedrado pavement and adoquinado pavement are the type of pavement which are constructed by methodically setting the stones or blocks, and a sand layer is employed for the base course. The former is widely used on the local streets in Asunción City and its environs, and the latter on interconnecting roads, such as Primer Presidente, Santa Teresa, Rca. Argentina and Boggiani Avenues, etc. Most of asphalt paved streets in Asunción City are those where a 6cm thick asphalt layer was set over the existing stone pavement.

The Telford base pavement consists of two layers: a 5cm thick pavement layer and a 20cm base layer. Stones similar in size to those employed for empedrado pavement are mainly used for the base layer. This Telford base pavement has currently been used in the widening projects of José Félix Bogado Avenue.

Note : Concerning the execution method, the empedrado pavement is carried out mainly by manual labor. However, machines such as rubber-tired rollers, macadam rollers, etc., are currently employed for the Telford base pavement.

1) R. de Francia Avenue

Originally, the north carriageway of this avenue was paved by empedrado, 9m wide. Between 1965 and 1968, the south part was widened to have a total width of 17m with a median strip and four lanes. The south carriage way was constructed with Telford base pavement (t = 25cm), and the asphalt overlay (t= 6cm) was set at the same period on the north carriage way (See FIGURE 4-3-1).

2) Eusebio Ayala Avenue (between Gral.Aquino Street and Madame Lynch Avenue)

Eusebio Ayala Avenue starts at the intersection with Gral. Aquino Street and was constructed by MOPC as a part of the National Highway No. 1. At that time, it was a Telford base pavement road (t = 45cm) of 6.50m width. Subsequently, it was widened, section by section with a 25cm thick Telford base. However, the road width was not uniform. Moreover, between 1982 and 1983, an asphalt overlay (t = 6cm) was done on this road, starting at the intersection with Gral. Aquino Street, as far as De la Victoria Avenue, with a total width of 15m (See FIGURE 4-3-2).

3) Mcal. Estigarribia Road

Mcal. Estigarribia Road has the same background as Eusebio Ayala Avenue, but with the difference that, the paved asphalt width is less than the width of Eusebio Ayala Avenue, and the base material strip surface that has no asphalt can be observed on both sides of the carriage way (See FIGURE 4-3-3).

4) Madame Lynch Avenue

This avenue is divided in two sections: from E. Ayala Avenue up to Santa Teresa Avenue, and from Santa Teresa Avenue up to Aviadores del Chaco Avenue. The asphalt pavement of the first section was done by setting the 6cm thick asphalt layer over the existing empedrado pavement, and the second section was done with a Telford base pavement (See FIGURE 4-3-4).

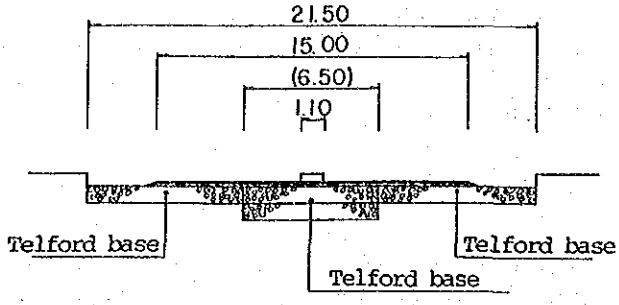


FIGURE 4-3-1 PAVEMENT STATUS OF R. DE FRANCIA AVENUE

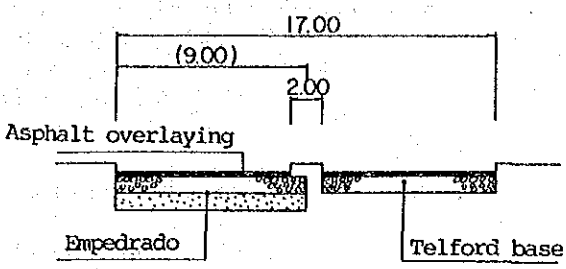
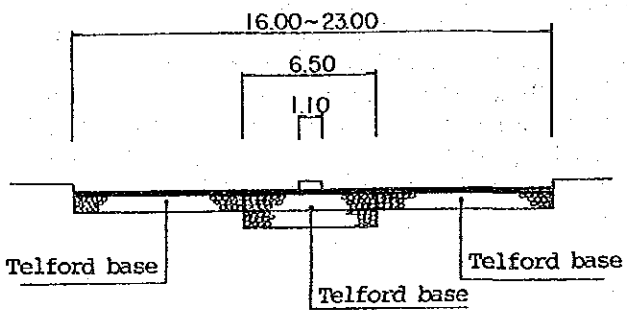
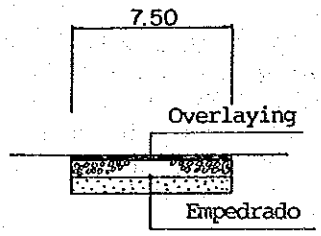


FIGURE 4-3-3 PAVEMENT STATUS OF MCAL. ESTIGARRIBIA ROAD

DE LA VICTORIA~M. LYNCH



E. AYALA ~ SANTA TERESA



GRAL. AQUINO~DE LA VICTORIA

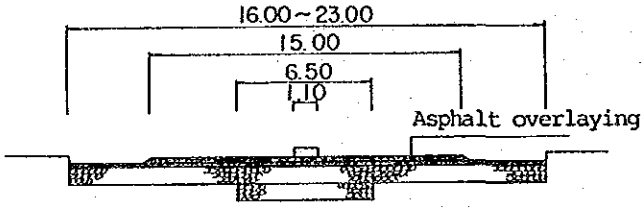


FIGURE 4-3-2 PAVEMENT STATUS OF EUSEBIO AYALA AVENUE

SANTA TERESA~AVIADORES DEL CHACO

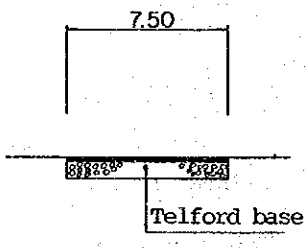


FIGURE 4-3-4 PAVEMENT STATUS OF MME. LYNCH AVENUE

4.3.3 Pavement Design

TABLE 4-3-1 shows the traffic volume, the CBR value and the structural number (SN) of each section.

Asphalt pavement was selected for the streets in the Study due to the necessity of achieving the continuity with the existing asphalt surface and due to the ease of repair and maintenance.

The conversion coefficient of each component of the asphalt pavement to structure number (SN) was based on TABLE 4-3-2. The pavement components are shown in FIGURE 4-3-5.

TABLE 4-3-1 REQUIRED THICKNESS OF PAVEMENT

Section	AADT in 1992		Annual Average Growth Rate	CBR of Subsoil	Required SN Value
	Light Vehicle	Heavy Vehicle			
Eusebio Ayala Avenue					
101	52,034	15,626	1.01	20	4.86
102	56,995	19,412	1.00	4	6.66
103	11,538	9,933	1.02	5	6.10
104	46,997	17,024	1.00	4	6.71
105	45,524	16,730	1.02	5	6.62
106	44,822	15,456	1.01	5	6.42
107	4,377	7,367	1.02	3	6.56
108	53,012	16,267	1.00	5	6.44
109	16,159	8,897	1.02	8	5.56
110	49,867	15,555	1.00	8	5.87
111	17,239	9,030	1.01	6	5.85
112	52,931	15,841	1.00	10	5.63
R.Francia Avenue					
201	50,244	12,237	1.00	10	5.45
202	57,401	16,699	1.01	20	5.02
Mme.Lynch Avenue					
301	37,499	8,140	1.02	4	6.24
302	34,452	7,704	1.01	6	5.71
303	27,159	6,035	1.03	6	5.64

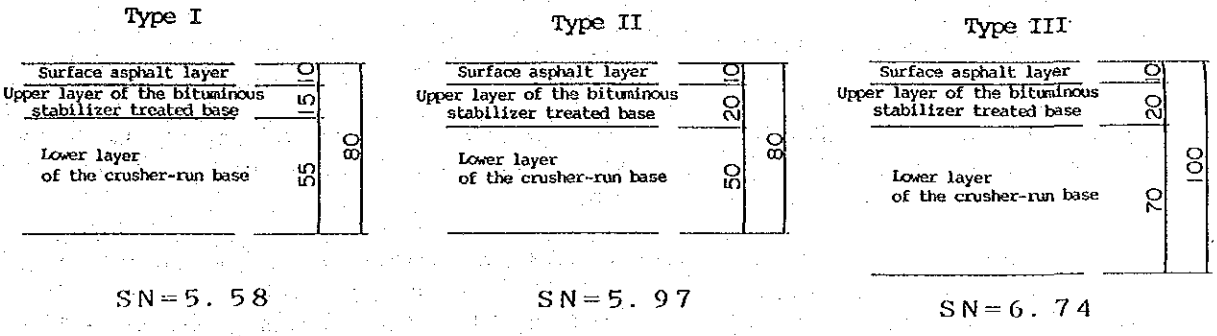


FIGURE 4-3-5 PAVING COMPOSITION BY TYPE

TABLE 4-3-2 STRUCTURE LAYER COEFFICIENTS

Pavement Component	Method,Material	Description	SN
Surface Course	Hot-mixed asphalt mixture		0.39
Base Course	Crushed Stone for mechanical stabilization	Modified CBR(more 80)	0.14
	Bituminous Treated	Hot-mixing,Stability (more 350kg/cm²)	0.31
	Cement Treated	Compressive Strength at 7days(30kg/cm²)	0.22
	Lime Treated	Compressive Strength at 10days(10kg/cm²)	0.18
Sub-Base Course	Crushed Stone	Modified CBR(more 30)	0.10
		Modified CBR(more 20)	0.08
	Cement Treated	Compressive Strength at 7days(10kg/cm²)	0.10

There are deflections on the existing pavement due to the lack of storm water drainage. Furthermore, there are some problems with the granulometric distribution of the base materials, but since many years have passed since the implementation, it is thought that it has fulfilled with its functions. Consequently, the possibility has been analyzed for adopting the empedrado pavement as the sub base layer and the Telford base pavement as the base layer for the setting of the pavement. FIGURE 4-3-6 shows the typical asphalt overlay.

Street paving is reviewed by section as follows (See FIGURE 4-3-7).

1) R. de Francia Avenue

The present carriageway overlay (t = 15cm) will be executed on section 201 and 202 and type I paving will be employed for the widening.

The section corresponding to 101 on R. de Francia Av. will have the same pavement structure as section 202.

2) Eusebio Ayala Avenue

Section 101 on E. Ayala Avenue will be overlayed with a 5cm thickness and a width of 15m including the center median. Type I paving structure will be employed for the widening part and the existing part beyond the 15m width.

Concerning sections 102 - 108 and 109 that correspond to the section between the connecting viaduct and the intersection with De la Victoria Avenue, they will be overlayed with a 15cm thickness and a width of 15m including the center median. Type III pavement will be employed for the widening part and the existing part beyond the 15m width.

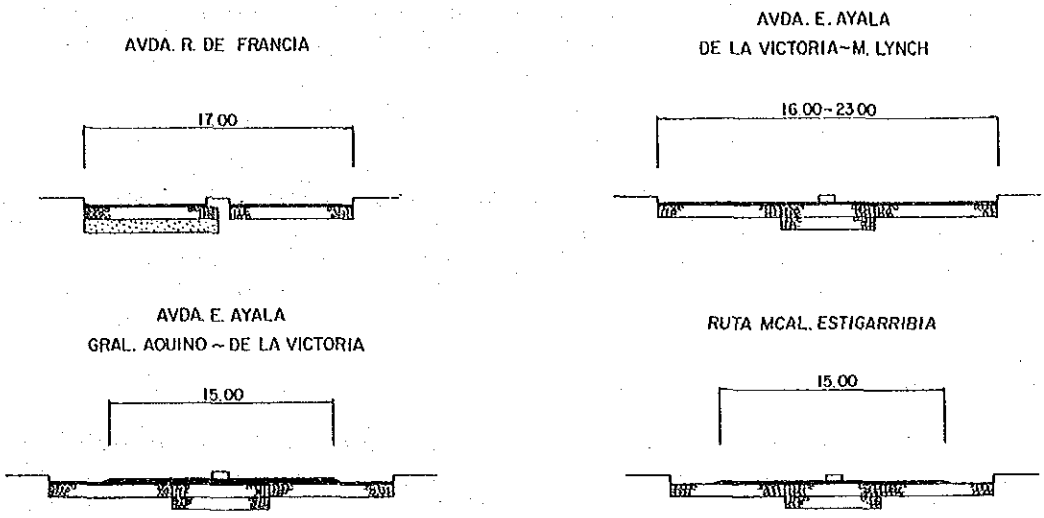


FIGURE 4-3-6 ASPHALT OVERLAYING AREA

FIGURE 4-3-7 PAVING TYPE BY SECTION

Sections 109 - 111 (from the intersection with De la Victoria Avenue up to the intersection with Mme. Lynch Avenue) will be overlayed with a 15cm thickness and type II pavement will be used for the widening part and the existing part beyond the 15m width.

3) Mcal. Estigarribia Road

Sections 111 - 112 (from the intersection with Mme. Lynch Avenue up to the end of the project) will be overlayed with a 15cm thickness and 15m wide asphalt pavement. Type II pavement will be used for the widening part and the existing part beyond the 15m width.

4) Madame Lynch Avenue

The present pavement of this avenue will be removed in order to replace it with new pavement. The pavement type of section 301 will be type III, and for sections 302 and 303 type II will be adopted.

5) Extension of España Avenue and Connecting Parts with Viaducts

As for the earthwork sections, the appropriate sub-soil material should be selected. Consequently, the pavement type will be type I.

4.4 DRAINAGE PROJECT

According to the project "Storm Water Drainage Improvement in Asunción City", carried out in 1984 by JICA, an implementation of the project in several stages for the drainage system was proposed. The mentioned study includes areas related to the present study, especially the Mburicao and Itay basins. Consequently, the actual drainage project will be carried out taking into consideration the contents of that project.

4.4.1 Rain Water Drainage Facility Design Standards

1) Rainfall Intensity

The curves of the rain intensity (See FIGURE 4-4-1), prepared by the Storm Water Drainage Improvement Project have been employed for the study. With a return period of 3 years, and the concentration time of 5 minutes for the road surface storm water drainage design, the rainfall intensity will be 150 mm/hour.

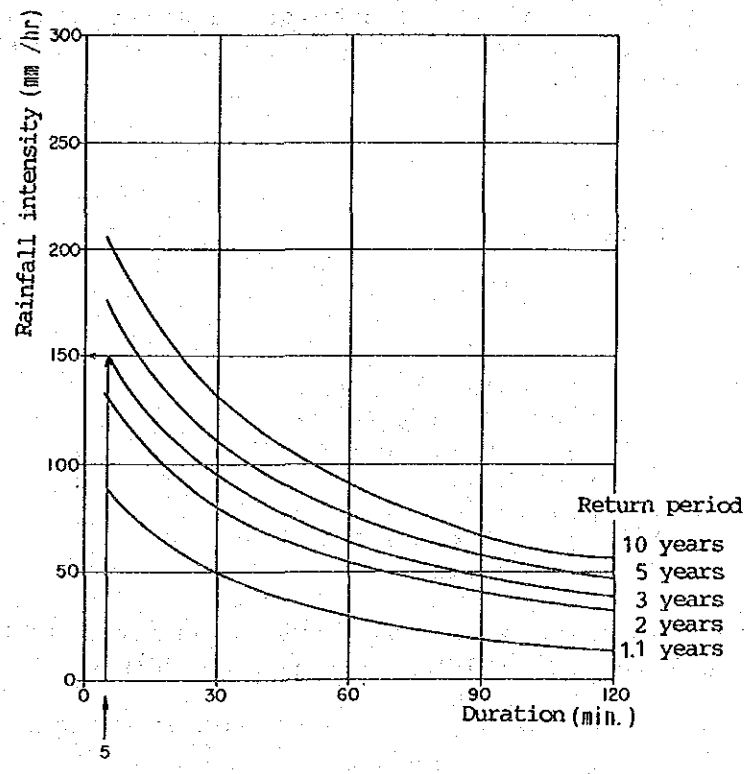


FIGURE 4-4-1 RAINFALL INTENSITY CURVES

2) Runoff coefficient

The runoff coefficient of the road surface will be 0.9.

3) Runoff Volume Estimation

The following formula is applied for the estimation of the runoff:

$$Q = \frac{1}{3.6 \times 10^{6}} \times C \times I \times A$$

where: Q = Volume of flow (Runoff) (m^3/sec)
C = Runoff coefficient
I = Average storm intensity during concentration time (mm/hour)
A = Storm water drainage area (m^2)

Furthermore, to determine the section of drainage, the planned volume of flow of Q/0.8 was adopted so that the runoff volume was equal to 80% of a planned section.

4) Runoff Capacity Estimation

The estimation of the discharge capacity which determines the section of the storm water drainage channel, is based on the "Manning uniform flow" formula:

$$Q = A \times V$$

$$V = \frac{1}{n} \times I^{1/2} \times R^{2/3}$$

$$R = A/P$$

where: Q = discharge (m^3/sec)
V = flow speed (m/sec)
n = roughness coefficient
I = slope (%)
R = Hydraulic depth
A = Area of cross section (m^2)
P = Wet perimeter

Since the storm water drainage structure will be a concrete one, the roughness coefficient will be n = 0.013.

The internal flow speed is assumed at : 0.8 m/sec - 5.0 m/sec for the design.

4.4.2 Actual Rain Water Drainage Facility

The location of the storm water drainage installations are shown in FIGURE 4-4-2.

The centro is installed with a sewage network, constructed with

a I.B.D. loan, but other areas do not have such improvements, or even when they have them, their capacity is not enough. Consequently, storm water flows onto the streets and finally flows into in the brooks or in the drainage installations.

The real situation of the drainage within the streets, the object of the present study, is as indicated:

a. On the R. de Francia/Ygatimí corridor section, between Colón and Perú Avenues, the collecting chamber is installed at those intersections located on low places, into which installations the surface drainage water flows into.

b. Concerning the section located east of Perú Avenue (close to the Municipal Market No. 4), although it is a low place, it does not have an adequate storm water drainage installation. Consequently, the storm water flows along Pozo Favorito Street and finally reaches Ferreira Creek.

c. A box culvert is installed at the intersection formed by Eusebio Ayala Avenue and 1ro. de Noviembre Street, but on the following sections, the channel is not equipped, therefore, the storm water flows over No. 1 street and sheds into Sosa creek.

d. Mburicao Creek crosses Eusebio Ayala Avenue at the intersection with Choferes del Chaco Avenue.

e. The channel, which flows into Mburicao Creek is located north of Eusebio Ayala Avenue at the intersection with Rca. Argentina Avenue, but does not have the drainage channel of Eusebio Ayala Avenue, which makes the drainage slip through Tte. Espinoza Street.

f. The closed channel, which crosses the intersection with G. Boggiani Avenue, flows into in the Itay Creek arm, parallel to Mme. Lynch Avenue.

g. The draining channel is located in the north sector of Eusebio Ayala Avenue, at the intersection with Pitiantuta Street, but there is no channel which connects the avenue with the drainage channel.

h. San Lorenzo Creek is located in the south sector of Mcal. Estigarribia Road, from Fernando de la Mora Municipality toward San Lorenzo City, but does not have any channel from the road to the creek.

i. Along Mme. Lynch Avenue, the arm Itay Creek flows parallel to the avenue. In the report on the Storm Water Drainage System Improvement Project, it is suggested to implement the recovery and improvement of the draining systems of the Itay and Mburicao Creek basin during the first stage (See FIGURE 4-4-3).

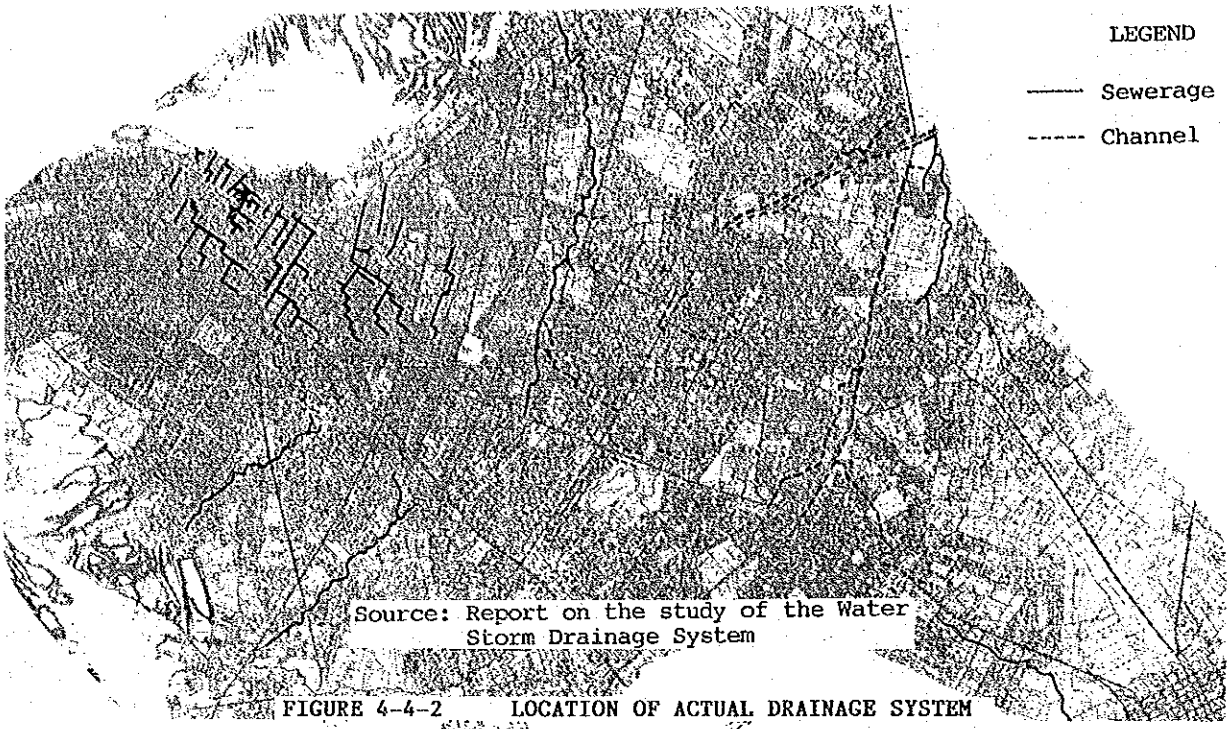


FIGURE 4-4-2 LOCATION OF ACTUAL DRAINAGE SYSTEM

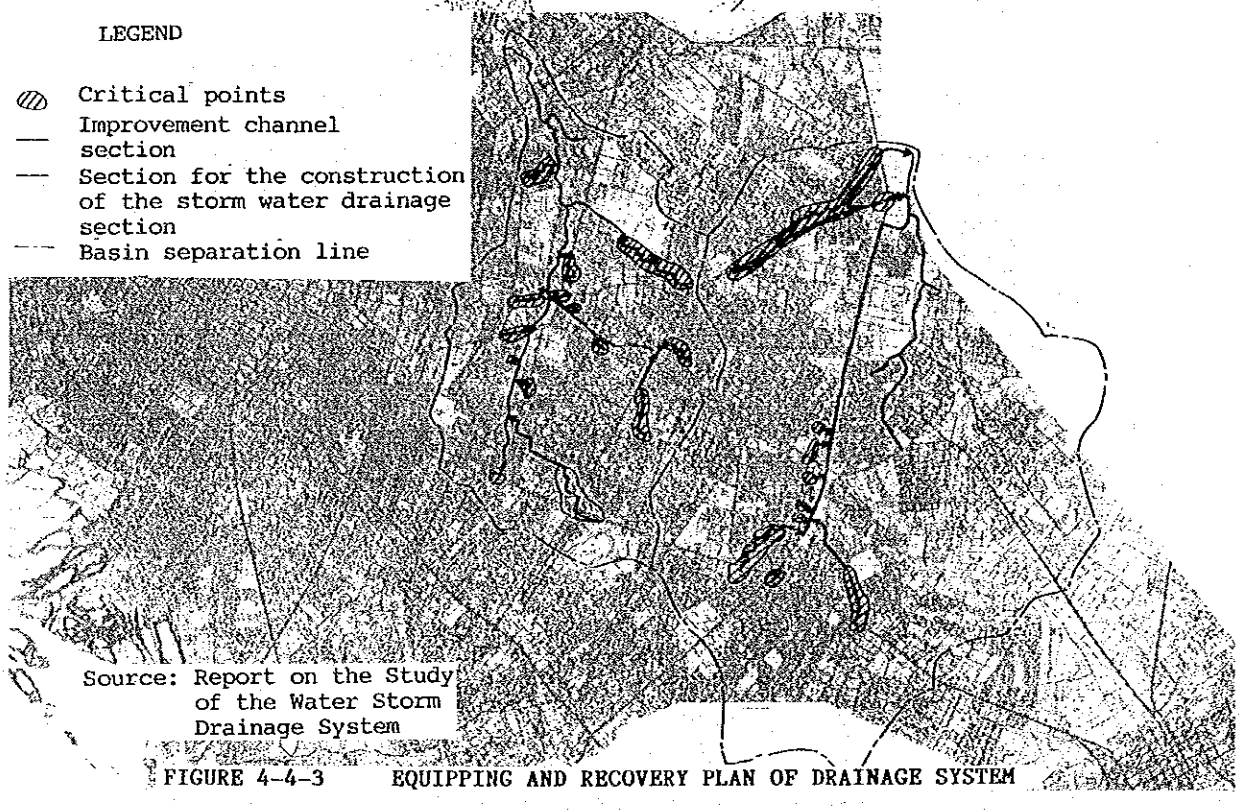


FIGURE 4-4-3 EQUIPPING AND RECOVERY PLAN OF DRAINAGE SYSTEM

4.4.3 Rain Water Drainage Facility Design

The surface drainage as well as the structures which serve to conduct the storm water to the main drainage system or the creeks will be the object of design.

1) Outlet

The vertical alignment of the arteries, the object of the current project, was planned following the actual alignment, without major changes. Therefore, the concentration area will be similar to the present one. However, there are cases where the storm water drainage installations are missing. In such cases, it is necessary to have new drainage installations.

(1) R. de Francia/Ygatimí Avenues

Concerning the centro, it will be connected to the storm water sewerage of that area, similar to the current draining project. Concerning Municipal Market No. 4, drainage pipes will be installed as far as Ferreira creek.

(2) Eusebio Ayala Avenue

A new drainage pipe will be built from the intersection formed with 1ro. de Noviembre Street up to Sosa Creek. The storm water of the intersection with Choferes del Chaco Avenue will be shed into the Mburicao creek.

A new channel will be built on Rca. Argentina Avenue area, which will be extended up to the Mburicao Creek arm.

At the intersection with Boggiani Avenue, the new channel will be built up to the Itay Creek arm.

(3) Mcal. Estigarribia Road

The new channel will be built on 12 de Junio Street, which will lead up to the San Lorenzo Creek arm. The storm water drainage of the following areas will be conducted to San Lorenzo Creek.

(4) Madame Lynch Avenue

The storm water will be shed into the Itay Creek arm, which flows parallel to the Avenue.

(5) España Avenue Extension

It will be shed into the ditches which are located behind the railway yard and at the intersection with México Street.

2) Storm Water Drainage Installations

(1) Eusebio Ayala Avenue

The storm water drainage system will consist of catch basins next to the sidewalk curb, connected to the longitudinal drainage pipe. The storm water are conducted through this piping around 100m, in order to be shed into the main drainage pipe, which is located under the sidewalk, through the connecting piping. When carrying out the widening of the avenue to 50m, the catch basins and the

longitudinal pipe should be installed along the marginal road and this should be connected to the main pipe. The catching width of the road was assumed at 50m for the determination of the section of the main pipe. FIGURE 4-4-4 shows the plan of the drainage system and FIGURE 4-4-5 shows the catchment area and its respective installations.

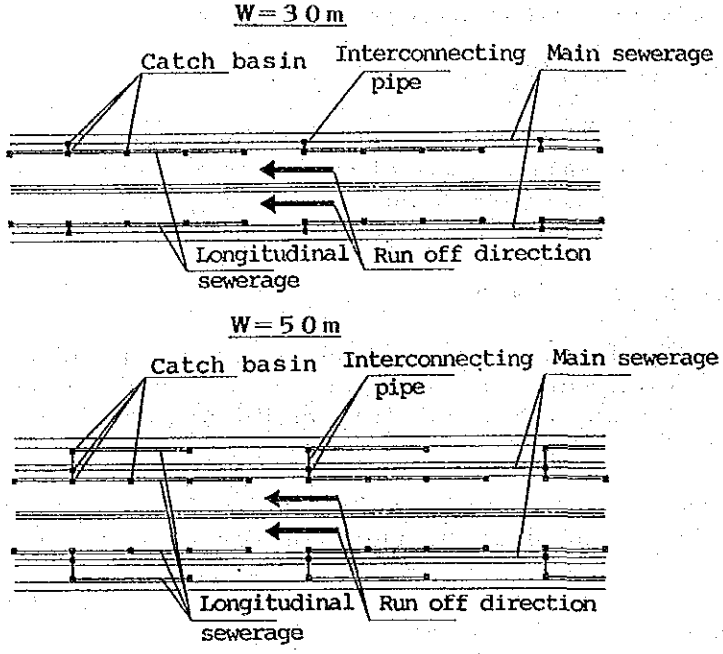


FIGURE 4-4-4 TYPICAL PLAN OF ROAD DRAINAGE SYSTEM

(2) Madame Lynch Avenue and España Avenue Extension

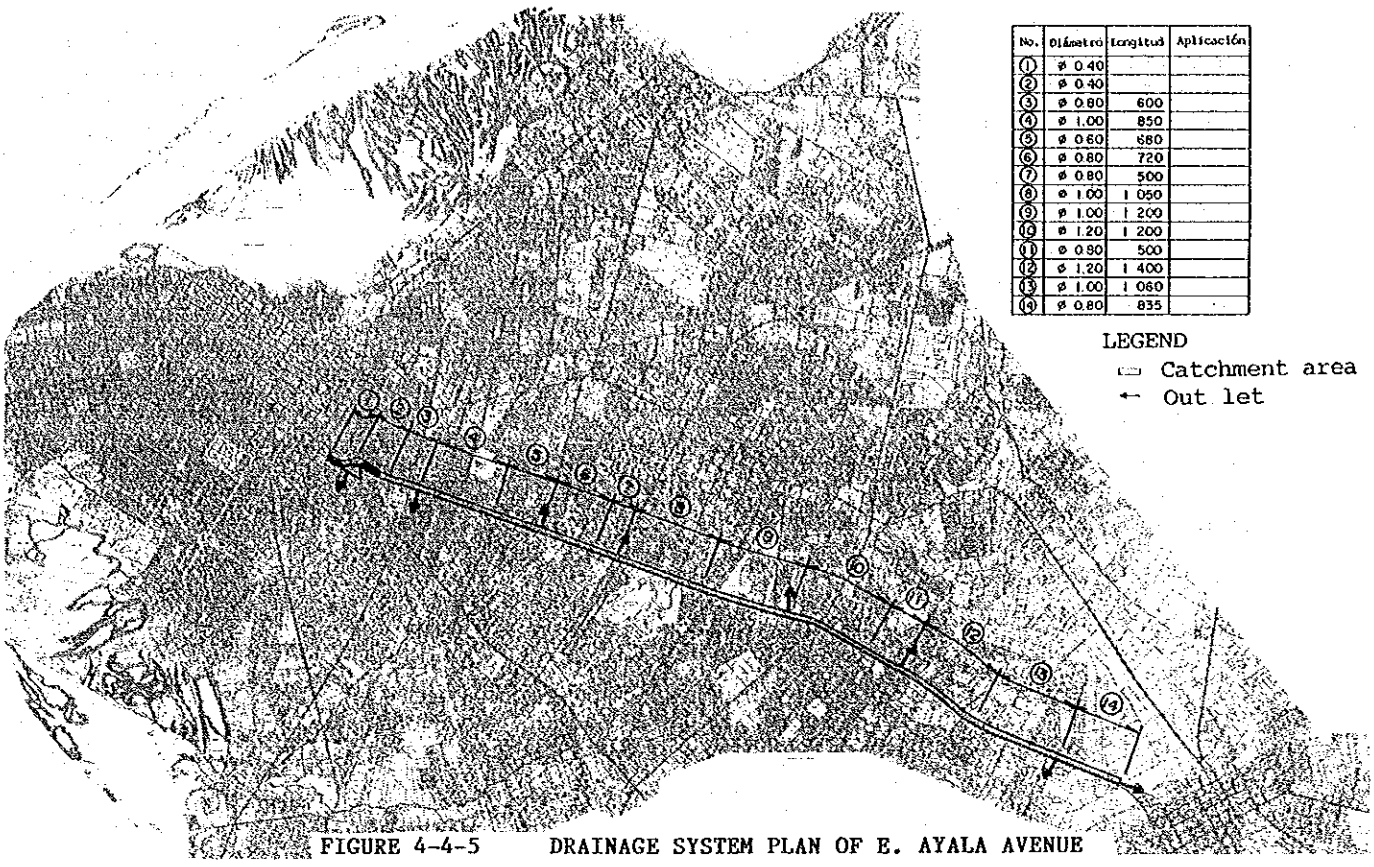
Along these arteries there are channels which may serve as outlets, therefore, they allow water to be carried out only by the catch basins and the longitudinal pipe.

As it was already mentioned in Chapter 4.4.2, the channels, which may serve as outlets, are not in good condition. Therefore, it is urgently required to carry out improvement projects.

Concerning relationship of the storm water drainage structures. (considered in the mentioned report about the storm water drainage project) and the object roads, they were included in the present project. FIGURE 4-4-6 shows the storm water drainage system which has no relation with the road.

3) Improvement Project of the Channel which Flows Parallel to Madame Lynch Avenue

The section shown in FIGURE 4-4-7 for the improvement project of the Itay Creek arm, which flows parallel to Mme. Lynch Avenue, is proposed in the "storm water drainage project" report.



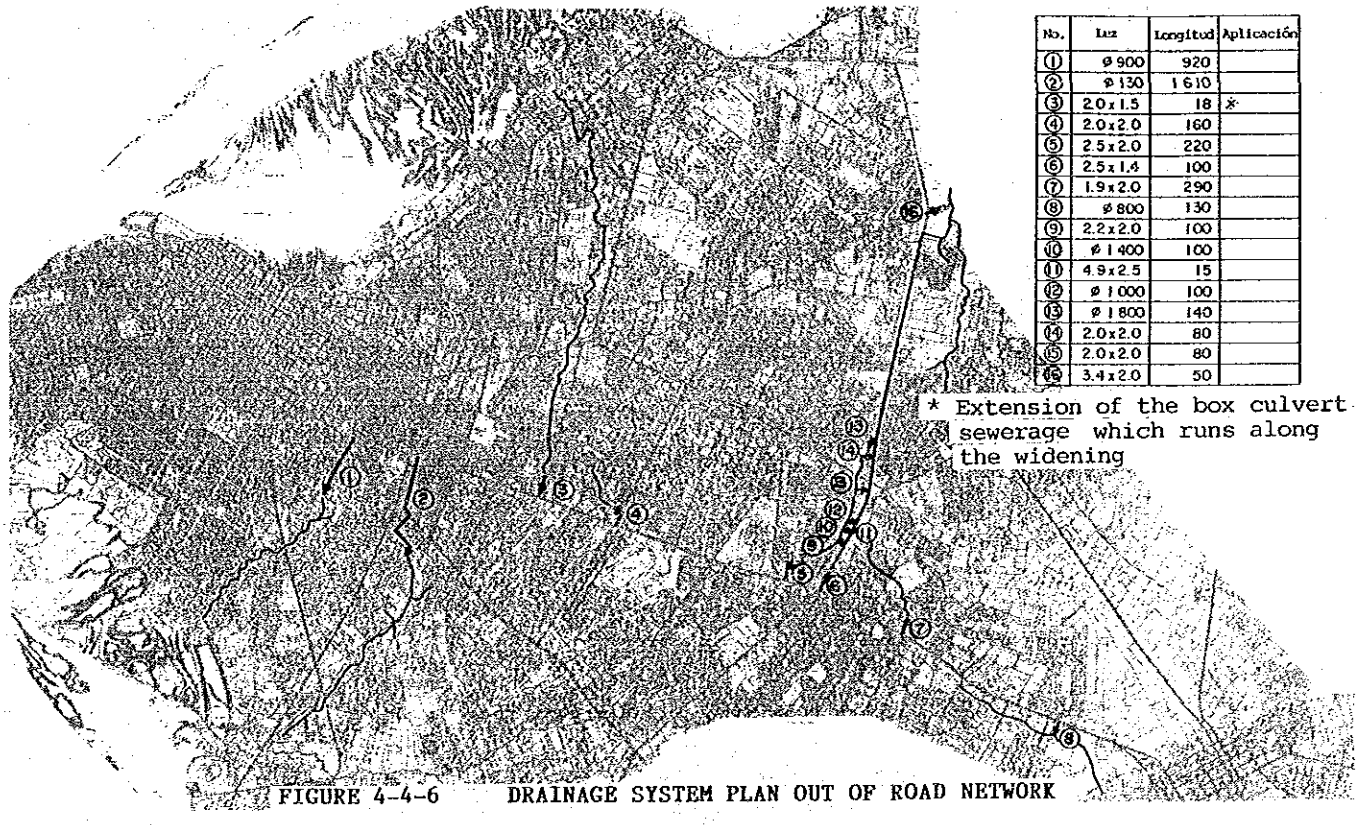
No.	Diámetro	Longitud	Aplicación
①	ø 0.40		
②	ø 0.40		
③	ø 0.80	600	
④	ø 1.00	850	
⑤	ø 0.60	680	
⑥	ø 0.80	720	
⑦	ø 0.80	500	
⑧	ø 1.00	1 050	
⑨	ø 1.00	1 200	
⑩	ø 1.20	1 200	
⑪	ø 0.80	500	
⑫	ø 1.20	1 400	
⑬	ø 1.00	1 060	
⑭	ø 0.80	835	

LEGEND

▭ Catchment area

← Out let

FIGURE 4-4-5 DRAINAGE SYSTEM PLAN OF E. AYALA AVENUE



No.	Luz	Longitud	Aplicación
①	ø 900	920	
②	ø 130	1 610	
③	2.0x1.5	18	*
④	2.0x2.0	160	
⑤	2.5x2.0	220	
⑥	2.5x1.4	100	
⑦	1.9x2.0	290	
⑧	ø 800	130	
⑨	2.2x2.0	100	
⑩	ø 1 400	100	
⑪	4.9x2.5	15	
⑫	ø 1 000	100	
⑬	ø 1 800	140	
⑭	2.0x2.0	80	
⑮	2.0x2.0	80	
⑯	3.4x2.0	50	

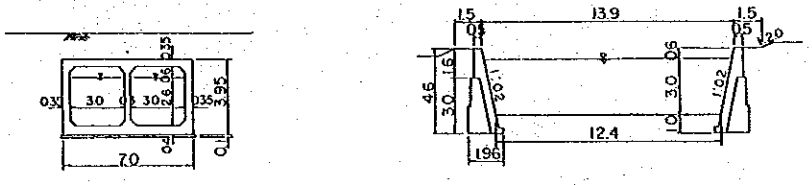
* Extension of the box culvert sewerage which runs along the widening

FIGURE 4-4-6 DRAINAGE SYSTEM PLAN OUT OF ROAD NETWORK

FIGURE 4-4-8 shows the section of the first sectors, from Eusebio Ayala Avenue up to Mcal. Estigarriba adjacency, which is already being executed. Therefore, the starting of the channel improvement at the current project will be up from this last mentioned artery. For the section between this one and Santa Teresa Avenue, the closed channel was suggested, but after the revision from the maintenance and building cost the open channel was suggested. Since there has been no major change in the flow volume, the open channel section will be the same one that was shown in FIGURE 4-4-7 (3), but the slope of the channel bottom was modified from 1/170 to 1/280.

On the other hand, the "gravity" type retaining wall was changed to the "recumbent" type, in order to decrease the construction cost (FIGURE 4-4-9). Also, the soil of Mme. Lynch Avenue has the value N = 20 at 3m of depth, and although the upper stratum is a clay-sand soil, the excavation wall keeps firmly up, so the "recumbent" type was planned for the design.

1. Cerro Cora - Mcal.Estigarribia 2. Mcal.Estigarribia - Santa Teresa



3. Santa Teresa - Tte. 2do. Victor Valdez 4. Tte. 2do. Victor Valdez - Itay stream

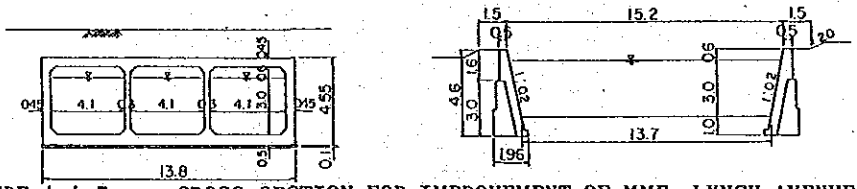


FIGURE 4-4-7 CROSS SECTION FOR IMPROVEMENT OF MME. LYNCH AVENUE CHANNEL
(Source) Report on the Study of the Storm Water Drainage System

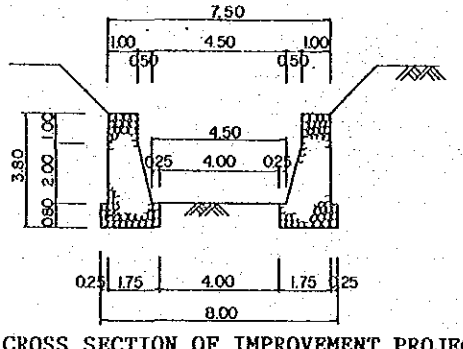


FIGURE 4-4-8 CROSS SECTION OF IMPROVEMENT PROJECTS PRESENTLY UNDER CONSTRUCTION

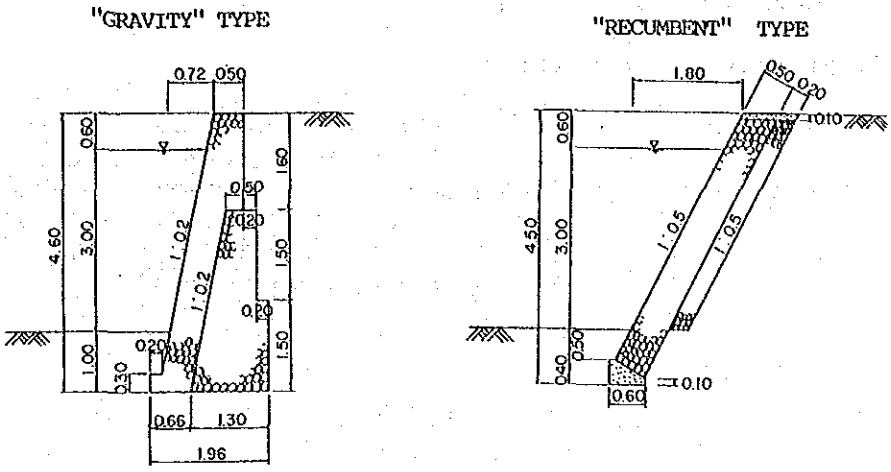


FIGURE 4-4-9 STRUCTURE OF BANK PROTECTION

4.5 MICROCENTRO SIGNAL PLAN

4.5.1 Total System Composition

The system composition will be shown in FIGURE 4-5-1. The command of the traffic signal set and the green wave system will be done employing the same existing system. The general system command is established connecting the computer to the Main Controller of the central command room which controls the existing system. The communication unit is required for this connection.

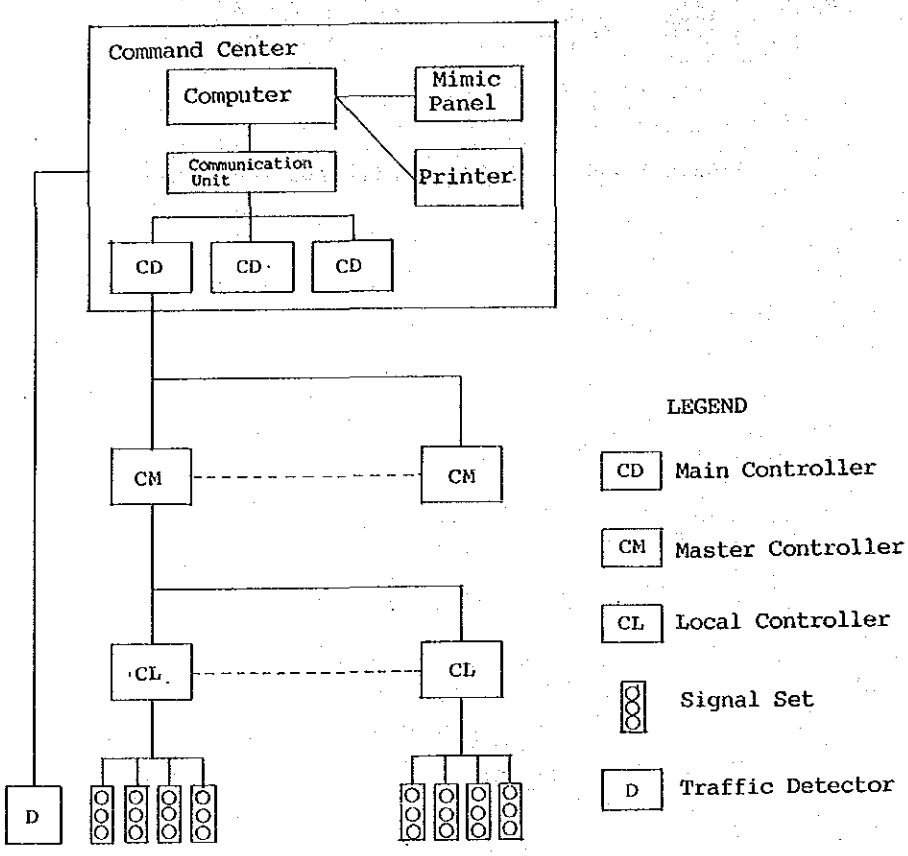


FIGURE 4-5-1 GENERAL COMPOSITION OF TRAFFIC SIGN SYSTEM

4.5.2 Equipment Plan

1) Central Command Room

(1) Computer

The computer functions are:

a. Operation of the Main Controller
b. Command of the Main Controller (program change)
c. Primary processing of data coming from traffic detector
d. Terminal operation (traffic signal set)

e. To provide information to the mimic panel with lamps, concerning the terminal (traffic signal sets) operational status
f. Data statistical processing, provided by the traffic detector

In the primary system, the computer will be employed for the traffic signal system operation and maintenance. In future, it will be connected with the traffic detector, in order to directly command the traffic signal sets. Considering the modification of such a system, the equipment to be installed will be one which could command around 100 intersections of the centro.

(2) Mimic Panel

Indicates the location and operational status of the traffic signal terminals over the artery network chart (1:10,000) of Asuncion City.

The artery network which includes the defined projects and the integral board and not the mosaic will be adopted; assuming that there will be no major changes on the artery network.

(3) Printer

It will serve as the output of statistical data concerning the traffic signal set operational status and the traffic detector operational status.

2) Terminals

(1) Master Controller

It commands the local controller and controls the green wave system. The electrical controller will be adopted and one unit for the green wave system will be used. It will be installed at the intersections.

(2) Local Controller

It commands the traffic signal set. The new one will be an electrical system and will be installed at the intersections.

(3) Traffic Signal Set

Sets with the same characteristics as the existing ones will be adopted, the lens diameters are: 300mm for red light and 200mm for the remaining two.

The location, taking into account the trees and the traffic sign column, will be as shown in TABLE 4-5-1, based on the standard location (See FIGURE 3-6-32).

Furthermore, one of the location examples is shown in FIGURE 4-5-2.

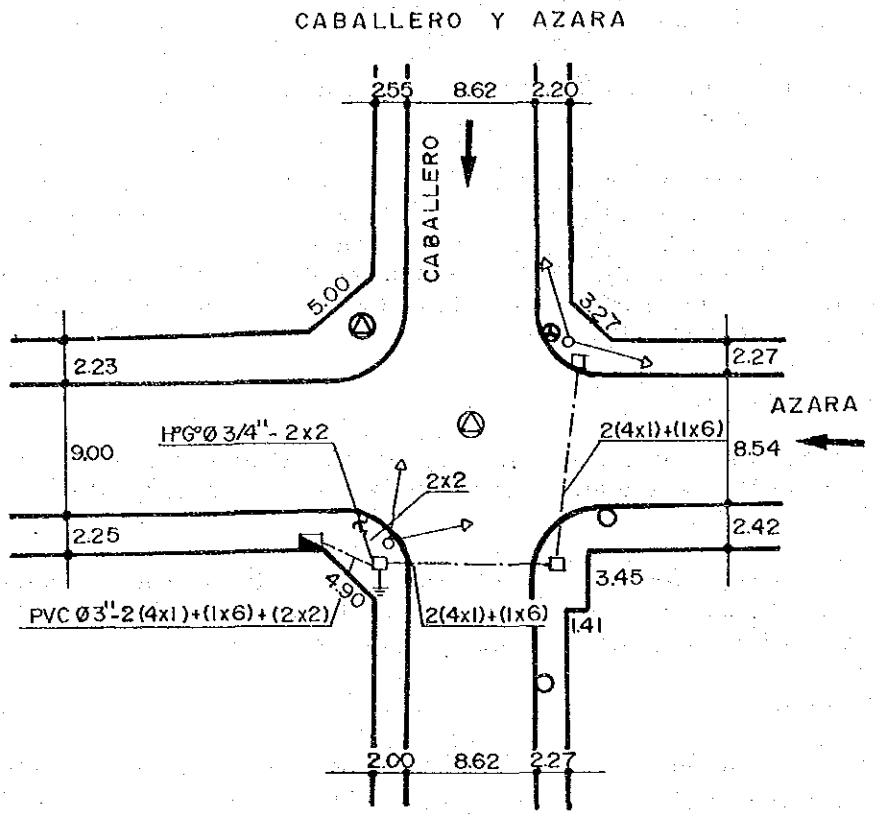


FIGURE 4-5-2 LOCATION EXAMPLE OF TRAFFIC SIGN SETS

(4) Traffic Detector

They are installed on each lane, around 30m away of the intersection. The traffic volume and the occupancy index will be obtained. The type of detector to be employed will be the hanging detector with supersonic waves in order to avoid the influence of pavement works and/or recapping works (See FIGURE 4-5-3).

3) Wiring

(1) Intersection

A PVC underground pipe will be employed for the wiring of the traffic signal intersection.

(2) Green Wave System

A PVC underground pipe will be employed for the wiring of the green wave system. The pipe will be located under the sidewalk, and every 50m, more or less; cable maintenance manholes will be installed.

TABLE 4-5-1 LOCATION AND TYPE OF TRAFIC SIGN SET (1)

Artery	Intersection	Cross Type
Colón	Pte. Franco	Type 5 + 2 Simple Columns
	Palma	Type 5 + 2 Simple Columns
	Estrella	Type 5 + 1 Simple Column
	Oliva	Type 5 + 1 Simple Column
	E.V.Haedo	Type 5 + 1 Simple Column
	Humaitá	Type 5 + 2 Simple Columns
	Piribebuy	Type 5 + 1 Simple Column
	Manduvirá	Type 5
	I. del Campo	Type 5 + 1 Simple Column
Montevideo	Pte. Franco	Type 5
	Palma	Type 1
	Estrella	Type 1
15 de Agosto	Pte. Franco	Type 2
	Estrella	Type 2
	Oliva	Type 2
	Gral. Díaz	Type 2
	E.V.Haedo	Type 2
14 de Mayo	Estrella	Type 1 + 1 Simple Column
	Oliva	Type 1 + 1 Hanging Column
	Gral. Díaz	Type 1
	E.V.Haedo	Type 1 + 1 Hanging Column
	Humaitá	Type 1 + 1 Simple Column
	Manduvirá	Type 1 + 1 Hanging Column
	I. del Campo	Type 1
	Ygatimí	Type 3
Alberdi	Estrella	Type 1
	Oliva	Type 1
	Gral. Díaz	Type 1 + with 1 Hanging Column
	E.V.Haedo	Type 1
	Humaitá	Type 1
	Piribebuy	Type 1 + 1 Simple Column
	Manduvirá	Type 1 + 1 Hanging Column
	I. del Campo	Type 1
	Ygatimí	Type 3

Artery	Intersection	Cross Type
Chile	El Paraguayo	
	Independiente	Type 4
	Pte. Franco	Type 2 + 1 Simple Column
	Estrella	Type 2
	Oliva	Type 2
	Gral. Díaz	Type 2 + with 1 Hanging Column
	E.V.Haedo	Type 2 + 1 Simple Column
Yegros	Eligio Ayala	Type 2
	25 de Mayo	Type 2
	Cerro Corá	Type 2
	Azara	Type 2
	L.A.Herrera	Type 2
Caballero	Cnel. Bogado	Type 4 + 1 Simple Column
	25 de Mayo	Type 1
	Azara	Type 1
	L.A.Herrera	Type 1
	F.R.Moreno	Type 1 + 1 Simple Column
	M.Dominguez	Type 1
	Tte. Fariña	Type 1 + 1 Simple Column
	Rca.de Colombia	Type 1
	Av.R.de Francia	Type 3
México	Cnel. Bogado	Type 4
	25 de Mayo	Type 5 + 1 Simple Column
	Azara	Type 1
	L.A.Herrera	Type 1
	F.R.Moreno	Type 1
	M.Dominguez	Type 1
	Tte. Fariña	Type 1 + 1 Simple Column
	R.de Colombia	Type 1 + 1 Simple Column
	Av.R.de Francia	Type 3

TABLE 4-5-1 LOCATION AND TYPE OF TRAFFIC SIGN SET (2)

Artery	Intersection	Cross Type		
		Existent No. of Columns		New
		Simple	Hang.	
Colón	Gral. Díaz	4		Type 5 + 1 Simple Column
	Ygatimí	6		Type 5 + 5 Simple Columns & 2 Pedestrian Traffic Lights
14 de Mayo	Piribebuy	3		Type 1 + 1 Simple Column & 1 Hanging Column
Caballero	Eligio Ayala	3		Type 1 + 1 Simple Column
	Cerro Corá	3		Type 1
México	Eligio Ayala	4		Type 1 + 1 Simple Column
	Cerro Corá	3		Type 1 + 1 Simple Column
Tacuary	Cnel.Bogado	4		Type 4(except Hanging Column)
	L.A.Herrera	3		Type 2 + 1 Simple Column
	F.R.Moreno	4		Type 2 + 1 Simple Column
EEUU	Cnel.Bogado	4		Type 4(except Hanging Column)
	Mcal.Estigarribia	3		Type 3
	Cerro Corá	3		Type 1
	L.A.Herrera	3		Type 3
	Rca.de Colombia	3		Type 1 + 1 Hanging Column & 1 Simple Column
	Av.R. de Francia	8		Type 3 + 1 Hanging Column & 1 Simple Column
Brasil	Mcal.Estigarribia	4		Type 1 + 1 Simple Column
	25 de Mayo	4		Type 1 + 1 Simple Column
	Azara	4		Type 1 + 1 Hanging Column
	L.A.Herrera	4		Type 1 + 1 Simple Column
	Av.R. de Francia	3	2	Type 3 - 1 Simple Column
Montevideo	Oliva	3		Type 1
	Gral. Díaz	3		Type 1

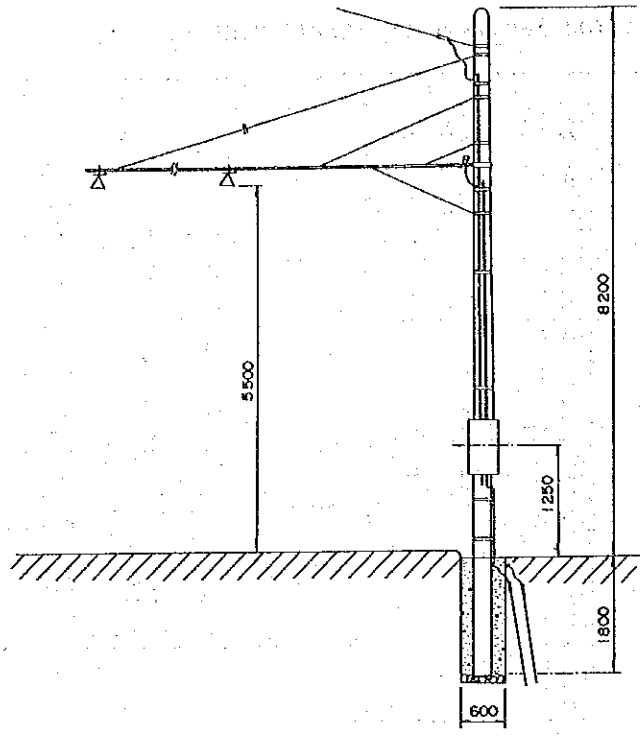


FIGURE 4-5-3 ULTRA-SONIC VEHICLE DETECTOR SYSTEM

4.5.3 Control Parameter

The parameter of the signal command is established based on the results of the traffic volume and of future estimation. However, the parameter will have to be modified based on constant volume observation. Therefore, it cannot be said that the indicated rates are the most exact at the time of the implementation.

1) Command Schedule of Multiple Time

The variation of the entrance and exit composition index is shown in FIGURE 4-5-4. The parameter of the traffic signal command will be changed according to the index.

a. Entrance peak hour : 6:00 - 9:00
b. Off peak hour : 9:00 - 11:00, 13:00 - 23:00
c. Exit peak hour : 11:00 - 13:00
d. Night time and down: 23:00 - 6:00

At night time and at dawn, as well as on Sundays and holidays, there is a low traffic volume. Consequently, the flash yellow light will be implemented.

The analysis was done based on the traffic volume data, obtained in summer. Consequently, it will be necessary to analyze it in winter.

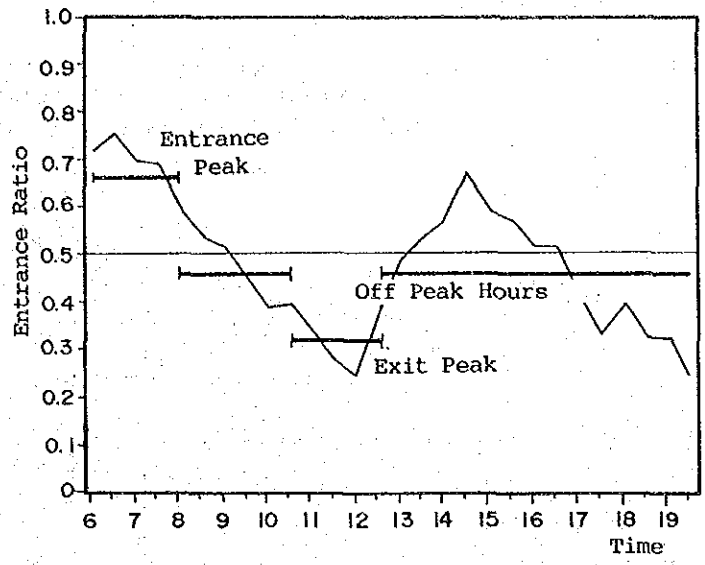


FIGURE 4-5-4 HOURLY TRAFFIC VOLUME FLUCTUATION

2) Green Wave

Considering the entrance and exit flows, system synchronized chain will be shown in FIGURE 4-5-5.

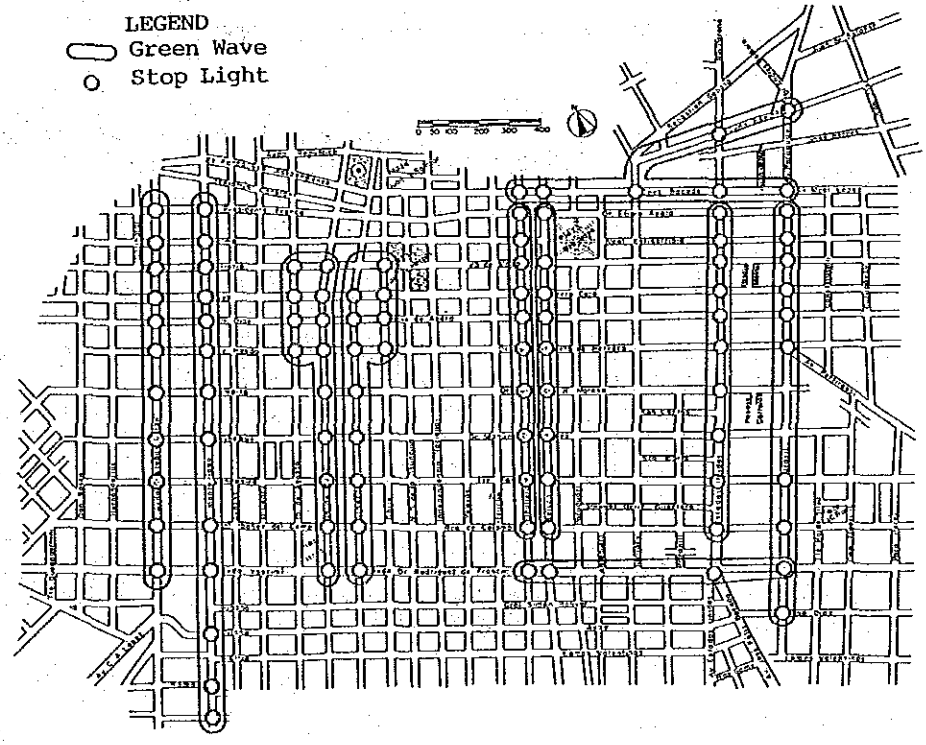


FIGURE 4-5-5 GREEN WAVE PATTERN

3) Cycle Length and Split

When establishing the duration of the most convenient cycle (per schedule) for the traffic signal intersections of the main vehicle traffic arteries, based on the traffic volume projection results for the future, it will be as shown in FIGURE 4-5-6.

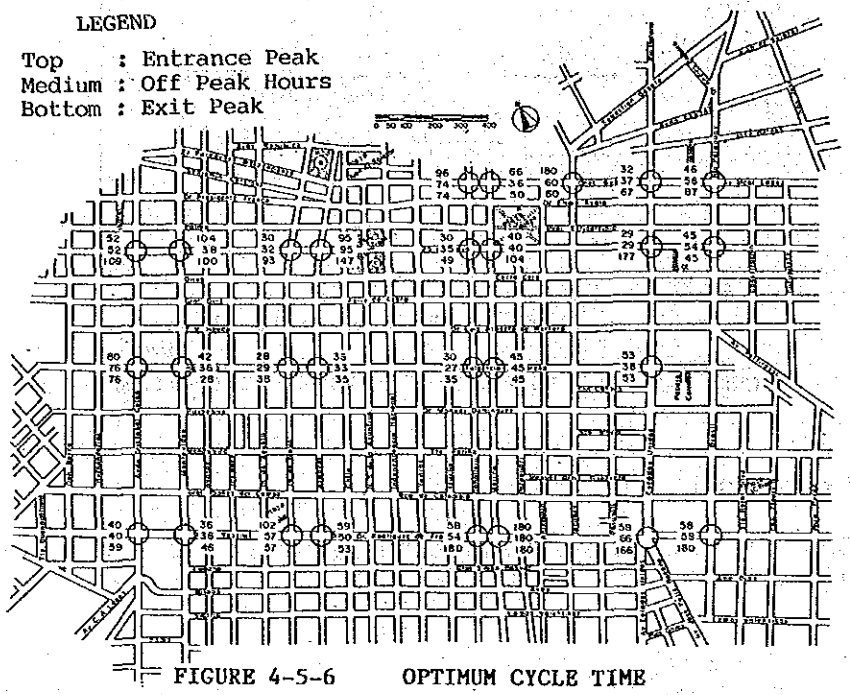


FIGURE 4-5-6 OPTIMUM CYCLE TIME

The optimum cycle length was calculated based on the HCM (Highway Capacity Manual) with the following formula:

$$Co = \frac{L \times \lambda o}{\lambda o - \lambda}$$

where: Co = Duration of the mostconvenient cycle (seconds)
L = Loss time of one cycle (seconds)
λo = Critical saturation flow rate of the intersection (1.0)
λ = Critical saturation flow rate of the intersection (1.0)

In order to achieve synchronization, the cycle length at the centro has been unified, establishing the same split for each synchronized chain (See TABLE 4-5-2).

4) Offset

Since it concerns the centro, the speed of green wave on the main vehicular traffic arteries was determined as 40 km/h.

TABLE 4-5-2 DURATION OF CYCLE AND GREEN WAVE FOR EACH SYNCHRONIZED CHAIN

Street	Approaching Peak Hours (Cycle:90sec.)		Off Peak Hours (Cycle:90sec.)		Exiting Peak Hours (Cycle:120sec.)	
	Green Time E-W	N-S	Green Time E-W	N-S	Green Time E-W	N-S
Colón	30	60	25	55	30	80
Montevideo	30	60	25	55	50	60
14 de Mayo	60	30	55	25	80	30
Alberdi	60	30	55	25	60	50
Caballero	60	30	55	25	60	50
México	60	30	55	25	80	30
EE.UU	60	30	55	25	60	50
Brasil	60	30	55	25	60	50
R. de Francia	60	30	55	25	80	30
Cnel.Bogado	60	30	55	25	60	50

Note : The waste time is 10 sec. within 2 cycles.

The offset displacement of each synchronized chain was established based on this speed of green wave and considering the existing time difference when moving from one intersection to another. Also, it has been established on R. de Francia Avenue (which is two-way), considering the following points, in order to allow a phase displacement between one and an other synchronization chain. Its guide-lines are shown in FIGURE 4-5-7 (1)-(3).

(1) Entrance Peak Hours

The main purpose is to enable entrance to the Microcentro.

(2) Off Peak Hours

It was planned in such way to avoid stopping at each intersection in order to somehow enable the entrance and exit to and from the Microcentro.

(3) Exit Peak Hours

The main purpose is to enable exit from the Microcentro. The vehicles coming from the north-south oriented streets have also been considered in such way to avoid immediate delays after entering R. de Francia Avenue.

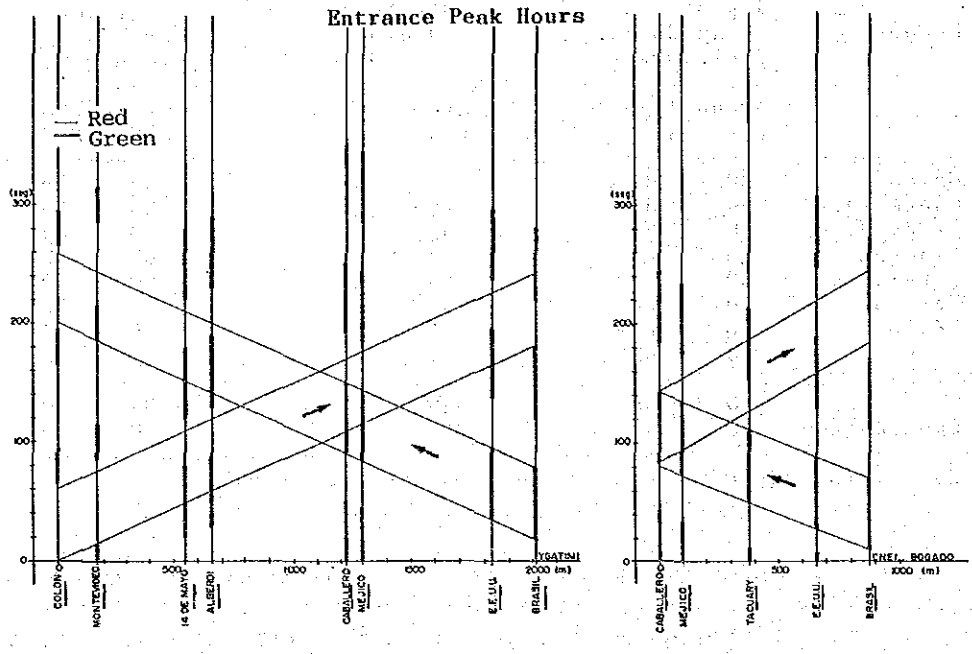


FIGURE 4-5-7 OFFSET PATTERN (1)

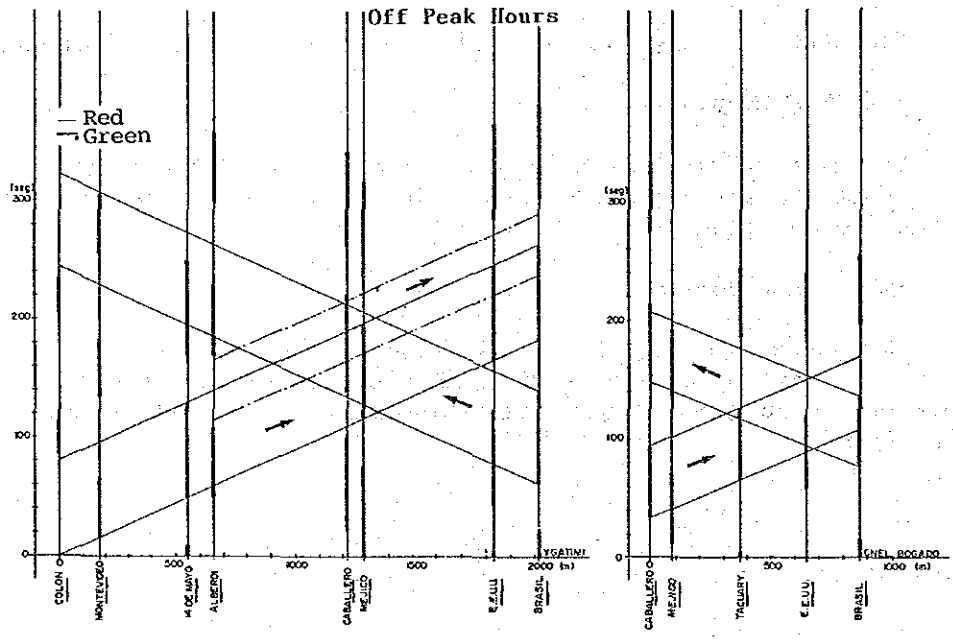


FIGURE 4-5-7 OFFSET PATTERN (2)

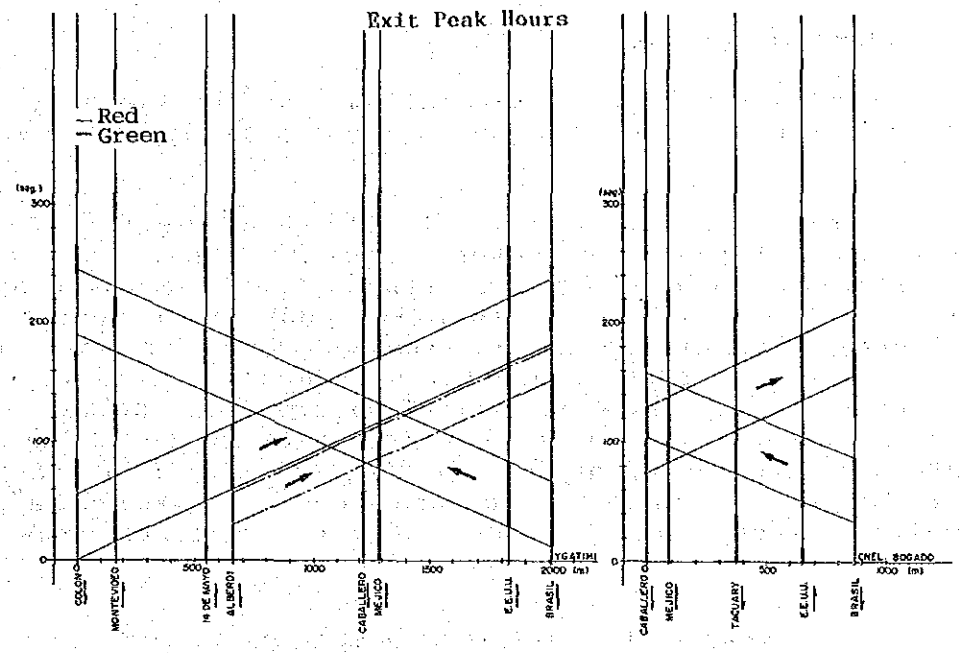


FIGURE 4-5-7 OFFSET PATTERN (3)

5) Points to be considered during Implementation

The established parameter is based on the estimated traffic volume for the after construction phase of E. Ayala Av. widening project and the connecting bridge project.

In the case of implementation, it is necessary to realize each synchronization chain. For that purpose, the following process was defined:

a. At the time of bus route modification moment, West sector: 4 synchronized chains
b. At the moment of culmination of the widening projects of Eusebio Ayala Avenue and the connecting bridge project, West sector: 6 synchronized works

4.6 MICROCENTRO PARKING PLAN

1) Types of Parking

Considering land use regulations and the adequacy to parking demands in the microcentro, the types of parking will be logically selected.

Parking building are classified as mechanized and non-mechanized and their characteristics are shown in TABLE 4-6-1. Basically, the determining the type of parking building will be subject to the relation of indemnity cost and construction cost. Considering that in Paraguay, the construction cost of a non-mechanized one is lower than that of the mechanical type, and the microcentro lands are still free of saturation, the non-mechanized system was adopted since it offers greater advantage in the aspects of maintenance and operation. The parkings that will be located at the plazas "Juan de Salazar y Espinoza" and "Independencia", will be constructed underground, for the sake of environmental conservation.

TABLE 4-6-1 PARKING BUILDING CHARACTERISTICS

	Non-mechanized	Mechanized
Land Extent	It requires relatively ample site area.	It allows effective use of limited site area.
Construction Cost	It is relatively lower, due to its concrete structure.	It is expensive, due to the mechanical equipment acquisition.
Usage Facility	It allows usage, without waits	It takes more time for entering and exiting
Maintenance & operation	The cost of maintenance and operation is not too expensive.	It requires expenditures for conservation, checking and operation. It presents risk of equipment breakdown and of generating accidents.

2) Parking Building Scale

The parking capacity will be based on the estimated required demand for the year 2000. The number of necessary floors based on available land is indicated in TABLE 4-6-2.

TABLE 4-6-2 PARKING CAPACITY AND NUMBER OF REQUIRED FLOORS

Parking	Parking demand (year 2000)	Parking capacity	Land surface (m^2)	Number of floors *
A	1058	1000	6730	5
B	1925	1900	28560	2
C	815	800	4040	6
D	1110	1100	5740	6
E	1359	1350	12000	4

* Including the ground floor

3) Dimension and Type of Parking

(1) Parking Lot

According to the Master Plan Report, 90% of the existing vehicles in Asunción City are Brazilian, Japanese, and German (See TABLE 4-6-3). Consequently, the parking space dimension will be fixed in 5m x 2.5m, including the longitudinal and lateral free spaces of 30cm and 80 cm respectively, taking the Mercedes Benz 300E as the representative car, which is the biggest among the above mentioned vehicles (See TABLE 4-6-4).

TABLE 4-6-3 RESULT OF STUDY OF VEHICLE TYPE AT THE MICROCENTRO

Origin	Proportion (%)
Brazilian	68
Japanese	19
German	4
French	4
Swedish	2
Argentinian	1
American	1

TABLE 4-6-4 TECHNICAL SPECIFICATIONS OF REPRESENTATIVE VEHICLE

	Dimension
Length	4.740m
Width	1.740m
Height	1.446m
Cylinder size	2,962cc
Weight	1,860 Kg

(2) Parking System

There are two ways of parking: forwards and backwards, whose characteristics are specified in TABLE 4-6-5. The former will be adopted due to the following reasons:

a. The influence of vehicles concentration at the adjacent space is smaller due to ease of access.
b. This method is employed in most of the existing parking areas in the microcentro.
c. Also, the perpendicular way will be employed, which occupies the least space.

TABLE 4-6-5 CHARACTERISTICS OF PARKING SYSTEM

	Forwards	Backwards
Easiness for access	High	Low
Easiness for exit	Low	High
Parking lot per unit	Relatively large	Relatively small
Width of circulation	Relatively narrow (about 5.5m)	Relatively wide (about 6 - 6.5m)

(3) Circulation Space

In order to let the vehicles circulate normally and safely, the width of circulation space will be greater than 5.5m in case of two-way streets, and greater than 3.5m in case of one-way streets.

(4) Vertical Slope

The vertical slope is 8%.

4) Structure Type

(1) Structure

Reinforced concrete structure will be used. The parking buildings will not have the side-walls, for better ventilation.

(2) Foundation

It will be an underground direct foundation.

(3) Live Load

It will be 550 kg/m^2 for the slab and of 400 kg/m^2 for the beams. Concerning underground parking, the 2.0m earth stratum on the slab will be taken into account.

(4) Floor Height

Vertical clearance will be 2.50m. Consequently, the vertical distance between each floor will be 3.0m, including the 0.5m space occupied by beams and slabs.

(5) Cross Section

The cross sections of the parking building structure and of the underground parking are shown in FIGURES 4-6-1 and 4-6-2. The technical characteristics are indicated as follows:

a. Section of column square (0.4m x 0.4m),in case of underground parking (0.6m x 0.6m) will be employed.
b. Space between one and other columns to be minimum 7.5m corresponding to the width of the parking space of 2.5m.
c. Thickness of slab: 0.15m.
d. Height of beam: 0.50m.

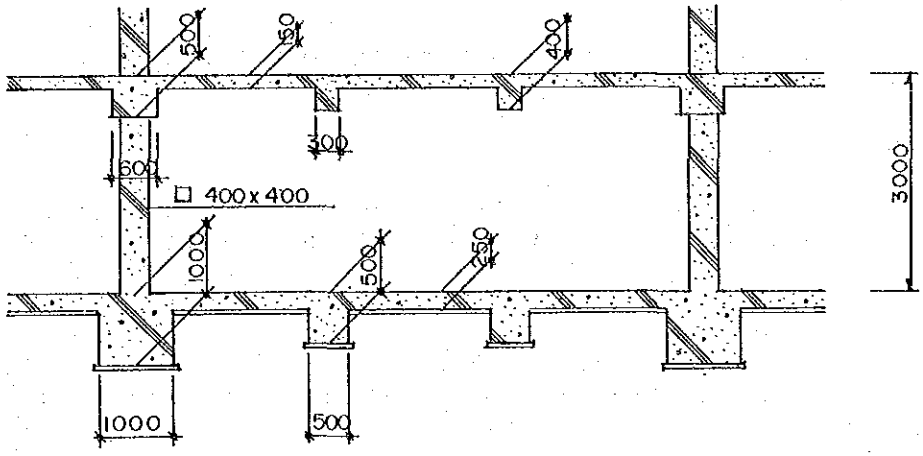


FIGURE 4-6-I CROSS SECTION OF PARKING BUILDING

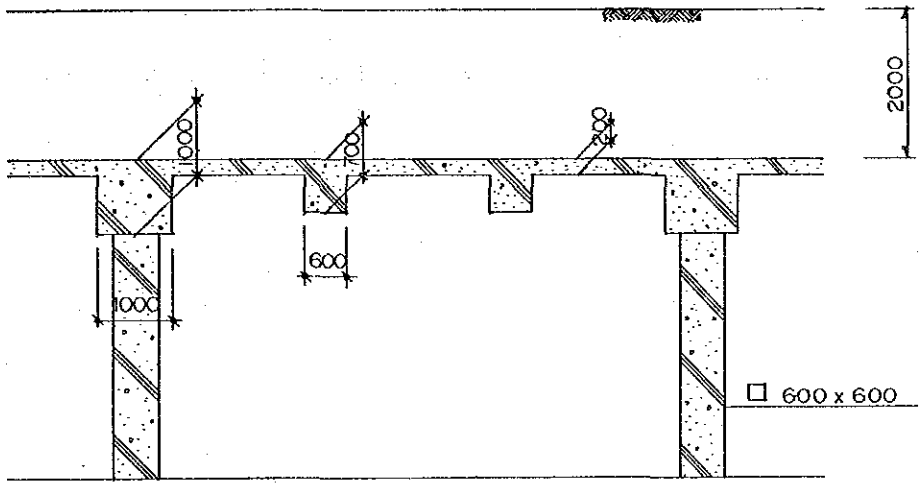


FIGURE 4-6-2 CROSS SECTION OF UNDERGROUND PARKING

5) Auxiliary Facilities

(1) Administrative Office

A 5.0m x 5.0m office will be built on the 1st floor, for building administration.

(2) Entrance and Exit Gate

It will be constructed according to the number of entrances and exits, with dimensions for 1 or 2 persons.

(3) Lighting

A line of lights will be set on the beams next to the slope, and they will be useful for the rest of the area.

(4) Ventilation System

The parking buildings will have a natural ventilation system. Adequate equipment for ventilation will be installed in the case of underground parking.

(5) Elevator

4 elevators/building for parking patrons (for the parking building over 4 floors)

(6) Fire Sprinkler System

A fire sprinkler system on the beams is to be installed.

4.7 SIDEWALK AND MALL PLAN IN THE MICROCENTRO

4.7.1 Exclusive Pedestrian Street Project

1) Pavement

The existing pavement in this project area will be raised up to the sidewalk level, in order to create a comfortable pedestrian area.

As a general rule, the existing asphalt pavement will not be removed. The 20cm difference will be filled with crushed gross product up to the first 10cm. Then, sand will be laid over it for level regulation and on top of the sand, the surface material will be laid. The pavement cross section is shown in FIGURE 4-7-1.

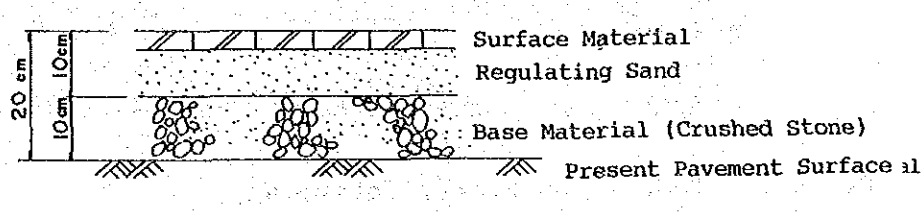


FIGURE 4-7-1 PAVEMENT CROSS SECTION

The vainilla type floor tile (25cm x 25cm) commonly used on the city sidewalks will be used for the surface cover. The white floor tile will be base, and the black is employed for figures design, in order to introduce variants. Besides, the existing floor tile thickness is 2cm, but the 4 - 5cm thickness floor tile will be employed for the lane designated for emergency vehicles.

2) Transfer of Tram

The tram will be transferred 1.0m to the center of the street, in order to obtain a width of 3.0m for the north strip of the pedestrian street, considering its future extension.

This transfer will be done not only between Yegros and O'leary Streets, but also in the whole section between Mexico St. and Colon Av., since the continuity of shops occurs also on the adjacent sectors to the exclusively pedestrian street.

The aerial electric wiring for the energy supply will be installed on the bearer arm that will be set on the street light column.

3) Implementation of Underground Conductors

Underground conductors will be implemented in order to keep the pedestrian space esthetic. Most phone wiring is already located in underground, except those which link the currency exchange houses and/or the banks, which are required to be eliminated. ANTELCO is planning to set this wiring underground, and therefore, it is proposed to do it together with the pedestrian street equipping projects.

Concerning the electric power wiring, those of 23 Kv are underground up to the distribution point, which are located along Palma street. The aerial wiring for residential connection emerges from these points. They will be installed in the sidewalks.

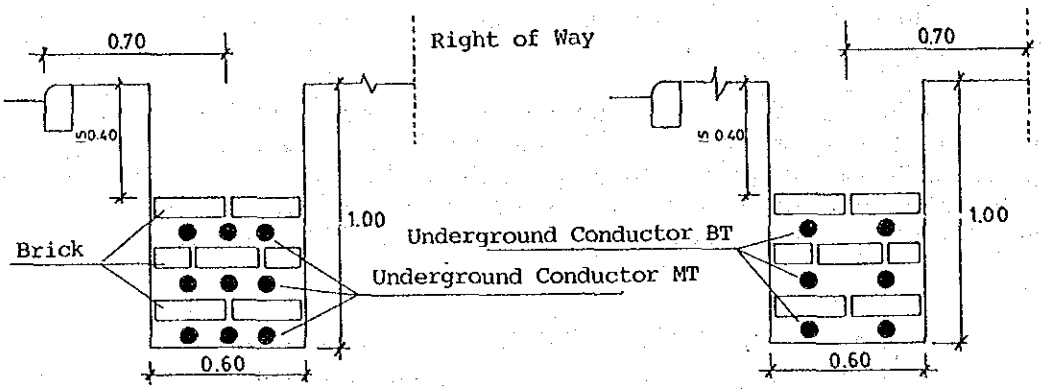


FIGURE 4-7-2 CROSS SECTION OF UNDERGROUND WIRING

4) Exclusive Pedestrian Street Equipping

(1) Planting

The "naranja jhai" tree was selected, which has an average height of 4m, and a 3m diameter of leafage. It will be planted in groups of 2 - 5 plants in order to offer shadow. 2 - 3 groups of these will be set on each block, combined with the pergola to provide variety.

For the planning of the location of plant groups on each block, efforts should be made to avoid obstruction of the view of the architecturally beautiful buildings and shops with glass windows (See FIGURE 4-7-3) that render a pleasant view to the pedestrian.

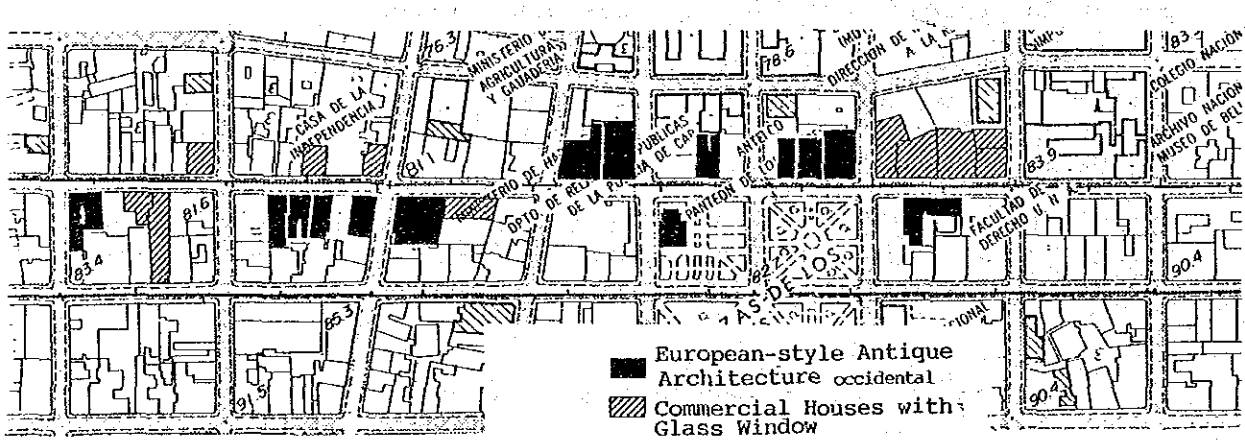


FIGURE 4-7-3 LOCATION OF ARCHITECTONIC BUILDINGS

Furthermore, the city block where the "Panteon de los Heroes" is located (between Ntra. Señora de la Asunción and Chile Streets) will be the central point of the "Event zone", which requires wide spaces, and therefore, it will not have any tree continuity.

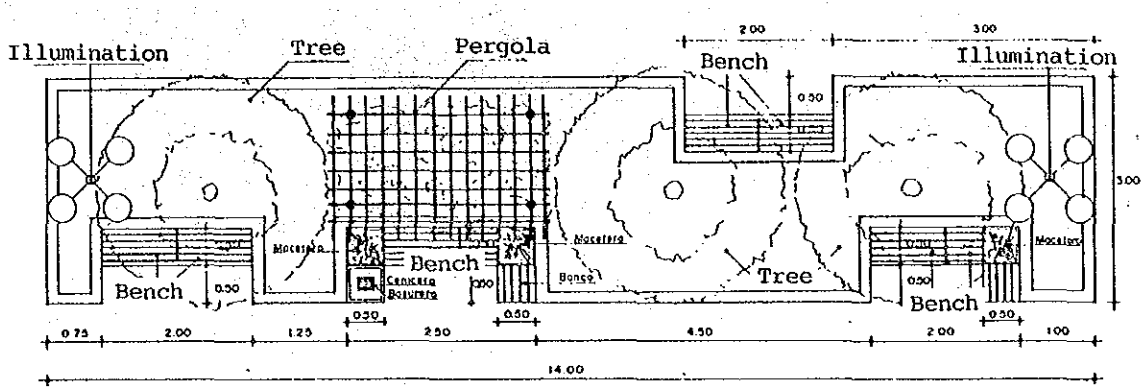


FIGURE 4-7-4 DETAIL OF CANTERO

(2) Pergola

Pergolas will be set next to the plant groups, in such a way to reduce obstruction of the pedestrian's sight. Benches will be set under the pergola for pedestrians.

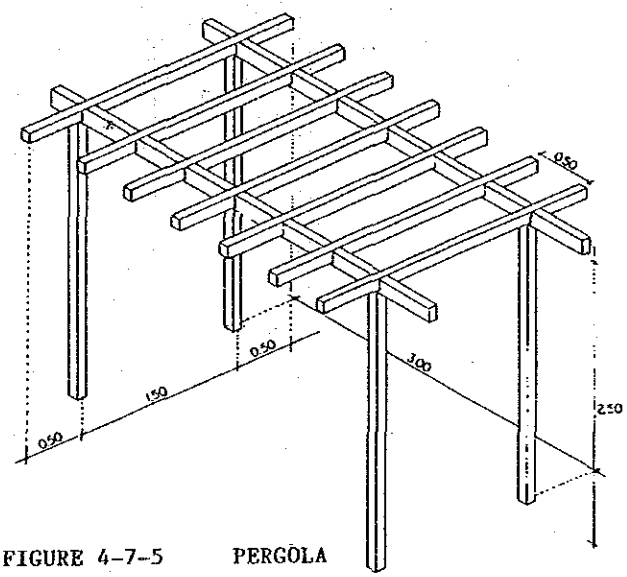


FIGURE 4-7-5 PERGOLA

(3) Bench

Benches will be set under the pergola.

(4) Illumination

The lighting fixtures will be installed on both sides of the plant groups, the height will be of 4m, in such way that the light can serve the whole area.

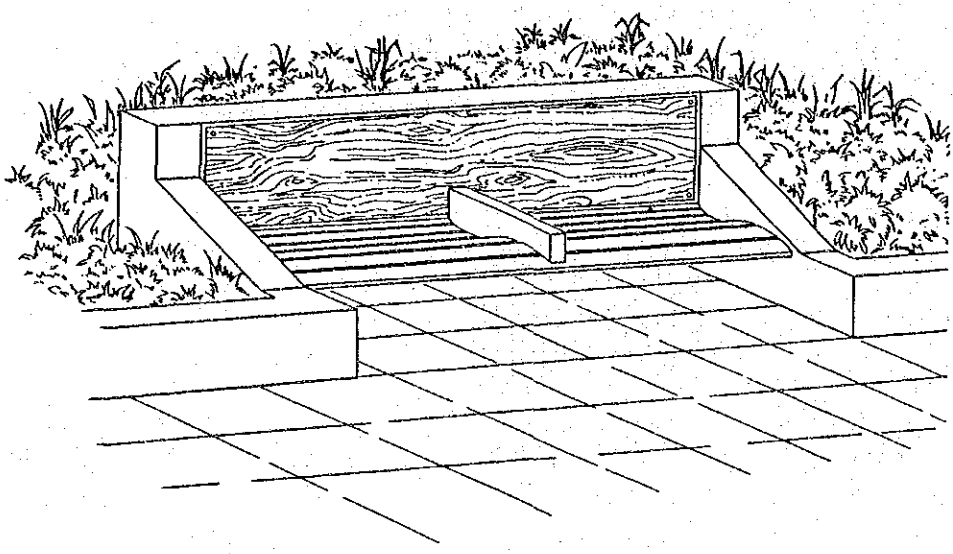


FIGURE 4-7-6 BENCH

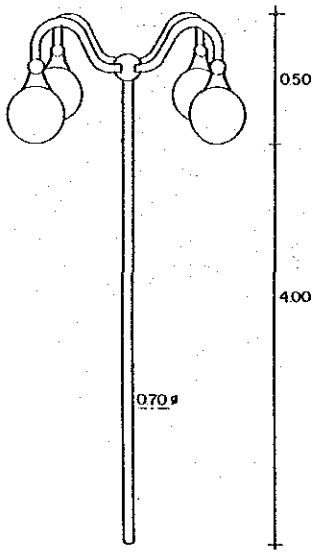


FIGURE 4-7-7 ILLUMINATION

Street lights on 5m high columns will be installed on the north side, and the columns serve at the same time as a support to fix the bearer arm for the tramway aerial wiring. In order to on which reveal the architectonic frontage of buildings, light spots will be implemented.

(5) Garbage Can

Garbage cans with ashtray will be adopted and two units will be installed for every trees group.

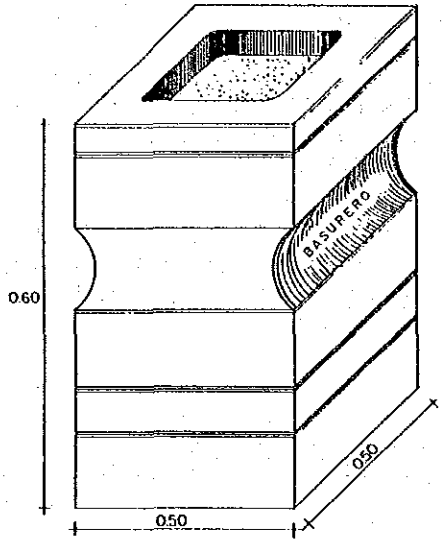


FIGURE 4-7-8 DUST BOX

(6) Information Board

One information board will be installed on each block of pedestrian street and events zone for information purposes.

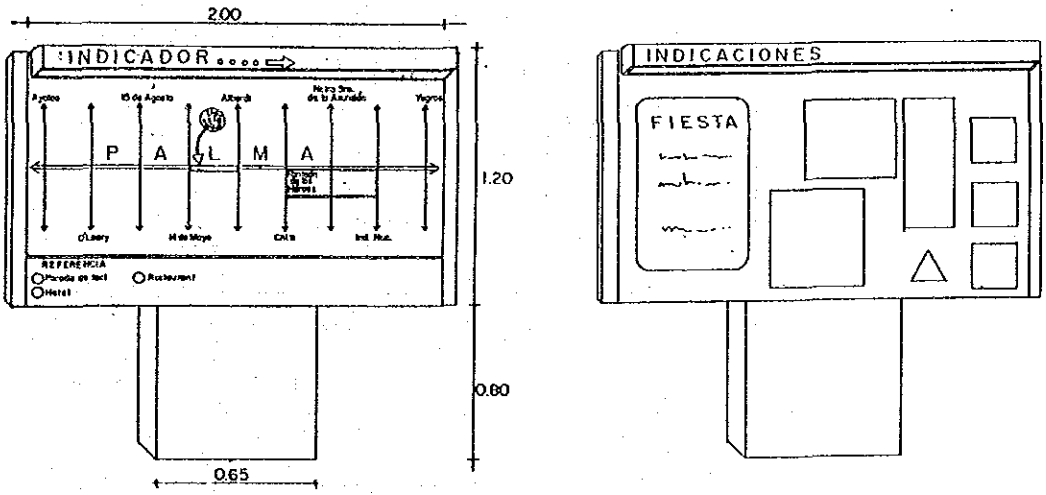


FIGURE 4-7-9 INFORMATION BOARD

(7) Others

Besides the mentioned fixture, one mailbox will be installed every 2 blocks and 2 public phones on each block.

5) Storm Water Drainage

The storm water drainage is executed by slanting the horizontal slope toward the plants group, which is located on the south sector. The catch basins will be installed every 10m, connected to the existing collecting chamber.

Taking into account of the size of the floor tiles to be used, the dimension of the catch basins will be 0.75m x 0.50m. If the tramway is not transferred, drainage will be done with the existing installations.

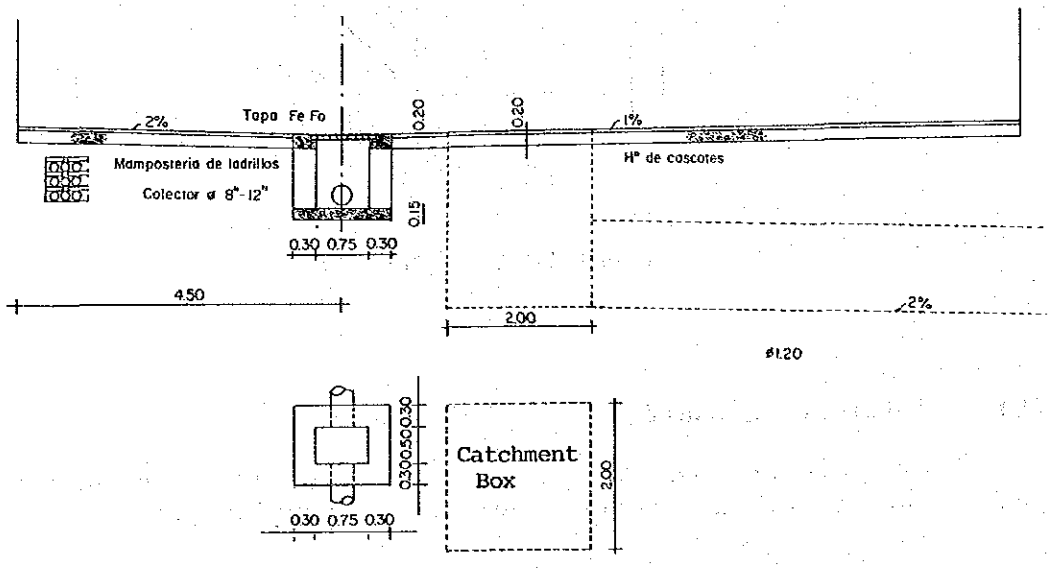


FIGURE 4-7-10 CROSS SECTION OF DRAINAGE FACILITY

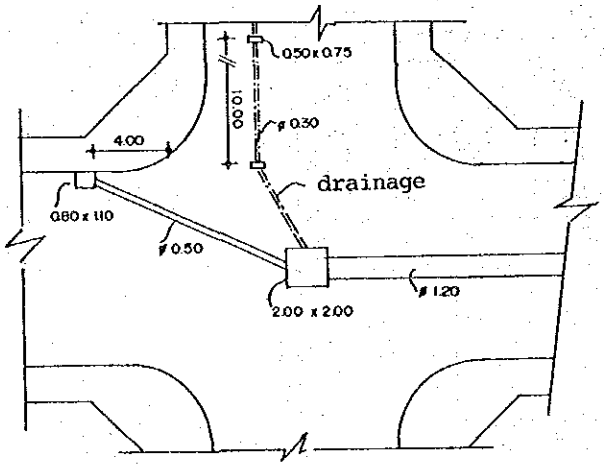


FIGURE 4-7-11 PLAN OF DRAINAGE FACILITY

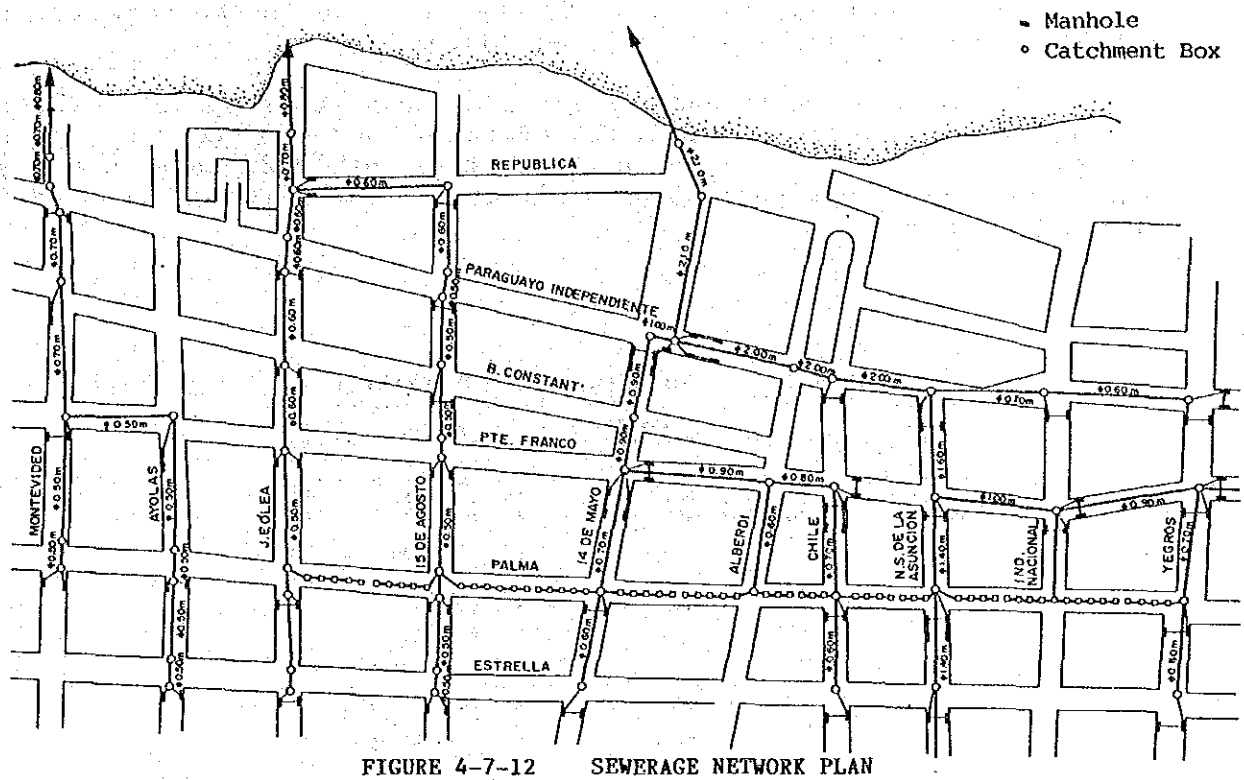


FIGURE 4-7-12 SEWERAGE NETWORK PLAN

4.7.2 Sidewalk Plan

1) Priority Street for Pedestrians

(1) Planting

The same type as for pedestrian streets will be adopted. It will be planted in a linear way on both sidewalks, with 6m separation.

(2) Pavement

Same as on pedestrian streets, the existing asphalt pavement will not be removed for the sidewalk widening, from 2.0m - 4.0m. Therefore, the existing street surface will be elevated by 20cm; of which 10cm will be with crushed stone. The surface cover will be of vainilla type floor tile (20cm x 20cm).

The same type as for the pedestrian street will be adopted. It will be planted in a linear way on both sidewalks, with 6m separation.

2) Bus Preferential Streets

The right sidewalk (where the bus stop is located) of the bus streets will be widened to 3.0m, in order to offer greater space to passengers who are waiting on the sidewalk.

The pavement material will be the same one as the pedestrian preference street (vainilla type floor tile).

The number of berth and bus lines at each bus stop is as shown in TABLE 4-7-1. These were calculated based on the number of buses that would be estimated in peak hours by the year 1992, in such a way as not to exceed more than 45 units/hour for one parking area and 5 lines for each berth.

TABLE 4-7-1 BUS LINES BY ITINERARY (1)

Direction	Street	Transversal Street	Bus Stop	Bus Line	Volume at Peak Hour
East/ West	Pte. Franco/ Eligio Ayala	O'leary	A	1-6-8-13	45
		Alberdi	B	12-17-37 39-44	45
		Yegros	C	16-25-30 31-41	44
	Mcal. Estigarribia	Antequera	A	1-6-12	35
			B	13-16-25-31-37	25
			C	30-39-41-44	37
	Oliva/Cerro Corá	15 de Agosto	A	28-30-31-44	45
		Chile	B	8-17-23-25	45
		Iturbe	C	9-16-34-35	44
		EE.UU	D	1-12-15-36-37	44
	Gral. Díaz/ Azara	15 de Agosto	A	2-3-4-41	42
		Chile	B	9-15-23-29	42
			C	10-19-28	43
			D	14-26-40	40
			E	21-38	42
			F	27-45	42
		Iturbe	A	2-3	24
			B	9-15-23-29	42
			C	10-19-28	43
			D	14-26-40	40
			E	21	33
			F	27-45	42
		EE.UU	A	9-15-23-29	42
			B	10-19-28	43
			C	14-26-40	40
			D	21	33
			E	27-45	42
	V. Haedo/ L.A. Herrera	15 de Agosto	A	2-21	45
		Chile	B	4-13-26-27	45
			C	6-7-20-29	45
			D	10-14-33-38-39	45
		Iturbe	A	2-21	45
			B	13-26-27	34
			C	6-2--29	39
			D	10-14-33-39	36
		EE.UU	A	2-21	45
			B	13-26-27-40	43
			C	6-20-29	39
			D	10-14-22-33-39	39
			E	3-19-41	41
			F	45	38
	Humaitá/ F.R. Moreno	O'leary	A	7-20-33	33
		Chile	B	22-24-26-36	33
		Yegros	C	32-34-35	34
		Antequera	A	2-8	37
			B	7-24-32	35
			C	17-20-22-36	34
			D	26-33-34-25	36

TABLE 4-7-1 BUS LINES BY ITINERARY (2)

Direction	Street	Transversal Street	Bus Stop	Bus Line	Volume at Peak Hour
East/ West	Piribebuy/ M. Dominguez	15 de Agosto	A	3-22-32	27
			B	19-40	31
			C	45	38
	Manduvira/ Tte. Fariña	O'leary	A	18	10
		Chile Yegros Antequera	A	4-18-38-41	37
	Ibanez del Campo/Rca. Colombia	15 de Agosto	A	18-24	27
		Chile Yegros			
		Antequera	A	7-18-24	33
	Ygatimi/ R. Francia	Montevideo	A	9-30-41	29
		15 de Agosto	A	3-30	19
		Chile	A	3-30-41	26
		Yegros	A	3-30	19
		Antequera	A	3-4	23
			B	30-38-41	
North/ South	Colón	V. Haedo	A	2-6-12-29	41
			B	9-16-41-44	42
			C	10-13-14-18	41
			D	15-26-31-37	39
			E	21-38	42
			F	23-30-40	39
		Manduvira	A	2-6-12-19	41
			B	9-16-41-44	42
			C	10-13-14-18	41
			D	15-26-31-37	39
			E	21-38	42
			F	23-30-40-22	42
			G	7-33-34--35-36	35
	O'leary	Piribebuy	A	2-3-6-29	40
			B	7-13-26-33	40
			C	10-14-22-40	40
			D	21-38	42
	EE.UU	Eligio Ayala	A	23-24-35-37	41
		L.A.Herrera	A	24-26-40	43
		Tte. Fariña	A	8-17-32	42
			B	24-26-38	43
	Brasil	Mcal. Estigarribia	A	23-24-35	36
		L.A.Herrera	A	8-22-35	37
			B	17-24-34-36	38
		R. Colombia	A	8-22-35-36	40
			B	14-24-34	44

4.8 URBAN BUS TERMINAL PROJECT

1) Location

The total land surface is 13,700 m^2, from which about 2,700 m^2 are in an irregular situation. An "irregular situation" means the illegal occupation of such municipal lands by poor persons and families. These people live in precariously constructed homes and shops. The Municipal Administration would re-locate these people with eventual reduction of cost concerning the indemnifications to be carried out.

On the other hand, the small amount of owners to be indemnified (33 in total) and the precarious constructions existing on such city blocks, enable the achievement of the project.

2) Design Standards

According to the survey of frequencies, as well as of passengers, Urban Bus Terminal characteristics were established. The conditioning factors are:

a. Actually, there are 4,700 departures and arrivals/day, around Municipal Market No. 4.
b. The unloading of passengers is done in an average time of 1.5 minutes/bus at the bus stops which are spread in the environs of Municipal Market No. 4.
c. The dimensions of one parking area were determined as 3m x 20m, taking into account the utilization of greater units of buses in future.
d. The platform capacity will be 40 buses/hour.
e. The bus roadway will have two lanes of 3.50m width for each one.
f. The Bus Terminal will be projected in a terrace form, following the land slope (the difference of the height is north-south 10m, and west-east 2m), in order to decrease the construction cost.

3) Auxiliary Facilities

The installations to be installed, will be those which fit the following purposes:

a. Orientation and ordering of great number of passengers.
b. Safe and efficient orientation of buses.
c. Recording of the number of passing buses.

Furthermore, concerning the installations which allow increase at user facilities, such as kiosks, public phones, ticket offices, etc.; they will be excluded from the current project. Their implementation will be carried out gradually and with the corresponding regulations.

These installations are summarized in TABLE 4-8-1. Concerning the planning of the bus circulation road, the space which will allow to carry out the maneuvers has been established.

TABLE 4-8-1 BUS TERMINAL FACILITIES

Facility Group	Facility	General Importance	Necessity
Facilities for Passengers	1. Platforms	A	0
	2. Concourse		0
	3. Information counter		-
	4. Lavatories		0
	5. Cafeteria		+
	6. Kiosks		+
	7. Telephone Booths		+
	8. Waiting hall	B	+
	9. First aid station		+
	10. Restaurants		0
	11. Locker rooms		-
	12. Shopping arcades		+(0)*1
	13. Telecom. office	C	+
	14. Luggage claim office		+
	15. Game corner		+
Other Facilities	1. Traffic signs	A	0
	2. Sun/rain shades		-
	3. Street lights		0
	4. Green-belt	B	0
	5. Flower beds		0
	6. Parks	C	-
	7. Fountains		-
Facilities for Administration	1. Administration office	A	0
	2. Operation room		+
	3. Drivers room		-
	4. Rest rooms		-
	5. Ticket offices		-
	6. Refectory	B	-
	7. Guardsmen room		-
	8. Meeting room		-
	9. Announce room		-
	10. Saloon	C	-
	11. Bathrooms		-
Facilities for Vehicles	1. Entrance/exit roads	A	0
	2. Circulation roads		0
	3. Loading/unloading space for		
	3-1 Buses		0
	3-2 Taxis		-
	3-3 Private cars		+*2
	4. Parking/queueing space for bus		-
	5. Toll gate		-
	6. Fuel stands	B	-
	7. Parking/waiting space for cars		-
	8. Bus wash stands		-

Note : 0 (To be constructed), + (License system), - (Not necessary)
*1 (Alternative), *2 (For the restaurant)

4) Preliminary Design

(1) Alternative No. 1

a. Shopping center of 2,500 m^2 area approx., with two levels; the second level connected with the central walk
b. Each shop will have at least a 12 m^2 area
c. The restaurant on the 2nd. level will have 500 m^2 area
d. Administrationandinformationofficeof theBus Terminal
e. Security and control office
f. Separated lavatory for each platform

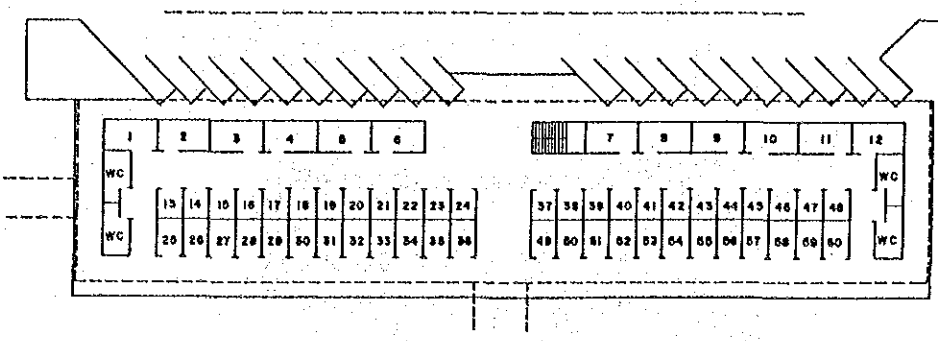
(2) Alternative No. 2

a. Shopping Center of 2,500 m^2 area approx., with two levels, the 2nd level connected to the central walk
b. Each shop will have at least 12 m^2 area.
c. The restaurant on the 2nd level will have 500 m^2 area.
d. Administration and information office of the Bus Terminal
e. Security and control office
f. Separated lavatory for each platform
g. Shops in the different platforms, 113 units in total; each unit will have two levels of 16 m^2 area each, which could be used independently or together, according to the tenant necessities.

For both alternatives, there would be one central walk 3.50m wide, which connects all the platforms, and the shopping 2nd level, where a restaurant, offices and shops are located. As well, it connects with Pettirossi Avenue to the north, and with R. de Francia Avenue to south.

The pedestrian walk is a total of 260m in length. A cover is planned for the walk.

These 2 alternatives have their significance in the aspect of securing job opportunity after land expropriation, as well as in the terminal administrative aspect, but do not present major differences when the congestion decrease generated by the boarding and getting off of bus passengers is considered. Consequently, considering the facility of land expropriation, the present study will be based the alternative number 2.



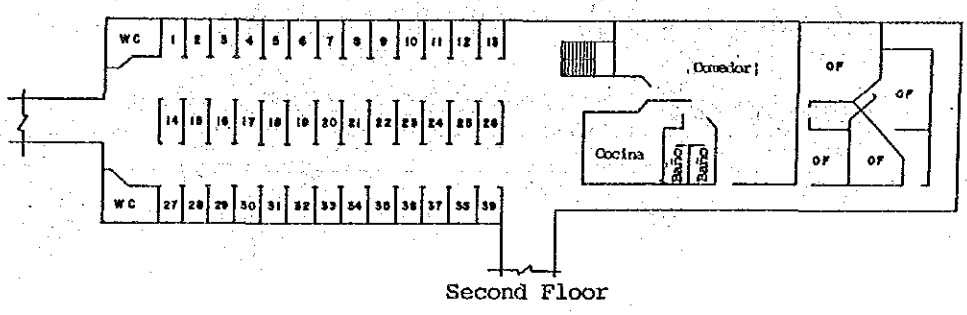
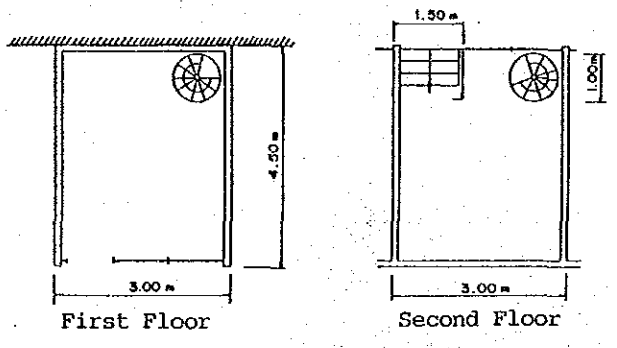


FIGURE 4-8-1 PLAN OF URBAN BUS TERMINAL SHOPPING CENTER



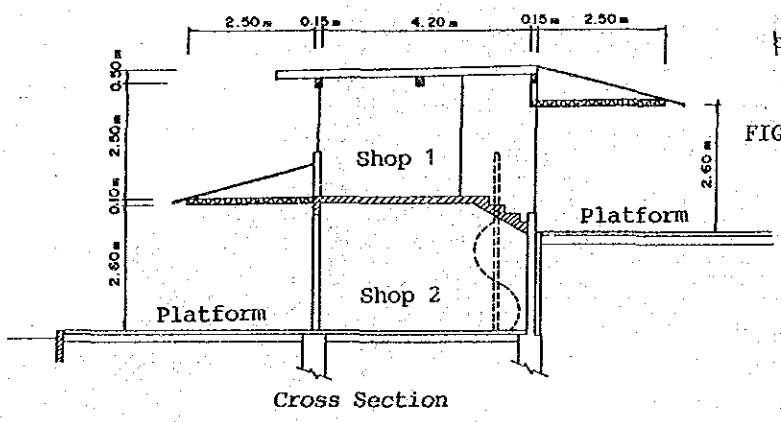


FIGURE 4-8-2 SMALL COMMERCIAL SHOP STRUCTURE

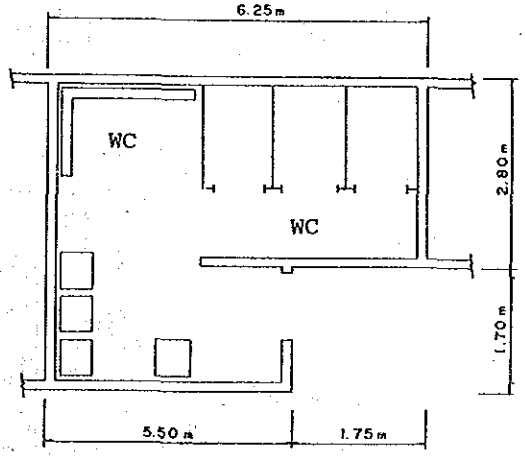


FIGURE 4-8-3 PUBLIC LAVATORY PLAN

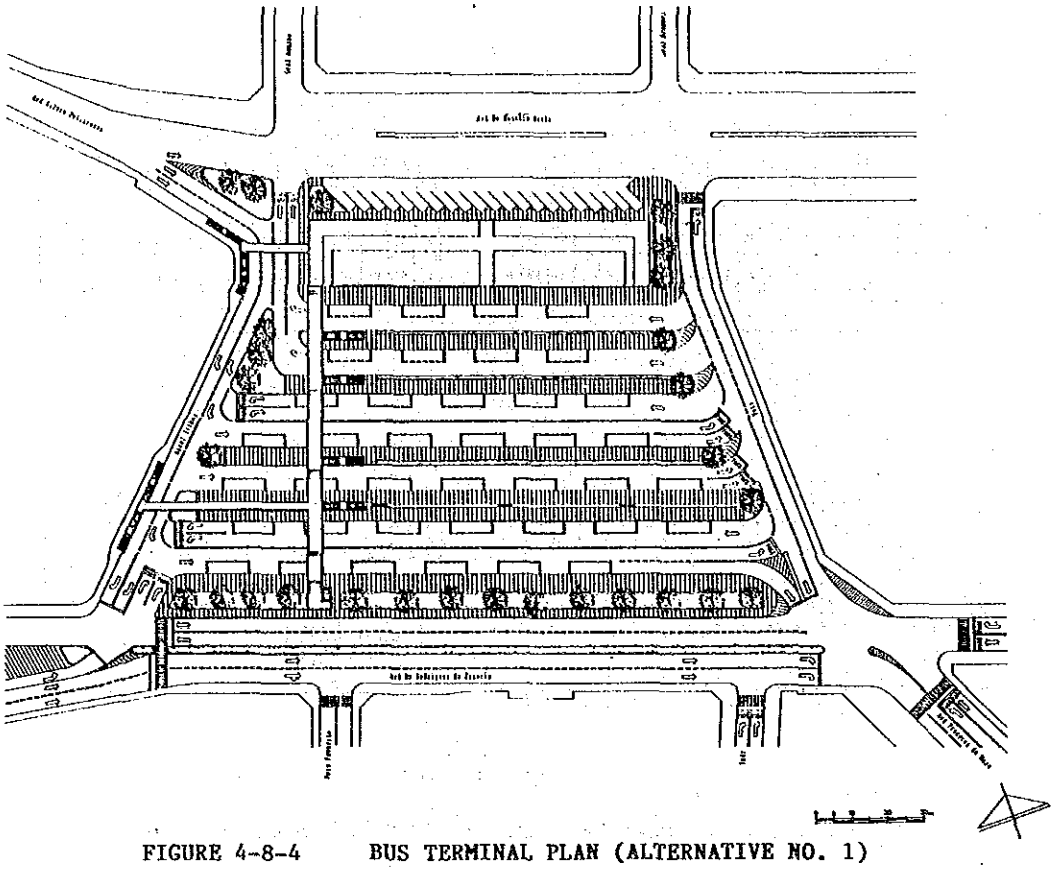


FIGURE 4-8-4 BUS TERMINAL PLAN (ALTERNATIVE NO. 1)

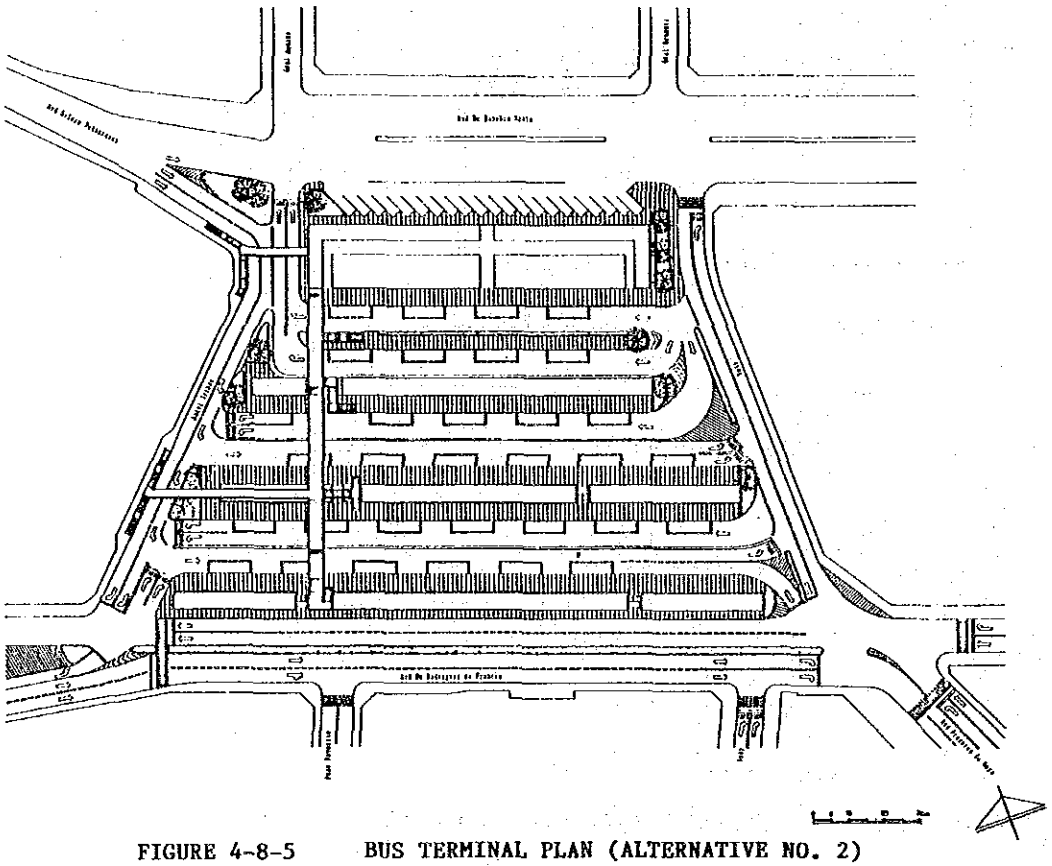


FIGURE 4-8-5 BUS TERMINAL PLAN (ALTERNATIVE NO. 2)

4.9 STRUCTURE PLAN

4.9.1 Design Standards

The design standard recommended in AASHTO (American Association of State Highway and Transportation Officials) were applied as the design standard of the Study. The major design criteria are described below.

1) Loading

(1) Live Load

AASHTO prescribes four kinds of live loads. In view of the fact that the designing of the bridges and viaducts of the important arterial roads in Asunción and its Metropolitan Area is at hand, the most heavy, HS20-44 loading, shall be used.

(2) Earthquake Effects

Although earthquakes are not so frequent in Paraguay,they occasionally happen without damage to structures. The Study shall consider seismic load with the lowest coefficient value prescribed in AASHTO; C=0.06.

2) Clearance

According to AASHTO standard, horizontal clearance is roadway width (including the curbs), and vertical clearance is 16 feet (4.877m). The Study shall use the rounded figure of 5.0m for vertical clearance.

3) Material Strength

The strengths of cement concrete was decided taking the actual conditions in Asunción, and the strength of steel is based on the ASTM standard. The strengths of principal materials are shown in TABLE 4-9-1.

TABLE 4-9-1 MATERIALS STRENGTH

Material		Strength
Concrete for	Superstructure	fc= 350 kg/m^2
	Pier	fc= 270 kg/m^2
	Foundation	fc= 210 kg/m^2
	Prestressed Concrete	fc= 350 kg/m^2
Reinforcing Bar (Grade 40)		fy=2,800 kg/m^2
Prestressing Steel (Grade 270)		fy= 161 kg/mm^2
Structural Steel (M-183)		fu=4,000 kg/mm^2

Note: fc; Specified compressive strength of concrete at 28 days
fy; Specified yield strength of reinforcement
fu; Minimum tension strength

4.9.2 Structures to be designed

1) Viaduct and Bridges

Bridges to be designed are:

a. a connecting bridge between G.R. de Francia and E. Ayala Avenues
b. four bridges for E. Ayala Avenue at the intersections over Kubitscheck, Rca. Argentina, De la Victoria and Mme. Lynch Avenues

2) Pedestrian Bridges

Eight pedestrian bridges over E. Ayala Avenue beside the planned bus stops and the pedestrian bridges at the planned bus terminal are to be designed.

3) Box Culverts

Box culverts to connect the roads that run parallel on both sides of the channel along Mme. Lynch Avenue are to be designed.

4) Other Structures

Other structures to be designed are: storm water drainage structures on the España Avenue extension.

The locations of these structures are shown in FIGURE 4-9-1.

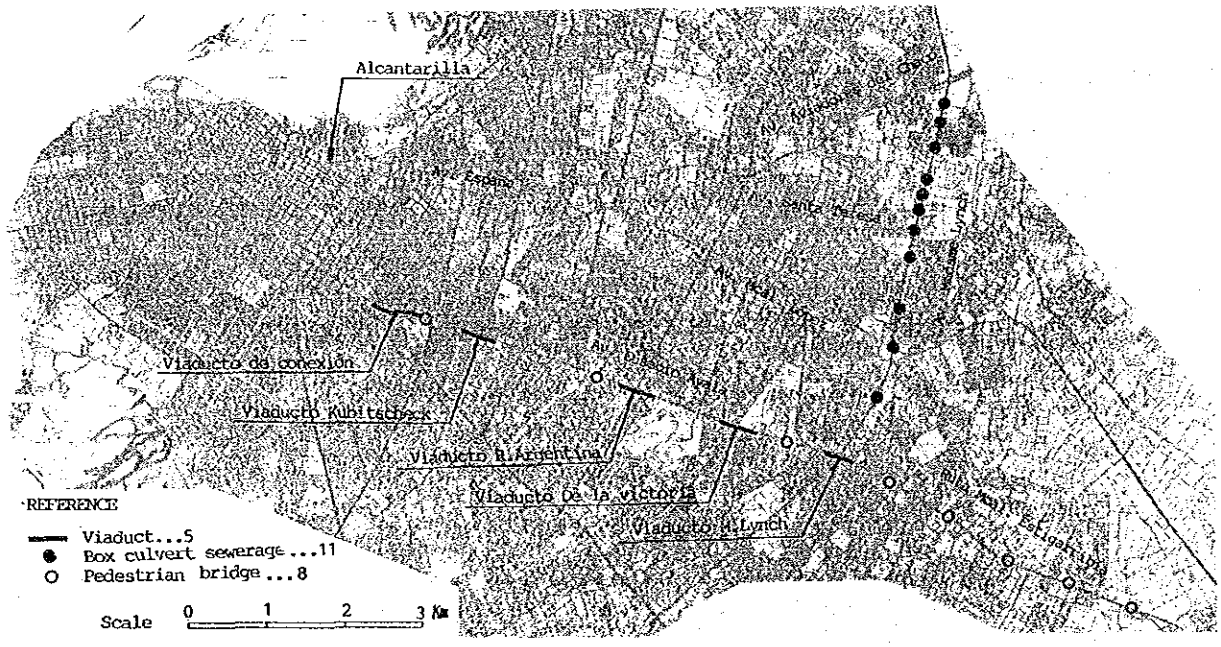


FIGURE 4-9-1 ART WORKS LOCATION

4.9.3 Superstructure of Bridges

1) Types of Bridges

The superstructures of the bridges can generally be classified the reinforced concrete bridges (hereinafter called "RC bridge"), prestressed concrete bridges (hereinafter called "PC bridge") and steel bridges. The general applicable spans of each bridge are given in TABLE 4-9-2. The RC bridge shall be applied only to small spans, while both the PC and steel bridges shall be applied to small, medium and long spans.

Taking into consideration the size of bridges, maintenance economy, social condition of Asunción City and etc. (See TABLE 4-9-3), the PC simple composite girder is adopted for the superstructure of the viaduct.

The roadway height on the bridges should be designed as low as possible keeping the necessary girder heights and vertical clearance over the under-passing-road, in order to keep the total bridge length as short as possible. For that reason, the type of structure shown in FIGURE 4-9-3 is not adopted.

Accordingly, the normal viaduct form shown in FIGURE 4-9-2 is not adopted. The form shown in FIGURES 4-9-3, where the girder is cut off at the end, and the top of pier is designed as the cantilever slab type, is adopted in order to have a slender view and to lower the height of the bridge surface.

TABLE 4-9-2 BRIDGE TYPE AND STANDARD SPAN APPLICATION

	Type of Superstructure	Bridge Span (m) 0 10 20 30 40 50 60 70 80 90 100
R	R.C. Simple T-Beam	
	R.C. Hollow Slab (Voided Slab)	
C	R.C. Box Girder	
	P.C. Hollow Slab	
P	P.C. Simple Composite Girder	
	P.C. Simple T-Beam	
C	P.C. Simple Box Girder	
	P.C. Continuous Box Girder	
	Steel Simple Composite Girder	
S	Steel Simple Box Girder	
	Steel Continuous Girder	

Note : R.C.; Reinforced Concrete
P.C.; Prestressed Concrete
S ; Steel

TABLE 4-9-3 STRUCTURAL COMPARISON OF SUPERSTRUCTURE

	Metallic Bridge	Prestressed Concrete Bridge	Concrete Bridge
Admissible Span	Medium to large (more than 20m)	Medium to large (more than 20m)	Short (less than 23m)
Works	Factory prepared beams, transporting & setting with truck & cranes. It has high accuracy and labor at work is smaller.	Prefabricated beams at the area close to work site. Transporting with trucks & cranes. It has high accuracy and labor at work is relatively smaller.	It allows the field work, due to the shorter span length. Besides, it is possible to implement prefabricated beams.
Maintenance	It requires periodical repainting.	Basically, it does not require maintenance.	Basically, it does not require maintenance.
Cost	High	Average	Low
National Production	Impossible	Relatively possible	Possible
National Manufacture			
Experience	Two pedestrian viaducts	*Pedestrian viaduct *Large scale bridge with foreign incorporated technology	With experience
Esthetics	Rust will occur through improper maintenance.	It allows to introduce variations on the structure form.	It allows to introduce variations on the structure form.
Global Evaluation	From the lack of experience and the necessity to import all the materials, it makes some doubts come up, concerning the work qualitative aspect and materials.	Structurally, it is the most appropriate due to the length of the bridges, that will be 30 - 35m. It requires a specialized technician for works control.	Appropriate for those of short span length. Even when having experience, it requires a specialized technician for works control.

2) Determining Span Length

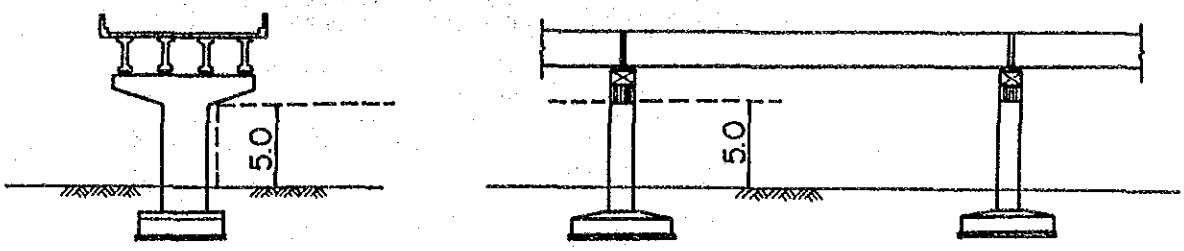
The superstructure span length was determined taking into account the following aspects:

a. Dimension of the intersection
b. Reductionofgirderheight
c. Location of abutments
d. Lowering the total cost of the bridges

Concerning the abutments, the minimum vertical clearance under the girder was planned as 2.0 to 2.5m. With this provision, the height of the approach retaining wall gets reduced and the existing community separation is avoided to the maximum.

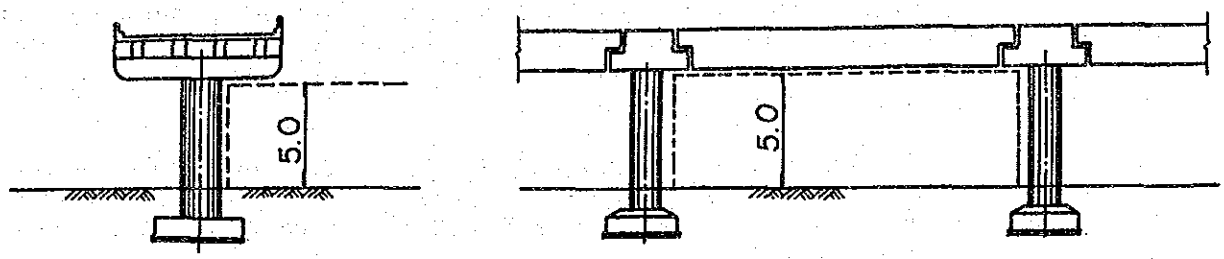
The Eusebio Ayala - R. de Francia Avenues connecting bridge was determined taking into account the effective use of spaces for the urban bus terminal.

The span length of the viaducts which are indicated next, are distances taken from the center of the pier up to the center of the other one.



Note: To keep the required vertical clearance under the pier cantilever, the bridge height should be higher than the following type.

FIGURE 4-9-2 NORMAL VIADUCT TYPE



Note: The girder and the beam of pier are designed to be the same height by cutting off the end of girder and taking the cantilever slab type (T type) for the pier, so that the roadway height on the bridge could be lowered and the bridge as a whole could have a slender and unified view.

FIGURE 4-9-3 PROPOSED VIADUCT TYPE

- Connecting bridge Eusebio Ayala - R. de Francia Avenues:
  L= 25.0 + 3 x 30.0 + 18.0 + 39.0 + 38.0 + 35.0 + 38.0 + 32.0 + 3 x 35.0 = 420m
- Kubitscheck: L= 9 x 32.0 = 288m
- Rca. Argentina: L= 7 x 32.0 = 224m
- De la Victoria: L= 8 x 32.0 = 256m
- Mme. Lynch: L= 7 x 32.0 = 224m

The structure of one and the other carriageway of the connecting bridge Eusebio Ayala-R. de Francia Avenues will be independent due to the location difference of the pier, attributable to the effective space use for the urban bus terminal. The other viaducts will be monolithic type structures.

3) *Girder Height*

The simple composite prestressed girder with the height of 1/17 to 1/20 of the span length is the most economic. TABLE 4-9-4 shows the relation between the standard girder height and the span length established by AASHTO.

In the present project, the H = 1.37m and 1.60m girders will be implemented, corresponding to the adopted span length of 1 = 28.7m to 1 = 35.7 respectively.

TABLE 4-9-4 RELATION BETWEEN SPAN LENGTH AND GIRDER HEIGHT (SIMPLE COMPOSITE PRESTRESSED GIRDER)

Girder Height(m)	Span length (m)								
	5	10	15	20	25	30	35	40	45
0.70		—							
0.90			—						
1.150				—					
1.370					—				
1.600						—			
1.850							—	—	

4) Girder Number

In the Study, the standard height girder has been adopted with respect to the span length, which is more economic. Therefore, 4 main girders are used for a 2 lane street (width 8m approx.), with a space between girders of 1.80m - 1.85m.

The slab thickness is subject to the intervals of the main girders interval. According to the calculation results, it has been determined to t = 15cm, having #16 and #20 reinforcement bars with a 30cm spacing between each other.

4.9.4 Substructure

1) Subsoil Characteristics

The subsoil at the planned bridge site consists of silty to clay type sand layer called "Patino Formation". The foundations of the structure are planned based on the soil layer at the depth of 3.0 to 10.0m from the surface with the N value of over 30, judging from construction experience in Asunción City.

2) Foundation Type

Concerning the determination of the foundation type, the conditions of superstructure, subsoil, construction method, etc., should be previously analyzed with accuracy, in order to select the most economical and reliable.

At present, the soil stratum with "N" value of over 30 is taken as bearing stratum, and considering the economical aspects, ease of construction, water table level, width of work, etc., a direct foundation will be employed when the solid stratum reaches to around 4.5m of depth, and in case it gets deeper, a pile foundation will be employed. Considering the small seismic power and previous experience, the 400mm x 400mm reinforced concrete prefabricated piles will be adopted.

The bearing capacity of the soil stratum is estimated from the "N" value, obtained by the standard penetration test. The allowable bearing capacity (Qa) of soil in the Asunción City area is estimated as follows:

Qa = 1.2 to 1.5 times N (t/m^2)

assuming that the safety index Fs is 3.

The soil stratum of R. de Francia Avenue is a clay type sand, with "N" value of 26 to 31, so the allowable bearing capacity is:

Qa = 1.2 x 26 = 31.2 t/m^2 (minimum)
= 1.5 x 26 = 39 t/m^2 (maximum)

Consequently, taking into account the safety, it has been assumed that Qa = 30 t/m^2.

At the site of the other viaducts, Qa was assumed as 40t/m^2 since the "N" value is more than or equal to 40 at those sites.

Considering the bearing capacity of top of the piles, and the frictional resistance, the allowable bearing capacity of one pile has been calculated as 38 t/unit and 35 t/unit respectively for the *viaduct over Kubitscheck and Mme. Lynch Avenues.*

3) Footing Depth

The depth of the upper surface of the footing will be taken as 1.0m as a minimum, considering the future underground installation, pavement depth, vegetation, etc.

4) Pier Form

Form and structure of pier should be reasonable, economical and safe.

Concerning the form of the pier, it could sometimes be restrained by outer factors, such as the alignment of the street under the viaduct, etc. Also, from the esthetic point of view, it is necessary to take note of the standardization factor according to conditions such as location, sector, etc.

Since Asunción City has lack of seismic effects, it allows the adoption of smaller piers.

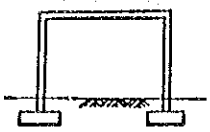
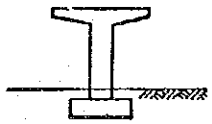
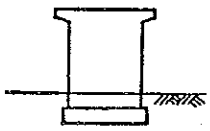
TABLE 4-9-5 shows characteristics of rigid frame, T type and wall type piers, which are commonly employed.

The form of the viaduct pier of the present project will be planned as follows:

(1) Connecting Bridge Eusebio Ayala - R. de Francia Avenues

The viaduct is located on an "S" form curve, and also, due to the utilization of the urban bus terminal, the location of the piers are restrained. Therefore, the West and East carriageway of 8.0m in width, will have independent structures.

TABLE 4-9-5 PIER TYPES AND CHARACTERISTICS

Pier Type	Admissible height of pier 10m 20m 30m	Characteristics
Rigid frame type 		It is adequate in case of existence of limitations of the settlement point of the column. The cross beam construction is more difficult when compared to others (especially when it is a high pier). It is adequate in case of a wide superstructure.
T type 		It is adequate when the width of the super-structure is narrow (in case the superstructure is wide, the number of piersshould be increased). The number of levers is larger than wall type.
Wall type 		Easy construction. The numbers of levers is smaller than other type.

Consequently, the T type piers will be adopted, which will be located in the center of each superstructure. Structurally, the column will be cylindrical. However, when setting the piers in the center of the corresponding carriageway over R. de Francia Avenue and Eusebio Ayala Avenue, the traffic gets disturbed at the secondary arteries which are located under the viaduct. Therefore, at those points, the rigid frame type piers will be employed supporting both carriageways. Considering the form standardization, the column of the rigid frame will be cylindrical.

(2) Remaining Viaducts

The superstructure of both carriageways will be monolithic, with 4 lanes and a total width of 15.5m. Therefore, wall type piers will be employed. The pier will have inverse-trapezoid form, of thin wall, which besides of being simple and esthetic, results in ease of the construction projects. The edges will be rounded in such way to offer a gentle aesthetic appearance.

5) Dimension of Substructure

(1) Pier Dimension

A) Connecting Bridge Eusebio Ayala-R. de Francia Avenues

The pier diameter was determined at 1.5m and 1.8m. The cross dimension will be determined by the compressive stress of concrete under seismic loading. The determinative factors are the superstructure span and the pier height.

B) Remaining Viaducts

The thickness of the pier body will be 1.0m and the width 4.0m at the joint with the footing, in order to keep the general counterbalance.

The cross dimension will be determined by the compressive stress of the concrete under seismic loading.

(2) Foundation Dimension

A) Pile Foundation

The number of piles is defined by the allowable bearing capacity of the pile. The determining loads are the reaction force of the dead and live load of the superstructure, dead load of the pier and the soil load over the foundation.

The foundation thickness was determined at 1.4m, considering the anchorage length in the footing of the pile and its cover etc.

B) Direct Foundation

The direct foundation dimension will be determined by the allowable bearing capacity of soil stratum. The determining loads are the reaction forces of the dead and live load of the superstructure, dead load of the pile and the soil load over the foundation.

The perpendicular dimension to the linear axis of the viaduct is determined considering the unbalanced live load of the superstructure and the eccentric load moment, produced at the time of erection of prestressed girders.

The footing thickness will be greater than 1/5 part of its length, considering the footing global rigidity.

(3) Foundation Summary

TABLE 4-9-6 shows the summary of the foundation of each viaduct.

4.9.5 Pedestrian Bridges

1) Girder Length

A comparison was done between Case No.1, which consists of two span girders with one pier on the central median of Eusebio Ayala Avenue, and Case No.2 which consists of one girder without, center pier (See TABLE 4-9-7).

According to the comparative result of cost, Case No. 1 is cheaper, but the difference is small. Consequently, Case No. 2 was adopted, because it fits the urban scenery, and also takes into consideration the possibility of future implementation of massive transport facilities.

TABLE 4-9-6 SUMMARY TABLE OF FOUNDATION

Viaduct Location	Pier Type	FOUNDATION				
		Depth of Solid Stratum	Foundation Type	No. of piers	Dimension of the Foundation (m)	Note
R. de Francia/ Eusebio Ayala Avenues	Solid Structure (1.5 & 1.8m diameter)	GL-2.0 to GL-6.3	Direct (6 units) with piers (22 units)	L= 5.0m 430 units	(Representative value) 5.0 x 5.0 x 1.4	* The foundation depth has been defined taking into account the bus terminal height design. * The admissible settlement capacity of the direct foundation is: Qa = 30 t/m² * The superstructure will be independent for one or another road.
Kubitscheck Avenue	Wall (t= 1.0m)	GL-10.0	With piers (10 units)	L= 7.5m 50 units	7.0 x 5.0 x 1.4	* Pier of existing reinforced concrete (0.4 m x 0.4m)
Rca. Argentina Avenue	Wall (t= 1.0m)	GL-4.0 to GL-4.75	Direct (8 units)		8.0 x 6.0 x 1.3	* Qa = 40 t/m²
De la Victoria Avenue	Wall (t= 1.0m)	GL-4.10 to GL-4.15	Direct (9 units)		8.0 x 6.0 x 1.3	* Qa = 40 t/m²
Madame Lynch Avenue	Wall (t= 1.0m)	GL-7.3 to GL-4.3	With piers (5 units) Direct (3 units)	L= 4.9 m 190 units	8.0 x 5.0 x 1.4 8.0 x 6.0 x 1.3	* Asunción side with piers * Fdo. de la Mora side will be direct.

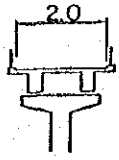
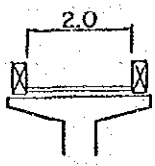
TABLE 4-9-7 COMPARISON GIRDER LENGTH

Case	Viaduct Width	Construct. Cost (mill.Gs.)	Easiness of Execution	Esthetics	Evaluation
Case 1: Two rows of girders	13.0m + 13.0m = 26.0m	34	* Traffic deviation during central pillar construct. * Traffic should be deviated during setting of girders. (closure of one carriage way)	* It does not allow vegetation continuity due to the setting of the pillar on the central medium, and it also does not allow space freedom in comparison with case 2.	* The urban esthetic is lower in comparison with case 2.
Case 2: One row of girders	26.0m	36	* Traffic must be closed in order to set the girders. (around five hours)	* It allows vegetation on the center medium. * It offers freedom in urban area.	* It presents some problems such as the construction cost and the traffic restraining during execution of work, but it offers a greater urban esthetics.

2) Comparison of Structure Types

Pedestrian decks with upper and lower decks are compared. The upper deck was adopted, granting priority to public safety and maintenance aspects (See TABLE 4-9-8).

TABLE 4-9-8 COMPARATIVE TABLE OF SUPERSTRUCTURE FORM

Form	Cross cut	Structure	Execution	Others
Case 1: Upper deck		The stairway will be more elevated, because the girders upper face is a transit.	The field works will be easier when employing "T" girders.	It allows public safety, since pedestrian can be seen from outside.
Case 2: Lower deck		Comparing it with case 1, the stairway will be lower, but the pillar will be greater.	The slab will be manufactured by field work, consequently, shoring will be required.	There are maintenance and public safety problems, since slight delicts could happen, because the girder prevents pedestrians from being seen.

3) Width and Stairway

The width of the existing pedestrian decks is 1.5m, except the one located next to the intersection formed by Eusebio Ayala and Mme. Lynch Avenues, which is 2.0m wide.

The pedestrian decks, planned in the current Study, are located next to the bus stops, consequently, the width will be 2.0m and also, 4 stairways will be provided for passenger convenience.

The urban bus terminal pedestrian deck will have a width of 3.5m, due to the massive concentration of users.

4) Pedestrian Bridge Design

Concerning the assumed load, it assumes a live load of 290 kg/m^2; besides the dead load, such as the girders load, slab load, etc.

The pedestrian bridge planned for Eusebio Ayala Avenue will have a 25.2m span. Therefore, two (2) T-type prefabricated prestressed girders will be adopted, in order to reduce as much as possible the field work.

In the area of the urban bus terminal pedestrian bridge there is a wide space for work, and also, the span length is only 12m approximately. Consequently, reinforced concrete slab manufactured by field work will be adopted.

5) Foundation Form

Concerning the column installation place for the pedestrian deck, it will be convenient to avoid facing as much as possible, since they are near the houses. Cylindrical columns will be adopted for the present, avoiding columns with square sections.

Furthermore, the reaction force which is performed by the superstructure is lower. Therefore, considering the cost reduction, the direct foundation will be adopted.

4.9.6 Structure Works on Madame Lynch Avenue

There are 2 proposals for the road project of Madame Lynch Avenue:

1st Alternative : a closed channel and the road on it.

2nd Alternative : an open channel and a road on both sides.

In the case of the first alternative, only a channel structure will have to be designed, whose cross section is shown in FIGURE 4-9-4.

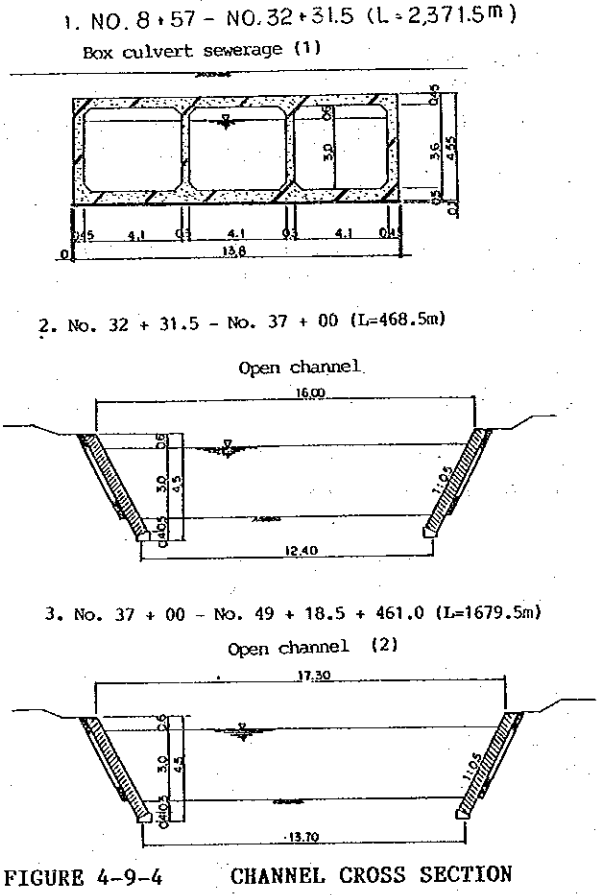
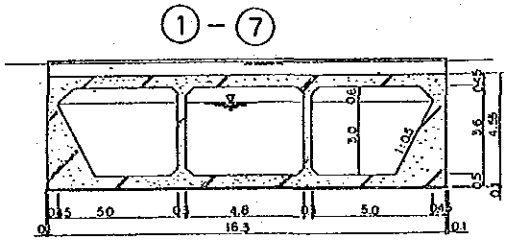
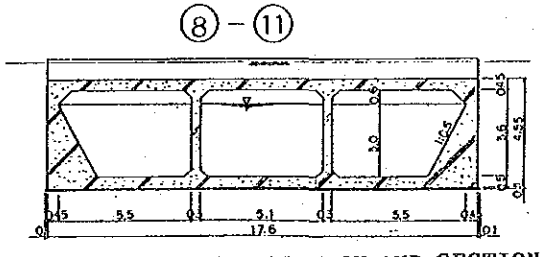


FIGURE 4-9-4 CHANNEL CROSS SECTION

In the second case, connecting structures between the roads that pass parallel on both sides of the channel are to be designed. If a bridge over the channel is planned, the girders of about 16m in length will be required and the total bridge extension will be greater than the existing Gral. Santos Avenue viaduct, which is too expensive. Consequently, the box culvert which is common in Asunción will be





	LENGTH (m)
①	15.0
②	63.0
③	10.0
④	63.0
⑤	47.0
⑥	15.0
⑦	15.0
⑧	10.0
⑨	10.0
⑩	10.0
⑪	33.0

FIGURE 4-9-5 LOCATION AND SECTION OF BOX CULVERT SEWERAGE BRIDGE

adopted to connect both roads. The cross section of the culvert will be the same as the open channel section, taking into account the channel is physical continuity.

In order to determine the length of the box culvert, the existing intersections width, the existing roads width and planned width of the road have been considered.

The location and length of these culverts are shown in FIGURE 4-9-5.

4.9.7 Structure Works for España Av. Extension

If it is planned to extend España Avenue by the filling method, the existing storm-water sewer tunnel will have to be extended around 80m. This sewer tunnel consists of a double 2.0m x 2.0m box, therefore, for the part to be extended, a reinforced concrete culvert with section fitting the existing one has been planned.

Also, a plain concrete channel and energy dissipation work with drainage holes have been planned in order to avoid the erosion of the earthfill and river bed.

4.10 EQUIPPING PLAN

1) Lighting

At present, ANDE is in charge of the street lighting equipment. Eusebio Ayala and Rodríguez de Francia Avenues are equipped with continuous lighting along their extension, and partial lighting can be observed on Mme. Lynch Avenue. The existing type of lighting is located on both sides of the avenue.

In the present project, street lighting will be planned in order to provide good visibility at night time. For that purpose, basic lighting of 1.0 cd/cm^2 will be adopted. Concerning the type of lighting, the side lighting will be adopted for the normal sections and central lighting in a one column row on the viaducts.

FIGURE 4-10-1 shows a cross section of the location of the lighting.

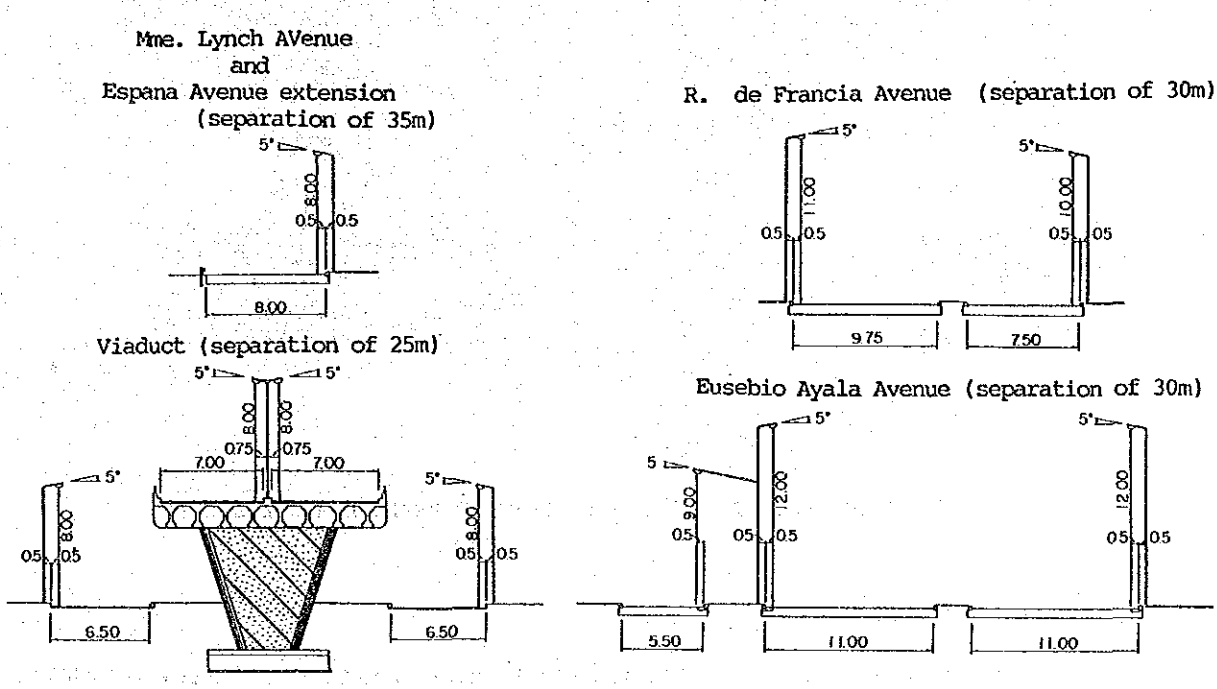


FIGURE 4-10-1 TYPICAL ILLUMINATION TYPE BY SECTION

2) Pedestrian Bridges

Among the roads that are the object of the present study, the Eusebio AyalaAv./Mcal. Estigarribia Road corridor has 5 pedestrian bridges.

In the present project, the pedestrian bridges will be constructed at the bus stops, in order to ease the congestion of the bus users crossing at those places.

FIGURE 4-10-2, shows the location of the existing pedestrian bridges, as well as those planned.

FIGURE 4-10-2 LOCATION PLAN OF PEDESTRIAN BRIDGES

3) Guardrails

In Asunción city no guardrails are installed except those on viaducts and bridges.

At present, it is planned to install guardrail along Mme. Lynch Avenue, in order to prevent vehicles falling into the channel which is 3.6m deep (See FIGURE 4-10-3).

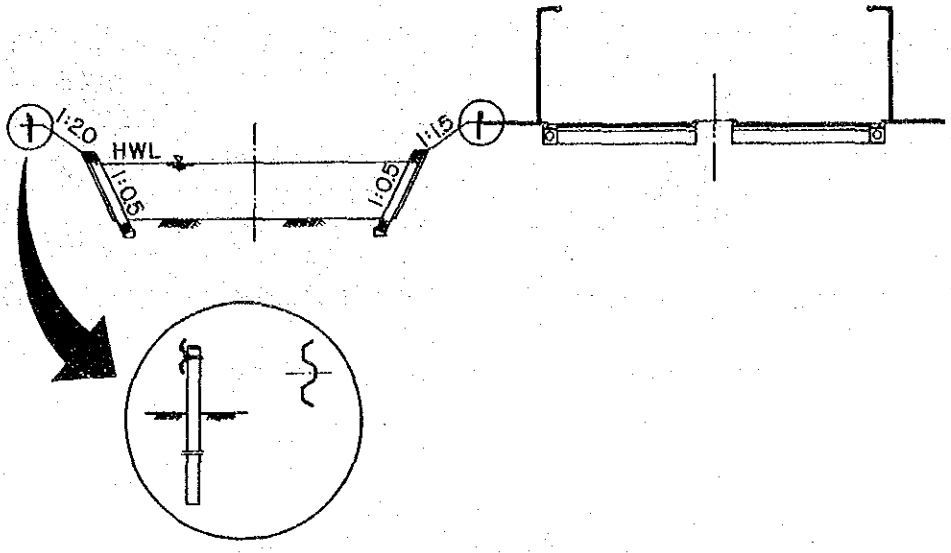


FIGURE 4-10-3 MME. LYNCH AVENUE GUARDRAIL

4) Bus Stop

The technical characteristics of the bus stop are indicated as follows:

- Length of the acceleration section L= 25.00m
- Length of the reduction section L= 20.00m
- Length of the parking area L= 15.00 m/unit

On the bus stops next to the intersection, the beginning point of the acceleration or reduction section will be located at a distance of 30m from the intersection, taking into account the weaving section.

FIGURES 4-10-4 and 4-10-5 show the standard plan and the location plan respectively of the bus stops.

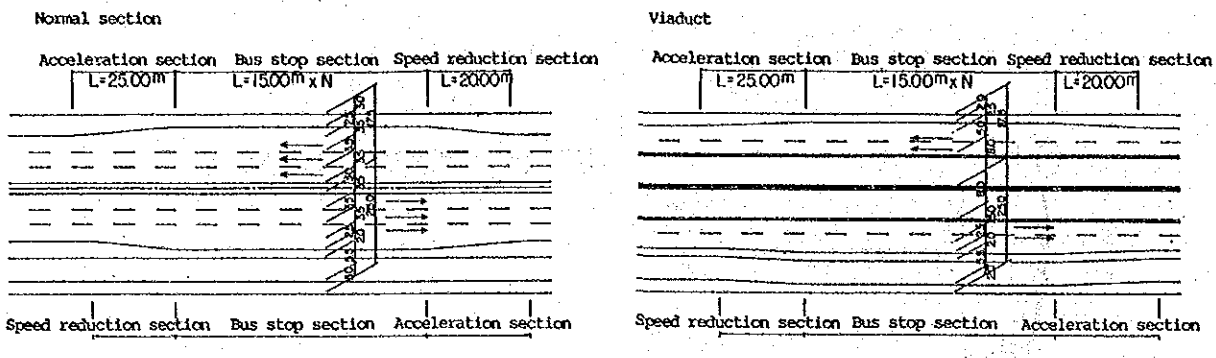


FIGURE 4-10-4 TYPICAL PLAN OF BUS STOP

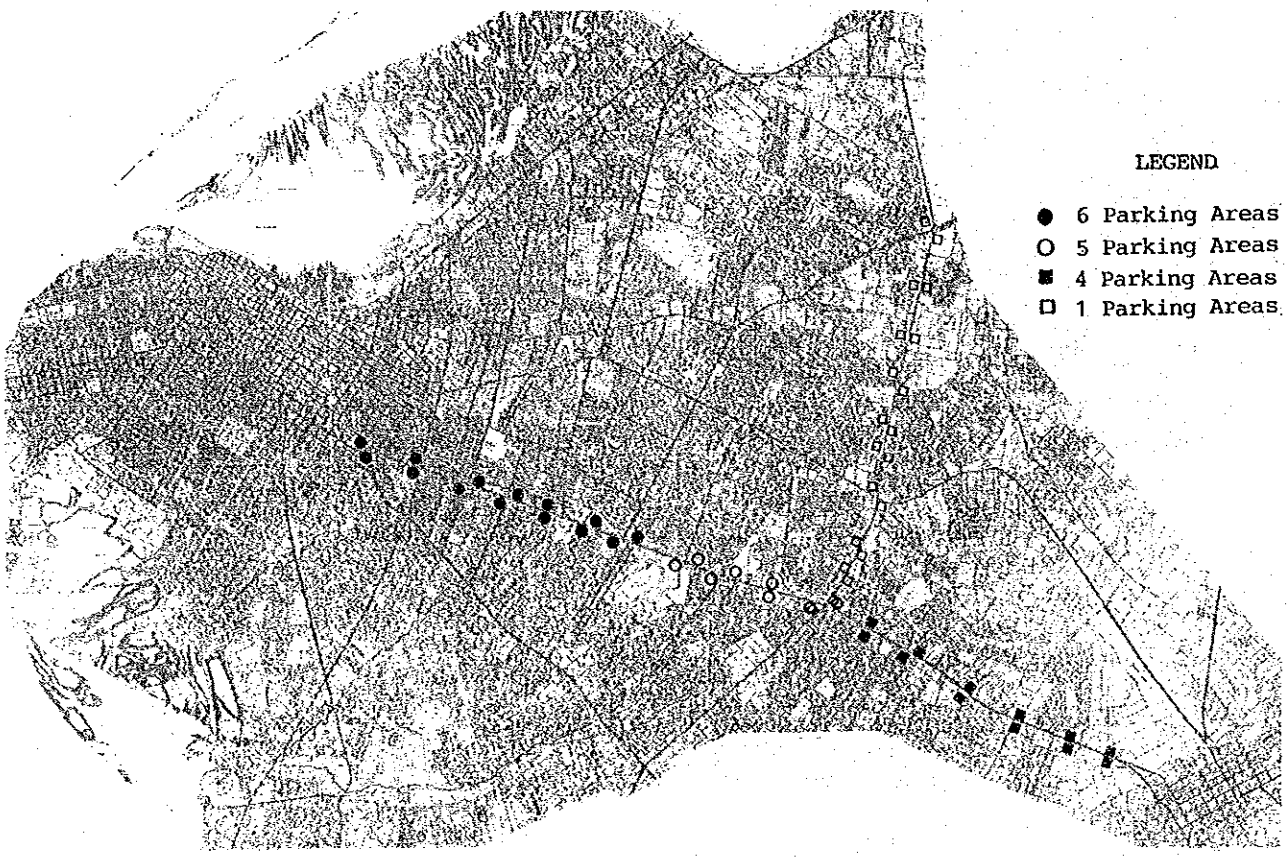


FIGURE 4-10-5 LOCATION PLAN OF BUS STOPS

5) Median Opening

Concerning the Eusebio Ayala Av. - Mcal. Estigarribia Road corridor there are no entrance and exit regulations for local streets. Also, the central median is open at those points, allowing left turns for vehicles coming from the local streets, and, consequently, interruptions of the normal traffic flow at the main corridor occurs.

In this study the opening of the central median was planned at an interval of 300m to 700m for Eusebio Ayala Avenue (in the case of 35m width), and from 200m to 500m for the Mcal. Estigarribia Road, in order to restrain the entrance and exit from local streets. When being widened to 50m, the side separators and the marginal streets will be constructed on both sides, and entrances and exits of vehicles from local streets to the main street and the marginal streets are planned as indicated in FIGURE 4-10-6, increasing the main street traffic capacity. FIGURE 4-10-7 shows the location of the Eusebio Ayala Av. - Mcal. Estigarribia Road openings.

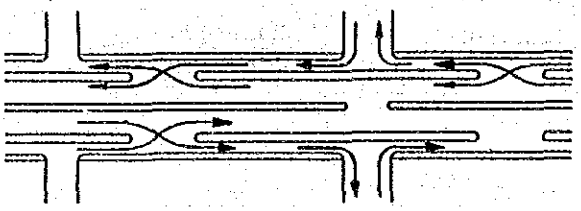


FIGURE 4-10-6 OPENING POINT LOCATION PLAN OF MEDIAN

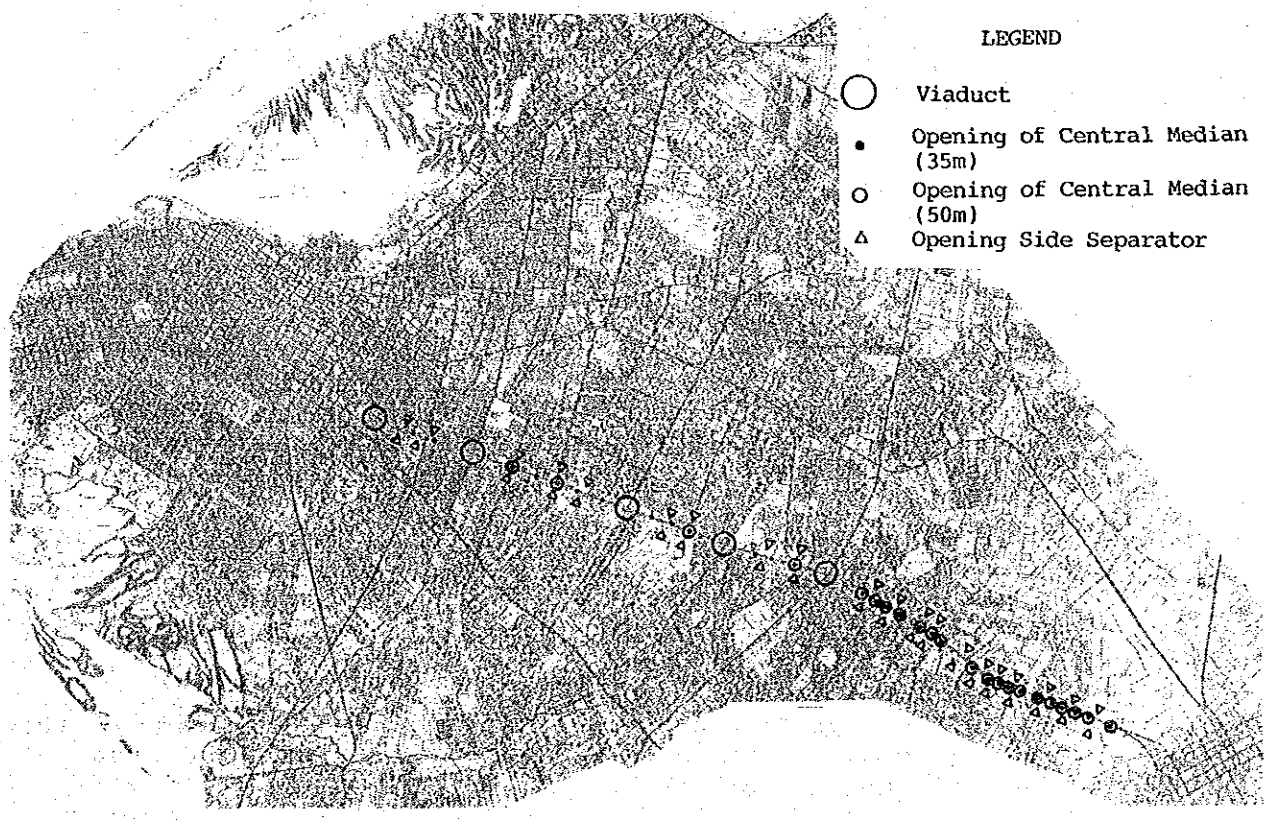


FIGURE 4-10-7 TYPICAL CROSS SECTION OF OPENING POINTS

6) Road Marking and Traffic Sign

(1) Pavement Marking

In Asunción City there are no pavement markings, except on Mcal. López Avenue, and part of the centro area. The pavement markings perform various functions such as lane identification, guidance of drivers sight. (mainly at the intersections), traffic safety, etc. Therefore, they will be adopted on the affected arteries of the present study. The lane line, the central line, the traffic channelization sign, stop line, pedestrian crossing, parking area, traffic direction sign (straight, left and right turn), exist as types of pavement marking. However, these do not last. Therefore, constant maintenance is required. FIGURE 4-10-8 shows the pavement marking standard plan.

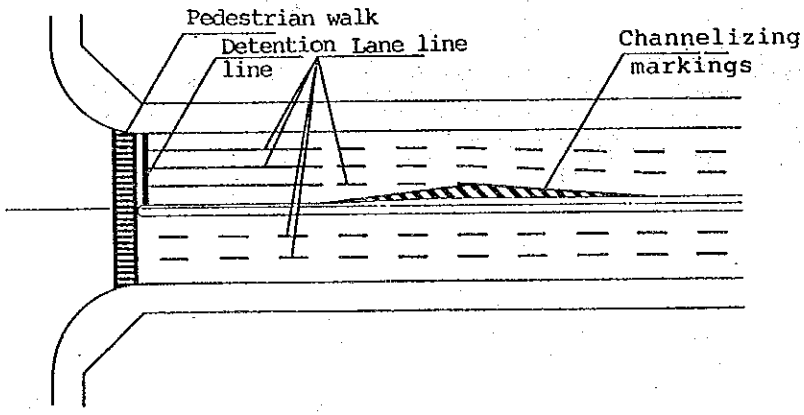


FIGURE 4-10-8 TYPICAL PLAN OF ROAD MARKING

(2) Traffic Signs

Traffic signs are classified as follows: restraining signs, warning signs and informative signs.

Restraining signs indicate those rules that the drivers must follow such as "no through way", "no parking", "maximum speed", etc.

Warning signs indicate the proximity to danger areas for drivers, such as intersections, curves, etc.

Informative signs indicate information such as the name of the place, the sign which directs the driver to a determined area, or other useful information for users.

Generally, restraining signs and warning signs are represented by symbols, therefore, a 60cm diameter plate of a simple column type is installed at the side of the road.

The informative sign gives for example, the name of a place. Therefore, it is installed on a double column support or a hanging or cantilever type column. FIGURE 4-10-9 shows the location and types of pavement markings.

In this study the signs will be used at intersections and at the entrance to viaducts.

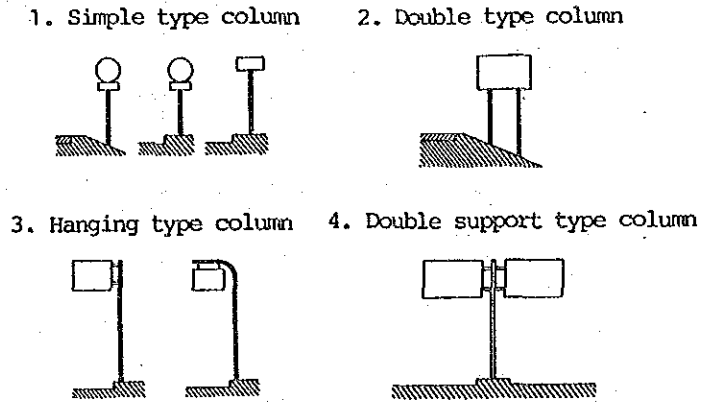


FIGURE 4-10-9 INSTALLATION METHODS OF TRAFFIC SIGN

7) Planting

Planting is classified as sidewalk planting and central median planting. It is carried out with the following purposes:

- To maintain pedestrian safety, through the separation of the sidewalk and the street
- to provide shadow
- To increase street esthetics
- To obstruct vehicle glaring from vehicles going in the opposite direction
- Sight orientation

For the selection of the types of trees, the climate of Asunción City has been considered. The selected types of tree are summarized in TABLE 4-10-1.

The interval between trees will be 8m, according to the corresponding municipal order. Besides, in order to characterize the streets, two tree types were selected, for the sidewalk, as well as for the central median. TABLE 4-10-2 shows the selected types of trees for each street.

TABLE 4-10-1 DESCRIPTION OF SELECTED TREES AND SHRUBS

Name	Type	Height (m)	Growing Period	Flowers Color	Blooming Period	Fruits	Leafs	DAP (cm)	Root
Lapacho rosado Tayy (Purple) (Yellow)	Tree	15-28	0.5 - 1m/year 0.5 - 1m/year	Pink Purple Yellow White	July August September Winter Spring	Cylindric pod, 15-20cm length	15-28m Perishable	60-120	Vertical
Lluvia de Oro	Shrub	3-5	0.5 - 1m/year	Yellow	November-December	Pod	Perishable	15-30	Horizontal & vertical
Crespon	Shrub	4-9	0.5 - 1m/year to 1-2m/year	Pink	More than once a year	Little capsule	Perennial	10-20	Horizontal & vertical
Inga'i	Tree	4-5	1 to 2m/year	White	Spring	Fleshy eatable pod	Perennial	15-30	Horizontal & vertical
Lapachillo	Shrub	2-4	Less than 2m/year	Yellow	Many times a year	Little pod	Perennial	10-15	Horizontal & vertical
Flor de orquidea	Tree	6-10	Average or fast	Pink	Spring	Pod	Perennial	20-40	Horizontal
Cibipiruma	Tree	5-10	Fast	White	Spring	Pod	Perennial	30-40	Vertical & horizontal
Sombrilla de playa	Tree	5-10	Fast	White	Spring	Drupes	Perishable	20-40	Vertical & horizontal
Villetana	Tree	5-10	Fast	Red	Spring	Wavy capsule	Perennial	15-30	Vertical
Laurel	Shrub	2-5	Fast	Pink	Spring & summer	Capsules	Perennial		Horizontal & vertical
Camba	Shrub	6-12	Average	White	Spring	Hard capsule	Perennial	2-50	Vertical
Sauce lloron	Tree	4-7	Average	Yellow	Spring	Capsules	Perennial	20-40	Horizontal & vertical

TABLE 4-10-2 SELECTED TREE TYPES

Street Name	Central Median	Sidewalk
R. de Francia Av.	Lapacho rosado Lapacho morado	Crespon rosa, sombrilla de playa, lapachillo, lluvia de oro, Inga'i.
Eusebio Ayala Av.	Villetana Inga'i	Camba-aca, Flor de orquidea, Tajy-hu, Cibipiruma.
Mme. Lynch Av.	Sauce Laurel	Sombrilla de playa, Flor de orquidea.
España Av. extension	-	Lapachillo, Inga'i.

4.11 IMPLEMENTATION PLAN

4.11.1 Project Sections

a. Road Network Projects

- Eusebio Ayala Avenue : Section 101 to 112
- Rodríguez de Francia Avenue : Section 201 to 202
- Madame Lynch Avenue : Section 301 to 303
- España Extension : Section 401

The sections for construction are shown in FIGURE 4-11-1. Considering the partial development of the project, the minimum units were taken between the intersections of the secondary arterial road. The cost of the intersections which include elevated structures will be considered independently, because the cost is high in comparison with the other ones. Also, the sections, where the existing pavement was executed at the same time , are unified if possible, in order to make it possible that the cost of the paving will be paid by the "frentistas".

b. Improvement Project of the Microcentro Traffic

- Tacuary intersection improvement : Section 501
- Exclusive pedestrian street project : Section 502
- Signals improvement project : Section 503
- Traffic sign improvement project : Section 504
- Sidewalk improvement project : Section 505

c. Urban Bus Terminal : Section 601

d. Parking Project : A(Section 701) - E(Section 705)

4.11.2 Execution Plan

1) Sub-structure of the Viaduct

(1) Excavation

The depth of excavation will be 3.0m - 4.5m. Therefore, the mechanical open cut method will be employed, with a 1:0.5 slope, taking into account of the dimensions and the clay-sand soil. However, the excavation of the last 30cm will be done by hand in order to protect the soil stratum under the foundation (See FIGURE 4-11-2).

(2) Foundation Base

In the case of pile foundation, a 20cm thick rubble layer will be placed in order to strengthen the foundation before placing concrete. In the case of direct foundation, 10cm of lean concrete is previously applied directly on the foundation soil.

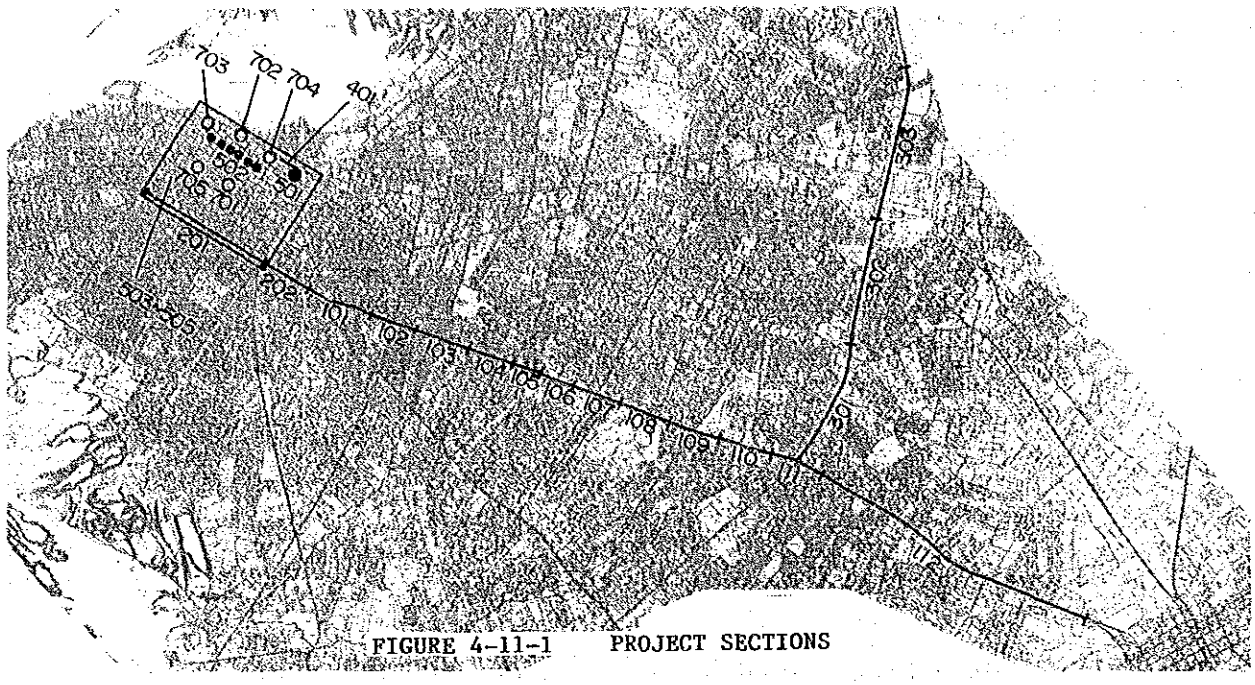


FIGURE 4-11-1 PROJECT SECTIONS

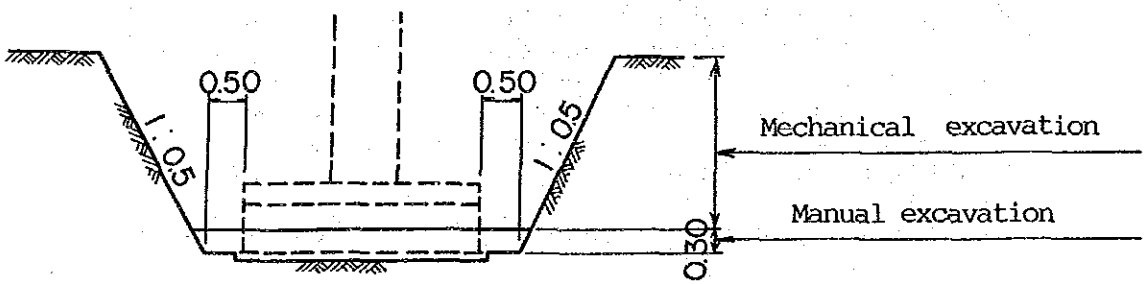


FIGURE 4-11-2 DIGGING CROSS SECTION

(3) Form Work

The forms are to be tightly fixed for good performance, accuracy, beauty, etc. Steel forms have advantages, in this sense, compared to wooden forms or plywood forms. Furthermore, they are able to be used many times and are more economical. Consequently, the steel forms will be used for the project.

(4) Concrete Works

The concrete work for the column is to be done after the completion of the foundation. The concrete work for the column is divided into 2 stages. The concrete work for the beam is to be done after backfilling the foundation and fabricating stages for concrete works.

2) Superstructure

Since the viaducts will be located on the main streets of the Asunción City, it is necessary to avoid those construction methods that obstruct the normal traffic flow for long periods.

For the construction of the viaduct superstructures, prefabricated girders will be placed with crane, taking into account of the economical aspects, agility, safety, and ease of work.

(1) Manufacture of Concrete Bed for Girders

There are 368 girders to be produced. Therefore, 22 set of concrete beds will be needed, taking into account their re-utilization.

(2) Forms for Girders

Eight metallic form sets are required for the fabrication of girders.

(3) Fabrication of Girders

The fabrication cycle of girders will be of 15 days/girder.

(4) Erection of Girder

The girders will be transported by trailer and will be set by two truck cranes. The necessary crane capacity for the connecting bridge of E. Ayala Av.- R. de Francia Av. is 70 tons and for the other viaducts, 45 tons will be enough. The daily performance is 3 beams/day.

(5) Slab

After the setting of girders, the construction of the scaffolding, forming , reinforcing and the concrete work for the slab will be done. Once the curing period is over, placing of the cables to tighten the transversal beams will be started. The standard work capacity for the slab concrete work will be of one span at one time (approx. 80m^3) and 25 days for each span will be required.

3) Management of Traffic Flow

The viaducts to be constructed are located on the main urban roads of R. de Francia Avenue and E. Ayala Avenue, Therefore, these roads should always be open, despite some inconvenience to those drivers along these roads during the construction period.

The management of the road space during the construction of the viaducts upon Eusebio Ayala Avenue and R. de Francia Avenue is shown in FIGURE 4-11-3.

At both locations, the construction of abutments will be done

in two stages.

Also, due to the land expropriation process, construction work of the connecting viaduct on R. de Francia Av. could be done separately for both ways of the road (See FIGURE 4-11-4).

At the moment of setting the viaduct's longitudinal girders, one direction of the road ways should be closed in order to insure work safety.

4) Area for the Fabrication of Girders

The free land, adjacent to E. Ayala Avenue (land of civil airport or "Jockey Club Paraguayo") will be leased as the prestressed beam production area.

The land of the affected area will be leveled and the internal roads will be reinforced with the setting of crushed stones etc. The required surface is of about 4.5 hectares (300m x 150m).

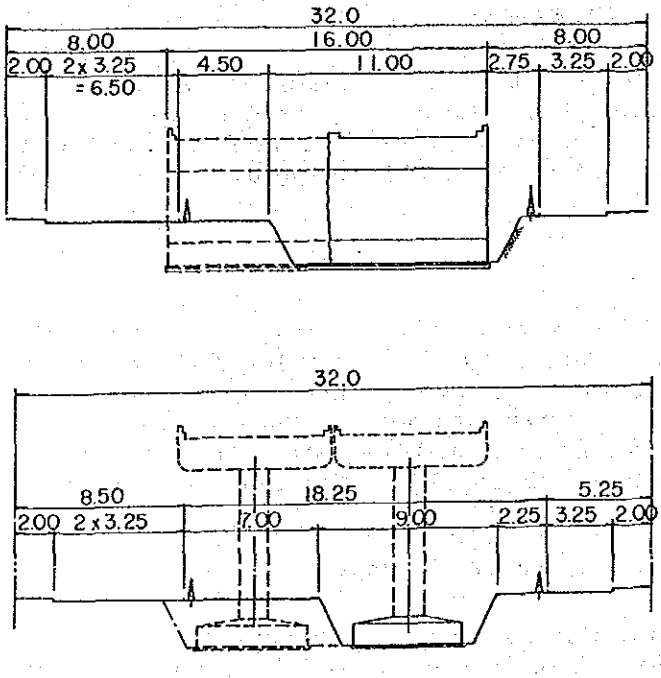


FIGURE 4-11-3 TEMPORARY CROSS SECTION OF R. DE FRANCIA AVENUE FOR CONSTRUCTION OF VIADUCT

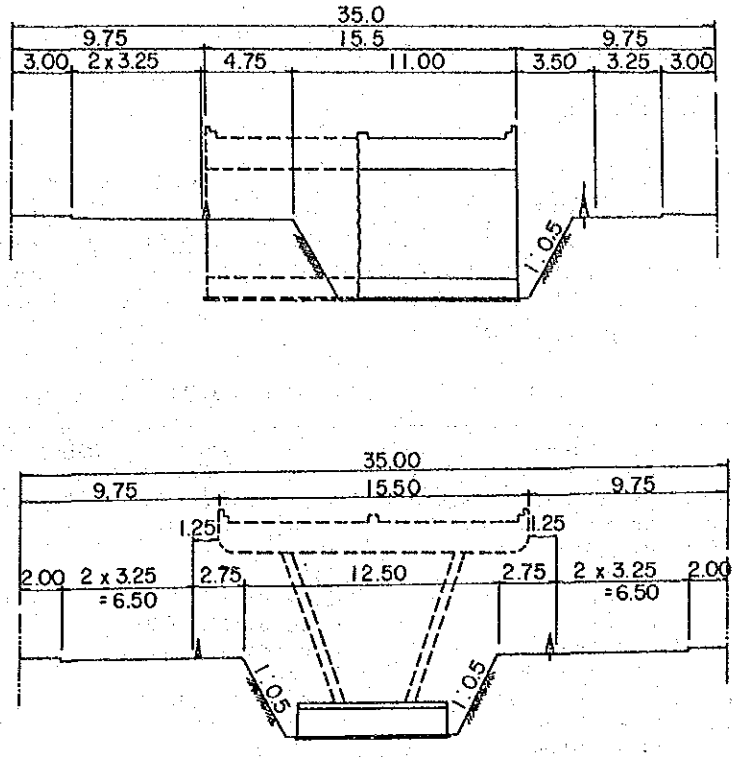


FIGURE 4-11-4 TEMPORARY CROSS SECTION OF E. AYALA AVENUE FOR CONSTRUCTION OF VIADUCTS

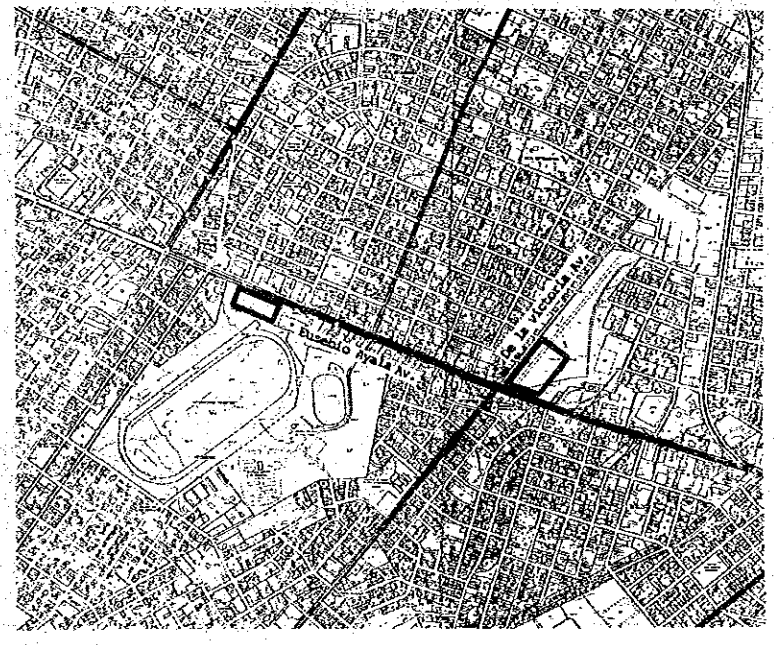


FIGURE 4-11-5 LOCATION OF GIRDERS MANUFACTURING AREA