

## 4.2 Intra-City Road Network

### 4.2.1 Classification of roads

Urban roads in Y.A.R. are categorized to five functional classes including two kinds of inter-regional arterial roads as listed below;

- 1) National arterial road  
Connecting directly to interurban road and composing the main frame of the road network of the city.
- 2) Regional arterial road  
Trunk roads connected to the above national arterial roads and composing a part of main frame of the city road network.
- 3) City arterial road  
Main roads inside the area surrounded by arterial roads.
- 4) Connector Road  
Regional service roads connecting the above categorized roads.
- 5) Collector road  
Small roads to approach housing areas, namely neighbourhood road.

### 4.2.2. Urban road network

#### 4.2.2.1 Arterial roads in Sana'a

Arterial roads under the constraint of the steep geographical features at east and west sides of the city are composed of 7 radial roads and 2 ring roads. The road network is shown on Fig. 4.2.2.1. and existing status of road facilities are shown on Table 4.2.2.1. General description for the arterial roads is edited in Appendix Note 4.1.1.

#### 4.2.2.2 Arterial roads in Taiz city

The city developed along Sana'a-Hodeidah road while the comparatively flat areas of northern part are under

Fig. 4.2.2.1 Main Road Network in Sana'a

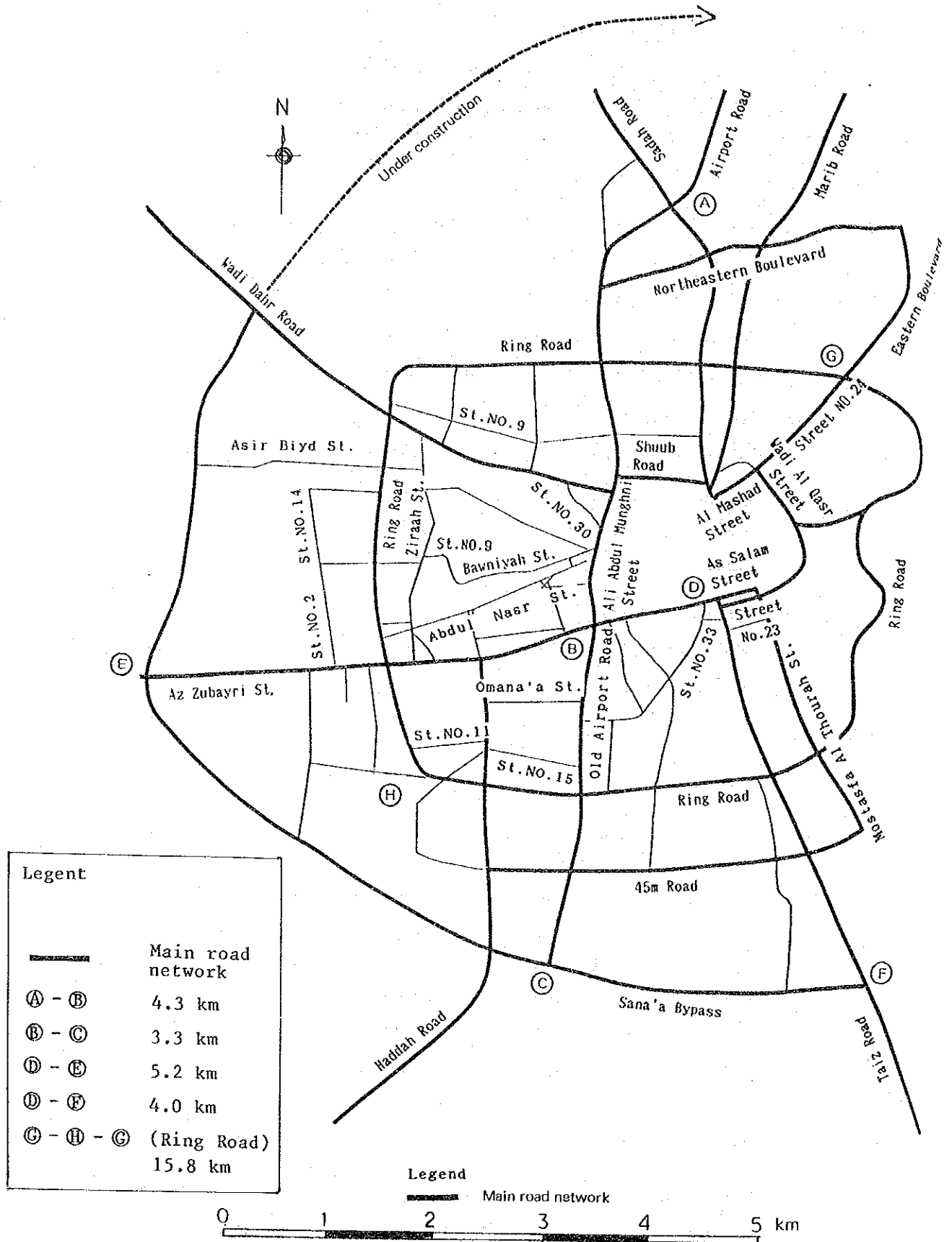


Table 4.2.2.1 Road Facilities in Sana'a

Name of Road	Classification	Distance (km)	Width (m)	Number of lane	Sidewalk	Median
Marib	N	2.3	14.8-35.2	2/4	o/x	o/x
Sadah	N	2.7	20.0-35.7	4/6	o	o/x
Airport	N	1.0	25.8-29.9	4/6	o/x	o/x
Wadi Dahr	N	3.6	6.8-28.0	2/4	o/x	o/x
Az Zubayri	N	5.2	28.5-34.3	6	o	o
Haddah	N	2.8	23.7-29.2	6	o	o
Taiz	N	4.0	7.7-24.6	2/4	o/x	o/x
Al Qiyada	R	1.1	25.6-26.3	6	o	o
A.A.Munghni	C	1.3	25.3-36.1	6	o	o
Old Airport	R	2.3	16.6-28.7	4/6	o/x	o/x
Shuub	C	0.7	13.0-18.2	2	o/x	x
Wadi al Qasr	C	2.2	12.7-28.9	2/4	o/x	o/x
Ring	R	15.8	20.5-31.0	4/6	o/x	o/x
45m	R	2.8	7.0	2	x	x
Sana'a Bypass	R	11.3	9.0	2	x	x
N. & E. Blvd.	R	4.6	16.9-44.9	4/6	o/x	o
NO.24	C	1.1	7.1-25.3	2	o/x	x
As Salam	C	0.4	12.9	2	o	x

N:National Arterial  
R:Regional Arterial  
C:City Arterial  
o:With x:Without

development due to the topographic constraint in the southern area. The road network is a rudder pattern in their original concept composed of two roads, Jamal street and Jaynai street as main roads. But the present network pattern becomes the combination with the radial and ring roads as shown on Fig. 4.2.2.2. General description of roads is in Appendix Note 4.1.2. and its summary is in Table 4.2.2.2.

#### 4.2.2.3 Arterial Roads in Hodeidah city

Hodeidah city is located on a flat area near the seashore, having port facilities in west side, seashore in south, the airport in east and desert in north. As shown on Fig. 4.2.2.3 and Table 4.2.2.3 the road network is organized to have the Sana'a street as an axis. Main streets and ring roads as described in Appendix Note 4.1.3 are mostly connected to this street.

Fig. 4.2.2.2 Main Road Network in Taiz

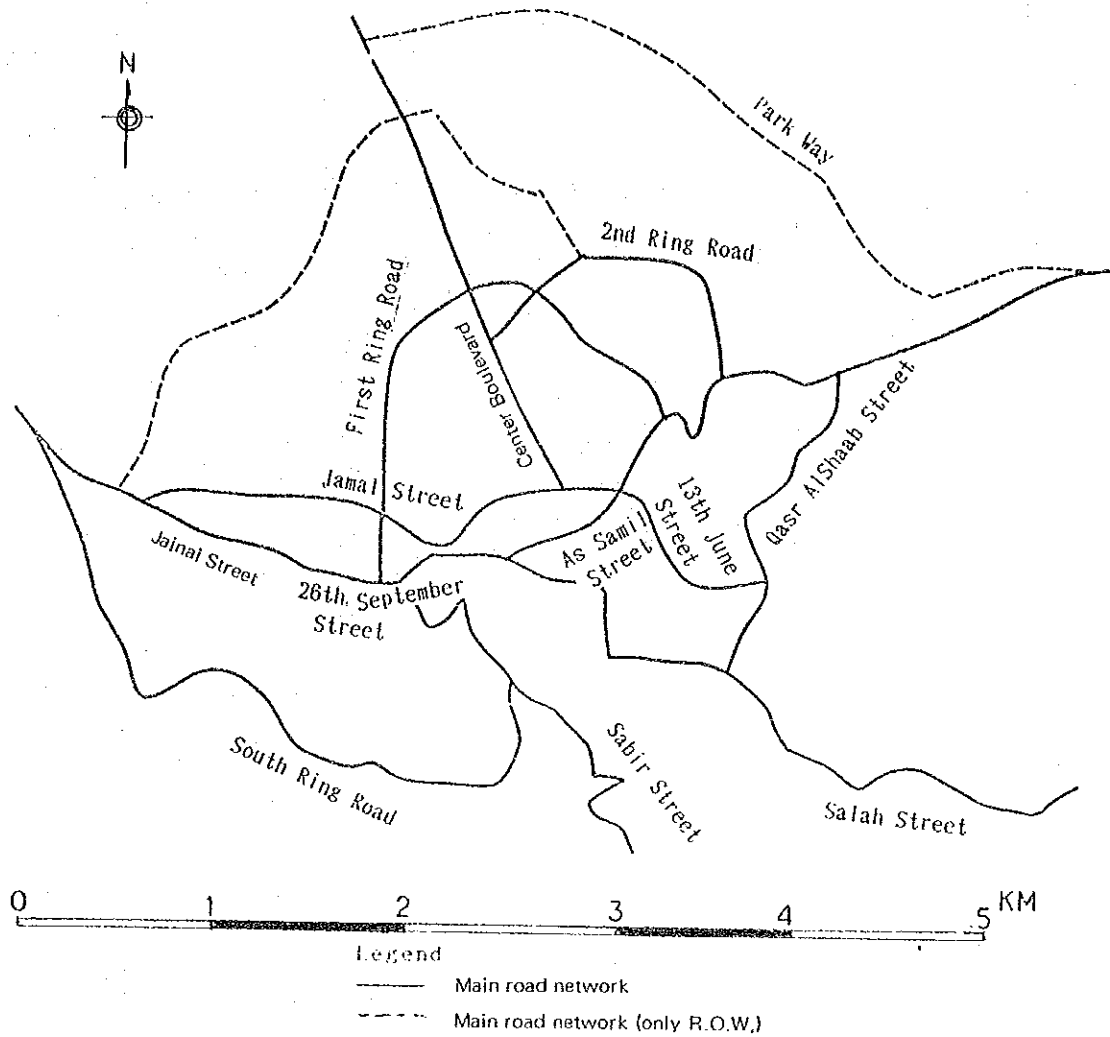


Table 4.2.2.2 Road Facilities in Taiz

Name of Road	Classification	Distance (km)	Width (m)	Number of lane	Sidewalk	Median
Jamal	N	3.3	19.8-28.5	4	o	o/x
1st. Ring	R	2.6	31.3	4	o/x	o/x
2nd. Ring	R	1.3	26.6	2/4	o/x	o/x
Center Blvd.	R	2.8	11.8-31.2	2/4	o/x	o/x
Sabir	R	1.4	15.0	2	o/x	x
Salah	R	2.3	6.0-13.9	2	x	x
26th Sep.	C	2.5	9.4-19.4	2/4	o/x	x
As Samil	C	0.8	9.0-14.6	2	o/x	x
13th June	C	1.5	11.0-19.9	2/4	o/x	x
O.A. Shaab	C	1.4	15.8-26.9	2-6	o	o/x

N:National Arterial  
R:Regional Arterial  
C:City Arterial  
o:With x:Without

Fig. 4.2.2.3 Main Road Network in Hodeidah

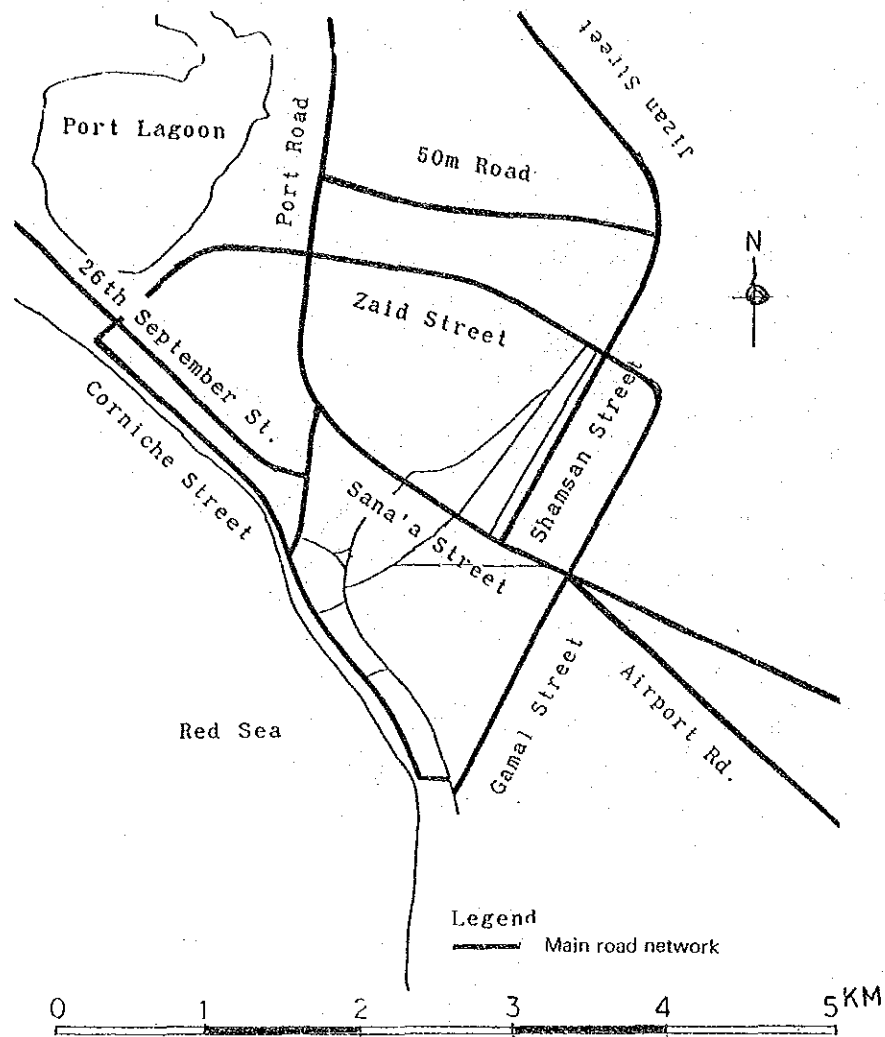


Table 4.2.2.3 Road Facilities in Hodeidah

Name of Road	Classification	Distance (km)	Width (m)	Number of Lane	Sidewalk	Median
Sana'a	N	2.1	28.5-29.8	4	o	o
Zaid	R	5.6	22.6-25.3	4/6	x	o
Gamal	R	1.8	19.3-27.9	4	o	o
Jizan	N	1.0	11.3	2	x	x
Corniche	R	4.0	8.2-29.6	2/4	o/x	o/x
Port	R	2.9	26.5	4/6	o	o
Shamsan	C	1.3	23.9	4	o	o
50m	C	1.8	8.3	2	x	x
Airport	C	3.7	7.6	2	x	x
26th Sep.	C	1.8	26.1-29.6	4	o	o

N:National Arterial  
 R:Regional Arterial  
 C:City Arterial  
 o:With x:Without

## 4.3 Physical Conditions of Roads

### 4.3.1 Sana'a

Main streets in the city have 4-6 lanes (each lane width is 3.0-3.5 m) with lane marks by paint which are worn out often. Roads by lane number are shown in Fig. 4.3.1.1. Street width is not uniform. Locations of these sections having narrow width are shown in Fig. 4.3.1.2. Some intersections are of substandard geometric design. In densely built areas roads are narrow, winding and sometimes without sidewalks. These features cause traffic conflicts. Right of way is not enough to cross at some sections. Roads crossing the wadi without elevated bridges also result in traffic interruption at times during the rainy season.

#### Pavement Conditions

Pavements are composed generally of a 7 cm thick asphalt pavement with 35 cm thick base course on the good subgrade which is a common geological product of Yemen. Fig. 4.3.1.3 shows the paved road sections and Table 4.3.1.1 shows the length for each zone of the city. The ratio of paved to unpaved road mileage inside of Ring road is 32%. A pavement ratio of 66% at zone 21 and 48% at zone 51 are remarkable due to rapid development of housing projects in these areas.

#### Cross Section

A typical cross section of the main street is shown on Fig. 4.3.1.4. and Table 4.3.1.2.

#### Medians

Most center medians of the main street are mounted up and planted. Widths of the medians are classified and shown in Fig. 4.3.1.5. Open drainage with 2.0-5.0 meters width composes the median of Ring road from the western Wadi Dhar road to the intersection with Taiz road in the southern part of the city.

#### Shoulders

No clear separation is found between the traffic lane and the shoulder on most of the streets. The lane and shoulder are

Fig. 4.3.1.1 Lane Number of Main Roads in Sana'a

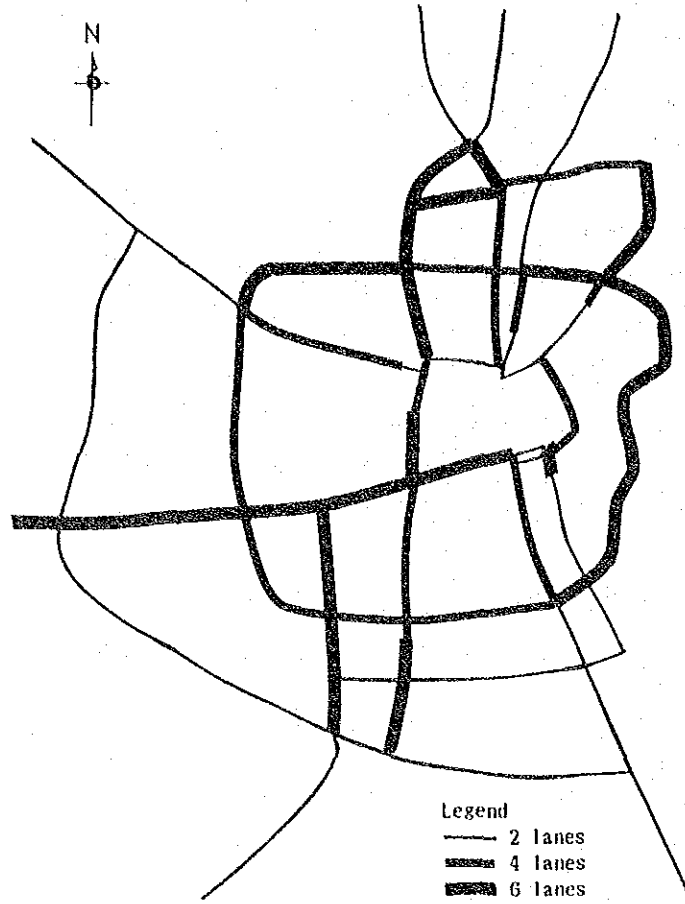


Fig. 4.3.1.2 Narrow Sections in Sana'a

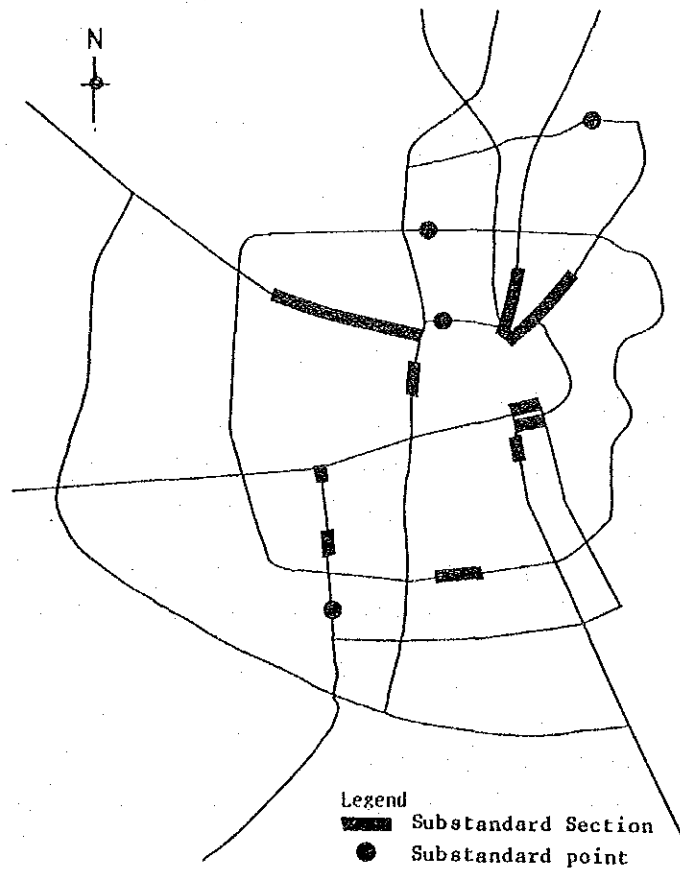




Fig. 4.3.1.3 Paved Roads in Sana'a

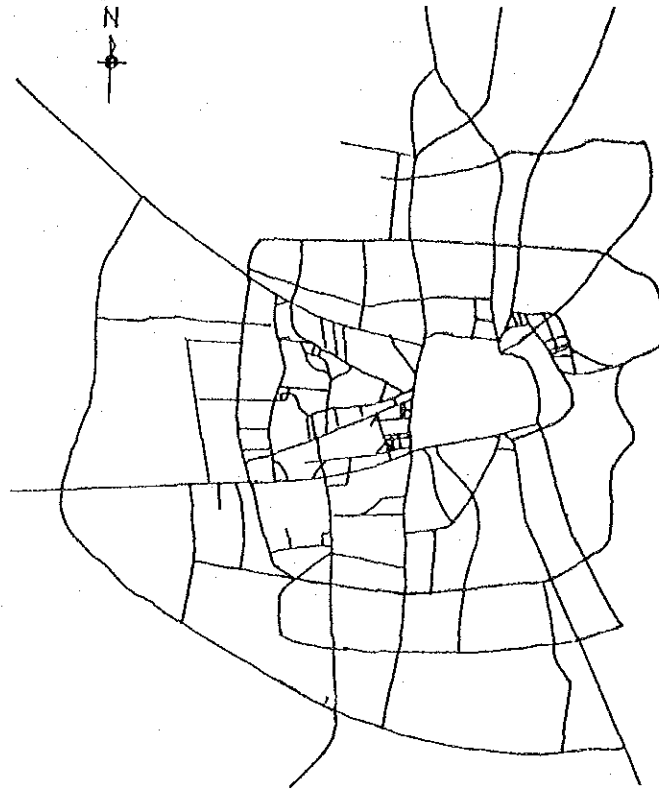


Table 4.3.1.1 Pavement Condition by Zone in Sana'a

Zone No.	Sub Zone No.	Road Length			Ratio of Paved Road %
		Total km	Asphalt km	Others km	
21	211	6.5	4.9	1.6	75.0
	212	7.9	4.5	3.4	57.0
	213	12.3	9.1	3.2	74.1
	214	2.5	1.2	1.3	49.0
	215	1.8	0.6	1.2	32.6
	Sub total	31.0	20.3	10.7	65.5
22	221	11.7	1.4	10.3	12.0
	222	10.0	0.7	9.3	7.0
	223	10.1	2.4	7.7	23.7
	224	9.2	1.3	7.9	14.2
	Sub Total	41.0	5.8	35.2	14.2
31	311	9.7	3.6	6.1	37.0
	312	10.4	1.0	9.5	9.2
	313	8.3	1.4	7.0	16.2
	314	7.6	2.1	5.5	27.7
	Sub Total	36.1	8.0	28.1	22.2
32	321	13.1	3.2	9.9	24.6
	322	11.1	1.8	9.2	16.6
	Sub Total	24.2	5.1	19.1	20.9
41	411	13.2	3.5	9.7	26.6
	Sub Total	13.2	3.5	9.7	26.6
	511	7.3	5.8	1.5	79.6
	512	4.2	2.4	1.8	56.2
	513	4.1	1.6	2.5	38.8
	514	4.6	3.1	1.5	68.3
	515	7.4	4.0	3.4	53.9
	516	5.9	3.0	2.9	50.4
517	7.1	3.6	3.5	50.1	
518	12.0	2.0	10.0	17.0	
	Sub Total	52.6	25.5	27.2	48.4
61	611	11.4	2.3	9.1	19.8
	612	11.2	2.5	8.7	22.0
	613	7.9	1.9	6.0	24.1
	Sub total	30.5	6.6	23.9	21.7
81	811	4.9	1.9	3.1	37.9
	812	10.3	1.5	8.7	14.7
	813	4.0	1.3	2.8	31.2
	Sub Total	19.2	4.6	14.6	24.1
	Total	247.6	79.4	168.3	32.0

Zone No. in Appendix Fig. 3.1.1.1

Fig. 4.3.1.4 Typical Cross Sections of Main Roads in Sana'a

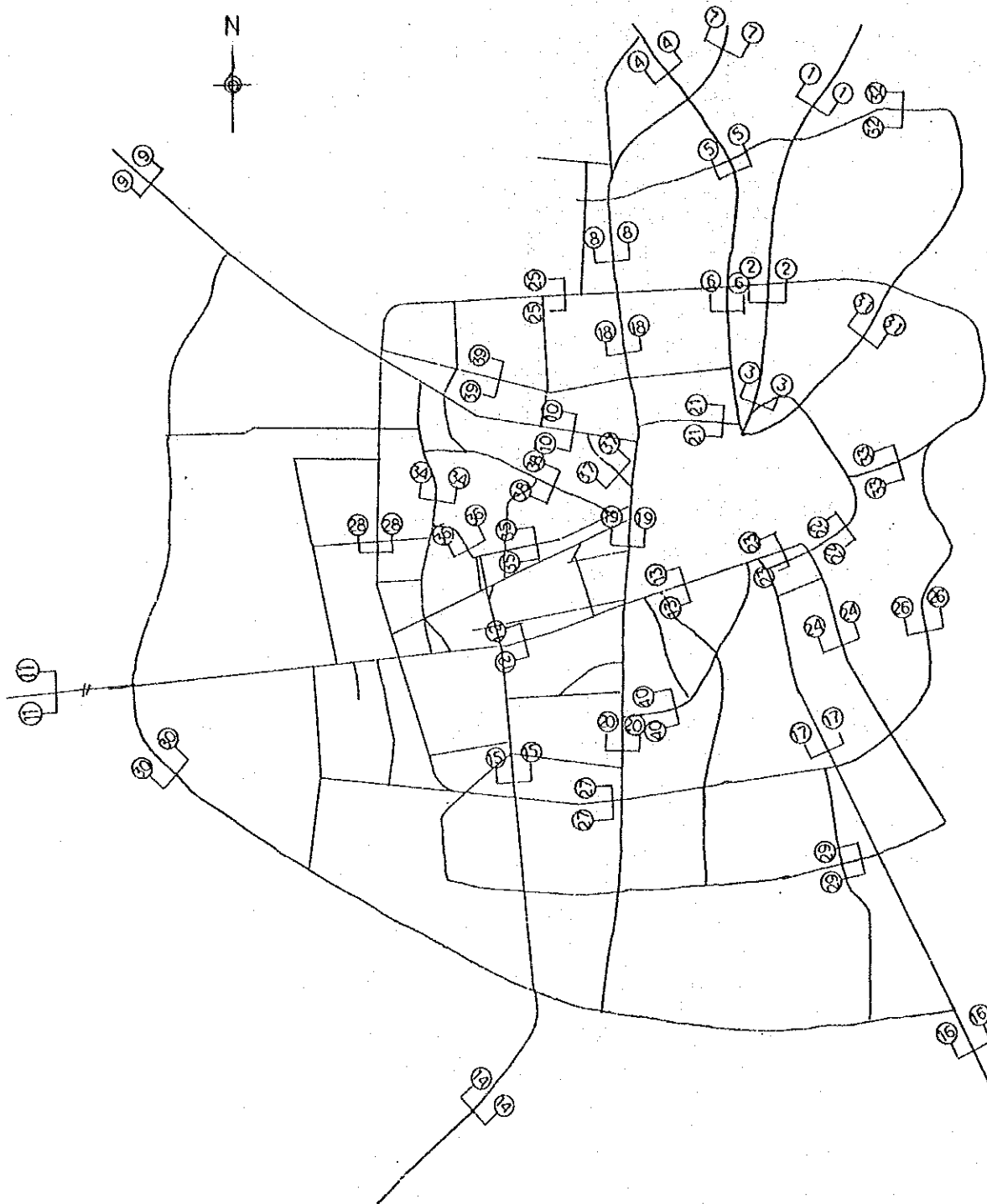


Table 4.3.1.2 Typical Cross Sections of Main Roads in Sana's

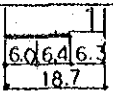
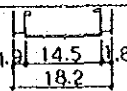
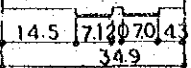
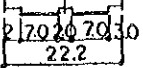


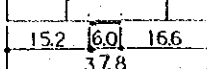
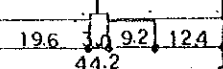
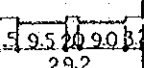
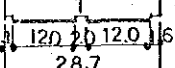
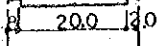
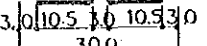
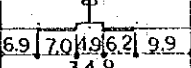
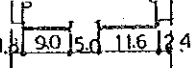
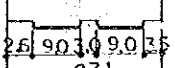
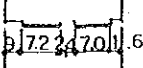
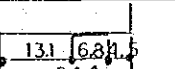
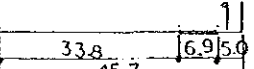

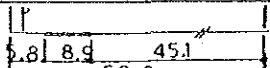
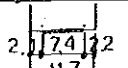

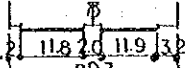
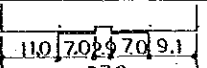
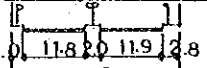
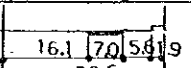
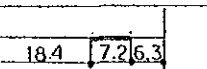

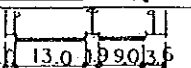

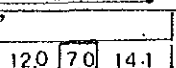
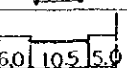
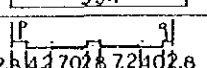
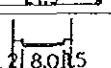
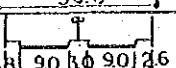

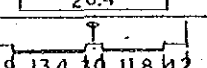
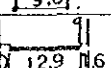
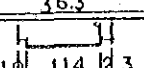
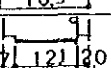
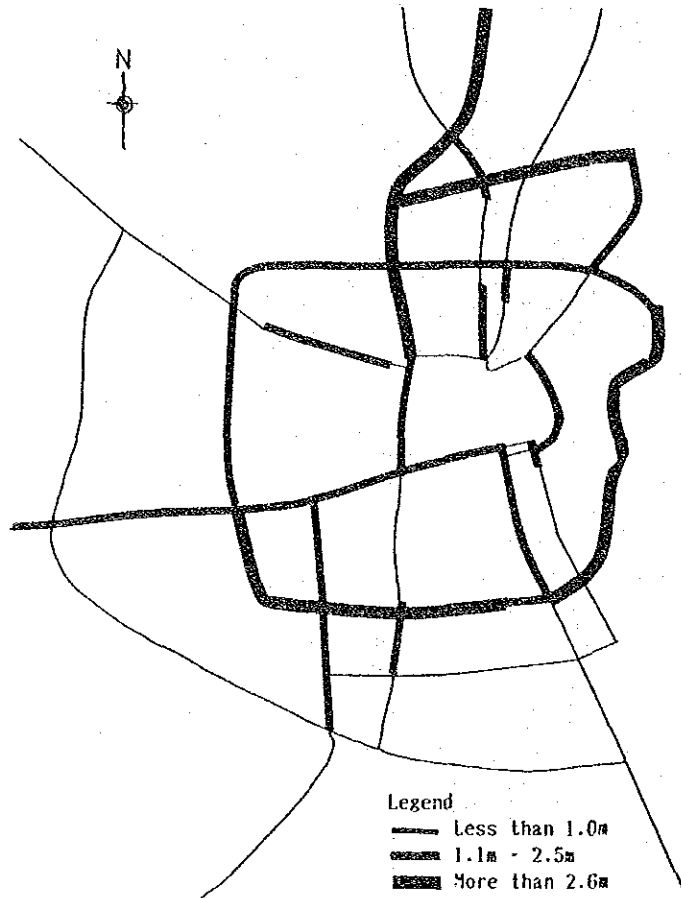
NO	NAME OF STREET	SECTION	NO	NAME OF STREET	SECTION
1	Marib Road		21	Shuub Road	
2	Marib Road		22	Wadi Al Qasr Street	
3	Marib Road		23	As Salam Street	
4	Sadah Road		24	Mostasfa Al Thourah St.	
5	Sadah Road		25	Ring Road	
6	Sadah Road		26	Ring Road	
7	Airport Road		27	Ring Road	
8	Airport Road		28	Ring Road	
9	Wadi Dahr Road		29	45m Road	
10	Wadi Dahr Road		30	Sana'a Bypass	
11	Hodeida Road		31	Street NO.24	
12	Az Zubayri Strrt		32	Northeastern Boulevard	
13	Az Zubayri Strrt		33	Citadel Link	
14	Haddah Road		34	Ziraah St.	
15	Haddah Road		35	Bawnyah St.	
16	Taiz Road		36	St.NO.9	
17	Taiz Road		37	St. NO.30	
18	Al Qiyada Street		38	26th September St.	
19	All Abdul Hungini Street		39	St. NO.9	
20	Old Airport Road		40	St. NO.33	

Fig. 4.3.1.5 Median Width of Main Roads in Sana'a



divided by studying the inventory data. The shoulder widths classified are shown in Fig. 4.3.1.6.

#### Sidewalk

Generally raised sidewalks are installed along the main street in the city. But the width of sidewalk is not constant as shown in Fig. 4.3.1.7. Some times parking bays reduce the width of sidewalk.

#### Intersection

All intersections in Sana'a are at-grade. Some intersections have the following problems;

- Roadways skew at the intersection.
- Extraordinarily large spatial area in the crossing.
- Unclear marking of directions of the traffic flow.
- No marking for pedestrian crossing.
- Provision for left turn lane is not satisfactory.

These points are again discussed in Chapter 11.

#### Drainage

There are drainage pipes of 1 meter diameter on the both sides of two streets; Az Zubayri street from Bab Al Yemen to Haddah road and the whole section of Ali Abdul Mughni street. No rain water drainage system is found on other streets.

### 4.3.2 Taiz

Most of main roads in the city have 2 lanes except for those in the northern urban area, i.e. Jamal street, which have 4 lanes as shown in Fig. 4.3.2.1. Unclear road markings, low geometric standards due to steep mountainous terrain and non-uniform widths are found in places. Fig. 4.3.2.2 shows the sections where width changes.

#### Pavement conditions

The pavement structures are same as those of Sana'a. Fig. 4.3.2.3 shows the sections of paved road and Table 4.3.2.1 shows the length for each zone of the city for the road having 5 meter width or more. Pavement ratio is high (60%) for the above class of roads in the city. Typical cross sections of the main streets are shown on Fig. 4.3.2.4 and Table 4.3.2.2.

Fig. 4.3.1.6 Shoulder Width of Main Roads in Sana'a

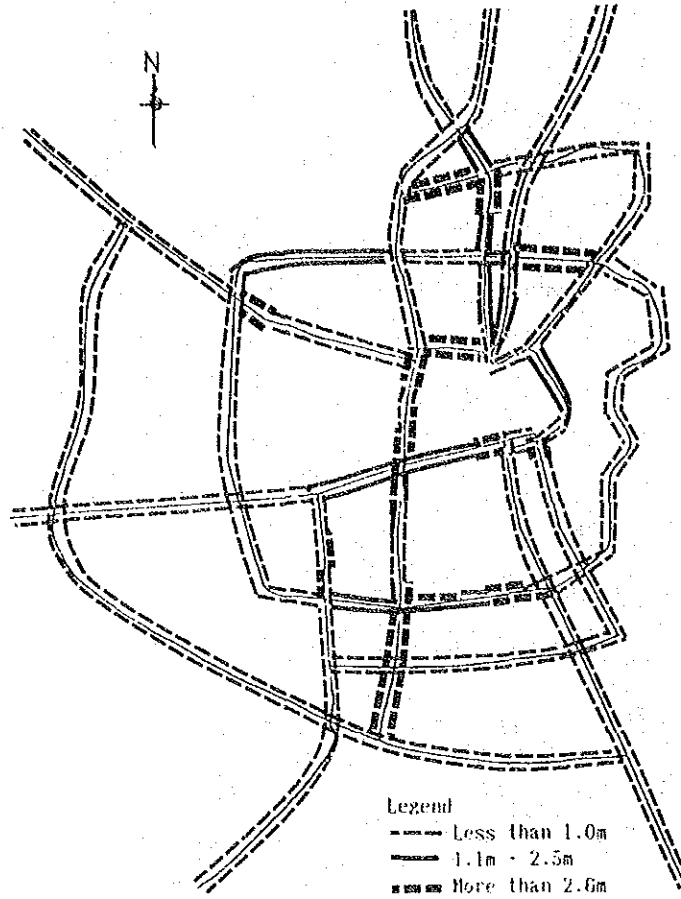


Fig. 4.3.1.7 Sidewalk Width of Main Roads in Sana'a

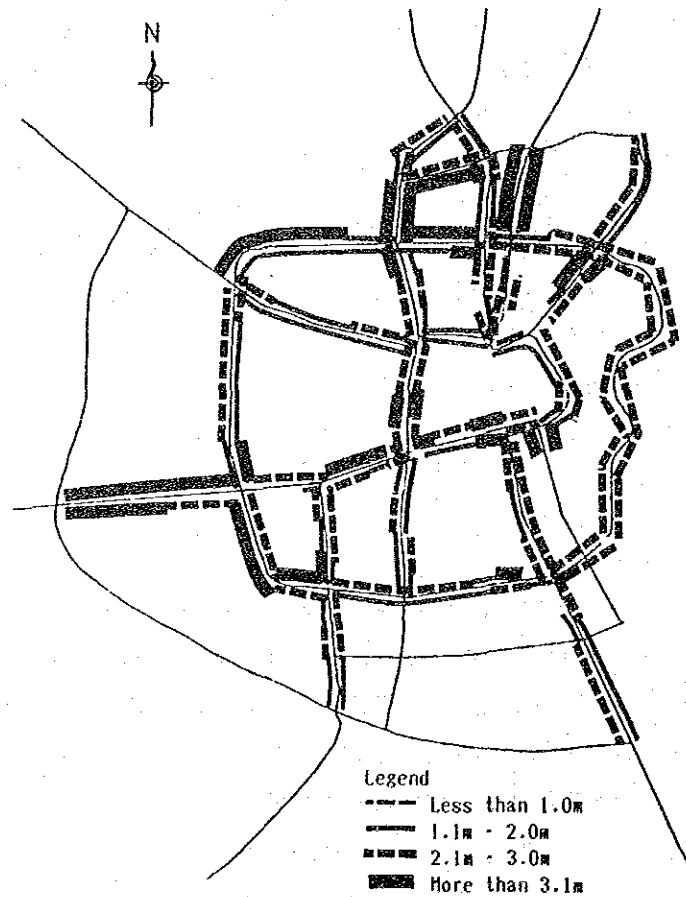


Fig. 4.3.2.1 Lane Number of Main Roads in Taiz

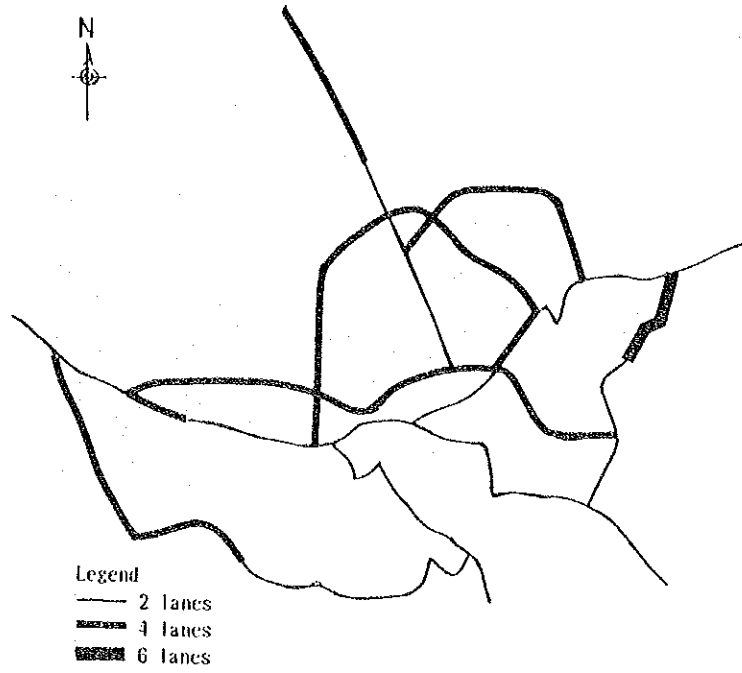


Fig. 4.3.2.2 Ununiform Sections in Taiz

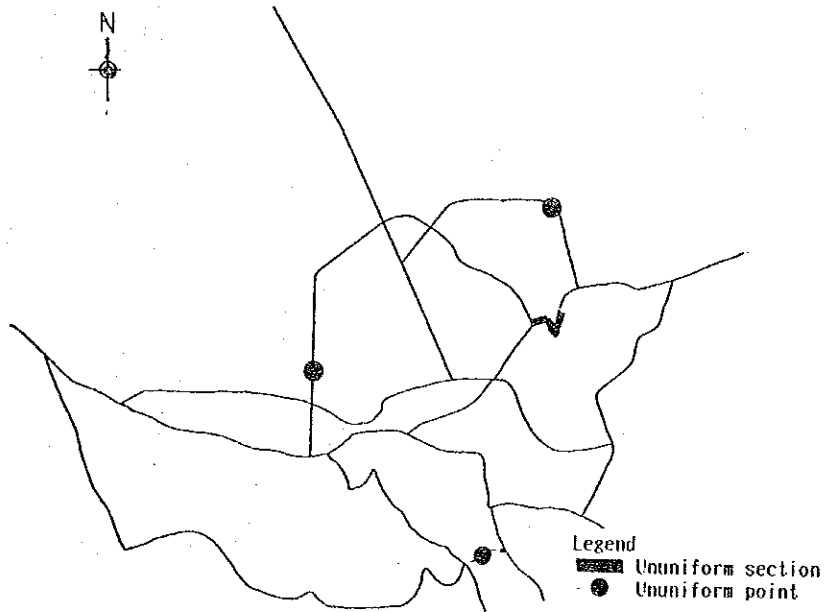


Fig. 4.3.2.3 Paved Roads in Taiz



Table 4.3.2.1 Paved Roads in Taiz

Zone No.	Sub Zone No.	Road Length			Ratio of Paved Road %
		Total km	Asphalt km	Others km	
	111	11.1	7.7	3.4	69.4
	112	2.8	2.2	0.6	78.6
	113	3.0	2.7	0.3	90.0
	114	2.5	1.0	1.5	40.0
11	115	2.9	1.9	1.0	65.5
	116	2.8	0.9	1.9	32.1
	117	2.7	2.0	0.7	74.1
	118	2.4	1.0	1.4	41.7
	119	1.1	1.1	0.0	100.0
	Sub Total	31.3	20.5	10.8	65.5
	121	3.6	2.3	1.3	63.9
12	122	0.6	0.6	0.0	100.0
	123	0.3	0.3	0.0	100.0
	124	1.0	1.0	0.0	100.0
	Sub Total	5.5	4.2	1.3	76.4
	211	3.8	2.9	0.9	76.3
	212	0.8	0.8	0.0	100.0
21	213	6.0	2.8	3.2	46.7
	214	3.4	1.3	2.1	38.2
	215	2.1	0.6	1.5	28.6
	Sub Total	16.1	8.4	7.7	52.2
	311	6.3	2.2	4.1	34.9
31	312	4.0	3.1	0.9	77.5
	313	2.2	0.8	1.4	36.4
	314	4.2	2.5	1.7	59.5
	Sub Total	16.7	8.6	8.1	51.5
	411	6.2	4.6	1.6	74.2
41	412	3.5	1.1	2.4	31.4
	413	2.4	1.2	1.2	50.0
	414	0.7	0.5	0.2	71.4
	415	2.8	2.3	0.5	82.1
	Sub Total	15.6	9.7	5.9	62.2
	Total	85.2	51.4	33.8	60.3



Fig. 4.3.2.4 Typical Cross Sections of Main Roads in Taiz

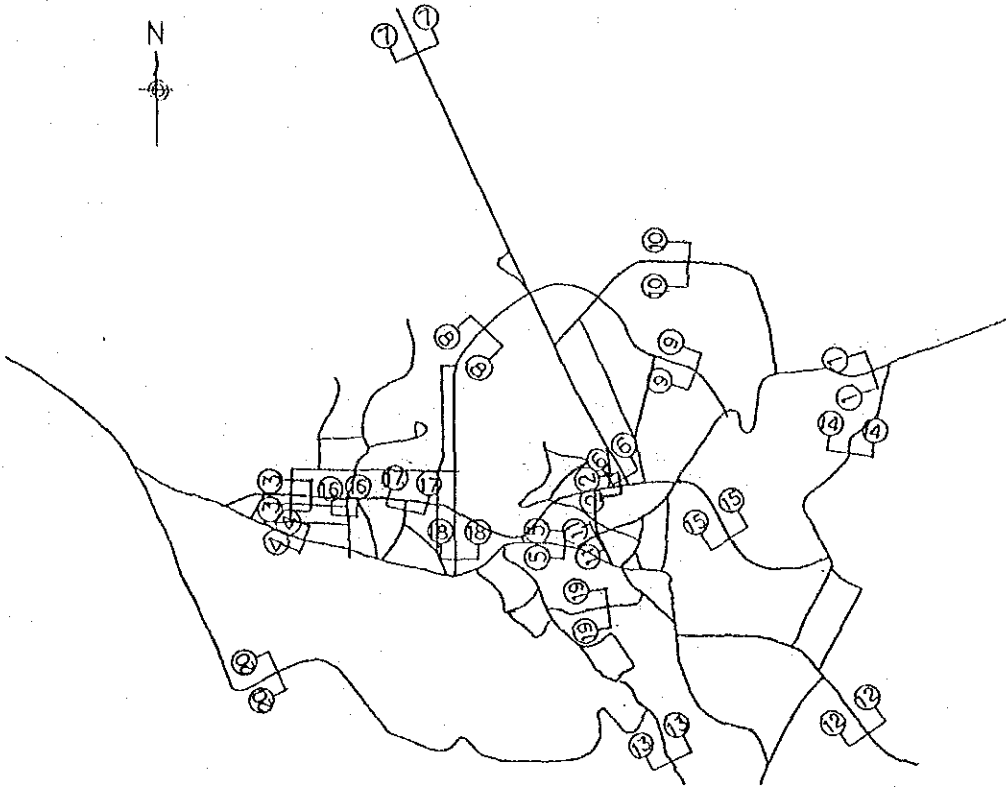


Table 4.3.2.2 Typical Cross Sections of Main Roads in Taiz

NO	NAME OF STREET	SECTION	NO	NAME OF STREET	SECTION
1	Sana'a Road	$\begin{array}{ c c c } \hline 9.6 & 7.6 & 20.7 \\ \hline \hline 37.9 \\ \hline \end{array}$	11	As Samil Street	$\begin{array}{ c c c } \hline 2.1 & 7.0 & 0.5 \\ \hline \hline 9.9 \\ \hline \end{array}$
2	Jamal Street	$\begin{array}{ c c c } \hline 0.8 & 7.5 & 0.7 & 1.2 & 1.4 \\ \hline \hline 19.9 \\ \hline \end{array}$	12	Salah Street	$\begin{array}{ c } \hline 8.0 \\ \hline \end{array}$
3	Jamal Street	$\begin{array}{ c c c } \hline 1.3 & 12.4 & 1.9 & 8.6 & 2.5 \\ \hline \hline 26.8 \\ \hline \end{array}$	13	Sabir Street	$\begin{array}{ c c c } \hline 3.2 & 10.3 & 1.8 \\ \hline \hline 15.3 \\ \hline \end{array}$
4	Al Jaynai street	$\begin{array}{ c c c } \hline 1.7 & 11.4 & 2.6 \\ \hline \hline 15.7 \\ \hline \end{array}$	14	Qasr AlShaab Street	$\begin{array}{ c c c } \hline 0.6 & 10.2 & 1.0 & 1.6 \\ \hline \hline 24.5 \\ \hline \end{array}$
5	26th September Street	$\begin{array}{ c c c } \hline 3.8 & 7.7 & 1.0 \\ \hline \hline 15.5 \\ \hline \end{array}$	15	13th June Street	$\begin{array}{ c c c } \hline 3.8 & 10.5 & 1.2 \\ \hline \hline 15.5 \\ \hline \end{array}$
6	Center Boulverd	$\begin{array}{ c c c } \hline 1.7 & 8.0 & 3.2 \\ \hline \hline 12.9 \\ \hline \end{array}$	16	Muhammed Ali Uthman St.	$\begin{array}{ c c c } \hline 3.4 & 13.7 & 3.0 \\ \hline \hline 19.9 \\ \hline \end{array}$
7	Center Boulverd	$\begin{array}{ c c c } \hline 12.7 & 6.6 & 0.6 & 9.3 & 0 \\ \hline \hline 32.2 \\ \hline \end{array}$	17	Al Awadi St.	$\begin{array}{ c c c } \hline 1.6 & 6.6 & 0.9 & 1.6 & 7.2 & 6 \\ \hline \hline 23.9 \\ \hline \end{array}$
8	First Ring Road	$\begin{array}{ c c c } \hline 7.0 & 19.1 & 3.2 \\ \hline \hline 29.3 \\ \hline \end{array}$	18	Tahrir St.	$\begin{array}{ c c c } \hline 1.5 & 7.2 & 4.4 & 7.1 & 1.5 \\ \hline \hline 19.8 \\ \hline \end{array}$
9	First Ring Road	$\begin{array}{ c c c } \hline 2.1 & 6.6 & 1.0 & 6.8 & 2.6 \\ \hline \hline 20.1 \\ \hline \end{array}$	19	Hospital St.	$\begin{array}{ c c c } \hline 1.8 & 7.5 & \\ \hline \hline 9.1 \\ \hline \end{array}$
10	2nd Ring Road	$\begin{array}{ c c c } \hline 1.3 & 7.4 & 1.0 & 7.5 & 2.6 \\ \hline \hline 26.9 \\ \hline \end{array}$	20	South Ring Road	$\begin{array}{ c c c } \hline 3.2 & 8.0 & 2.0 & 8.0 \\ \hline \hline 21.2 \\ \hline \end{array}$

Fig. 4.3.2.5 Median Width of Main Roads in Taiz

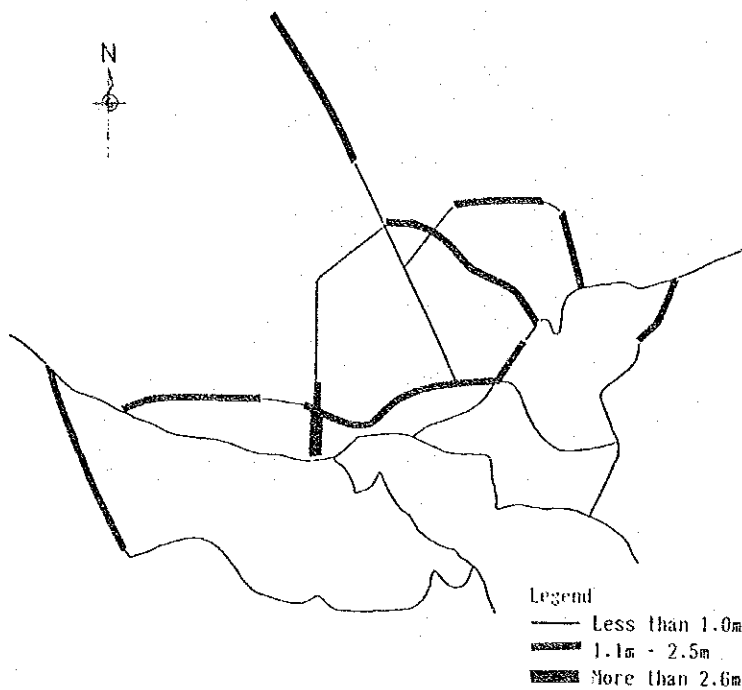


Fig. 4.3.2.6 Shoulder Width of Main Roads in Taiz

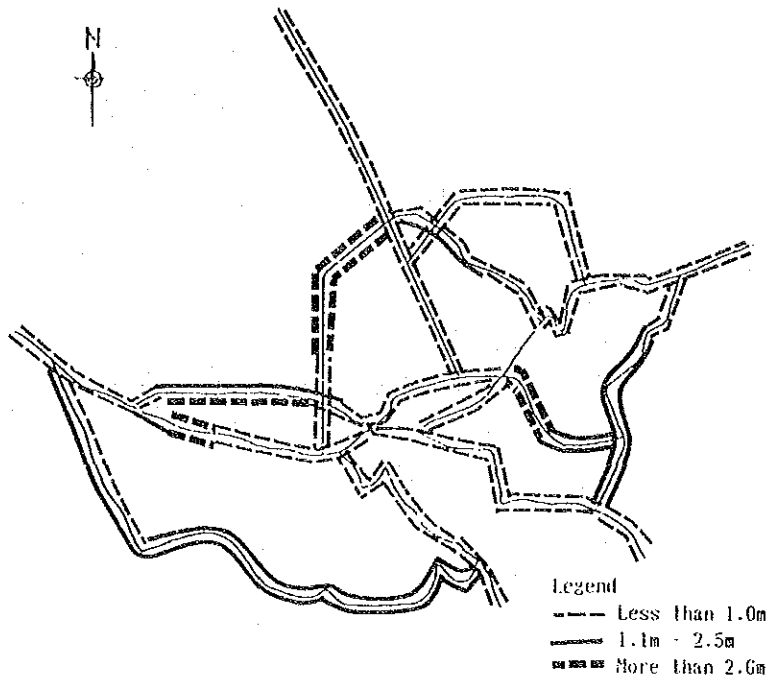
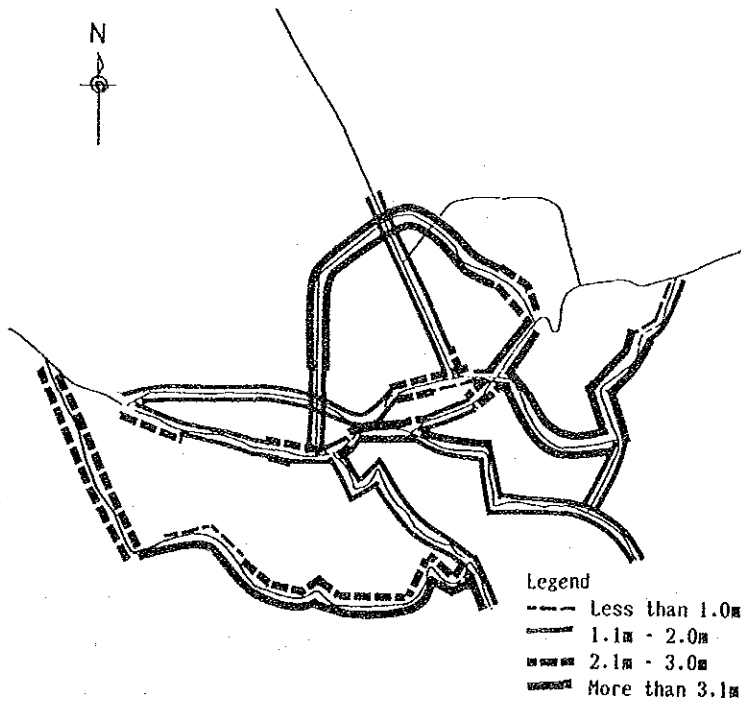


Fig. 4.3.2.7 Sidewalk Width of Main Roads in Taiz



#### Medians

Medians of 2.0-3.0 meter width are constructed on Jamal street, 1st Ring road, 2nd Ring road and Qasr Al Shaab as shown in Fig. 4.3.2.5.

#### Shoulders

As shown in Fig. 4.3.2.6 there are wide shoulders and parking zones at the west side of Jamal street, the western portion of 1st Ring road and so on. However, it can be said generally that shoulder width is not sufficient on the streets.

#### Sidewalk

Generally mount-up sidewalks are installed along the main streets in the city as shown in Fig. 4.3.2.7. But the width of sidewalk is not constant because of parking bays and stairs to the roadside houses.

#### Intersections

Present status of intersections are similar to Sana'a. There are two small roundabout intersections on Jamal street.

### 4.3.3 Hodeidah city

Most main roads in the city have 4 lanes with unclear road markings as shown in Fig. 4.3.3.1.

#### Pavement conditions

The pavement structures are similar to those of Sana'a. Fig. 4.3.3.2 shows the sections of paved road and Table 4.3.3.1 shows the length for each zone of the city. Pavement ratio is almost same for each zone and the ratio for the whole city is 36%. Some severe damages for the pavement are found at Zaid street caused by heavy vehicles. Roads in the densely built-up areas are similar as Sana'a and Taiz: narrow and curving. Typical cross section of the main street is shown on Fig. 4.3.3.3 and Table 4.3.3.2.

#### Medians

Medians are installed at main streets as shown in Fig. 4.3.3.4.

#### Shoulders

Shoulder widths with 1.0-2.0 meters are identified and shown in Fig. 4.3.3.5. Port road and the northern portion of Zaid street have 5-20 meters ROW on each side.

#### Sidewalk

Sidewalks of 1.0-4.0 meters are installed along the main street except Zaid street as shown in Fig. 4.3.3.6.

Fig. 4.3.3.1 Lane Number of Main Roads in Hodeidah

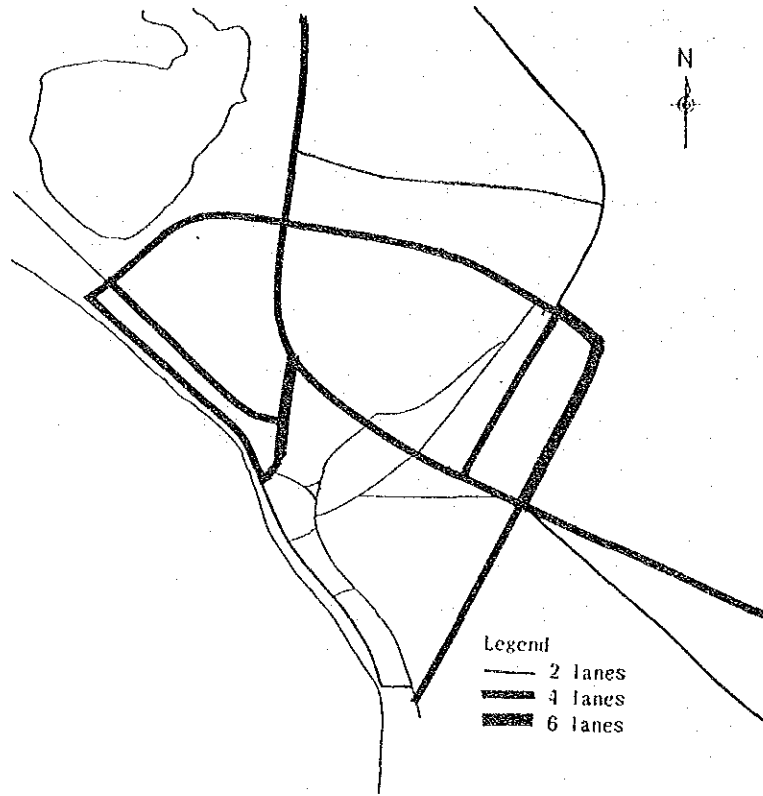


Fig. 4.3.3.4 Median Width of Main Roads in Hodeidah

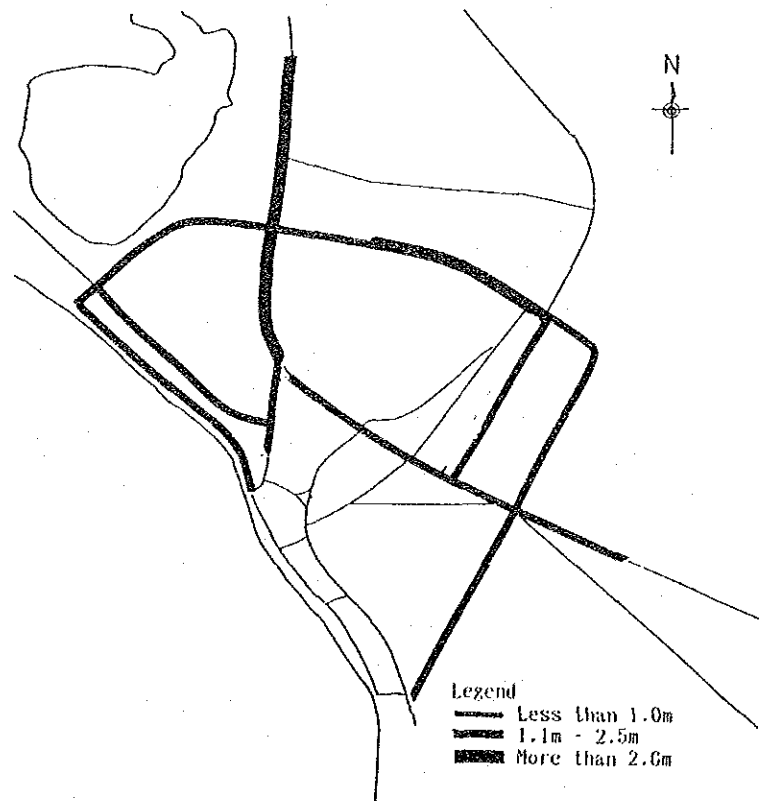


Fig. 4.3.3.2 Pavement Condition in Hodeidah

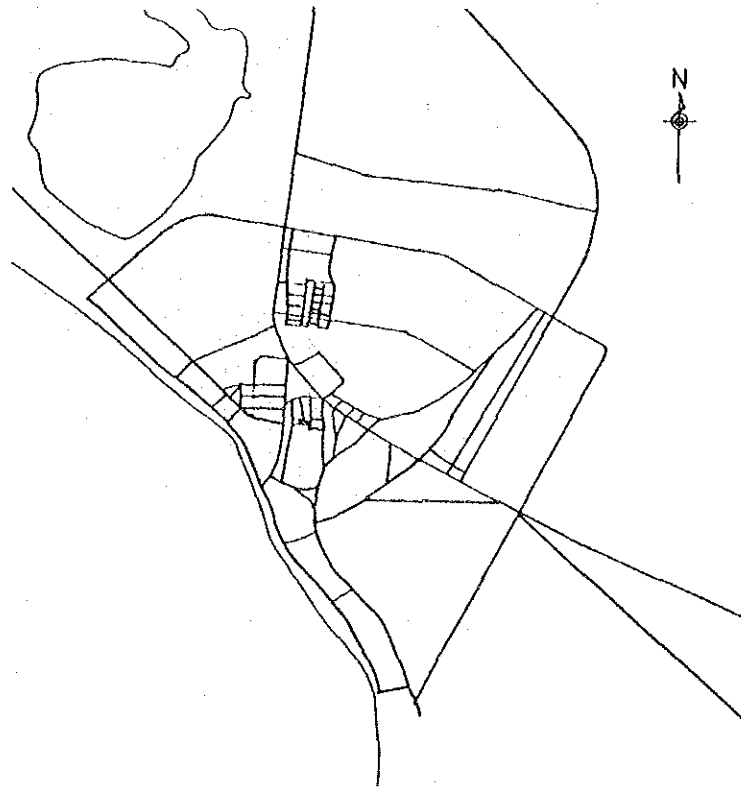


Table 4.3.3.1 Pavement Condition by Zone in Hodeidah

Zone No.	Sub Zone No.	Road Length			Ratio of Paved Road %
		Total km	Asphalt km	Others km	
11	111	5.1	3.6	1.5	70.7
	112	7.0	4.6	2.4	65.4
	113	5.2	1.4	3.9	26.5
	114	3.3	1.3	1.9	40.3
	115	2.6	0.8	1.8	29.9
	116	5.4	0.7	4.7	13.6
	117	2.7	0.2	2.5	8.1
	118	3.8	1.6	2.2	41.4
	Sub Total	35.2	14.2	21.0	40.4
12	121	12.9	5.3	7.6	40.9
	122	10.3	2.8	7.5	27.3
	123	7.2	0.9	6.3	12.5
	Sub Total	30.5	9.0	21.5	29.5
13	131	3.7	2.2	1.5	60.3
	132	2.7	0.6	2.1	22.6
	133	11.7	4.1	7.6	34.9
	134	4.2	0.9	3.3	21.5
	135	5.2	3.5	1.7	67.2
	136	3.6	1.0	2.6	27.7
	137	5.7	1.4	4.3	25.2
	138	8.8	2.9	5.9	32.5
	Sub Total	45.5	16.6	28.9	36.4
	Total	111.1	39.8	71.3	35.8

Fig. 4.3.3.3 Typical Cross Section of Main Roads in Hodeidah

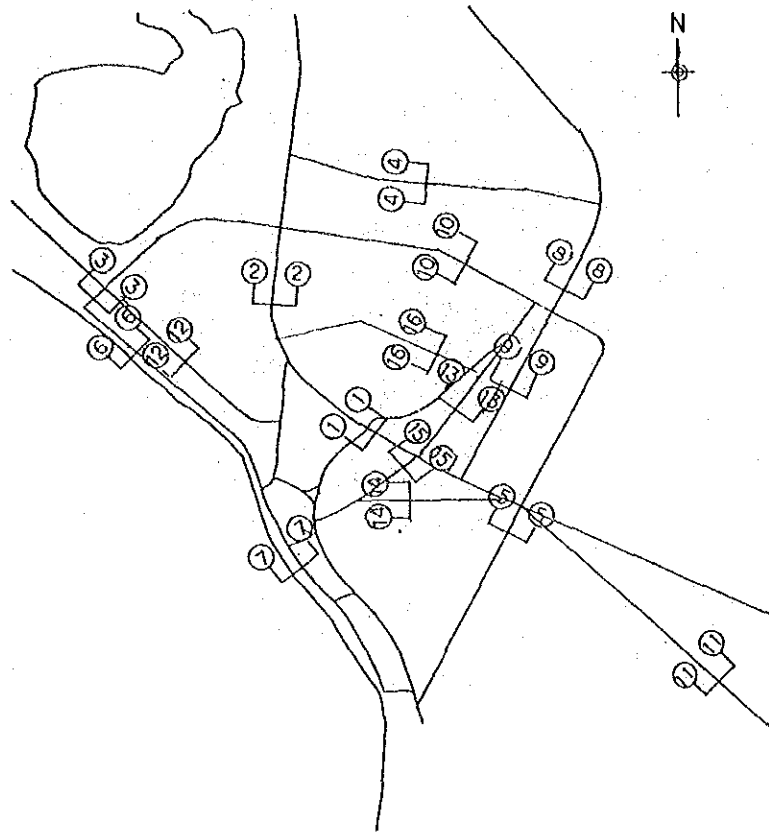


Table 4.3.3.2 Typical Cross Section of Main Roads in Hodeidah

NO	NAME OF STREET	SECTION	NO	NAME OF STREET	SECTION
1	Sana'a St.	$\begin{array}{c} 4.3 \quad 10.0 \quad 2.0 \quad 10.0 \quad 3.6 \\ \hline 29.9 \end{array}$	9	Shamsan street	$\begin{array}{c} 2.1 \quad 8.0 \quad 2.0 \quad 8.0 \quad 3.9 \\ \hline 24.0 \end{array}$
2	Port Road	$\begin{array}{c} 3.9 \quad 5.4 \quad 7.7 \quad 4.0 \quad 8.0 \quad 16.9 \quad 1.0 \\ \hline 48.8 \end{array}$	10	50m Road	$\begin{array}{c} 30.0 \quad 8.3 \quad 9.0 \\ \hline 47.3 \end{array}$
3	Zaid Street	$\begin{array}{c} 1.8 \quad 7.7 \quad 1.8 \quad 8.4 \quad 3.3 \\ \hline 24.0 \end{array}$	11	Airport Road	$\begin{array}{c} 4.0 \quad 7.6 \quad 13.5 \\ \hline 25.1 \end{array}$
4	Zaid Street	$\begin{array}{c} 1.5 \quad 0.9 \quad 9.9 \quad 8.0 \quad 19.9 \\ \hline 56.8 \end{array}$	12	26th Sep. St.	$\begin{array}{c} 4.0 \quad 8.2 \quad 2.1 \quad 8.0 \quad 3.6 \\ \hline 26.1 \end{array}$
5	Gamal Street	$\begin{array}{c} 4.8 \quad 7.7 \quad 4.0 \quad 7.7 \quad 5.9 \\ \hline 28.1 \end{array}$	13	Al Hakimi St.	$\begin{array}{c} 3.8 \quad 8.0 \quad 4.0 \quad 8.0 \quad 3.0 \\ \hline 24.8 \end{array}$
6	Corniche Street	$\begin{array}{c} 1.7 \quad 8.5 \quad 2.0 \quad 7.8 \quad 5.0 \quad 4.5 \\ \hline 27.9 \end{array}$	14	Al Duhmiyah St.	$\begin{array}{c} 0.6 \quad 8.0 \quad 6.7 \\ \hline 9.3 \end{array}$
7	Corniche Street	$\begin{array}{c} 2.5 \quad 8.3 \quad 1.5 \\ \hline 12.2 \end{array}$	15	An Nakhil St.	$\begin{array}{c} 4.0 \quad 8.4 \quad 2.7 \quad 8.0 \quad 5.0 \\ \hline 28.1 \end{array}$
8	Jizan Road	$\begin{array}{c} 9.8 \quad 11.4 \quad 9.9 \\ \hline 31.1 \end{array}$	16	Abu Musa Al Ashari street	$\begin{array}{c} 2.1 \quad 12.9 \quad 3.6 \\ \hline 18.6 \end{array}$



Fig. 4.3.3.5 Shoulder Width of Main Roads in Hodeidah

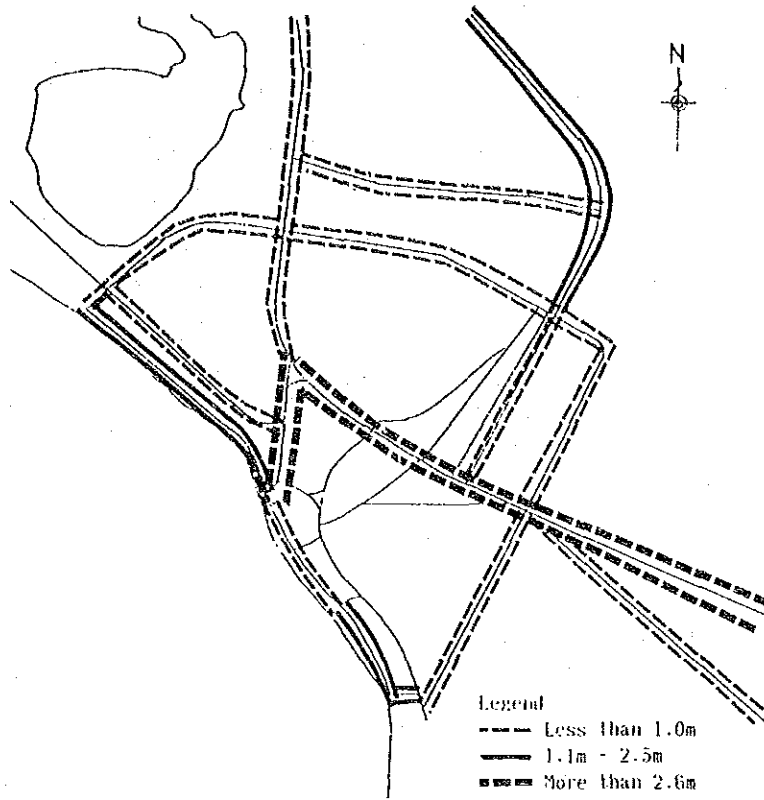
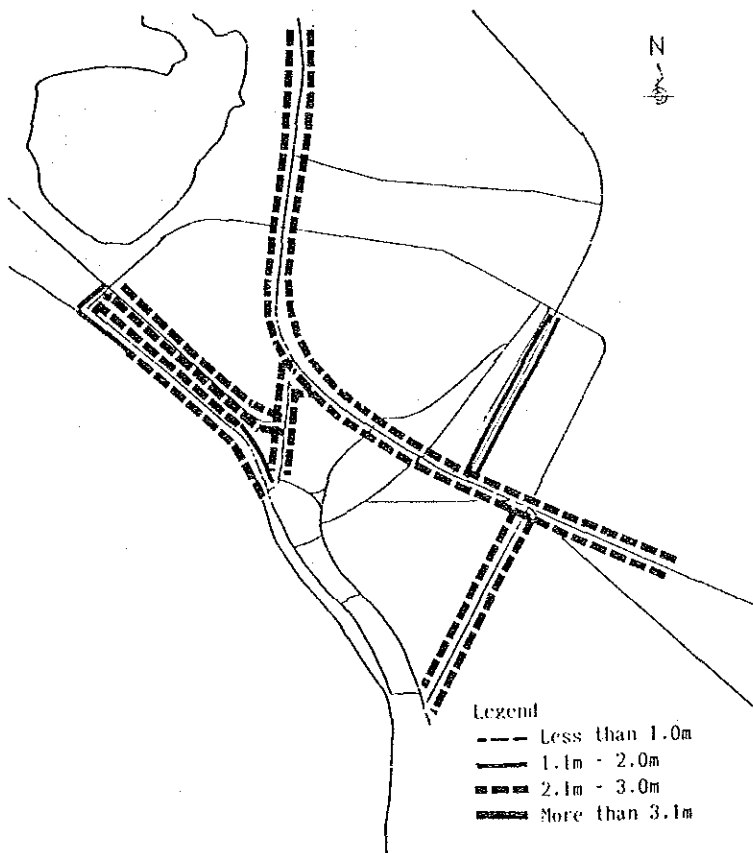


Fig. 4.3.3.6 Sidewalk Width of Main Roads in Hodeidah



#### 4.4 Road Maintenance System

##### 4.4.1 Road administration

The construction and maintenance for all roads in urban area are under the control of MMH (Ministry of Municipality and Housing). MMH is also in charge for administration of parks, drainage system, sewage treatment and solid waste treatment facilities. MMH has regional offices in 11 governorates as shown in Appendix Fig. 6.3.7. The ministry and its departments have a relationship as shown in the figure.

##### 4.4.2 Road construction

Physical Planning Department has a function for road planning, and Department of Projects controls road construction and rehabilitation. Local contractors get a project through competitive tendering while small jobs in the city area are directly implemented by MMH. There are about 10 local contractors for mainly road construction of which two contractors are considered capable of accomplished work in the range of Y.R. 50 million to 100 million.

MMH has equipment for small maintenance. The MMH expenditure for roads, including maintenance and lighting was YR 231 million for 1985-86 in the three cities. Annual expenditures of Sana'a, Taiz and Hodeidah are shown in Tables 4.4.1 through 4.4.3.

Table 4.4.1 Sana'a City Annual Road Expenditure

(Unit: Million Y.R.)

Year	Asphalt road		Lighting	Other road	Total
	Construction	Maintenance			
1981	43.3	11.7	3.0	1.8	60.8
1982	41.9	20.0	6.3	2.0	70.2
1983	32.7	15.6	7.4	2.2	57.9
1984	45.8	0.9	6.9	2.5	56.1
1985	50.7	12.5	4.9	2.7	70.8
1986	86.4	---	6.7	3.0	92.7

Source: Estimation from MMH data and interview, 1988

Table 4.4.2 Taiz City Annual Road Expenditure

(Unit: Million Y.R.)

Year	Asphalt road		Lighting	Other road	Total
	Construction	Maintenance			
1981	8.3	0.2	1.4	0.1	10.0
1982	2.4	3.9	1.9	0.1	8.3
1983	1.4	2.7	2.0	0.2	6.3
1984	1.5	3.3	0.7	0.2	5.7
1985	0.7	3.0	1.7	0.2	5.6
1986	6.9	---	1.8	0.2	8.9

Source: Estimation from MMH data and interview, 1988

Table 4.4.3 Hodeidah City Annual Road Expenditure

(Unit: Million Y.R.)

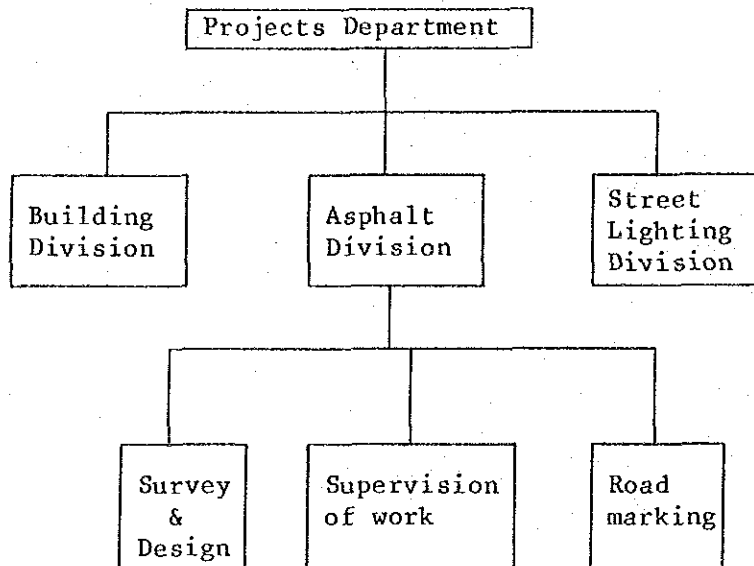
Year	Asphalt road		Lighting	Other road	Total
	Construction	Maintenance			
1981	----	0.2	0.4	---	0.6
1982	0.2	1.0	0.2	---	1.4
1983	6.4	6.1	1.8	---	14.3
1984	10.8	0.4	---	---	11.2
1985	2.0	0.2	1.5	---	3.7
1986	----	---	1.8	---	1.8

Source: Estimation from MMH data and interview, 1988

#### 4.4.3 Maintenance and administration

Road maintenance in urban areas are conducted by Asphalt Division under Department of Projects for such as maintenance of road marking, rehabilitation of roads and bridges, repair and maintenance for drainage facilities, overlay and small improvement works for asphalt roads, while other unpaved roads are maintained by Road Department under each Governorate. Road lighting maintenance is carried out by Street Lighting Division under Department of Projects.

#### Organization of Department of projects



#### 4.5 Traffic Congestion Rate (Traffic Volume and Capacity)

##### 4.5.1 Capacity analysis for the existing road sections

Traffic congestion rate was calculated for the evaluation of usage of existing main roads. The congestion is shown by a ratio of capacity and traffic volume. Capacities are calculated from the following formula considering the on-road parking status.

$$C_p = N \times C \times (V/C) \times F_p$$

where  $C_p$ ; Capacity of a road section

$N$  ; Numbers of lane in one direction  
(If parking vehicles occupy a lane substantially, this lane is reduced from the number of the traffic lanes)

$C$  ; Basic capacity of a lane  
 $C$  will be obtained from the maximum service flow rate for level of service D in Highway Capacity Manual (1900 PCU)

$(V/C)$ ; Adjustment factor of maximum service flow rate against capacity,  $V/C = 0.76$  is also from HCM.

$F_p$ ; Adjustment factor taking into account development environment, width of road and other reasons (1.00-0.94).

Road capacity and service level is quoted from Highway Capacity Manual as in Appendix Note 4.2. Capacity analysis is carried out entirely in PCU converted values on peak hour which came from the actual survey data in Chapter 5. Details are in Appendix Fig. 4.5.1-3 and Appendix Table 4.5.1-3. The calculation assumes no influence of intersections. The capacity of intersection is studied in the following 4.5.2.

Sana'a

Fig. 4.5.1.1 shows the traffic congestion rate on peak hour for each direction by using PCU values of the existing traffic volumes. For an example, traffic volume in the peak hour exceeds the capacity under the current use on the sections of Ring road near Sana'a University. The main reason is indiscriminate parking on roads, resulting in the reduction of lane-number in this section.

Taiz

Fig. 4.5.1.2 shows the traffic congestion rate for the peak hour for Jamal and Jainai streets. Congestion rate is over 1.0 at Mocha street in the peak hour.

Hodeidah

Fig. 4.5.1.3 shows the traffic congestion rate on peak hour for each direction by using PCU's of the existing traffic volumes. The congestion rate is not over 1.0 for any of the streets.

Fig. 4.5.1.1 Traffic Congestion Rate of Arterial Road in Sana'a (Peak Hour)

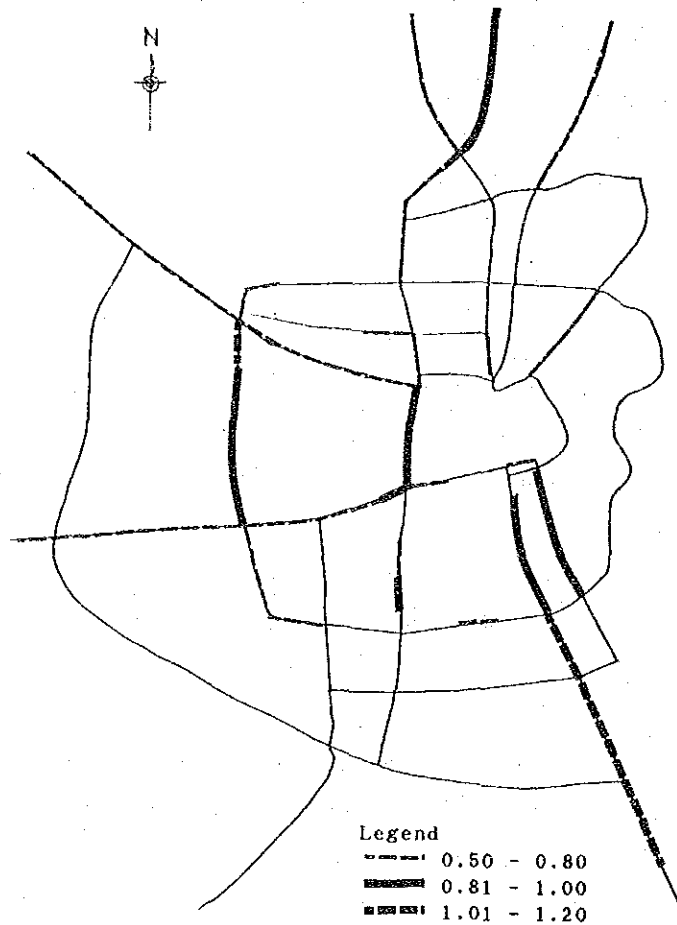


Fig. 4.5.1.2 Traffic Congestion Rate of Arterial Road in Taiz (Peak Hour)

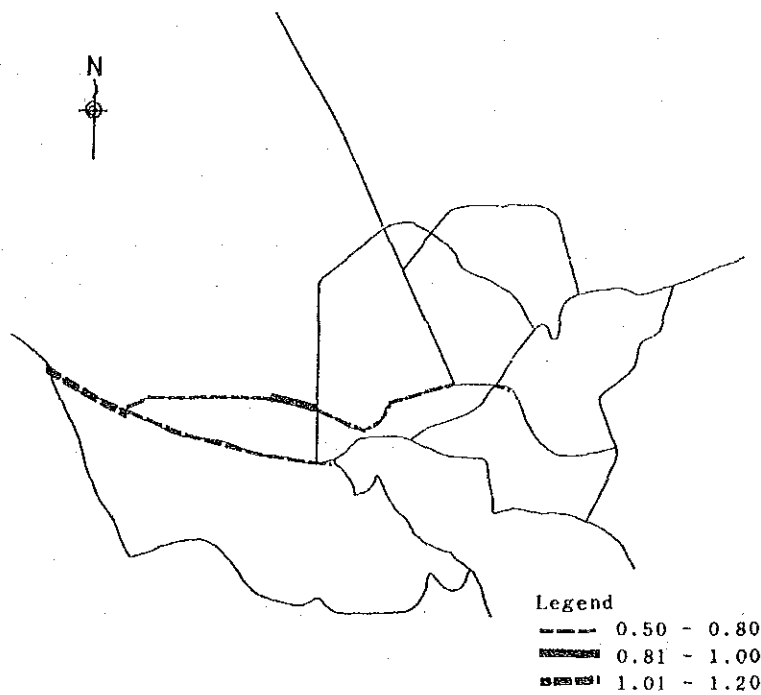
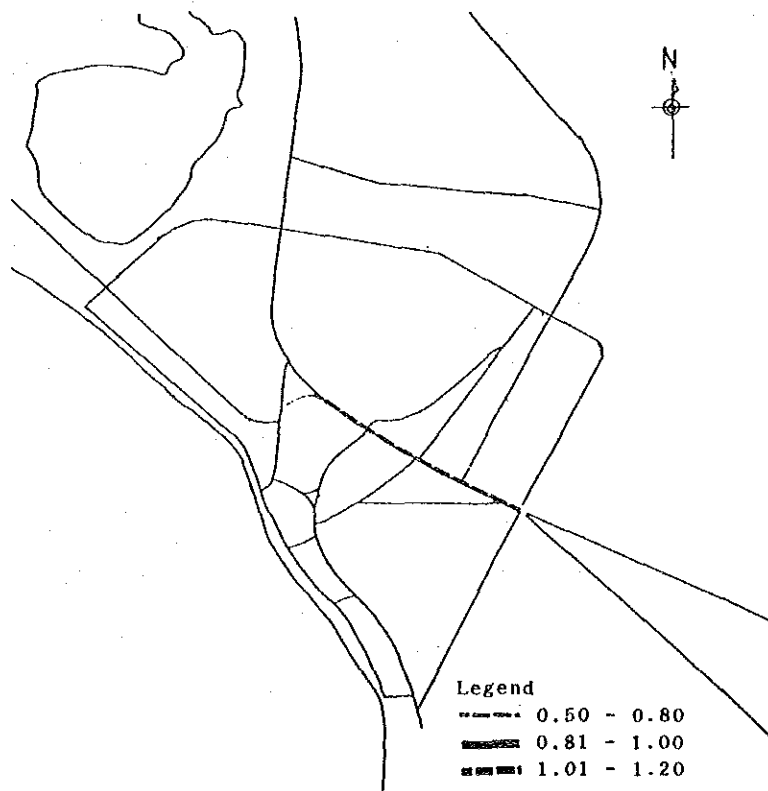


Fig. 4.5.1.3 Traffic Congestion Rate of Arterial Road in Hodeidah (Peak Hour)



#### 4.5.2 Capacity analysis for the existing intersections

Traffic congestion rate was calculated for the evaluation of existing main intersections. The calculation was in the following way:

- Traffic moves into the intersection from approach road sections, where the phasing system is to let one direction only to enter then each of the other directions in turn. There is no opposite traffic flows in the intersection under this phasing system.
- Capacity and congestion rate of the each approach section are calculated by the same formula and parameters used in road section analysis of the previous section 4.5.1.
- Adding up all calculated V/C of each approach section results in a degree of congestion at the intersection under the assumed service level D.
- Details are shown in Appendix Tables 4.5.4-6.

##### Sana'a

Fig. 4.5.2.1 shows V/C on peak hour at intersections. V/C value over 1.2 is found at intersections of Ali Abdul Mughni, Az Zubayri, where 1.2 means the practical saturation point of the capacity under the service level D.

##### Taiz

Main traffic flows concentrate on Jamal street extending from east to west. Fig. 4.5.2.2 shows V/C on peak hour at intersections. V/C value on peak hour at Jamal street is more than 1.2 at major intersections.

##### Hodeidah

Fig. 4.5.2.3 shows V/C of peak hour at intersections. The rates are 0.8 to 1.15. It is understood that traffic volumes do not arrive at the level of saturation point on those intersections.



Fig. 4.5.2.1 Traffic Congestion Rate of Intersection in Sana'a (Peak Hour)

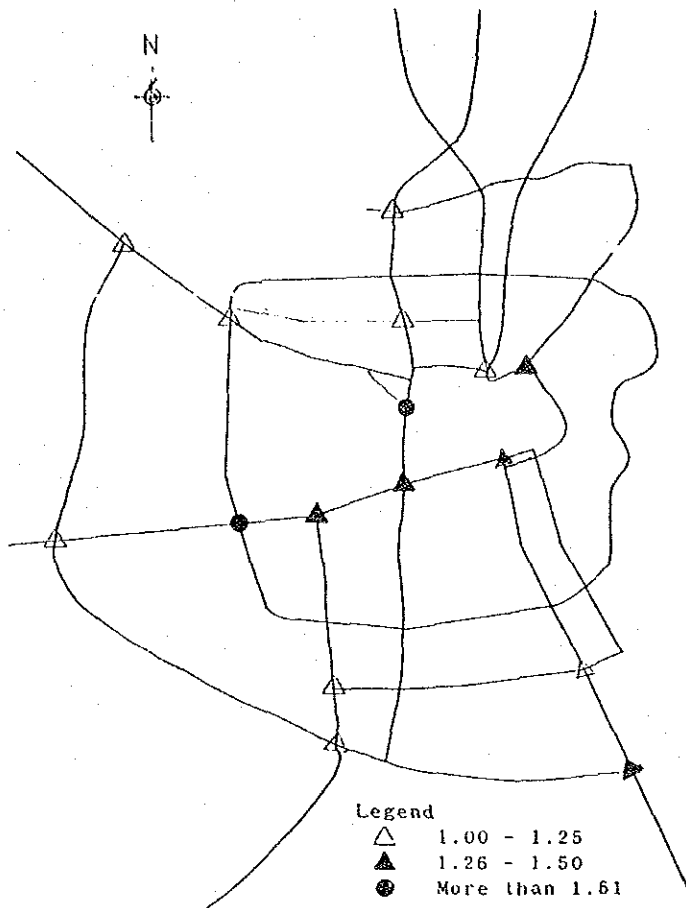


Fig. 4.5.2.2 Traffic Congestion Rate of Intersection in Taiz (Peak Hour)

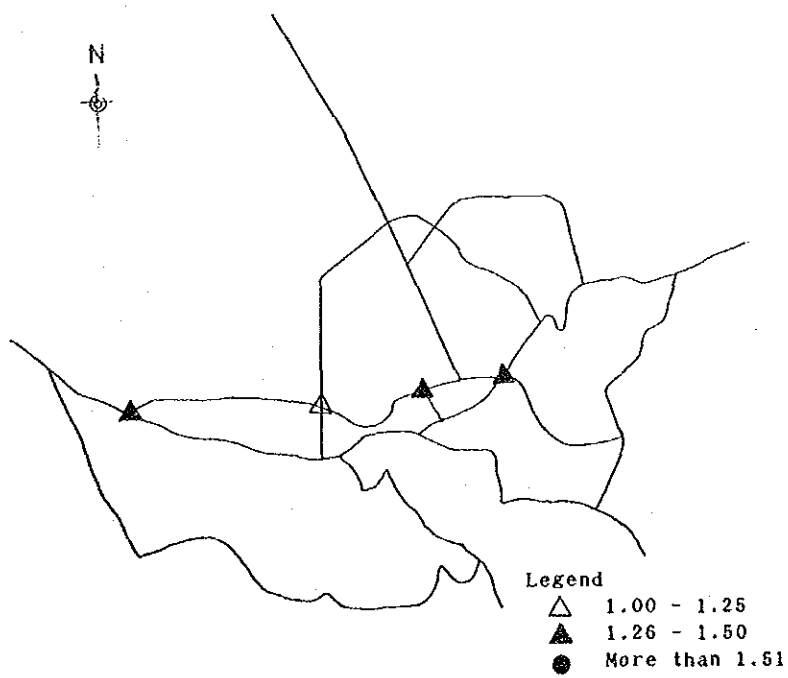
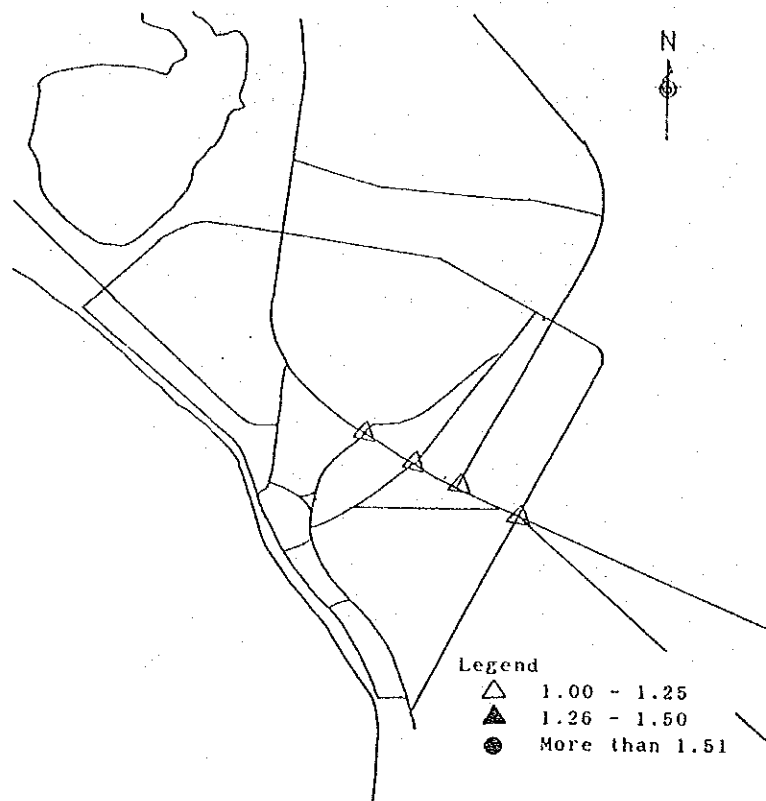


Fig. 4.5.2.3 Traffic Congestion Rate of Intersection in Hodeidah (Peak Hour)



## CHAPTER 5 TRAFFIC FLOWS



## CHAPTER 5 TRAFFIC FLOWS

### 5.1 Traffic Flows and its Characteristics

#### 5.1.1 Sana'a

##### 5.1.1.1 Traffic volumes

###### a) Vehicles

Traffic volume surveys were conducted on the major roads as shown on Fig. 5.1.1.1. for the study of existing traffic flows in the city. Roadside vehicle counting was conducted with the following categories.

- 16 hours (6 a.m. - 10 p.m.) at Nos. 1 - 4, 11 - 14, and 18
- 13 hours (7 a.m. - 8 p.m.) at other locations.
- One week (7 a.m. - 8 p.m.) at Nos. 17 and 21
- Vehicle classification
  1. Motorcycles
  2. Passenger cars
  3. Taxis
  4. Micro-buses (Public, 7 passenger seats)
  5. Medium-buses (Public, 24 passenger seats)
  6. Other buses
  7. Light trucks
  8. Heavy trucks

The results of the traffic counting are shown in Appendix Table 5.1.1.1. Traffic flow chart in Sana'a is shown on Fig. 5.1.1.2.

The traffic volumes of the each kind of the vehicles from the survey are converted to PCUs (Passenger car units) by using the following ratios;

• Motorcycle	0.3	
• Passenger car	1.0	
• Taxi	1.0	
• Micro bus	1.3	(Public, 7 passenger seats)
• Medium bus	1.5	(Public, 24 passenger seats)

Fig. 5.1.1.1 Traffic Counting Survey Locations, Sana'a

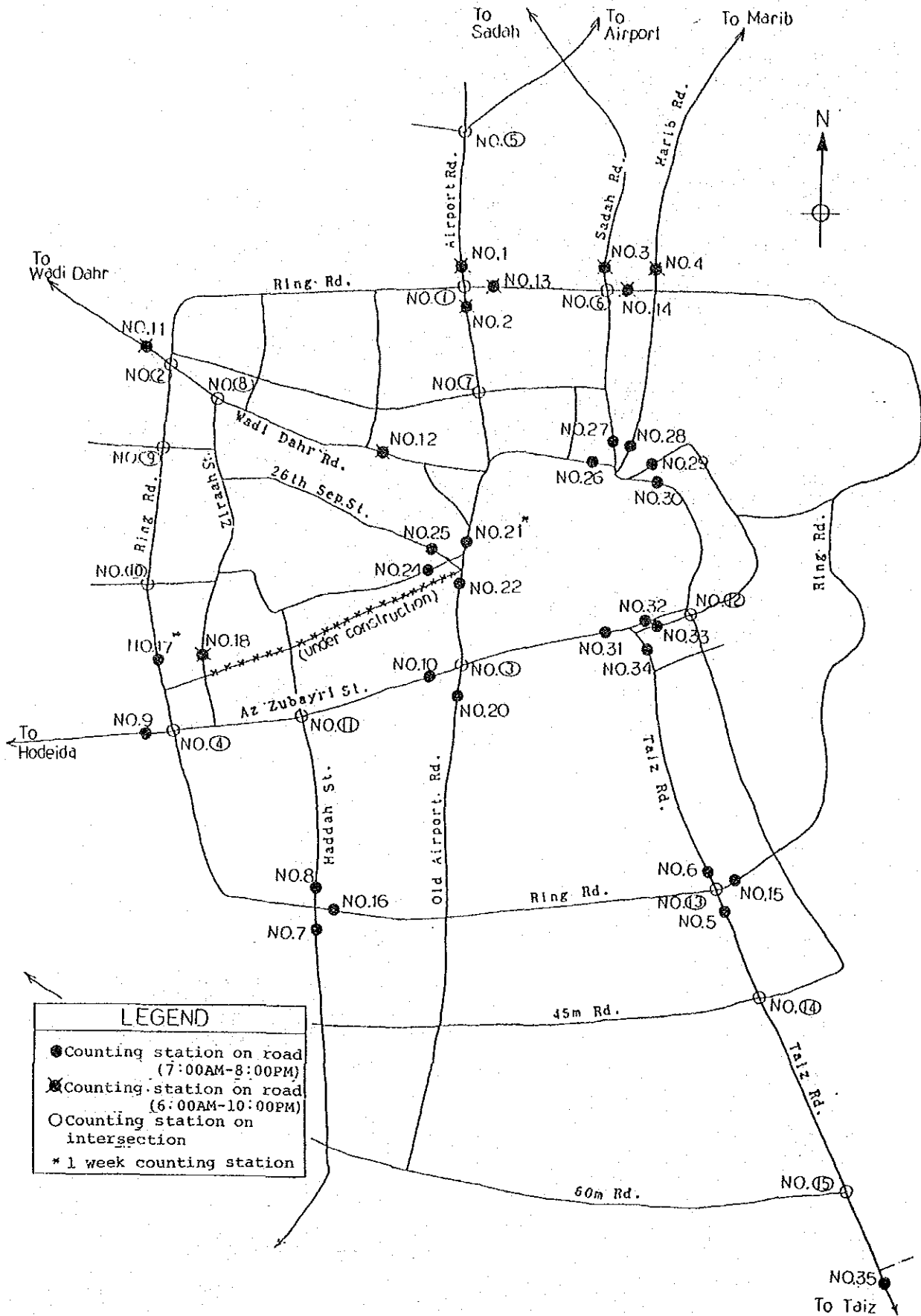
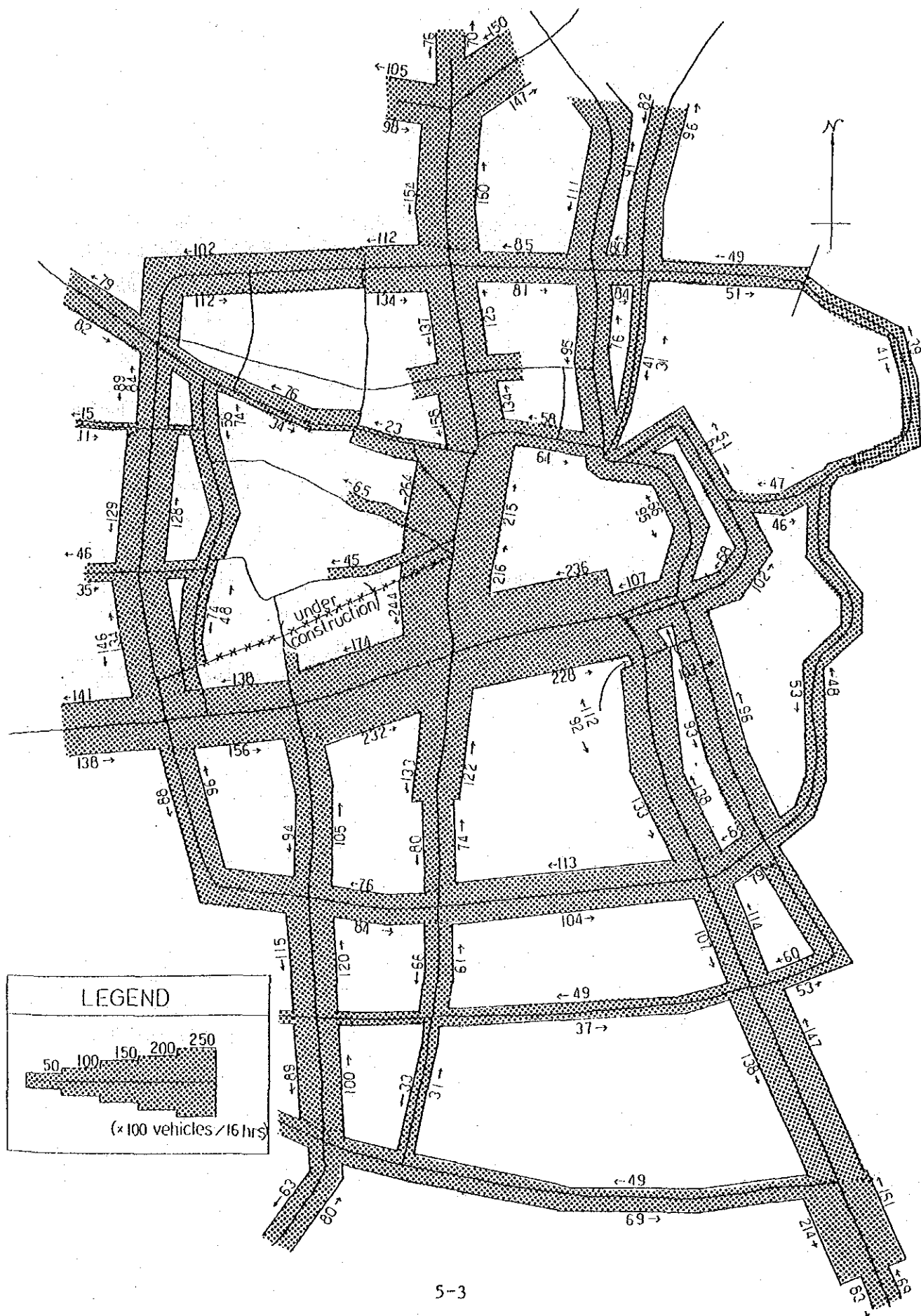


Fig. 5.1.1.2 Vehicle Traffic Flow, in Sana'a



- Other bus 1.6
- Light truck 1.3
- Heavy truck 2.0

The above conversion ratios were decided from field observation, the values adopted by the Study (1978 by Louis Berger & Kampsax) and the recent study in Cairo by another JICA Team. The traffic flow chart converted to PCUs in Sana'a is shown in Fig. 5.1.1.3. The 16 hours traffic volume from 6:00 to 22:00 is considered to be about 95% of daily traffic since traffic during midnight hours is very small.

Turning movements at the intersection were counted during the morning hours in which the peak hour is included.

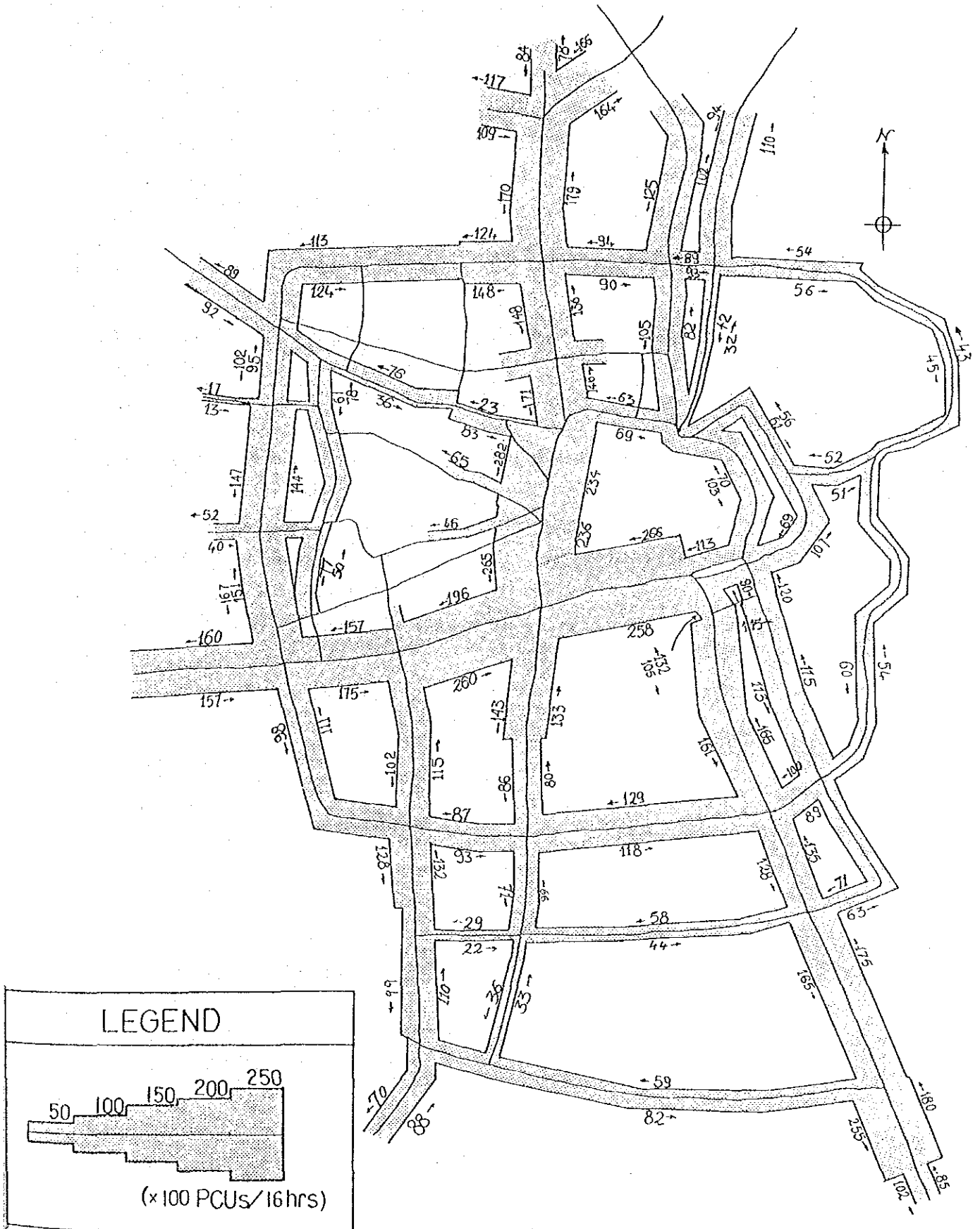
- 4 hours (9 a.m. - 1 p.m.), without vehicle classification.

The results are shown in Appendix Table 5.1.1.2.

The seven day counting was conducted at a point on No. 17 the Ring road West (in front of Sana'a University) and on No. 21 the Ali Abdul Mughni street (in front of the National Museum). The average volume per week was found at 26,200 on No.17 and 44,800 on No.21. Daily variation during Saturday through Tuesday was 100% - 107%, while the volume on Friday was 73% of the average in a week on those locations.



Fig. 5.1.1.3 Vehicle Traffic Flow Converted to PCUs, Sana'a



The largest volume is 47,900 vehicles/16 hours (51,600 PCUs/16 hours) at the point of the north of Tahrir square of the Ali Abdul Mughni street, and the second is 46,300 vehicles/16 hours (52,400 PCUs/16 hours) at Bab Al Yemen on the Az Zubayri street. The streets with a large traffic volume are at Ali Abdul Mughni street, Az Zubayri street, Al Qiyada street, Taiz road, Ring road and Haddah street as shown on Table 5.1.1.1.

The two main flows in Sana'a for the north-south direction are: the road connecting Airport road, Al Qiyada street and Old Airport road/Haddah road, and the road from Sadah road to Taiz road. Az Zubayri street has the main flow for the east-west direction.

The comparison of the survey results between the Study in 1978 and this study as shown in Table 5.1.1.2 indicates a remarkable growth of the traffic volumes at Ring road and radial roads compared with those on the streets near Old city. This fact is reflecting the rapid development during the recent 10 years at around and outside the Ring road.

Table 5.1.1.1 Routes with Large Traffic Volume

Street	Traffic Volume (PCUs/16hs)
Ali Abdul Mughni	50,100 - 51,600
Az Zubayri	31,700 - 52,400
Al Qiyada (Airport road)	28,400 - 43,900
Taiz road	18,700 - 43,500
Ring road	8,800 - 31,800
Haddah road	15,800 - 26,000

Table 5.1.1.2 Changes in Road Traffic Volume

(Unit: PCUs/14hs)

No. 1)	Location	1977 2)	1987 3)	Growth ratio
21	Ali Abdul Mughni St. (North of Tahrir Sq.)	25,500	47,300	1.85
22	Ali Abdul Mughni St. (South of Tahrir Sq.)	24,000	46,600	1.94
2	Al Qiyada St. (South of Ring Rd.)	10,400	26,000	2.50
1	Airport Rd. (North of Ring Rd.)	8,500	32,600	3.84
20	Old Airport Rd. (East of Officer's Club)	4,100	25,600	6.24
10	Az Zubayri St. (North of Officer's Club)	17,000	42,500	2.50
31	Az Zubayri St. (West of Bab Al Yemen)	22,300	48,800	2.19
26	Shuub St. (West of Bab Shuub)	11,000	12,300	1.12
8	Haddah St. (South of Az Zubayri)	7,800	20,100	2.58
5	Taiz Rd. (South of Ring Rd.)	3,200	24,500	7.66
3	Sadah Rd. (North of Ring Rd.)	9,400	21,300	2.27
4	Marib Rd. (North of Ring Rd.)	4,500	19,300	4.29

Note: 1) Refer to Fig. 5.1.1.1.

2) From the Study report (1978)

3) Adjusted to the traffic volume of 14 hours from 6:00 to 20:00 to compare them with the survey results in 1977.

b) Pedestrians

The survey for pedestrians was conducted in front of Tahrir square and Bab Al Yemen, where many pedestrians conflict with vehicles, resulting in danger of accidents for the road crossing pedestrians and slow vehicular travel as identified by the survey for travel speed. The potential conflict between pedestrians and vehicles is remarkably high from 10:00 to 13:00 and from 17:00 to 19:00 at both areas. Surveys were carried out for one hour at each location during 10:00 to 12:00. The results are shown on Fig. 5.1.1.4 and Fig. 5.1.1.5. The crossing pedestrians have amounted to 5,100 persons/hour for a length of 220 meters at Ali Abdul Mughni St. in front of Tahrir square, where the largest vehicle traffic volume has been recorded. Disordered pedestrian crossing causes further traffic congestion due to an absence of pedestrian crossing facilities.

Similar problems are found at Bab Al Yemen, where the pedestrians crossing Az Zubayri street are 1,600 persons/hour for a length of 160 meters and those crossing Taiz road are 2,600 persons/hour for 50 m. Also, pedestrians cross trunk roads in an indiscriminate manner. They are in large volume at the points near the school (where the school zone was separated by trunk road), markets and government offices.

5.1.1.2 Hourly fluctuation

Fig. 5.1.1.6 is indicating an hourly fluctuation of the traffic volume of vehicles on the major roads, and showing that the peak hours occur from 8:00 to 9:00 in the morning, 12:00 - 13:00 on the noon time and 17:00 - 18:00 in the evening. The hourly fluctuation of each point shows a pattern of two or three peak hours in a day. For example, two peak hours in a day are found at No.6 Taiz road and Wadi Dahr Rd. Three peaks are typical at No.13 Ring road and No.20 Old airport road, etc.

Fig. 5.1.1.4 Pedestrian Traffic Flow near Tahrir Square

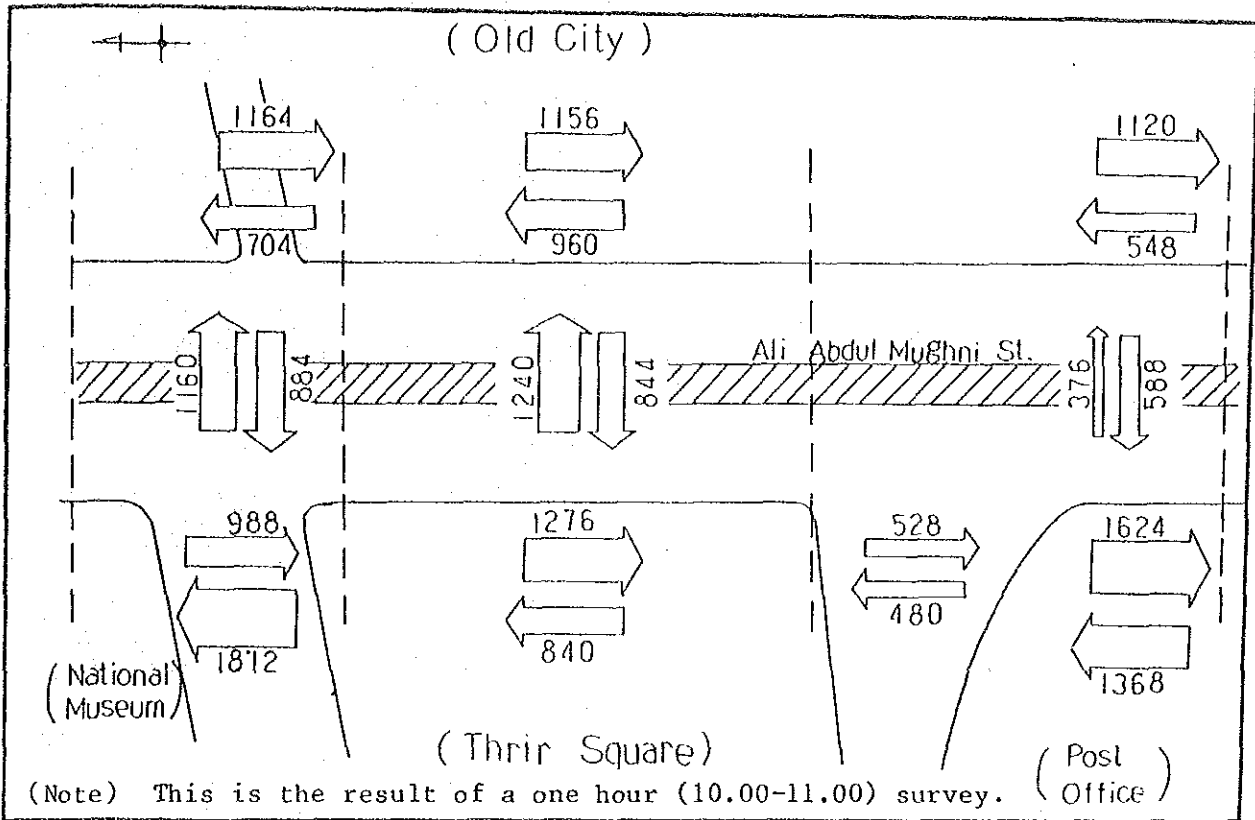


Fig. 5.1.1.5 Pedestrian Traffic Flow near Bab Al Yemen

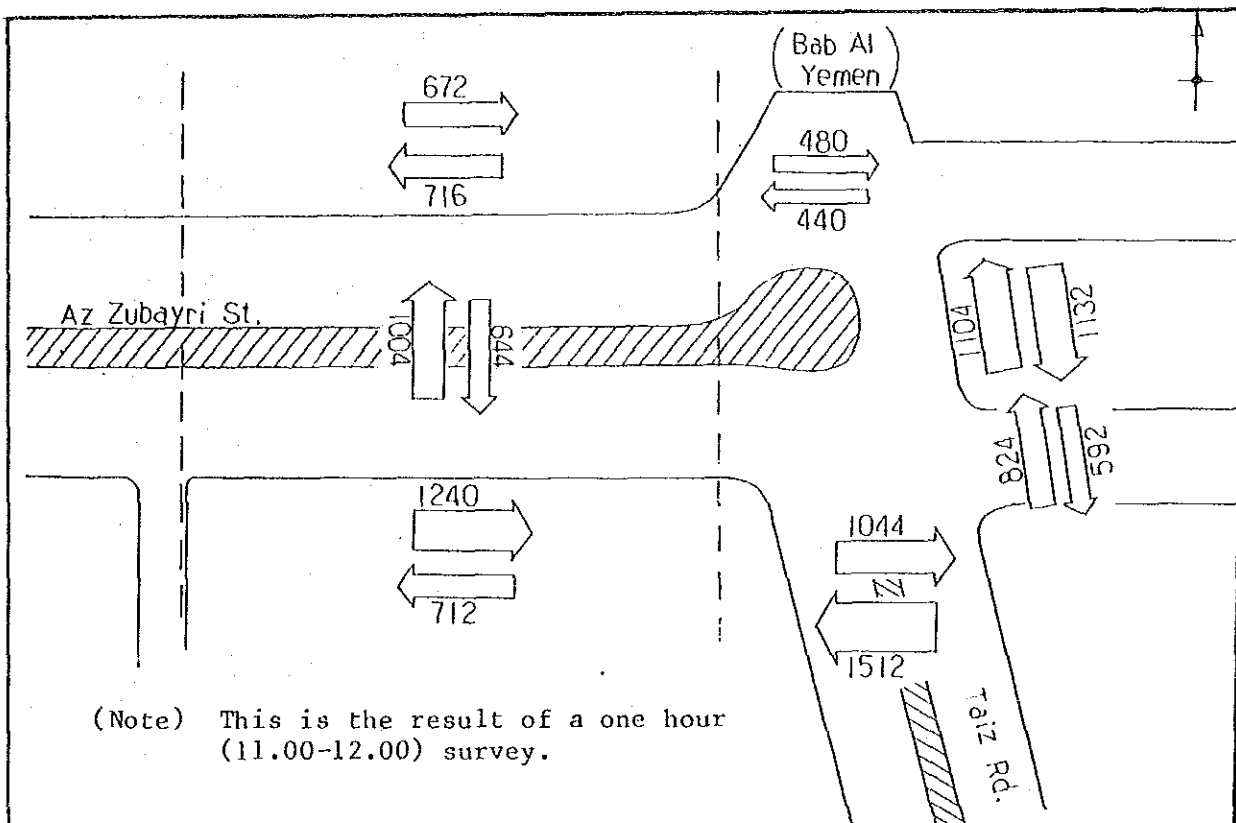


Fig. 5.1.1.6 Hourly Fluctuation of Vehicle Traffic Volume, Sana'a (1)

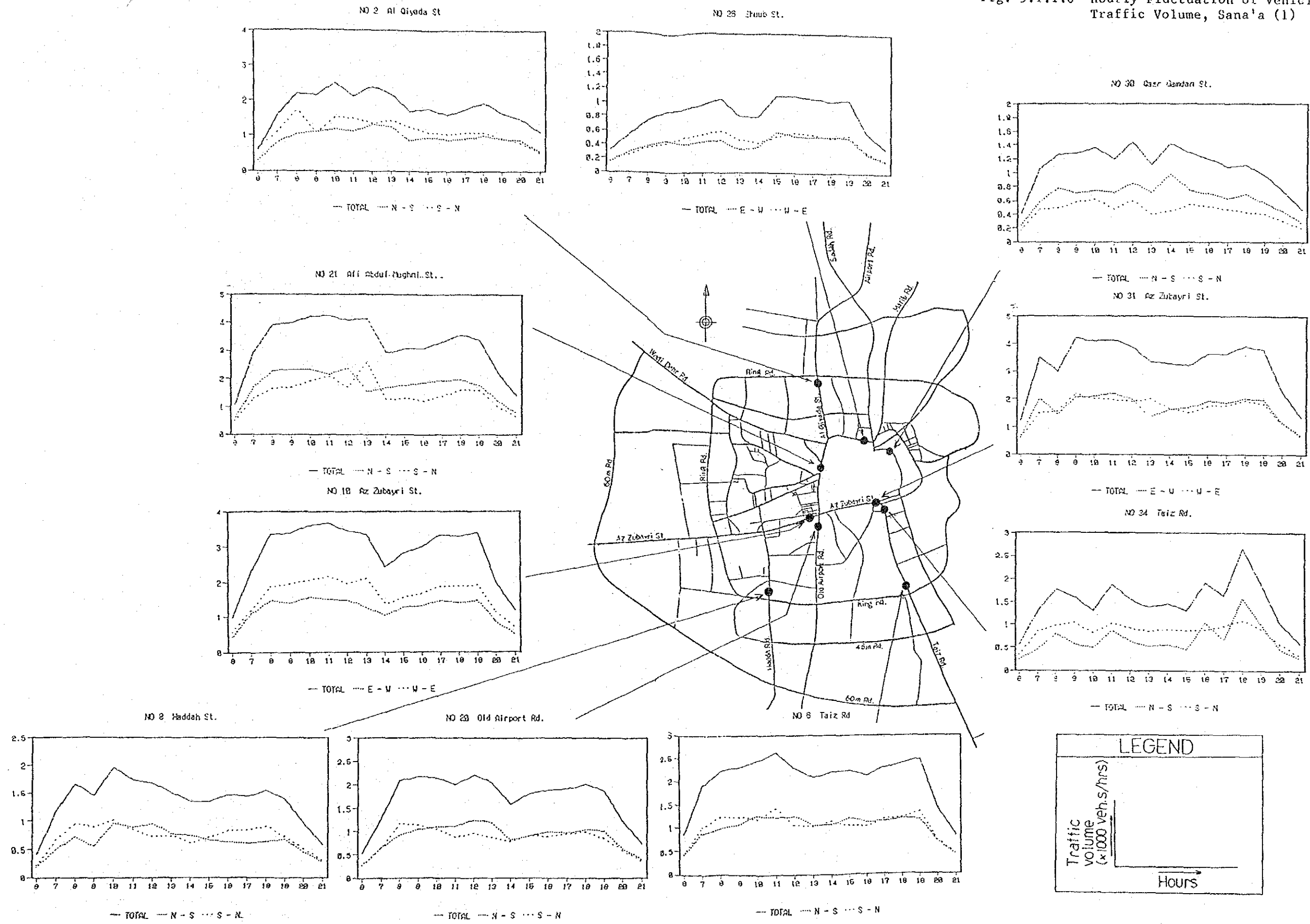
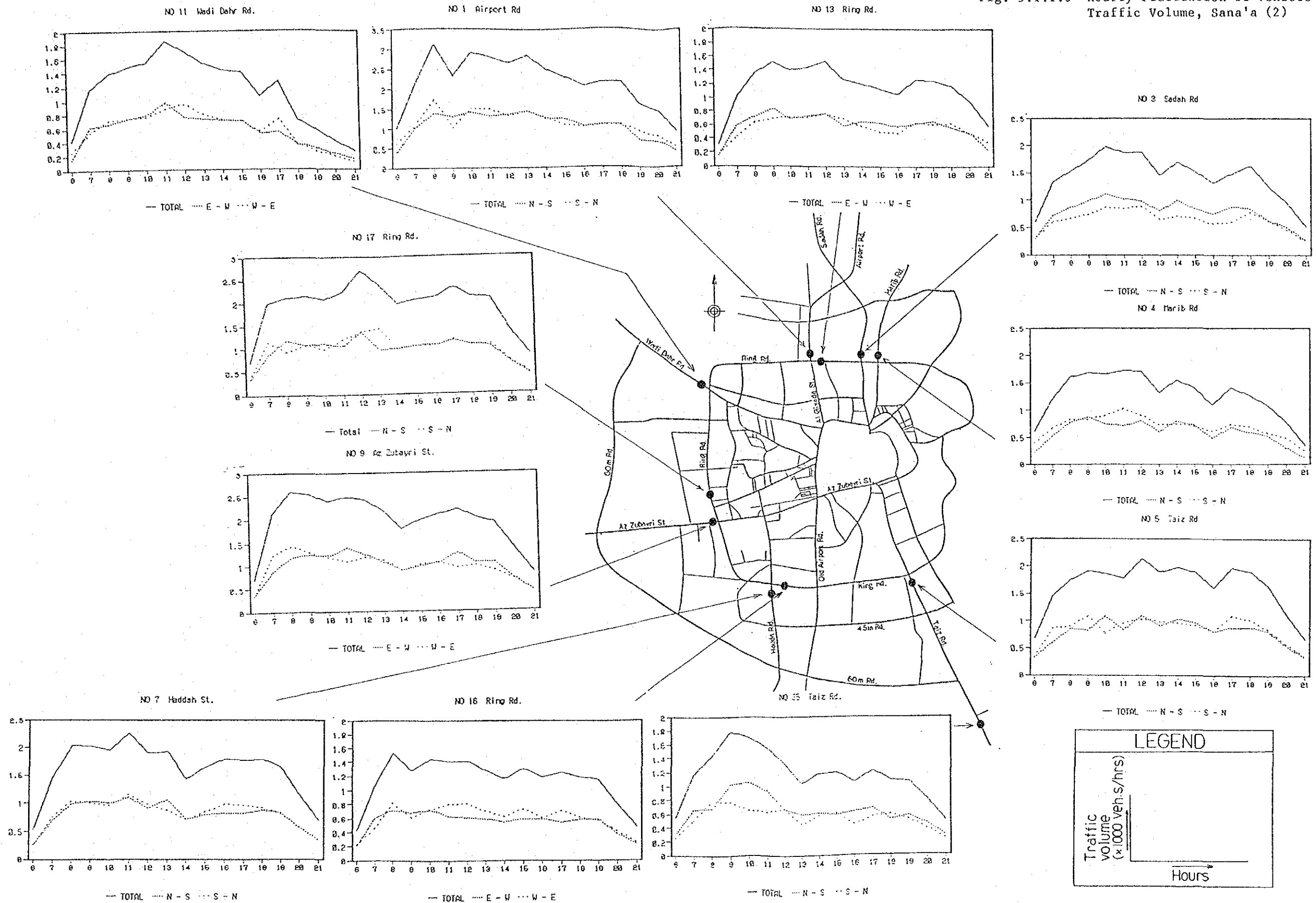


Fig. 5.1.1.6 Hourly Fluctuation of Vehicle Traffic Volume, Sana'a (2)



#### 5.1.1.3 Vehicle composition

Vehicle composition on the main points of the traffic survey are shown of Fig. 5.1.1.7. The percent ratio of public transportation for taxi, micro bus and medium bus accounts for 40 - 60% at most points in the center of Sana'a city. An especially high ratio of 60% has been recorded at No.34 Taiz road near Bab Al Yemen for the direction from North to South. Heavy truck ratios inside of the Ring road are very small due to the control of heavy truck movement inside it.

#### 5.1.1.4 Turning Movement

Turning movement at selected 15 major intersections were surveyed for 4 hours in the morning hours. The result is filed in Appendix Table 5.1.1.2.



Fig. 5.1.1.7 Vehicle Composition, Sana'a (1)

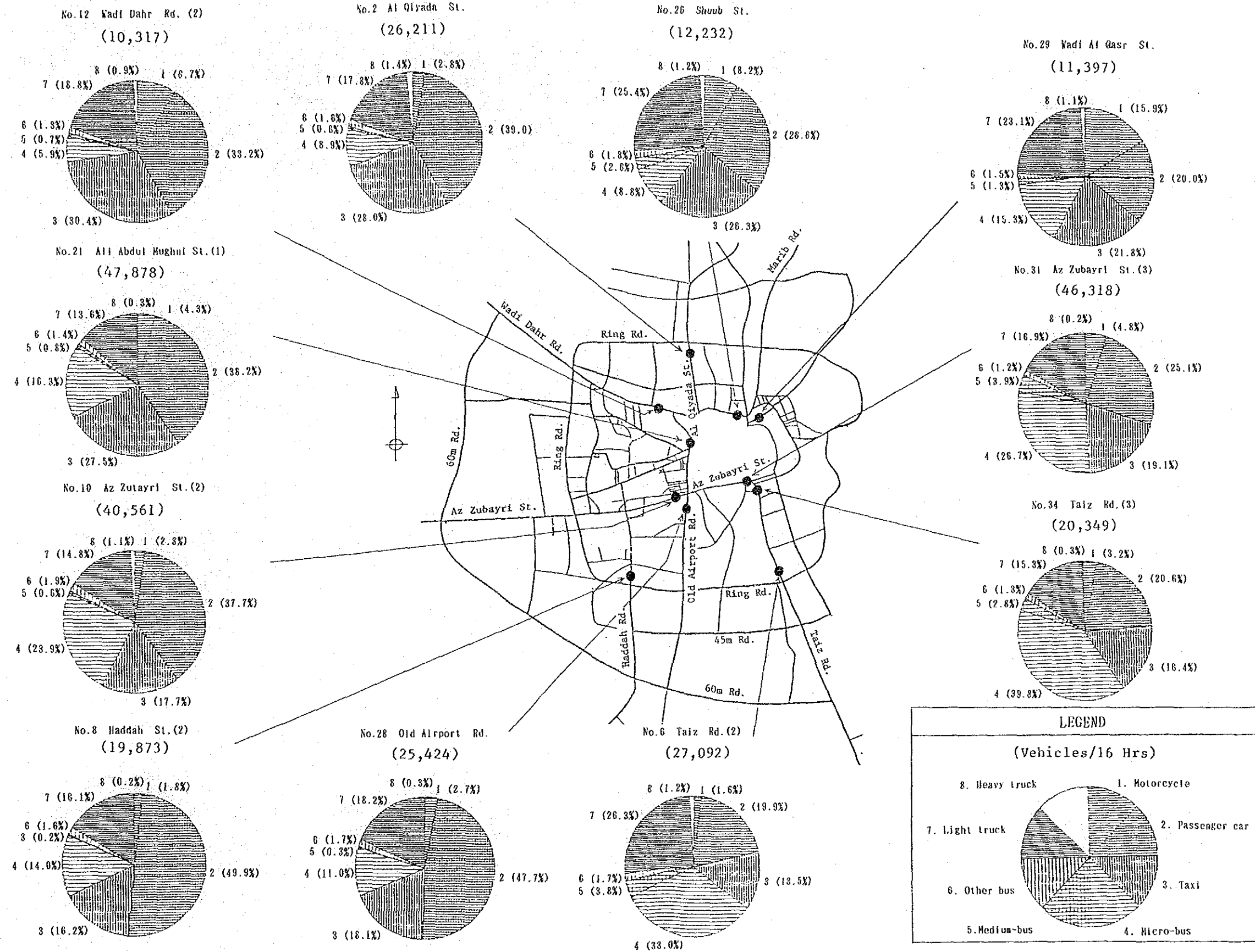
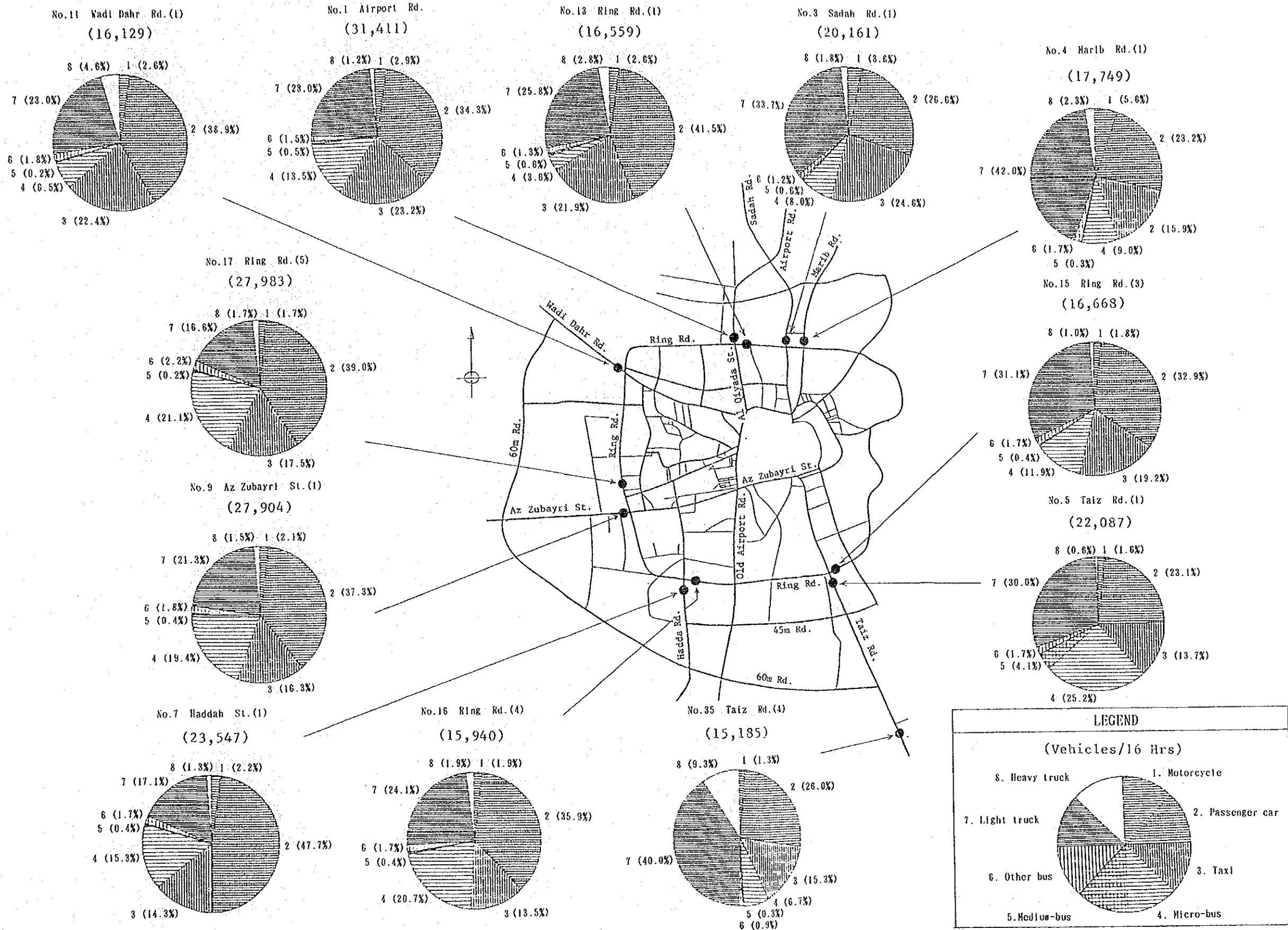


Fig. 5.1.1.7 Vehicle Composition, Sana'a (2)





## 5.1.2 Taiz

### 5.1.2.1 Traffic volume

#### a) Vehicles

Survey for the traffic volume at Taiz city was conducted at Jamal street, main street passing the city center from east to west, and at Jaynai-26th September street, parallel to the former road but narrow and curving. Locations of the counting stations are shown in Fig. 5.1.2.1.

- Roadside counting  
at 8 locations, from 7 a.m. to 8 p.m.
- Intersection directional flow counting  
at 5 locations from 9 a.m. to 1 p.m.

Vehicle classification was same as in Sana'a. The selected results of the traffic count are shown in Appendix Table 5.1.2.1. Fig. 5.1.2.2 shows the traffic flow in the center of the city based on the results of the survey of the traffic volume. Fig. 5.1.2.3 is the traffic flow in PCUs. The traffic volumes at Jamal street are from 15,900 to 37,300 vehicles/16 hours (18,600 - 42,800 PCUs/16 hrs) and those of Jaynai - 26th September street are 6,200 - 16,000 vehicles/16 hours (6,700 - 17,400 PCUs/16 hrs), that is a half of Jamal street. (PCU volumes are calculated by using the same unit values of Sana'a)

At Jamal street from the intersection of Central Bank Taiz branch to Ali Uthman street the ratio of the traffic volume for west and for east is nearly 3 : 2 because of partial one way control to west direction on 26th September street.

#### b) Pedestrians

The disorder of pedestrian crossings on trunk roads in Taiz city is same as in Sana'a city. There is little sidewalk at some sections of Jamal street due to parking bays, and pedestrians are obliged to walk the roadway. Although two pedestrian bridges are set up on Jamal street, the

utilization is very low, i.e. our survey result shows 5% or so at the pedestrian bridge in front of the central market.

Remarkable conflict between pedestrians and vehicles are found on roads near Bab Mosa, Bab Al Kabir and the central market area.

Fig. 5.1.2.1 Locations of Traffic Counting, Taiz

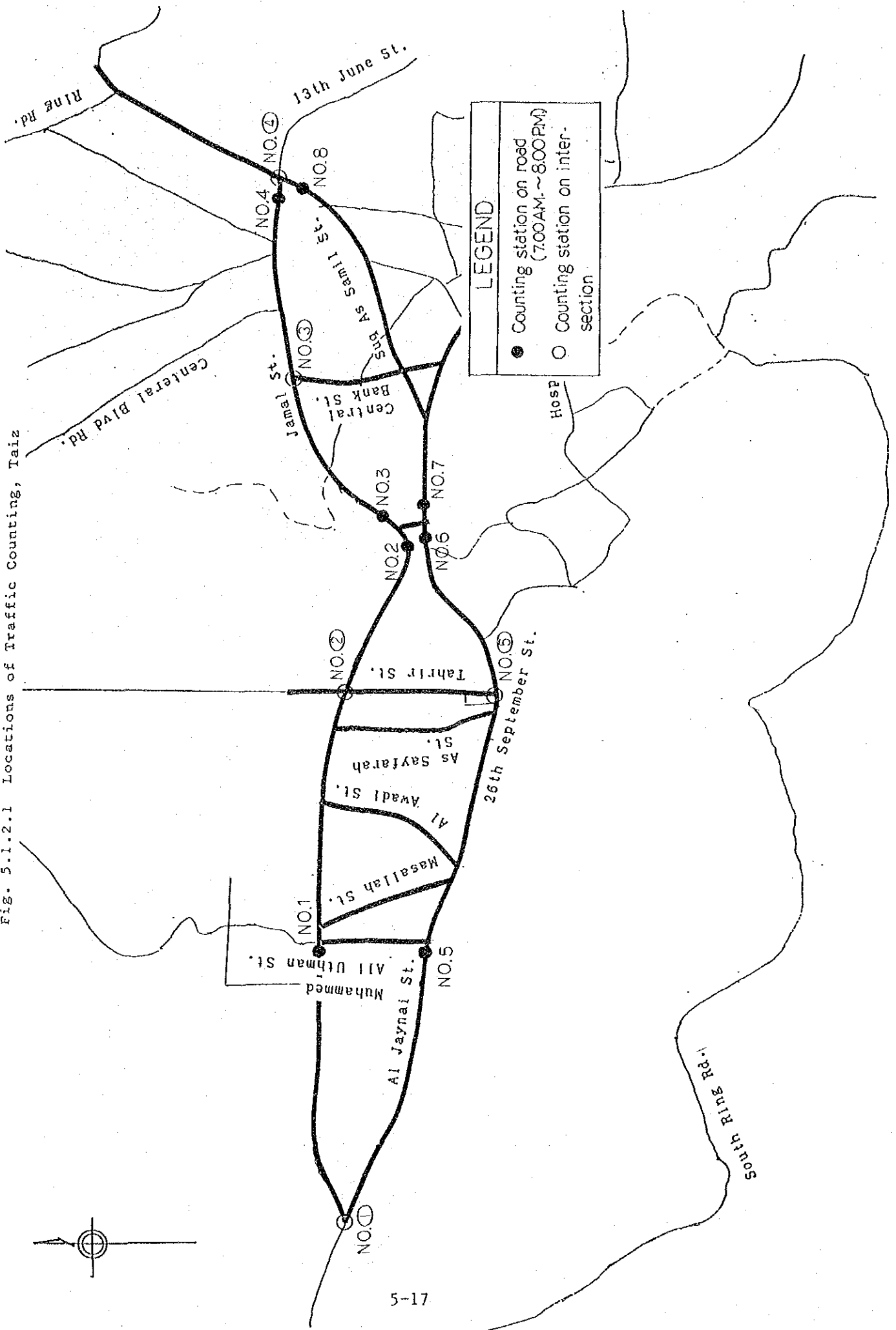


Fig. 5.1.2.2 Vehicle Traffic Flow, Taiz

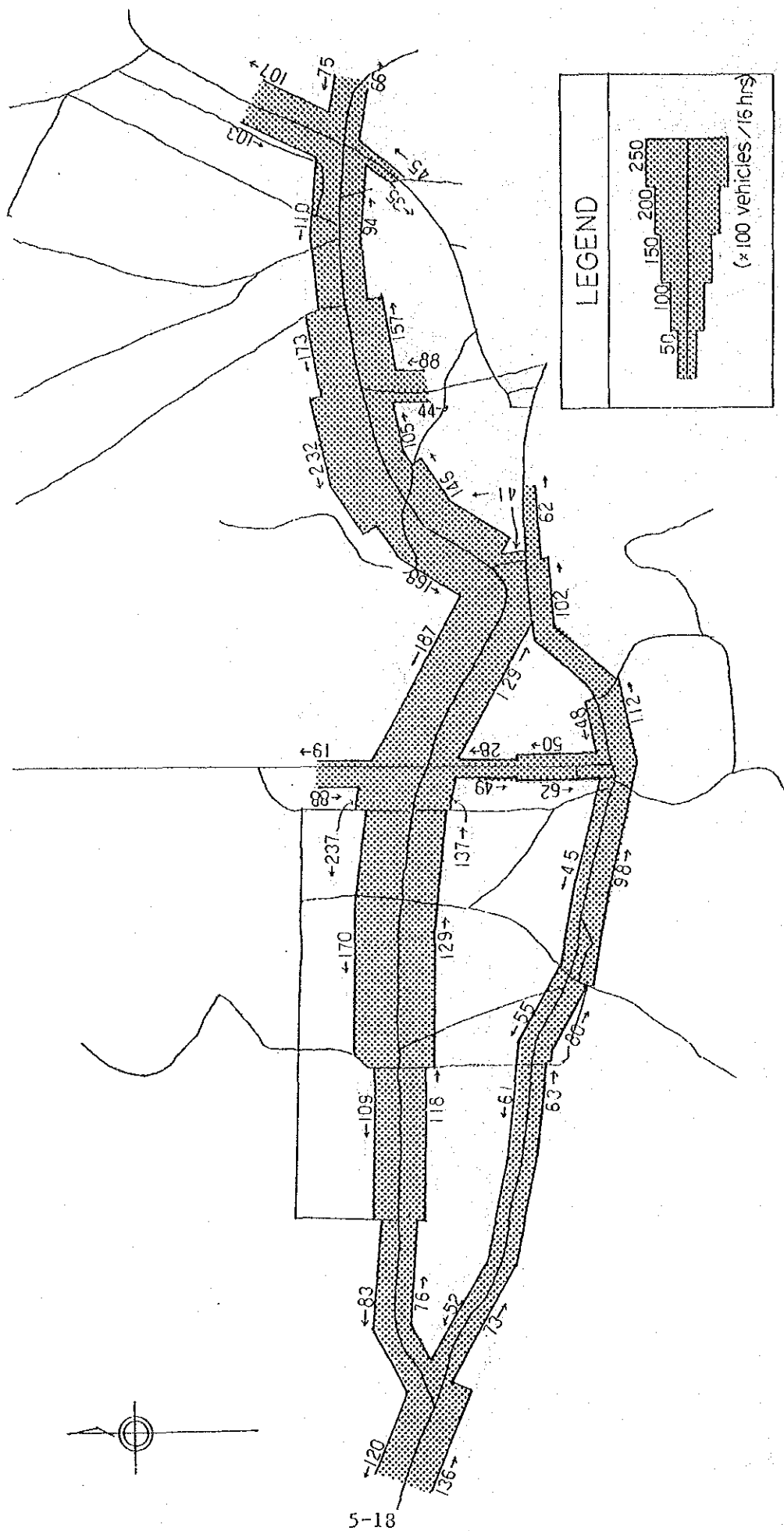
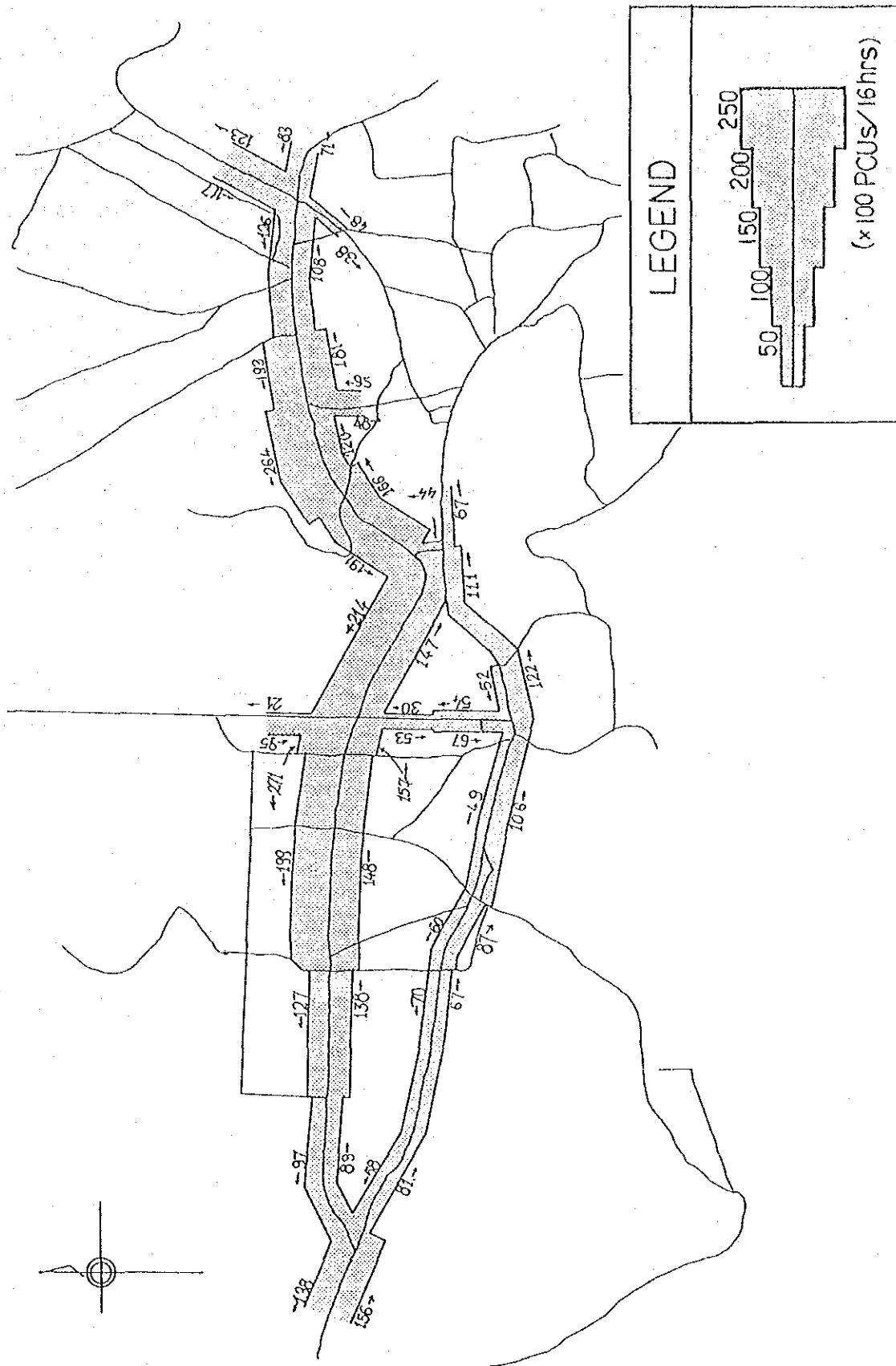


Fig. 5.1.2.3 Vehicle Traffic Flow Converted to PCUs, Taiz





#### 5.1.2.2 Hourly fluctuation

Hourly fluctuation at Jamal street and Jaynai-26th September street has a pattern with two peak hours; one in the day time and the other in the evening. High peak ratio is shown in the evening especially at Jamal street and Jayani street near the intersection with Ali Uthman street. Fig. 5.1.2.4 indicates the hourly fluctuation of vehicle traffic volume for each point in Taiz city.

#### 5.1.2.3 Vehicle composition

Vehicle composition for each point is shown on Fig. 5.1.2.5. The total ratio of public transportation by taxi and micro bus is almost 40% or more at all points. The high ratio of taxis is worth noting. There is no medium bus service for the public.

#### 5.1.2.4 Turning Movement

Turning movement of five major intersections were studied for four hours in the morning time. They are filed in Appendix Table 5.1.2.2.

Fig. 5.1.1.2.4 Hourly Fluctuation of Vehicle Volume, Taiz

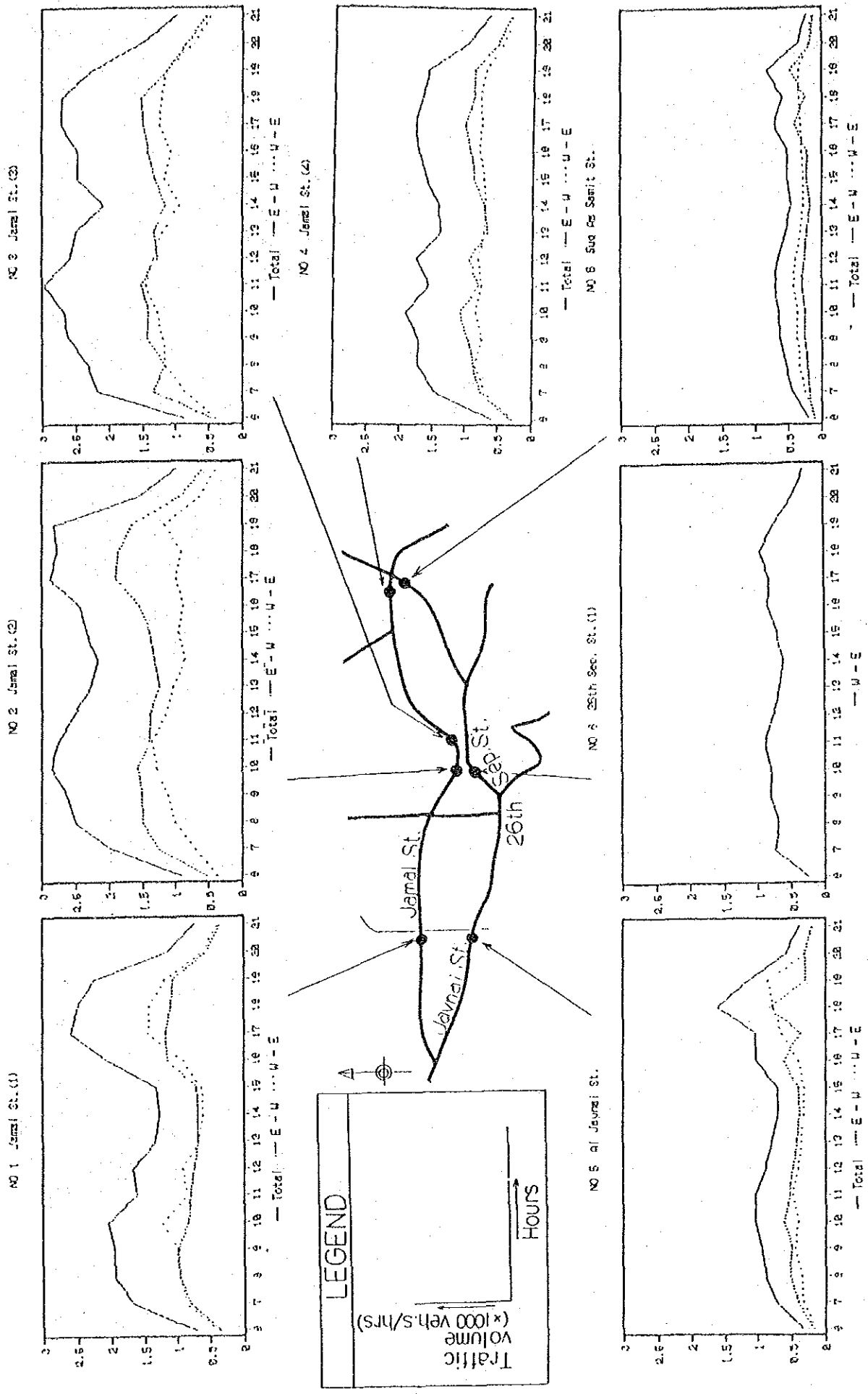
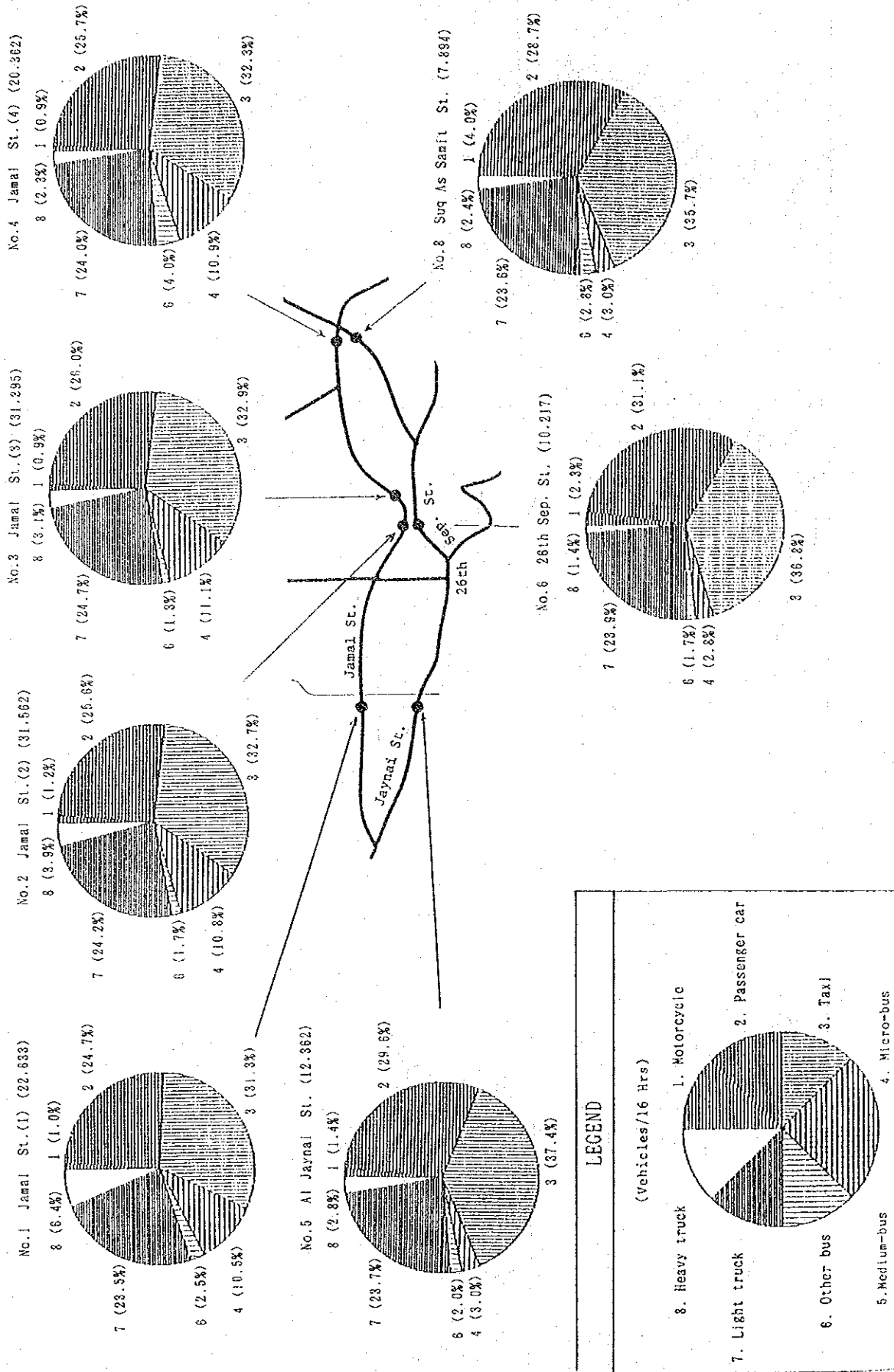


Fig. 5.1.2.5 Vehicle composition, Taiz



### 5.1.3 Hodeidah

#### 5.1.3.1 Traffic volume

##### a) Vehicles

Locations of the traffic counting survey in Hodeidah are shown in Fig. 5.1.3.1.

- Roadside counting  
at 3 locations from 7 a.m. to 8 p.m.
- Intersection directional flow counting  
at 3 intersections: 9 a.m. to 1 p.m.

Surveys were conducted in the same way as in Sana'a and Taiz. The results of surveys are shown in Fig. 5.1.3.2. and Appendix Table 5.1.3.1.

Traffic volume of Sana'a street passing the center of Hodeidah city is 15,700 - 32,700 vehicles/16 hours (18,000 - 34,800 PCUs/16 hs). Sana'a street is a well paved road with 4 lanes, and left turn movement is not allowed at the major intersections of the street to ensure the smooth traffic flow. Traffic flow in PCUs is on Fig. 5.1.3.3.

##### b) Pedestrians

Sidewalks of trunk roads in Hodeidah city are well completed, while the disordered crossing manner of pedestrians are similar with other cities.

#### 5.1.3.2 Hourly fluctuations

Each point shows a pattern with two peak hours in a day generally, and the peak ratio in the day time is comparatively higher as shown in Fig. 5.1.3.4.

#### 5.1.3.3 Vehicle compositions

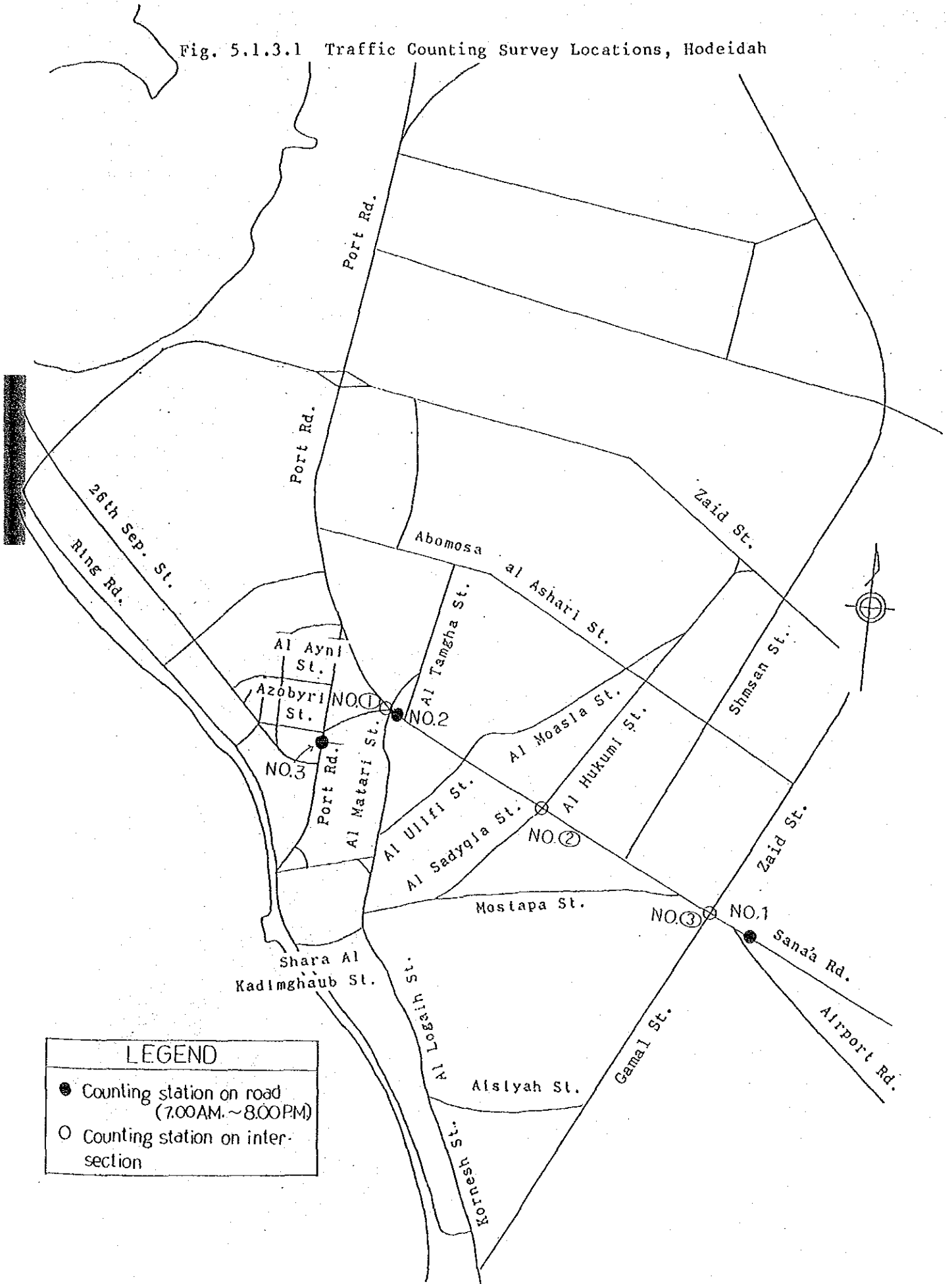
Fig. 5.1.3.5 shows the vehicle composition of each point. The shares of motorcycles and micro buses in Hodeidah city are higher than those of Sana'a city and Taiz city. A very low ratio of heavy truck is caused due to the control of passing

trucks at Sana'a street from the intersection of Zaid street to Port road. At the east side of the intersection heavy trucks ratio is higher because heavy trucks from Hodeidah port to the direction for Sana'a city detour to Zaid street.

#### 5.1.3.4 Turning Movement

Turning movement at three intersections were counted. The result is in Appendix Table 5.1.3.2.

Fig. 5.1.3.1 Traffic Counting Survey Locations, Hodeidah



LEGEND	
●	Counting station on road (7.00AM.~8.00PM)
○	Counting station on inter-section

Fig. 5.1.3.2 Vehicle Traffic Flow, Hodeidah

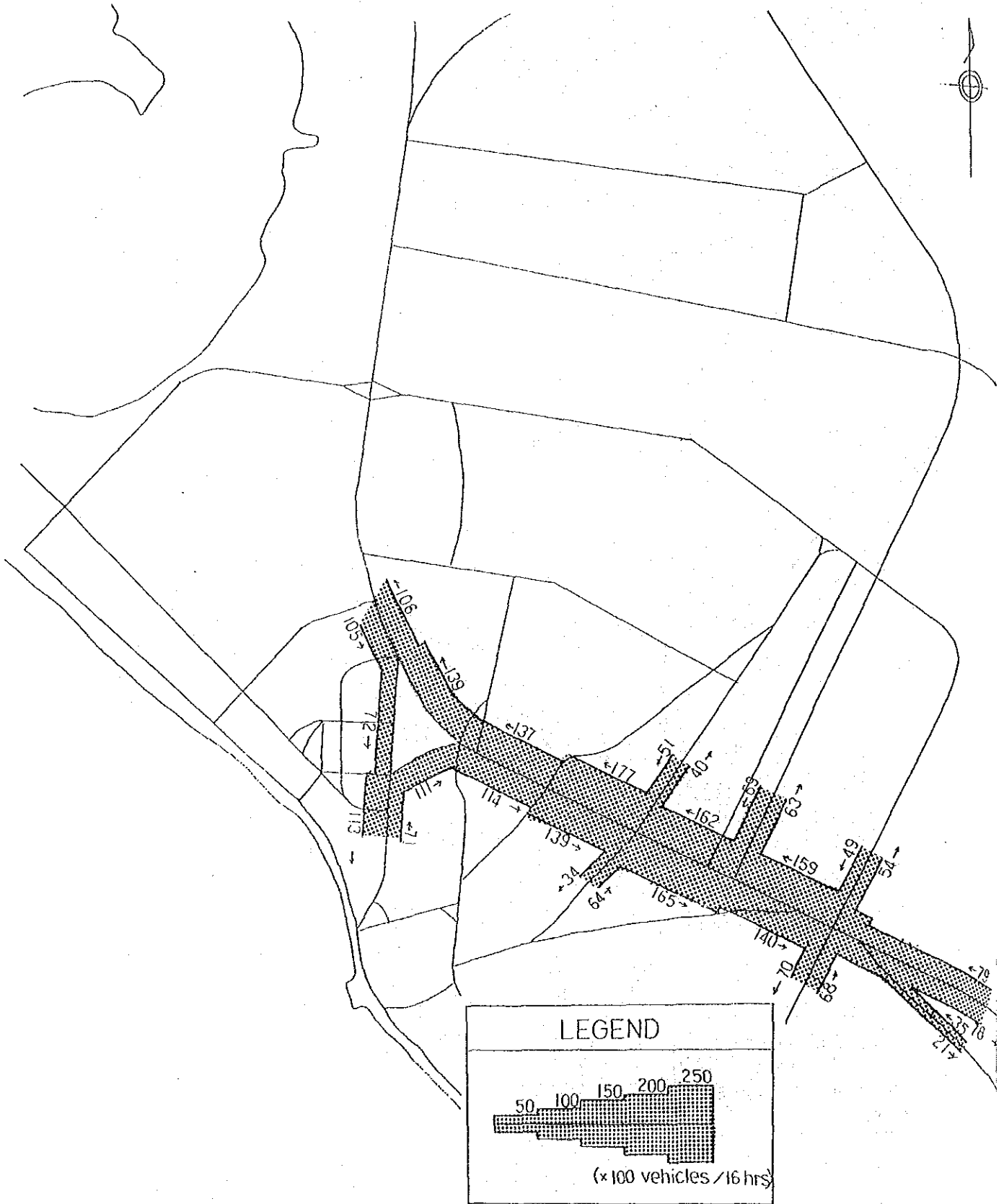


Fig. 5.1.3.3 Vehicle Traffic Flow Converted to PCUs, Hodeidah

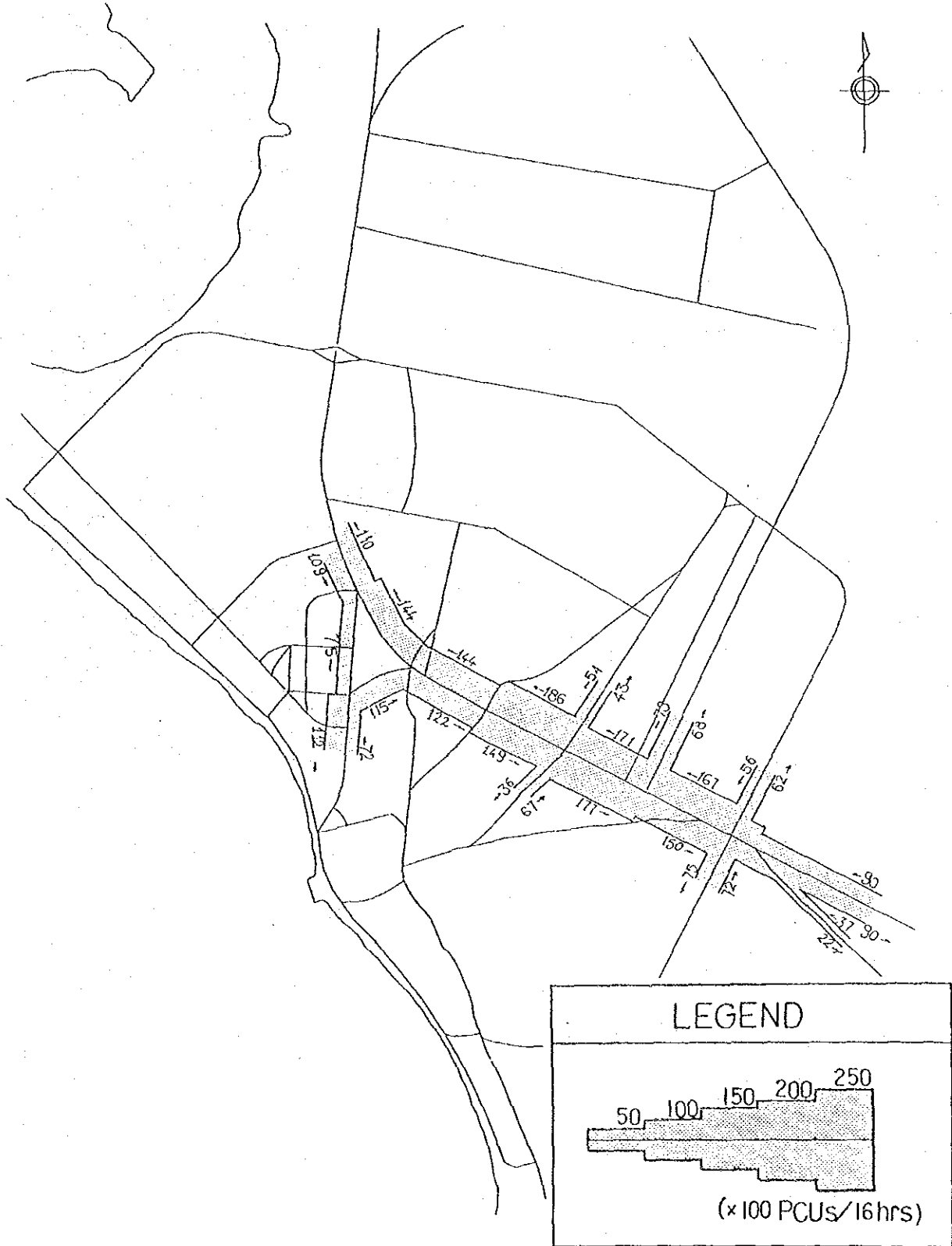




Fig. 5.1.3.4 Hourly Fluctuation of Vehicle Traffic Volume, Hodeidah

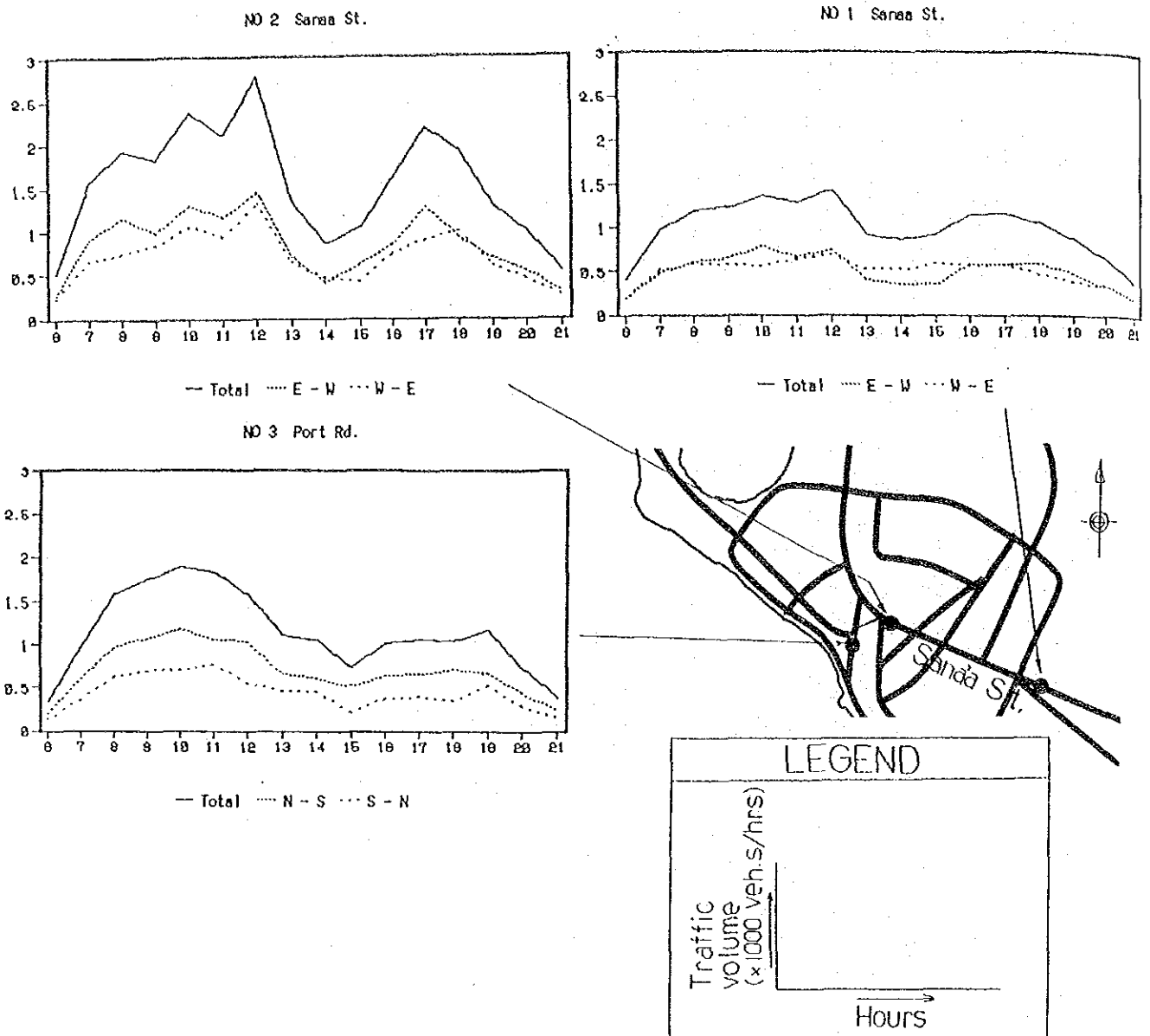
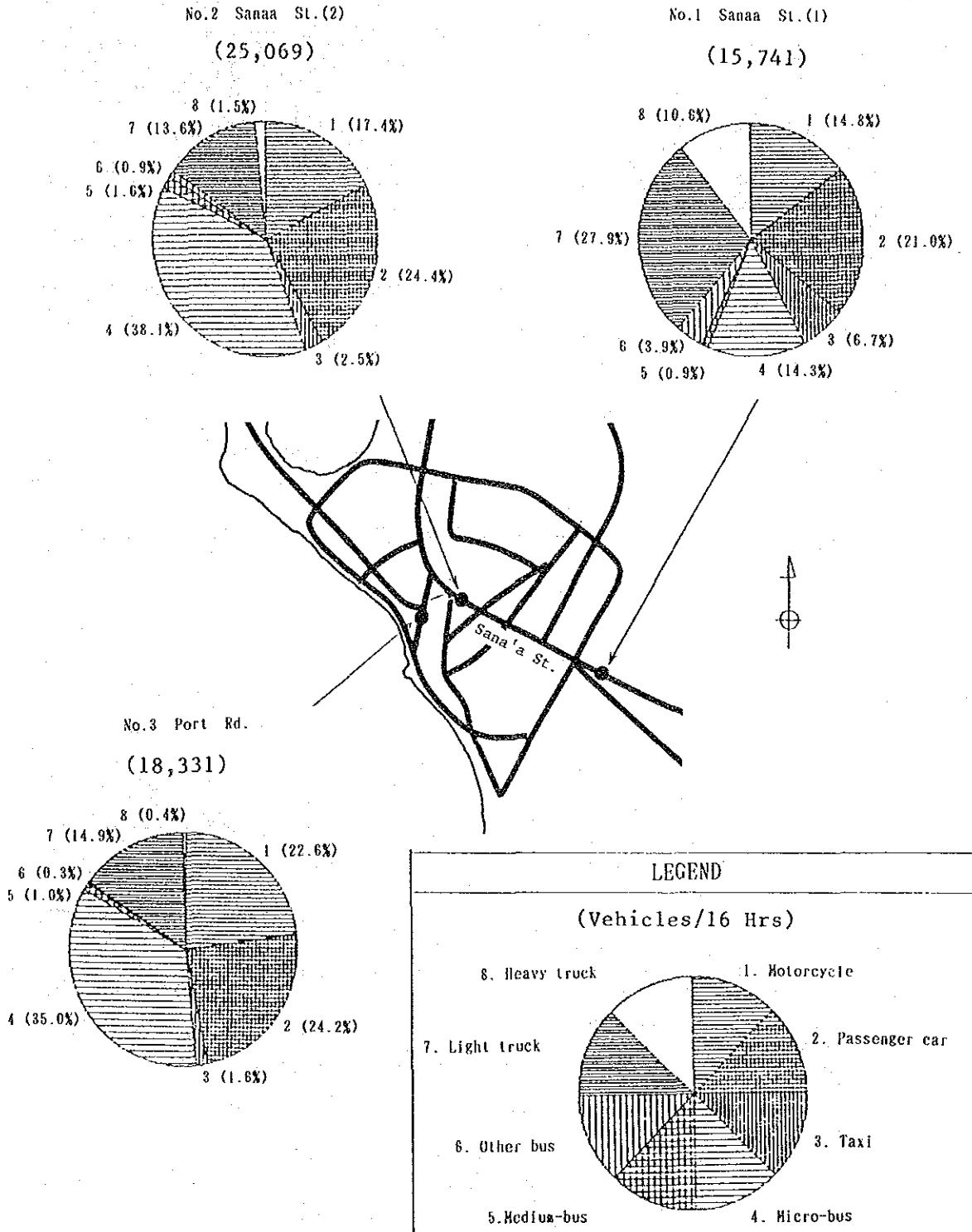


Fig. 5.1.3.5 Vehicle Composition, Hodeidah



## 5.2 Travel Speed

### 5.2.1 Travel speed survey

The travel speed survey was conducted on the roads of Sana'a and Taiz cities, with which a relationship to the traffic volume is studied. The followings are main target of the survey:

- 1) survey of the present travel speeds on each road
- 2) identify the factors preventing smooth traffic flow

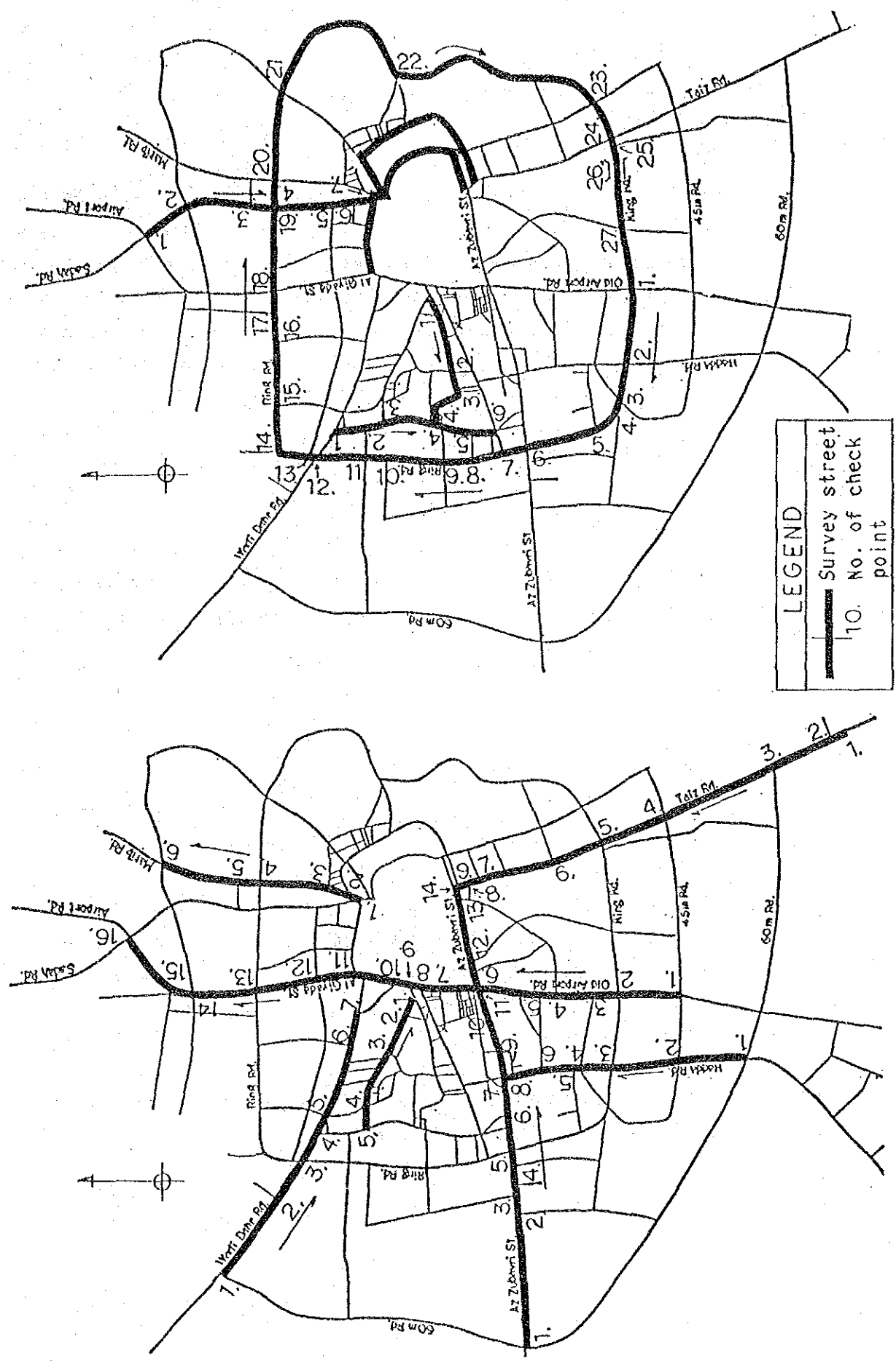
A passenger car of our survey team has traveled in the traffic flow of the survey section while taking the records for the followings;

- Time for passing each check point
- Stopping period and departure time of the test car
- Reasons for stopping
  1. waiting due to traffic signals
  2. due to pedestrians crossing
  3. conflict with taxi or micro bus
  4. merging with other traffic
  5. diverging traffic to another road
  6. influence of the left turning cars
  7. due to parking of other cars
  8. traffic accident
  9. by other reasons

Travel speeds are calculated from the above travelling time and from the actually measured distance. The surveys in Sana'a city were conducted with 3 round trips in peak hour (10:00 - 13:00) and 2-3 round trips in off peak hour (14:00 - 17:00) on the roads shown on Fig. 5.2.1.1. Surveys in Taiz city were done on peak hours only at Jamal street and Jaynai-26th September streets.

The results of travel speed survey are in Appendix Table 5.2.1.1. A relationship between the volume and the travel speed is analysed in regression analysis in Chapter 13.

Fig. 5.2.1.1 Travel Speed Survey Locations, Sana'a



## 5.2.2 Travel speed in peak hours

### 5.2.2.1 Sana'a

The result of the travel speed survey in peak hours in Sana'a city are shown on Fig. 5.2.2.1. The travel speed shows below 10 km/hour on roads near Bab Al Yemen, Tahrir square, Bab Shuub where many roads are concentrating and near the intersections of trunk roads. The waiting due to traffic signals, crossing pedestrians and irregular parking vehicles are the major reasons of decreasing of the travel speed.

### 5.2.2.2 Taiz

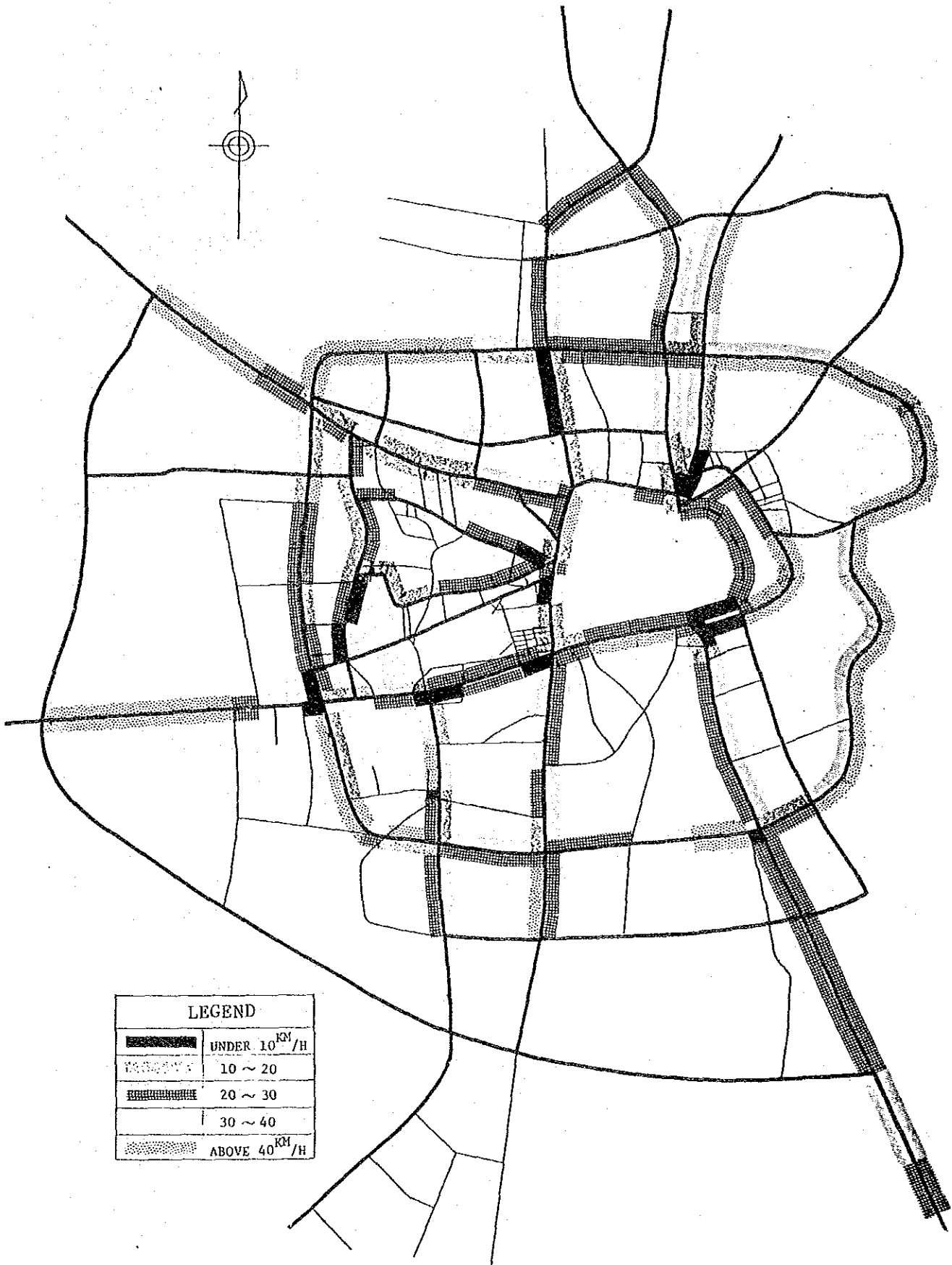
The result for Taiz city are shown on Fig. 5.2.2.2. The travel speed is below 10 km/hour near both market areas of Bab Mosa and Bab Al Kabir on 26th September street due to narrow width of roads, crowded pedestrian and parking on the roadside. The travelling speed is below 20 km/hour at other sections by the waiting due to traffic signals, by many parking on roadsides and by the steepness of the road.

## 5.2.3 Travel speed in off peak hours

Fig. 5.2.3.1 shows the result of the travel speed survey in off peak hours for Sana'a city. No section where the travelling speed becomes below 10 km/hour is found except for two places: on Taiz road near Bab Al Yemen and a part of Haddah road. The reason of low travelling speed is by crossing pedestrians and by diverging traffic.

There is no road section where travel speed registered less than 10 km/hour during off-peak hours in Taiz.

Fig. 5.2.2.1 Travel Speed in Peak Hours, Sana'a





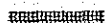

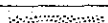
LEGEND	
	UNDER 10 <sup>KM</sup> /H
	10 ~ 20
	20 ~ 30
	30 ~ 40
	ABOVE 40 <sup>KM</sup> /H

Fig. 5.2.2.2 Travel Speed in Peak Hours, Taiz

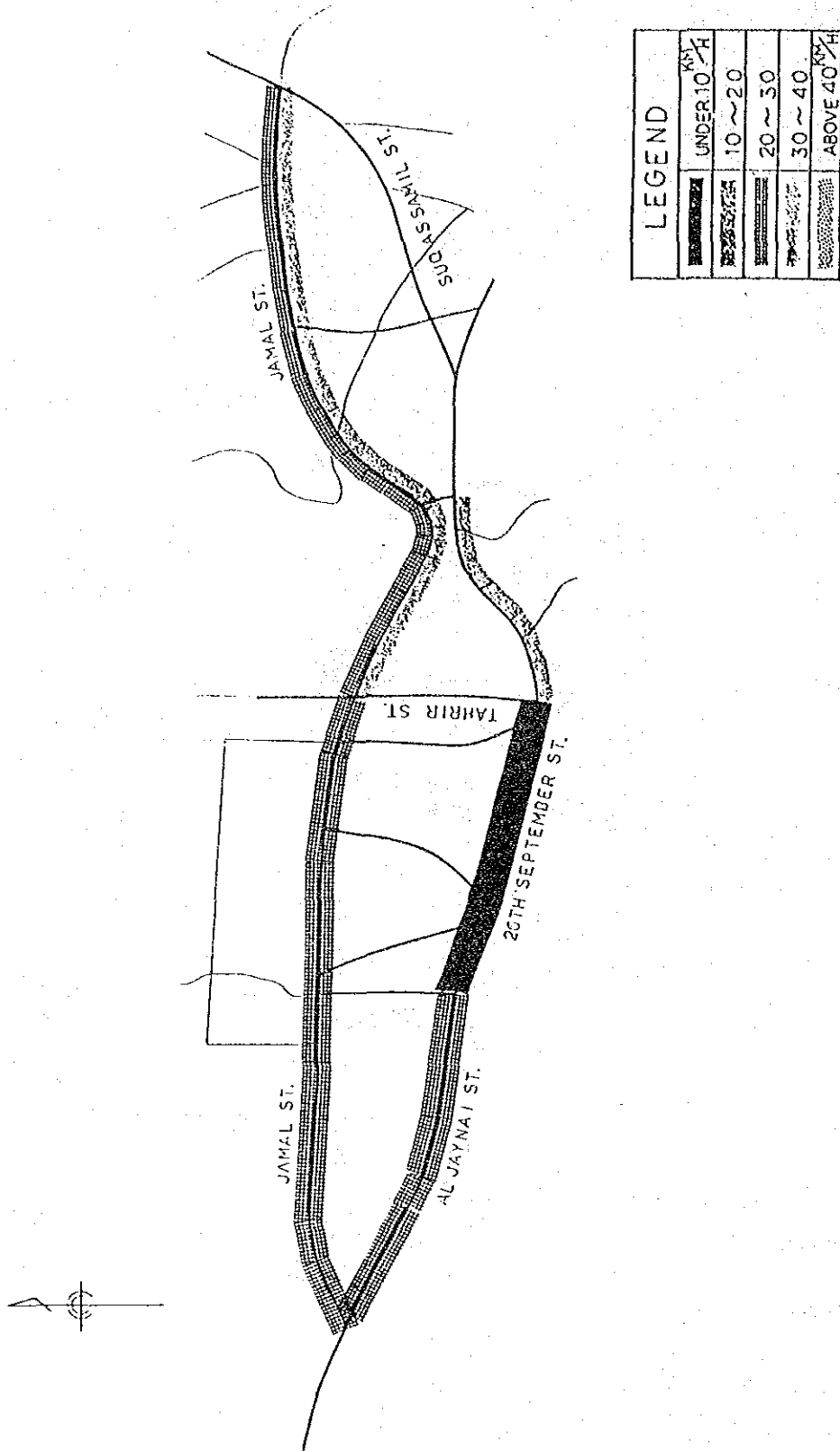
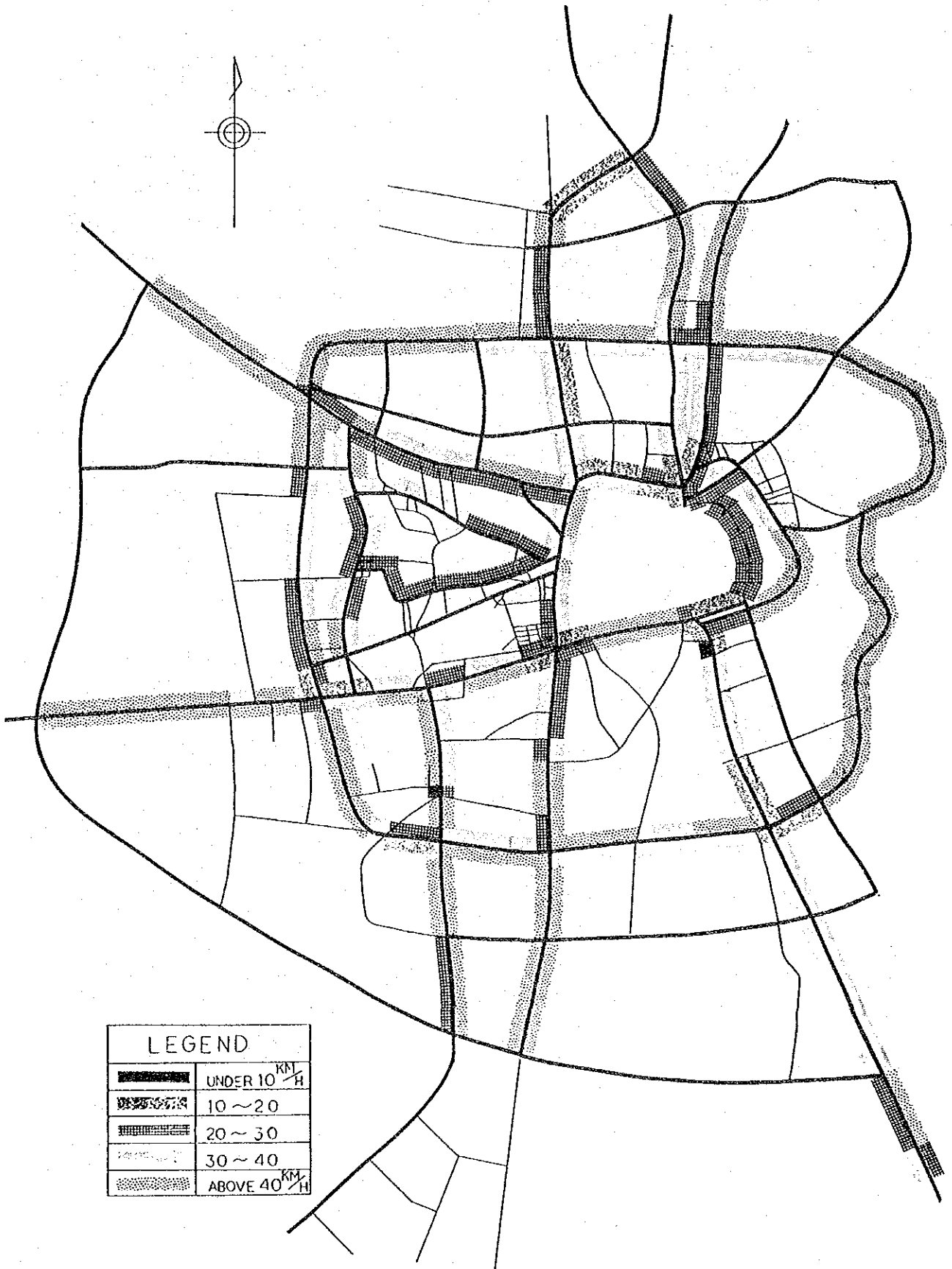


Fig. 5.2.3.1 Travel Speed in Off-peak Hours, Sana'a





## 5.3 Parking

### 5.3.1 Off-street parking

Locations of off-street parking lot in Sana'a city are indicated on Fig.5.3.1.1. The east side parking area of Taiz road near Bab Al Yemen is exclusive for inter-city taxis between Sana'a and Taiz, while the parking area in Bab Shuub is a terminal for medium buses operating in the city area. A use survey for off-street public parking was conducted at 4 places shown in Fig.5.3.1.2 from 9:00 to 13:00, and the results are shown on Table 5.3.1.1.

The largest parking demand was recorded at the parking lot near Bab Al Yemen, that was 527 vehicles/4 hours and the average parking duration was 86 minutes. A large demand was also shown at the parking site in front of the post office of Tahrir square. Although the capacity is small, efficient use can be shown from the data of 51 minutes for the average parking duration and 4.2 times being the average turnover.

Table 5.3.1.1 Parking Duration and Turnover (Off-street)

Location No.	Name of Car Parking	Capacity (veh)	Demand (Veh)	Average Parking Turnover	Parking Duration
9	Al Mahdi	193	190	1.0	77 min.
10	November St.	127	295	2.3	65
11	Tahrir sq. (front of post office)	56	234	4.2	51
12	Bab Al Yemen	381	527	1.4	86

Note: This is the result of 4 hours survey from 9:00 to 13:00, in a week day, December 1987

Fig. 5.3.1.1 Locations of Parking Lot and Parking Bay

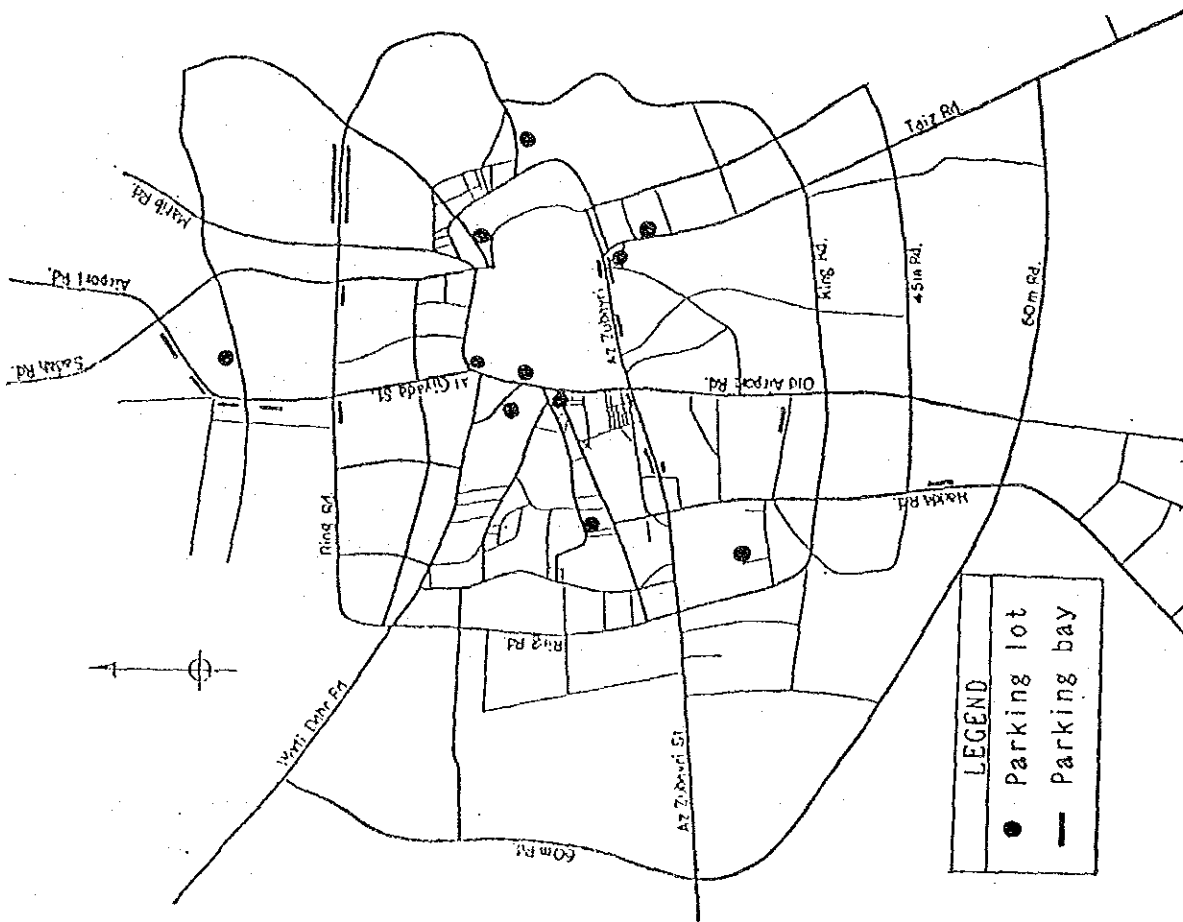
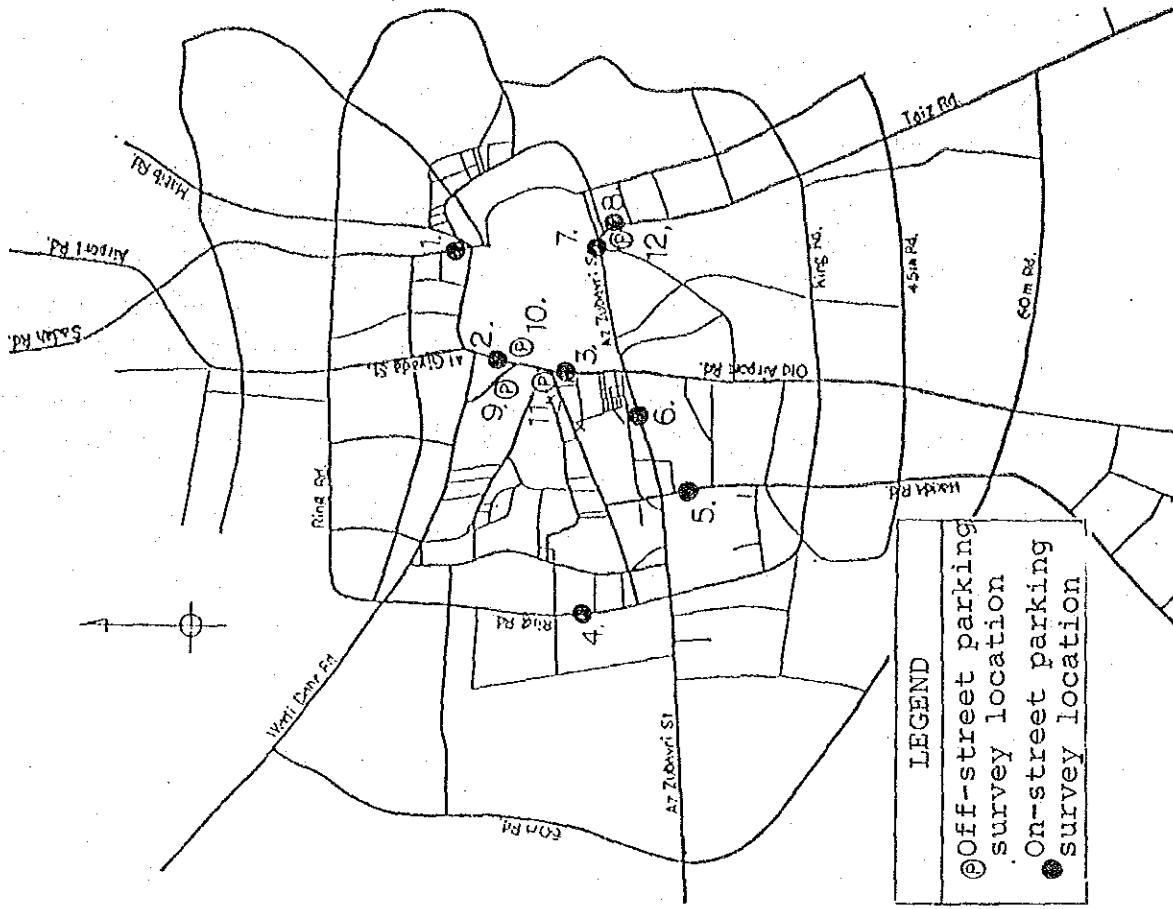


Fig. 5.3.1.2 Parking Survey Locations



### 5.3.2 On-street parking

Parking bays and shoulders on main streets in Sana'a city are shown on Fig. 5.3.1.1, and the survey result for the on street parking is shown on Table 5.3.2.1. Az Zubayri street (No.6, where the section length is 160 meters in the north and 140 meters in the south) has the largest parking demand, that is 379 vehicles/4 hours (221 in north and 158 in south). The second one is 274 vehicles/4 hours (136 in east side and 138 in west) at No.3 of Ali Abdul Mughni street (its section length is 145 meters). Both of these high parking demand area are in a busy commercial and business district.

Average parking duration is mostly less than one hour as shown below, and long term parking demand is rather low.

Average parking duration	Number of Sections
From 10 to 20 minutes	1
20 to 30	3
30 to 40	5
40 to 50	3
50 to 60	1
60 to over	1

Fig.5.3.2.1 shows the survey results for parking density on the main road in the city center. The survey for parking density was conducted by counting numbers of small cars and heavy vehicles parking on the street from 11:00 to 12:00, that corresponds to the peak hours of traffic of the day time. Parking density is calculated from the following formula;

$$\text{Parking density} = \frac{(\text{Actual parking car numbers from the survey})}{(\text{Estimated parking capacity for each section})}$$

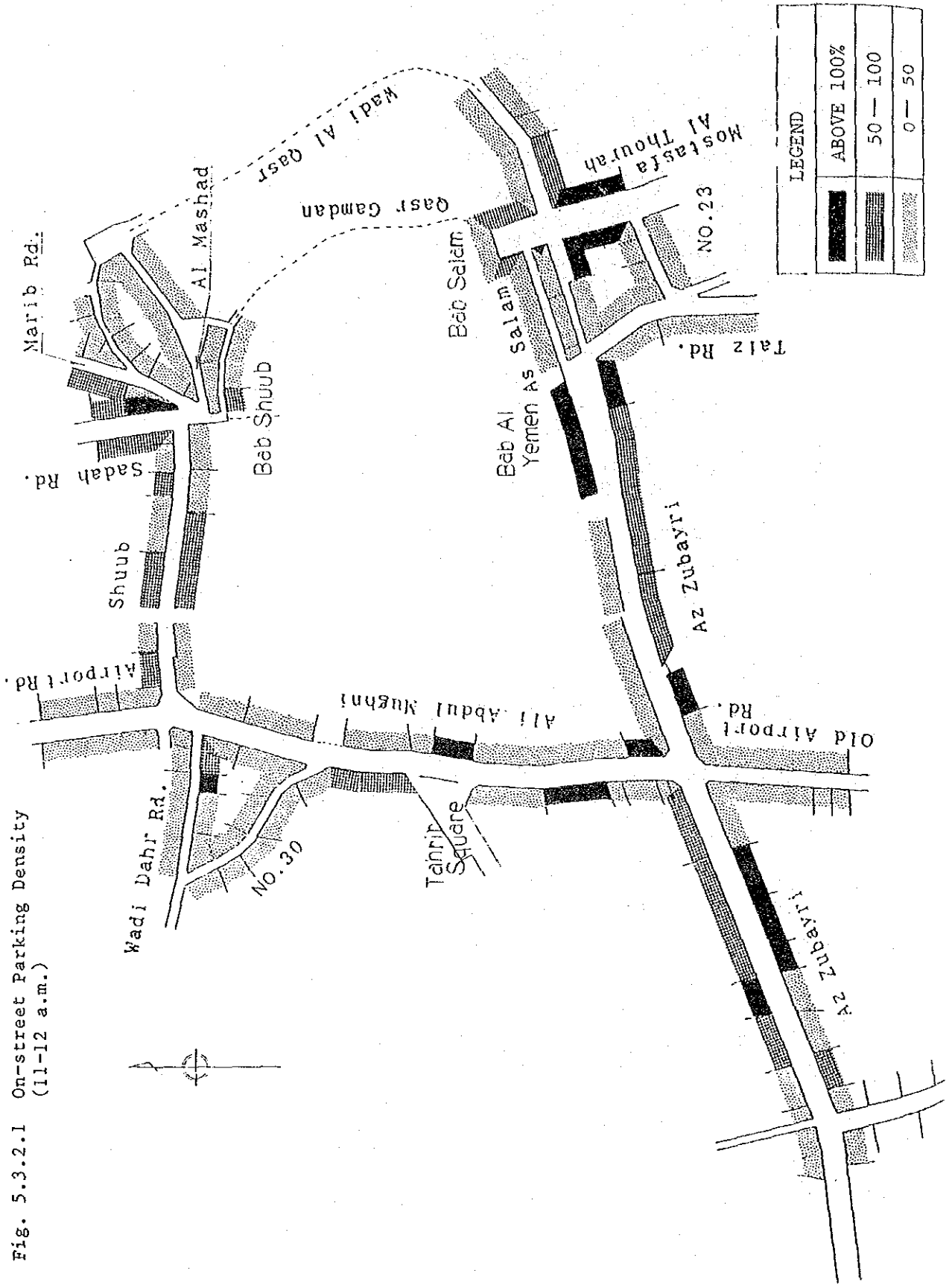
Parking density in Az Zubayri street is comparatively high, and more than 100% of parking density are found at some sections of Az Zubayri street, Ali Abdul Mughni street and near Revolution Hosptal because of disordered parking, such as 60 degrees parking or double parking.

Table 5.3.2.1 Parking Duration and Turnover (On-street)

Location No.	Name of Locations		Surveyed section length(m)	Capacity (Veh)	Counted vehicles (Veh)	Average Parking Turnover	Average Parking Duration
1	Sadah Rd.	East	110	44	94	2.1	33
		West	110	44	58	1.3	29
2	Al Qiyada street	East	115	46	129	2.8	36
		West	130	52	75	1.4	61
3	Ali Abdul Mughni st.	East	115	46	136	3.0	26
		West	125	50	138	2.8	35
4	Ring road	Eqst	145	29	43	1.5	15
		West	145	29	40	1.4	45
5	Haddah str.	East	130	52	30	0.6	26
		West	130	52	50	1.0	45
6	Az Zubayri street (1)	North	160	64	221	3.5	34
		South	140	56	158	2.8	53
7	Az Zubayri street (2)	North	120	48	111	2.3	52
		South	110	44	108	2.5	50
8	Taiz road	East	126	25	54	2.2	45
		West	126	25	51	2.0	39

Note: This is the result of 4 hours survey from 9:00 to 13:00, in a week day, December, 1987.

Fig. 5.3.2.1 On-street Parking Density  
(11-12 a.m.)



## 5.4 Traffic Accidents

### 5.4.1 Annual statistical data

The annual numbers of traffic accidents in Sana'a Governorate, Taiz Governorate and Hodeidah Governorate during the recent 6 years (1982 -1987) are shown in Fig. 5.4.1 and Fig. 5.4.2. The available statistical data of traffic accidents in each Governorate indicates the following a - c. But Traffic Police say there are many accidents not registered in Traffic Police. Consequently, the number of actual accidents is no doubt greater than what is discussed here.

#### a. Sana'a

The number of traffic accidents has increased during the past 5 years along with the increase in vehicle ownership. The number of traffic accidents in 1986 was about 2.3 times greater than that of 5 years ago. The number of accidents per 100 registered vehicles were about 2.1 in 1986 which is 50% more than that in 1982. There is no reduction in accidents per 100 vehicles during 1983 - 86.

#### b. Taiz

The annual trends of traffic accidents and the accidents per 100 registered vehicles are similar to those in Sana'a. The number of traffic accidents in 1986 shows about 3.0 times greater than that of 5 years ago and the rate of increase is higher than that of Sana'a.

#### c. Hodeidah

The number of traffic accidents in 1986 has decreased sharply after reaching a peak in 1985. The rate shows about 1.8 times greater than that of 5 years ago. The accident per 100 registered vehicles in 1986 was about 0.8.

### 5.4.2 Traffic accidents by type of accidents

The traffic accidents by type of accident in 1986 are shown in Table 5.4.1, Table 5.4.2, Fig. 5.4.3 and Fig. 5.4.4.

Fig. 5.4.1 Yearly Trend of Traffic Accident

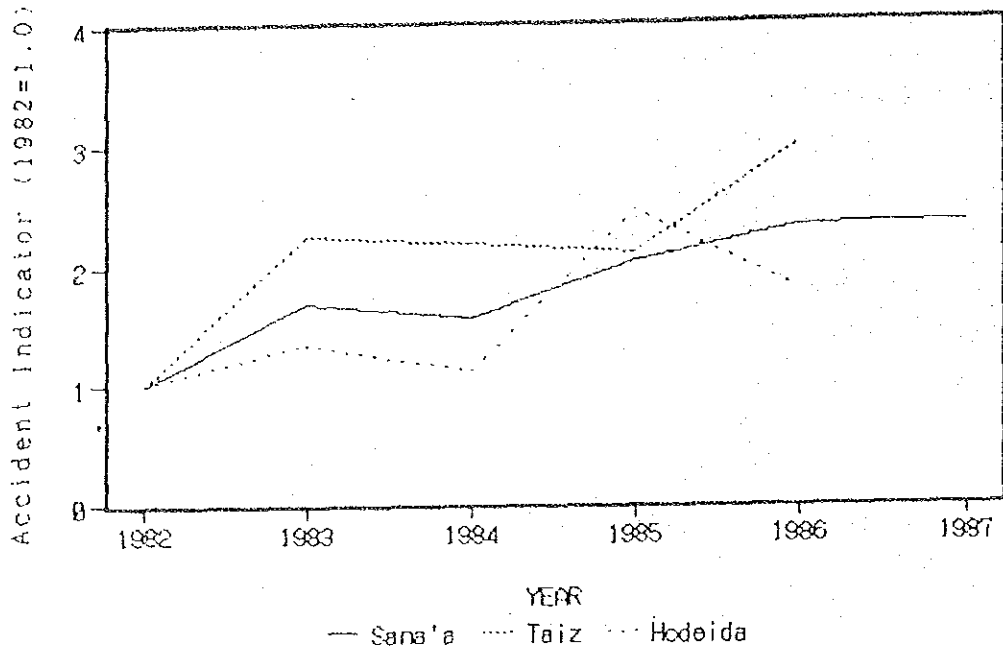


Fig. 5.4.2 Accidents per 100 Registered Vehicle by Year

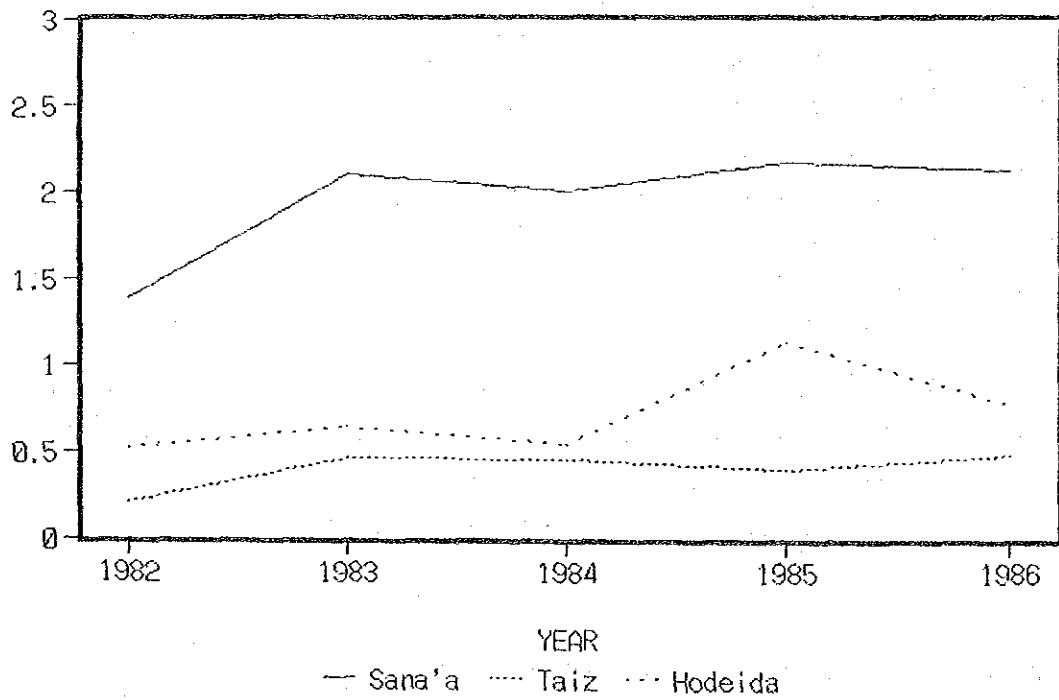


Table 5.4.1 Traffic Accidents by Type of Accident & by Type of Vehicles (1986) (Intra-City accidents)

Governorate	Collision	Type of Accident			Total	Type of Vehicles				Fatality & Injury				
		Car Itself	Car VS Car	Others		Passenger Car	Taxi	Small Truck	Heavy Truck	Others	Total	Deaths	Injury Total	
Sana'a	878	83	1005	135	2102	800	777	797	83	785	3242	115	1789	1905
Taiz	120	20	143	17	300	145	108	112	18	66	449	46	200	246
Hodeida	140	22	146	15	323	72	109	72	22	197	472	18	282	300
Total	1138	125	1294	168	2725	1017	994	982	123	1048	4163	180	2271	2451

Source: General Traffic Office, 1988

Table 5.4.2 Traffic Accidents by Type of Accident & by Type of Vehicles (1986) (Inter-city accidents)

Governorate	Collision	Type of Accident			Total	Type of Vehicles				Fatality & Injury				
		Car Itself	Car VS Car	Others		Passenger Car	Taxi	Small Truck	Heavy Truck	Others	Total	Deaths	Injury Total	
Sana'a	231	192	246	49	718	188	131	383	72	194	968	218	1080	1298
Taiz	118	102	88	9	317	95	95	151	40	97	478	95	314	409
Hodeida	109	91	49	23	272	55	25	129	28	145	382	142	417	558
Total	458	385	383	82	1308	338	251	663	140	435	1828	455	1811	2266

Source: General Traffic Office, 1988



Fig. 5.4.3 Traffic Accidents by Type of Accident (1986: In-city)

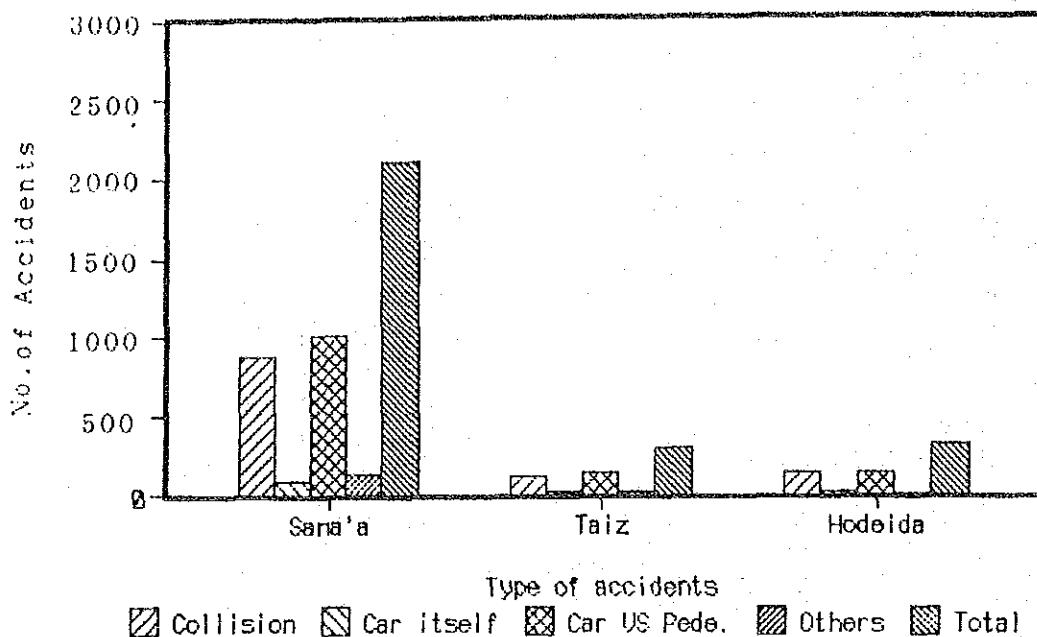
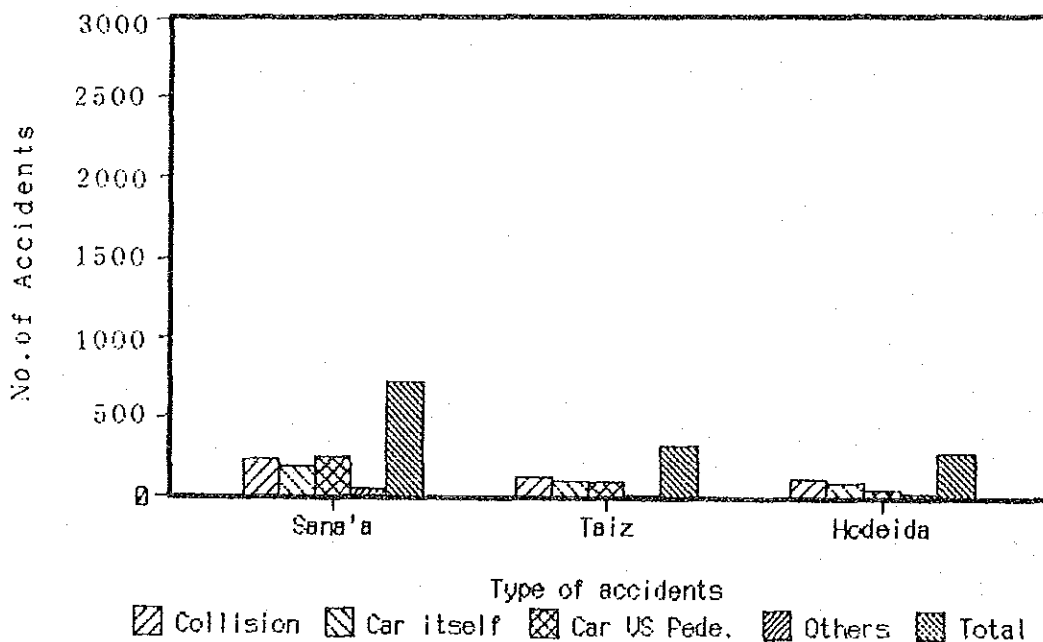


Fig. 5.4.4 Traffic Accidents by Type of Accident (1986: Inter-city)



1) Accidents in city

a. Sana'a

The most frequent type of accident is pedestrian accidents, which represents 48% of the total, followed by collisions representing 42% of the total. It's remarkable that the occurrence of pedestrian accidents is so high.

b. Taiz

The traffic accidents by type are similar to Sana'a situation. The occurrences of pedestrian accidents represent 48% of the total.

c. Hodeidah

The traffic accidents by type are almost equal to that in Sana'a and Taiz. The occurrence of pedestrian accidents represents 45% of the total.

2) Intercity accidents

a. Sana'a

The most frequent type of accidents is pedestrian accidents which represents 34% of the total, followed by collision of 32% in the total and by car itself at 27%. The occurrence of one-car accidents is higher than that in city.

b. Taiz

The most frequent type of accidents is collision accident which represents 37% of the total, followed by one-car with 32% of the total. The occurrence of pedestrian accidents represents 28% of the total.

c. Hodeidah

The traffic accident by type of accident is similar to Taiz.

### 5.4.3 Traffic accidents by type of vehicle

The number of traffic accidents by type of vehicles in 1986 is shown in Table 5.4.3 and Fig. 5.4.5.

#### a. Sana'a

Of all accidents, 32% involved trucks, about 23% involved passenger cars, others and taxis. When broken down into accidents per 100 vehicles registered by type, taxis show the greatest number of accidents per 100 registered with a high rate of 8.9. The type of taxi consists of taxi and micro bus. The rate by passenger cars is 3.2.

#### b. Taiz

The composition of traffic accidents by type of vehicle in Taiz is almost the same as that in Sana'a. Passenger car has the highest rate of accidents per 100 vehicles registered, with 1.4.

#### c. Hodeidah

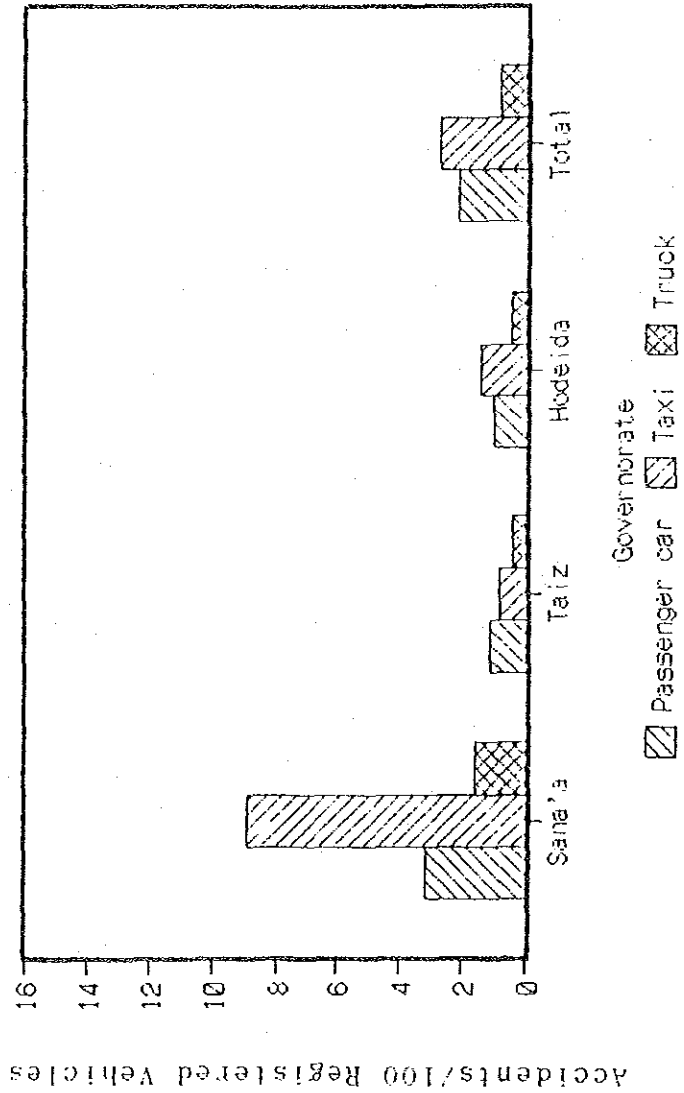
The "other" vehicle type (including motorcycles) shows a high rate of accidents. The rate is about 40% of the total and followed by trucks at 29% of the total. Taxies show the greatest number of accidents per 100 vehicles registered at the rate of 1.4.

Table 5.4.3 Traffic Accidents per 100 Registered Vehicles (1986)<sup>2)</sup>

Governorate	Type of Vehicles				No. of Accidents/100 vehicles	No. of Accidents/100 vehicles	No. of Accidents/100 vehicles	No. of Accidents/100 vehicles
	Passenger Car	Taxi	Truck	Others				
Sana'a	988	908	1335	979	3.2	8.9	1.6	-
Taiz	240	203	321	163	1.1	0.8	0.4	-
Hodeida	127	134	251	342	1.0	1.4	0.5	-
Total	1355	1245	1907	1484	2.1	2.7	0.8	-

- 1) Incity + Intercity, from Tables 5.4.1 & 5.4.2
- 2) Registered vehicles from Table 9.2.4

Fig. 5.4.5 Traffic Accidents per 100 Registered Vehicles (1986)



#### 5.4.4 Location of high accident frequency and types of accidents in Sana'a

The information of original accident data in 1987 was collected from Sana'a Traffic Police to know the location with high accident frequency and type of accidents (Appendix Table 5.4.1), and the data indicate only the traffic accidents in Sana'a city.

##### 1) Location of high accident frequency

The locations of high accident frequency are shown in Fig. 5.4.6. There are especially high occurrences of accidents at the following sections:

- a. Ring road - Hasaba section on Old Airport road, Ali Abdul Mughni and Airport road.
- b. Ring Road - Bab Al Yemen section on Az Zubayri street.
- c. Old Airport - Mostasfa Al Thourah section on Ring road.
- d. No.24 street - Hotel Sheraton section on Ring road.
- e. No.14 street - Ring road section on Wadi Dahr road.

As shown in Fig. 5.4.6, a large number of accidents occurs at intersections of arterial streets, and largest concentrations of accidents are located at the inside area bordered by Ring road. The location with the highest accidents is the Ring road-No.34 street intersection, where 36 accidents are recorded in a year.

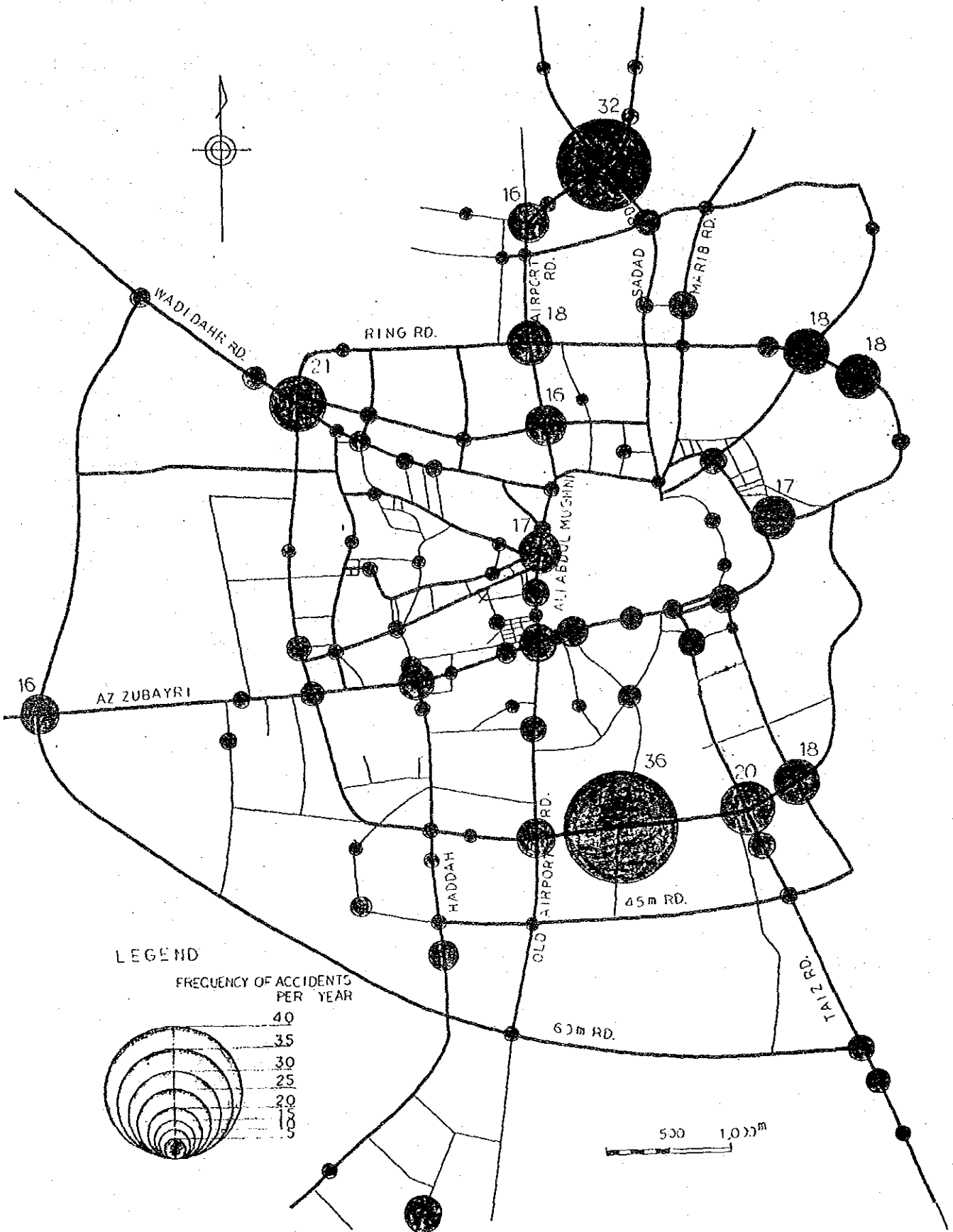
Other high frequency points are the intersections of Airport-Sadah road (32 accidents), Ring road-Airport (18 accidents), Ring road-No.24 street (18 accidents), near the Hotel Sheraton (18 accidents) and Ring road-Mostasfa Al Thourah.

##### 2) Types of accidents

The compositions by type and classified number of accidents which occurred at high accident frequency points are shown in Appendix Fig. 5.4.1, Fig. 5.4.2 and Appendix Table 5.4.1. The most frequent type of accidents is collisions, which represents 50% of the total, followed by pedestrian accidents of 47% and by car itself of 3%.

A qualitative analysis of accidents based on these data indicates the following:

Fig. 5.4.6 Locations of High Accident Frequency



- a. At most signalized intersections, there is a high occurrence of collisions. This is mainly due to indistinct stop line which causes driver to stop inside the intersection, and due to disregard for traffic lights.
- b. At points of high accident frequency in densely builtup areas, a high occurrence of pedestrian accidents is caused mostly by indiscriminate road crossing by pedestrians.
- c. At unsignalized intersections, there are high occurrences of collisions due to indistinct stop signs and lines and right-of-way (priority) indications.
- d. At congested intersections, there are high occurrences of collisions. This is caused mainly by the fact that the smooth flow of traffic is being obstructed by slow-moving bus and taxis, and by their sudden stops.
- e. At road sides with high density of curb parking, there is a high occurrence of collisions. This is caused mainly by the entering and leaving of vehicles parked.

## 5.5 Vehicle Classification

There is no international classification of vehicles, while there is one for traffic sign-boards, an international rule in issuing driving permits, and a rule in the maximum size and weight with cargo.

1. In Japan, a classification by "transport vehicle ordinance" is proclaimed by Ministry of Transport. Road planning works have used a different classification determined by Ministry of Construction, although they are quite similar.

The former case is based on the requirement to maintain safe and smooth vehicle movement and ownership clarification. The following measure units were taken into consideration in the classification:

- Number of wheels and axles
- Width, length, height, and weight
- Passengers in number
- Weight and volume of laden cargo
- Ownership and usage (commercial, private, others)

In the case of road planning works, the classification is used for the determination of geometric features; lane-width, thickness of pavement. Consequently, a clear definition is given on the maximum weight, height, length and width while the classification is mostly same with the "transport vehicle ordinance".

2. In Yemen Arab Republic

In YAR, "traffic rule" by Traffic Police Dept. is issued with the newest edition in 1983, which defines classification of vehicles. The classification is used for registration, mechanical safety check, and driving permit. Its classification is shown:

- a) Light vehicles (less than 3.5 tons)
  - 1) Private
  - 2) General (taxis & micro-buses)
  - 3) Goods transport



- b) Heavy vehicles (more than 3.5 tons)
  - 1) Private
  - 2) General
- c) Trailers
  - 1) Light (less than 7.5 tons)
  - 2) Heavy (more than 7.5 tons)
- d) Buses (more than 15 passenger seats)
  - 1) Private
  - 2) General
- e) Motor cycles
  - 1) Private
  - 2) General (serving as taxis)
  - 3) Goods transport

Highway Authority in Ministry of Public Works has done traffic counting at various points regularly, much concerned with weight and axles. The vehicle type composition is different from those in urban areas.

Traffic counting on roads in urban area has not been conducted as much as an intercity roads by HA. In order to develop road and traffic planning activities, the vehicle classification should be determined with which regular traffic counting be conducted. A uniform classification is necessary to study the time serial change in volume and composition of traffic. Considering the present composition of vehicle types in Sana'a the classification is proposed as shown below:

- Motorcycles
- Passenger cars (Sedan, Jeep, Land Cruiser, ... )
- Taxis
- Micro buses (seats 6 - 9 seats)
- Medium buses (seats 10 - 30 seats)
- Other buses (seats more than 31 seats)
- Light truck (pick up and small truck)
- Medium truck (Gross weight 3.5 - 8.0 tons with 2 axles and 4 - 6 wheels)
- Heavy truck (Gross weight more than 8.0 tons with more than 3 axles and 6 wheels)