CHAPTER 5 REQUIRED URGENT IMPROVEMENT OF ROAD TRAFFIC

5.1 Present Condition of Traffic and Intersections

At present approximately 200 intersections are under the control of signals and 60 flash beacons are provided. Major intersections have rotaries and there is not a single grade separation.

As described in Chapter 3, Part I, the major road network in the city is a 4 km square grid pattern, and many radial roads are surrounding the central grid pattern.

Traffic flow in one direction on the trunk road at the peak is estimated at 2,000 cars/hr.

Distance between each signal on the trunk road is from 200 to 300 meters. Fig. 5-1-1 shows traffic and road crossings on the Shareza Road, one of the most congested roads in Teheran.

5.2 Problems Requiring Immediate Solution

In almost all major cities in the world, traffic congestion is now posing a serious social problem. Trunk roads in the city are in confusion from morning till night and a long queue of cars are frequently formed at every intersection at the peak traffic rush hours. The decrease of speed caused by congested traffic and delay of traffic at intersections are not only the loss of time but also give drivers psychological stress and sometimes such kind of stress may become the cause of a traffic accident.

However, traffic delays and accidents are caused mostly by a combination of various factors and their solution must be sought not from the standpoint of road facility alone but from a wide range of vision such as the personality of drivers and pedestrians, the nature of the nation, climatic and natural features of the region.

Also in Teheran traffic is delayed throughout the city and the number of traffic accidents has already reached 10,000 a year. In order to solve the traffic problems, it is important to analyse the cause first. The major causes of traffic problems are pointed out as follows:

a) Total width of the roadway is not being utilized effectively.

Because of frequent parked and stopped cars on the curb even on the trunk roads (Fig. 5-2-1) and pedestrians often coming out to the roadway to wait or look for taxis (Fig. 5-2-2) and additionally, due to improper drainage provided on the roadway (Fig. 5-2-3) and along the curb, one lane on the road side is not fully utilized as a travelling lane.

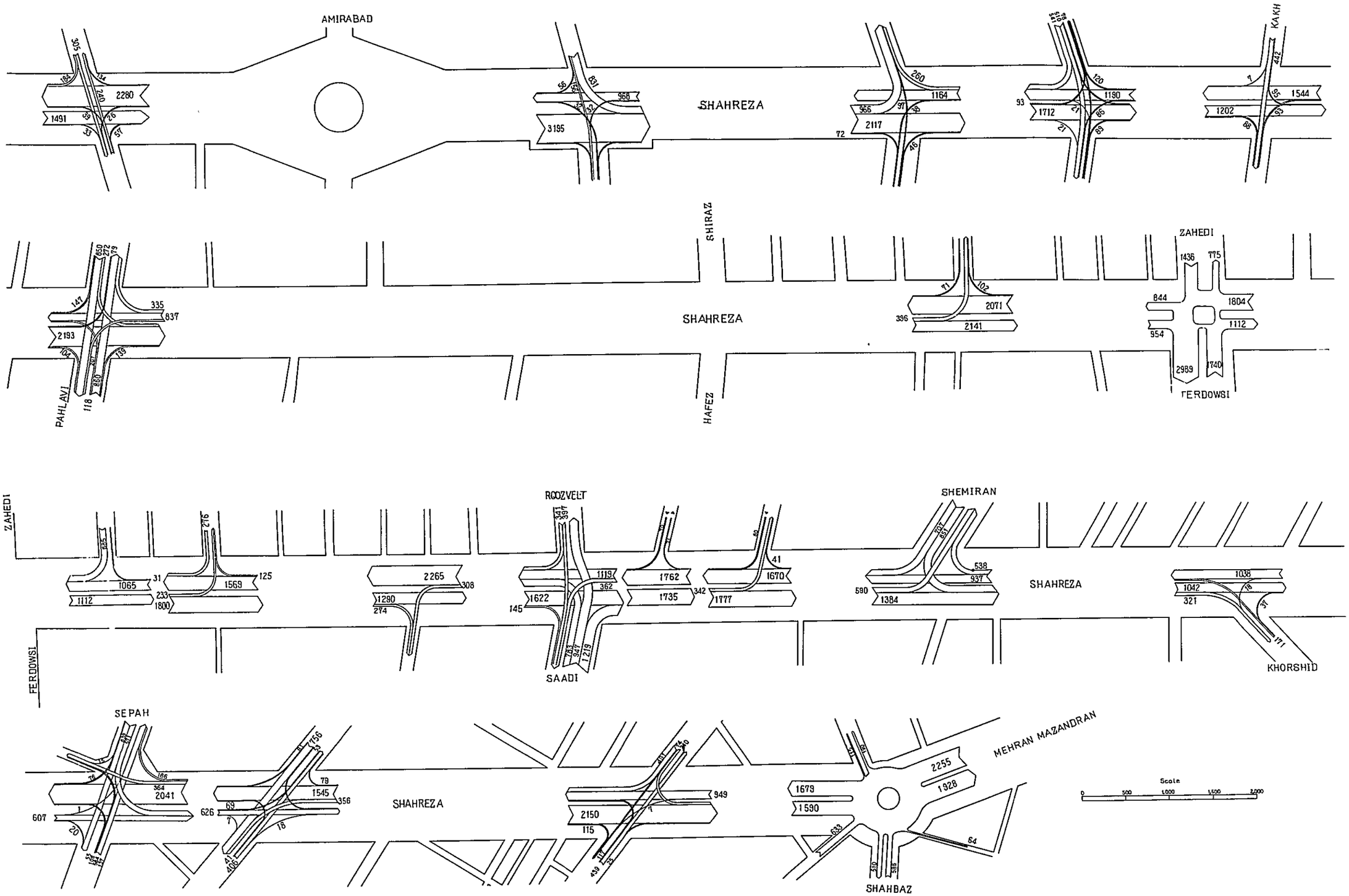


Fig. 5-1-1 Traffic flow map of Shah Reza Street

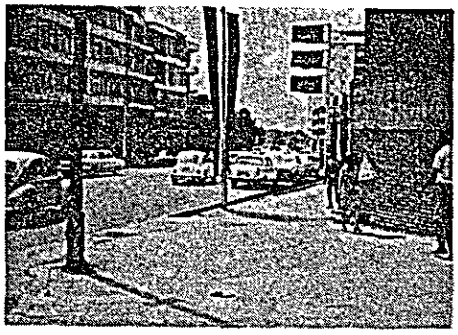


Fig. 5-2-1 One lane is completely blocked by vehicles parked on street.

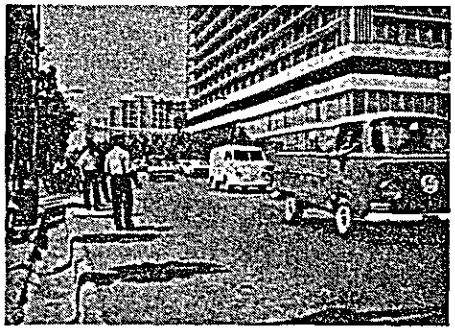


Fig. 5-2-2 One lane (to the extreme right) is not utilized because of pedestrians waiting for a taxi.

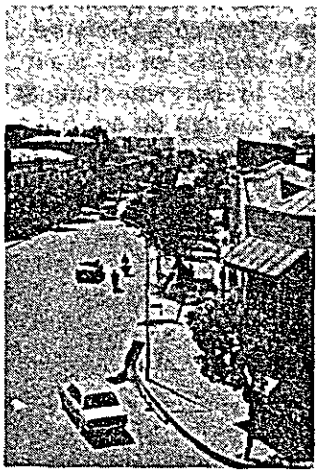


Fig. 5-2-3 Because of uncovered side drainage gutter at curve, vehicle making a right turn is travelling away from curb.

Fig. 5-2-4 Many people are walking on roadway. This is probably due to many dead spaces on the rotary side because of greater width of road.

b) Manners of pedestrians while crossing the road is not appropriate.

From the standpoint of both the safety and efficiency of traffic, vehicular traffic and pedestrian traffic should be separated each other. In Teheran roadway and sidewalks are obviously separated from one another and the pedestrians' crossing is clearly marked at the intersections. Nevertheless, in Teheran there are many people who, without justification, walk on the roadway (Fig. 5-2-4), cross the roadway (Jaywalk) where a pedestrians' crossing is located nearby (Fig. 5-2-5) and in some extreme cases, people cross the roadway while the signal is red (Fig. 5-2-6).

Fig. 5-2-5 A pedestrian crossing the roadway at the place other than pedestrian's crossing.

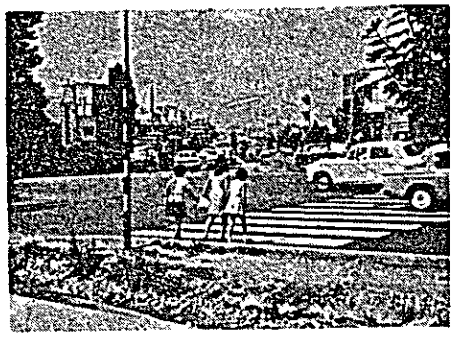


Fig. 5-2-6 A young lady trying to cross the intersection with children while the signal shows red.

c) Confusion of roadway

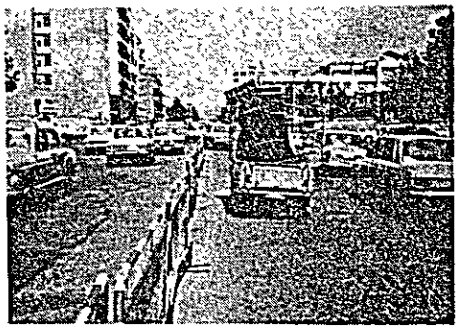


Fig. 5-2-7 Because of lack of lane marking, flow of vehicular traffic is in disorder.

It is important for drivers to drive the cars in the proper lane especially on the trunk roads. For this purpose, however, lanes with proper width must be clearly indicated by lane-marking. In Teheran many roadways do not have pavement markings and have caused disruption of smooth traffic flow (Fig. 5-2-7).

d) Medial divider is not of appropriate type.

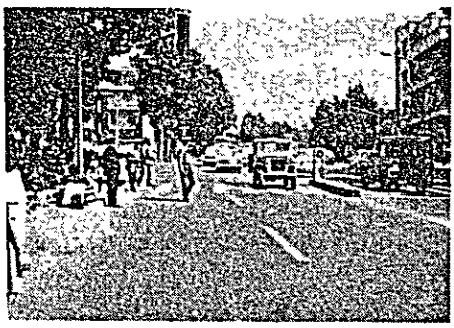


Fig. 5-2-8 A small island is provided only for pedestrians' crossing and lack of end indicators presents the possibility of head-on collision with the island.

To ensure smooth traffic flow and to provide sufficient space for the pedestrians waiting for green light signals and also for vehicles making a turn, medial dividers of appropriate width provided are a very effective means. When a center island is to be provided only at the intersection (Fig. 5-2-8), full consideration must be taken to the size of the island and installation of road signs as approach indicator. Dividing the carriage way with movable fences is quite effective as a temporary divider. However, when the alignment of the fence is disrupted by a pedestrian who forces his way through the divider against the law, the fence will sometimes

become an obstacle to the traffic and it may be the cause of an accident (Fig. 5-2-9).

Depending on the location, a proper left turn zone utilizing a medial divider is possible and advisable (Fig. 5-2-10).

Fig. 5-2-9 Alignment of fence is disrupted by pedestrians trying to cross the road at undesignated location.

Fig. 5-2-10 At the point where left-turn is frequently made, designation of left turn lane is advisable by reducing the width of medial divider.

e) Adequate measures are not being taken against blocking the traffic by road repair work.

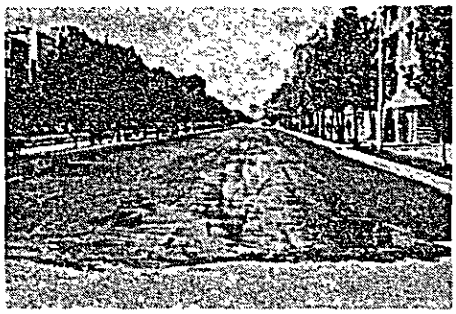


Fig. 5-2-11 Blocking of traffic by pavement work for the entire portion of road on the half of boulevard.

While the roads are under maintenance and repair work a careful arrangement must be made so as to minimize the interruption of traffic. Repairing the overall width roadway at one time should be avoided if possible to secure maximum traffic flow. When work is to be done on the major trunk road, the work should be carried out only in the night-time while traffic is much less. When working on a Boulevard, one half of the road way on one side may be used to avoid the blocking of traffic (Fig. 5-2-11).

f) Some intersections have no traffic phase for pedestrians.

As the traffic signal at the intersections on Pahlavi Street and Zardoshi Street are of the three phase system and always show "green" for the vehicle heading north on the Pahlavi Street, pedestrians crossing Pahlavi Street are facing a constant danger. Use of straight forward signals of the third phase should be discontinued (Fig. 5-2-12).

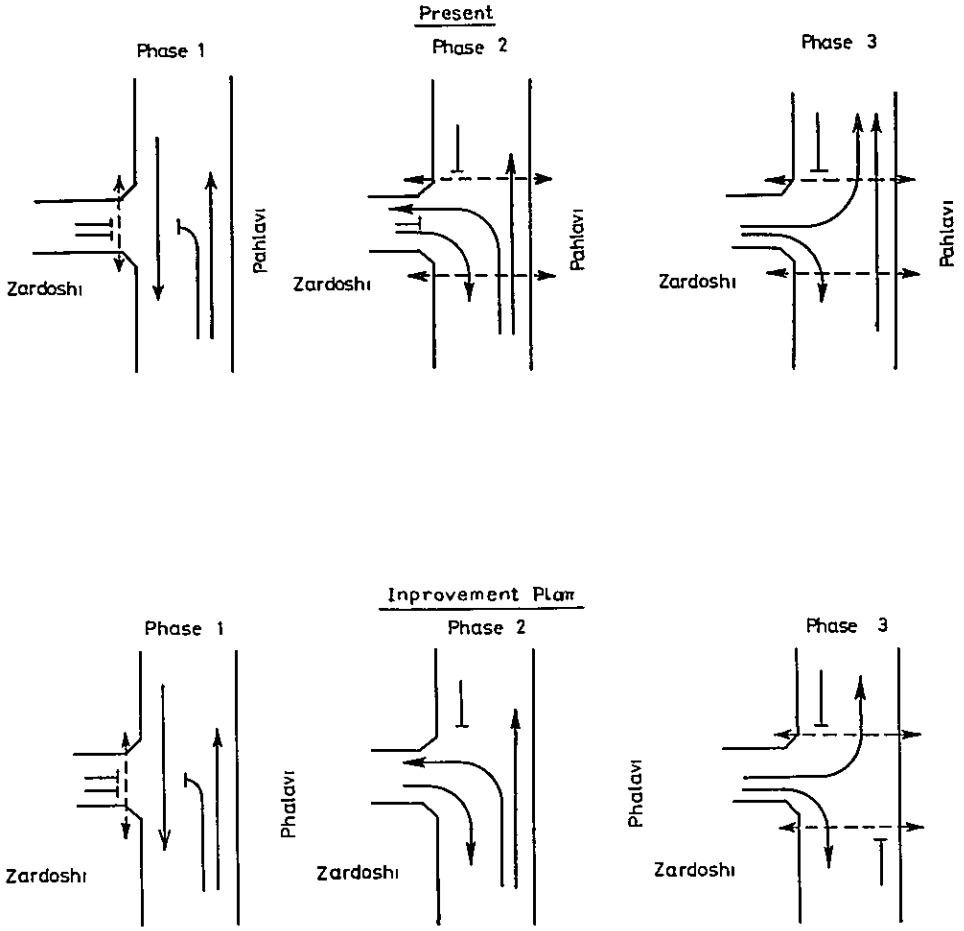


Fig. 5-2-12 Examples of signal indication hazardous to pedestrians

g) Rotary type crossing

Fig. 5-2-13 Traffic lights provided at each inlet of rotary also stop vehicles circling around the rotary

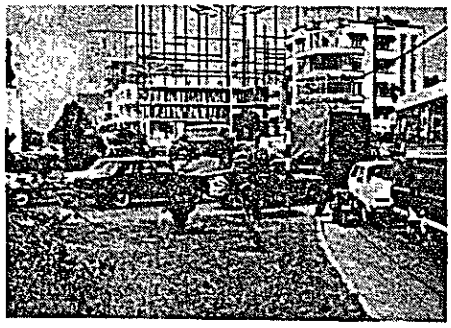


Fig. 5-2-14 With the increase of traffic volume, vehicles circling around the rotary and incoming vehicle get entangled, causing traffic jam at the rotary.

Rotary adds to the beauty of the city and has the advantage of allowing vehicular traffic to proceed without stopping at an intersection when there is less traffic and the convenience in arranging the inlets so the crossing has more than four ways. However, with the increase of traffic volume, smooth continuous flow is soon interrupted, and eventually a signal must be provided at each inlet of the rotary (Fig. 5-2-13). Thus, the merits of the rotary gradually diminish and its demerit, the vehicle proceeding straight forward are forced to make curve. Thus demerits are alone left behind decreasing the efficiency of the crossing in handling the traffic (Fig. 5-2-14) and increasing the danger of traffic accidents. Even though the rotary is so designed as to provide beautiful flower gardens, fountains and benches for the people, and the citizens may walk around and take a rest, it is now becoming meaningless to the pedestrians. (Fig. 5-2-15). It is important, therefore, to plan a measure which will enhance the traffic capacity of the rotary while maintaining the beauty of the street. On this point, several recommendations are given in Section 3.

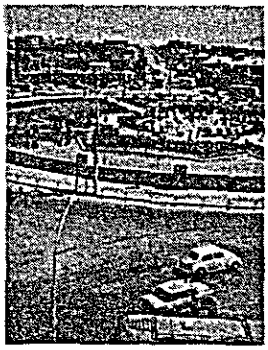


Fig. 5-2-15 Because of danger in crossing the roadway to get to the rotary, only a few people are seen in this beautiful rotary.

5.3 Improvement

Urgent improvement to be taken as a temporary solution to traffic problems of Teheran will be as follows:

a. The Shahreza, the most important street in Teheran city, should have a continuous underpass roadway to allow non-stop passage for all traffics on Shahreza Street.

b. All traffic signals on major roads should have coordinated control systems and there should be area control system in the center of the city.

c. Intersections having special problems such as the rotary-type crossing should be provided with better facilities with the special consideration for the safety of pedestrians as well as automobiles.

d. Bus terminal buildings should be built by utilizing available space in the existing bus terminals and to provide off-street parking lots in the building, and to prohibit or restrict street parking.

5-3-1. Grade separation

At the intersection where trunk roads with heavy traffic meet each other it is extremely difficult to expect smooth handling of traffic by signals alone. In this case, adoption of grade separation is strongly recommended.

For grade separation, two systems, the underpass (Fig. 5-3-1) and

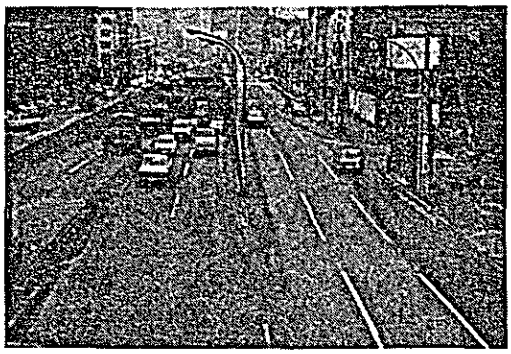


Fig. 5-3-1 Continuous underpass in Showadori, Tokyo

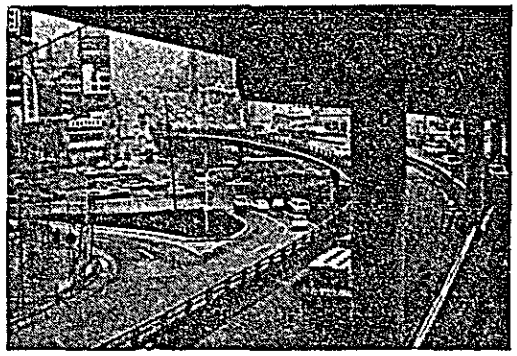


Fig. 5-3-2 Overpass at Akasaka-Mitsuke intersection, Tokyo Traffic below the overpass is channelized and the Tokyo expressway is running the above.

overpass (Fig. 5-3-2), are conceivable. From the standpoint of the beauty of the city or the efficiency of traffic or traffic control, the underpass system is more advantageous.

Cross-section of grade separation is shown in Fig. 5-3-4 and an overall width of 28.50 m is required under normal condition and the minimum width of 24 m must always be maintained for the carriage ways.

Generally speaking, to increase the efficiency of grade separation, the entire route should be of a continuous grade separation.

In the case of Teheran, a continuous grade separation should be planned for Shahreza Street for the time being if the present traffic volume and the width of road is taken into consideration. In that case, it is important to take appropriate measures not to allow other roads cross Shahreza Street at the point other than the intersections with grade separation. Refer to Fig. 5-3-3. Details of grade separation are shown in Fig. 5-3-4 to Fig. 5-3-7.

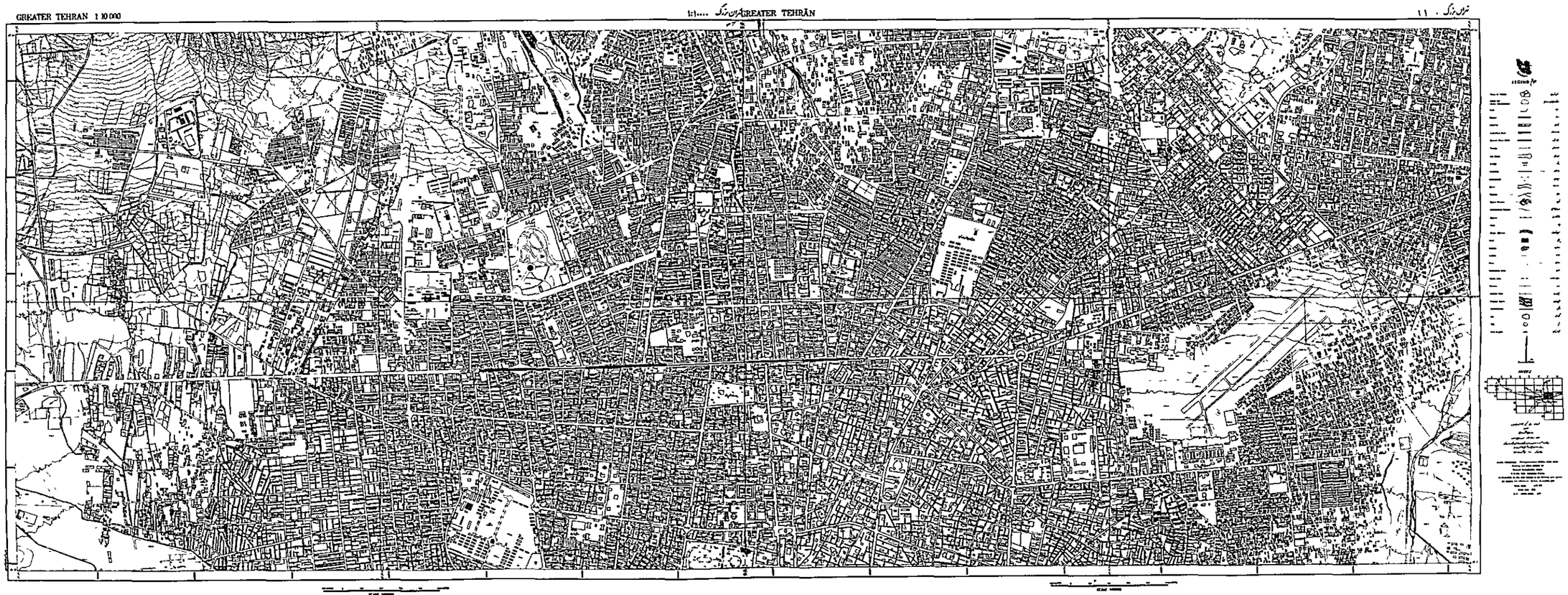


Fig. 5-3-3 Plan of grade-separated intersection of Shah Reza Street

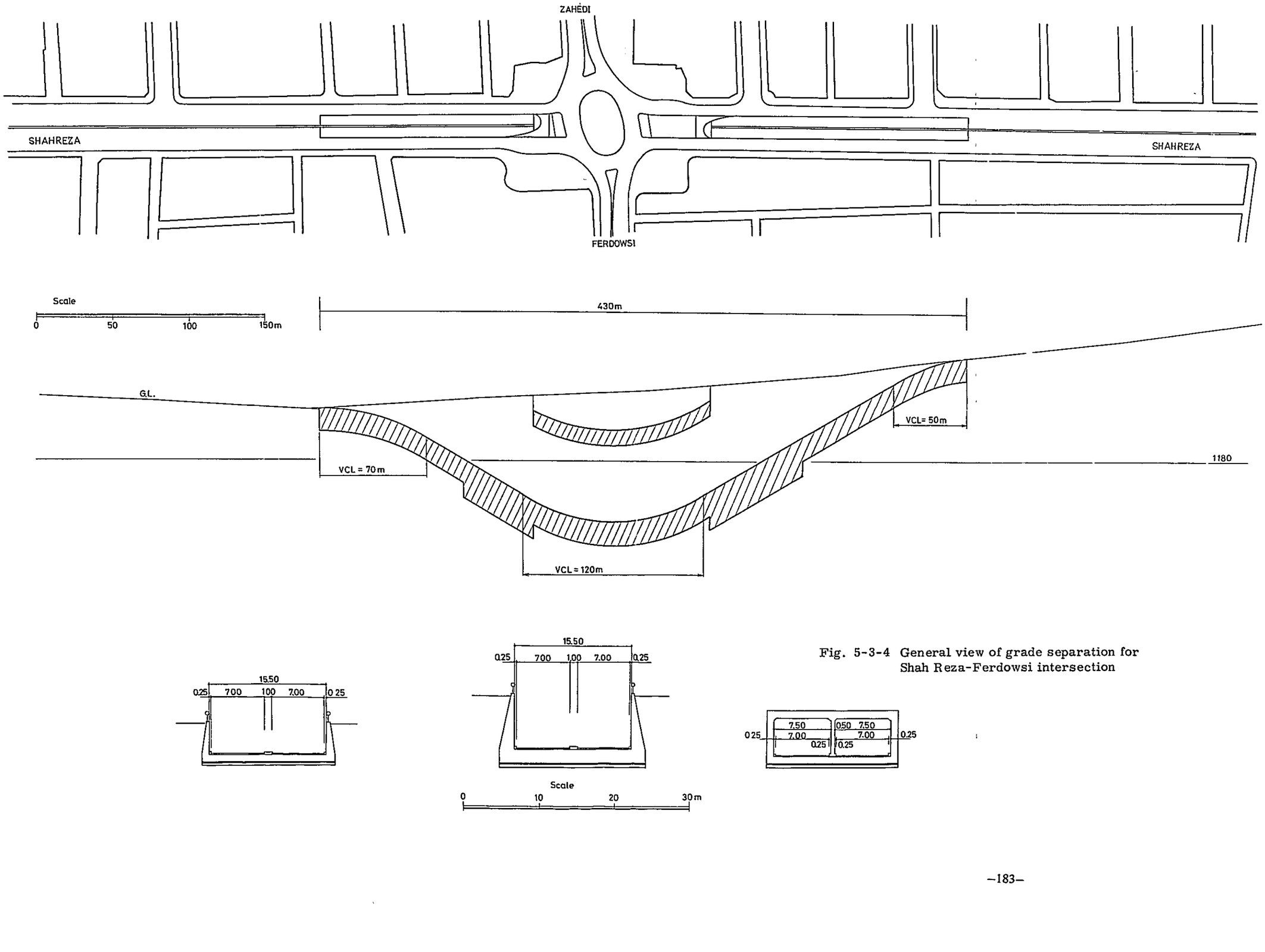
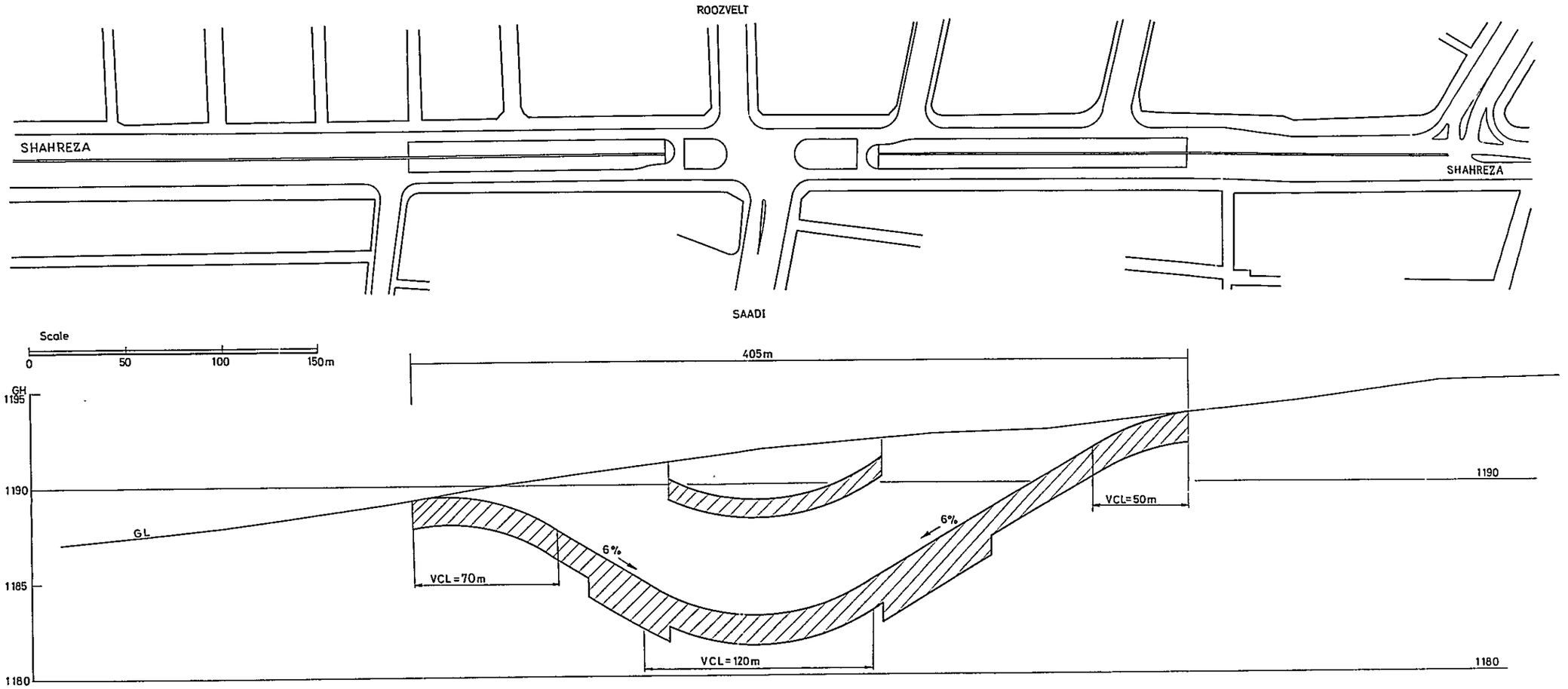
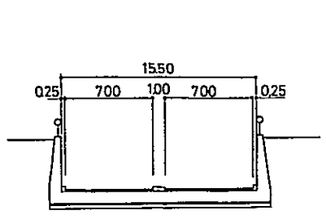


Fig. 5-3-4 General view of grade separation for Shah Reza-Ferdowsi intersection





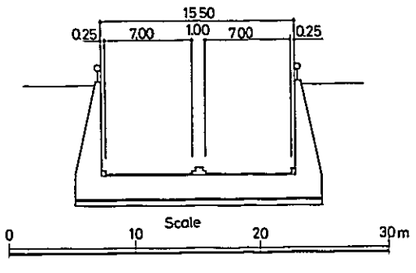
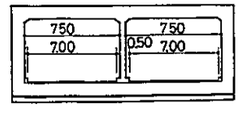


Fig. 5-3-5 General view of grade separation for Shah Reza-Roozvelt intersection



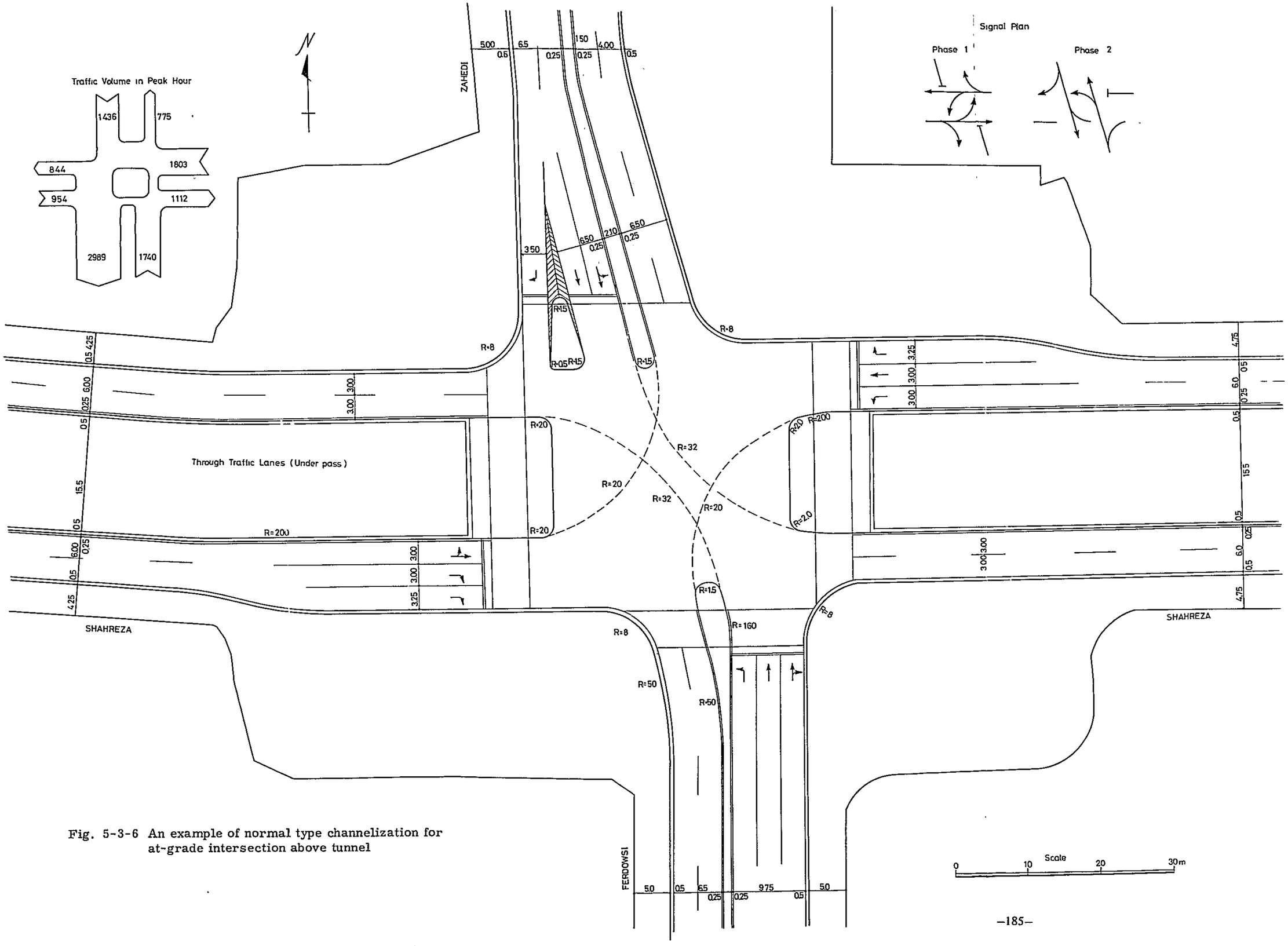


Fig. 5-3-6 An example of normal type channelization for at-grade intersection above tunnel

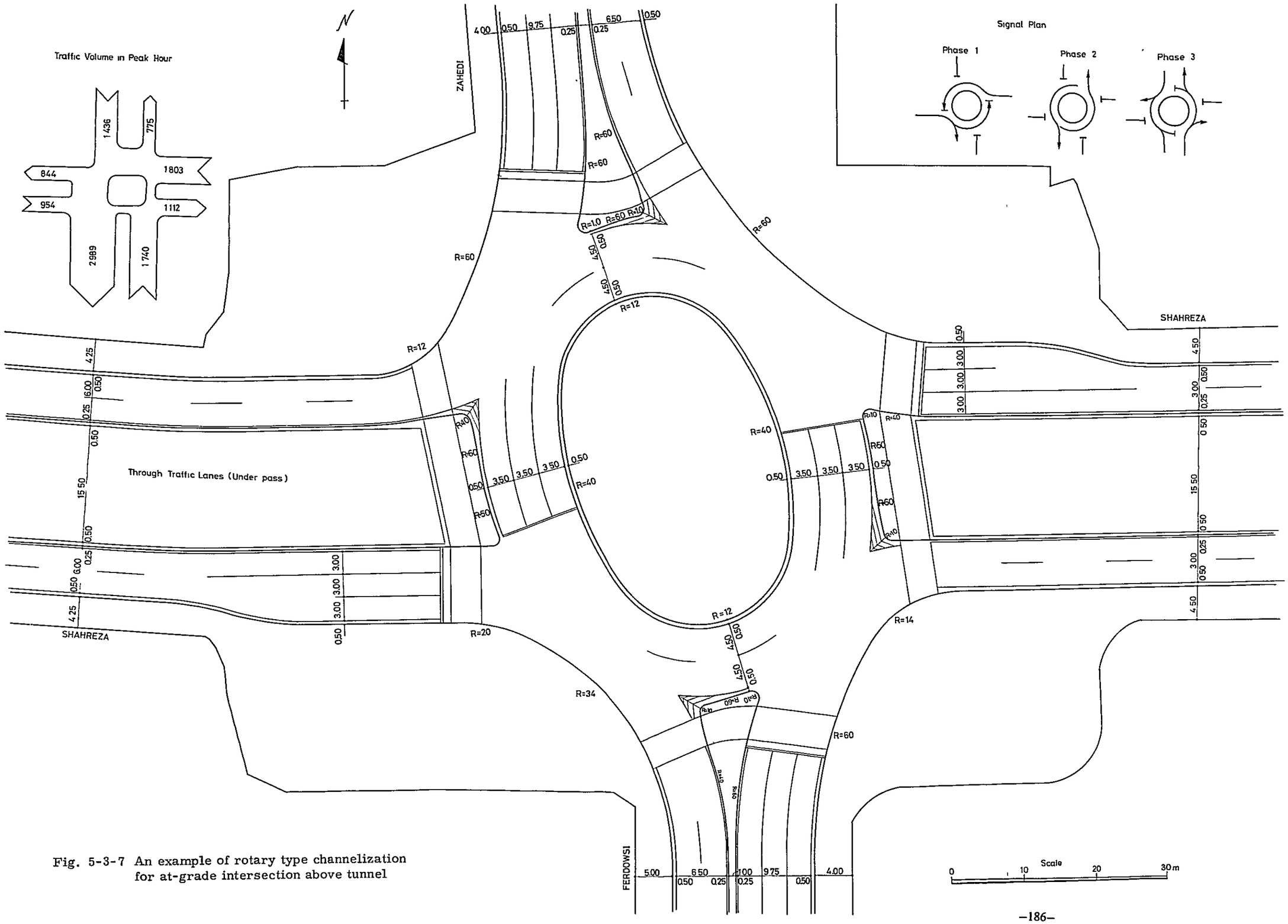


Fig. 5-3-7 An example of rotary type channelization for at-grade intersection above tunnel

5-3-2. Coordinated Control and Area Control of Traffic

1) Basic Policy

All trafic signals are to be controlled by a central control system with the use of an electronic computer. One electronic computer installed in the Traffic Control Center provides a centralized control such as area control for the city center, coordinated control for the three routes including Shahreza Road and traffic actuated control for major intersections and rotaries.

a) Signal Control at Intersections Rotaries

Vehicle detectors are to be provided at two points, 100 m and 300 m from the stop line at the inlet of each intersection crossing to measure traffic volume, traffic speed and the intensity of congestion. Automatic control systems for traffic signals changing according to the traffic conditions will minimize the long stoppage time considerably, and traffic delays will also be reduced.

b) Coordinated Control System

A series of signals along the trunk road are controlled according to the traffic conditions at a particular time to allow vehicular traffic to travel the road in a minimum of time and to reduce the number of stoppages by a red light. Conversely, the vehicle travelling at an excess speed is forced to make a stop at a red light and the driver will learn the worthlessness of speeding, thus reducing the number of speed offenders.

c) Area Control System

In the area where each road links one another like meshes of a net as in the case of the city center, a combination of the above mentioned traffic actuated and coordinated control systems is to be adopted for controlling signals so that the travel time within the area may be shortened as much as possible.

2) Control Points

The foregoing control systems are to be shown in Fig. 5-3-8.

Fig. 5-3-8 Plan of intersections to be controlled by computer

3) Outline of the Proposed System

This system has an electronic computer installed in the Control Center which receives and transmits information to many traffic signals and vehicle detectors installed in the streets through telephone cables and provides a centralized control on the collection of traffic information and operation of traffic signals.

For the detection of vehicles, the following two methods are available. (a) One uses a "loop coil" buried in the roadway. From the fluctuation of current that occurs every time a vehicle passes over the coil, the passage of vehicles may be detected. (b) The other is the continuous emission of ultrasonic waves from a height of about 5 meters above ground level which detects the passage of vehicles by the reflection of waves from the car roof, which gives much quicker response time than from the ground.

These vehicle detectors are placed at every intersection and major route, and every time a vehicle passes the electric pulse is fed into computer installed in the traffic control center. In response to those signals the computer calculates the number and speed of the vehicles flowing in and out of the city from every direction. On the basis of data, the computer transmits appropriate instructions according to the traffic conditions to all signals within the covered area. In other words, the computer makes a decision on the three elements of traffic control, namely, (1) Cycle (Time elapsed after the signal turns green, yellow and red and until it turns green again), (2) split (distribution ratio of time for green light at the trunk road side and for a green light at the cross road side) and (3) Offset (Time difference in showing a green light at each intersection), on the basis of collected data and transmits instructions to each traffic signal by means of an electric signal. In this way, extensive control of signals corresponding to the change in the traffic situation may be possible.

More plainly, in this system "The computer gives proper solution what signal should be given to the specific intersection to ensure most efficient handling of traffic according to the flow of vehicular traffic.

The time required for this operation, from the time information to transmit to all traffic signals within the area, is not longer than one second.

4) Details of the Traffic Control System

The setup of the traffic control system will be discussed a little more in detail by referring to Fig. 5-3-9.

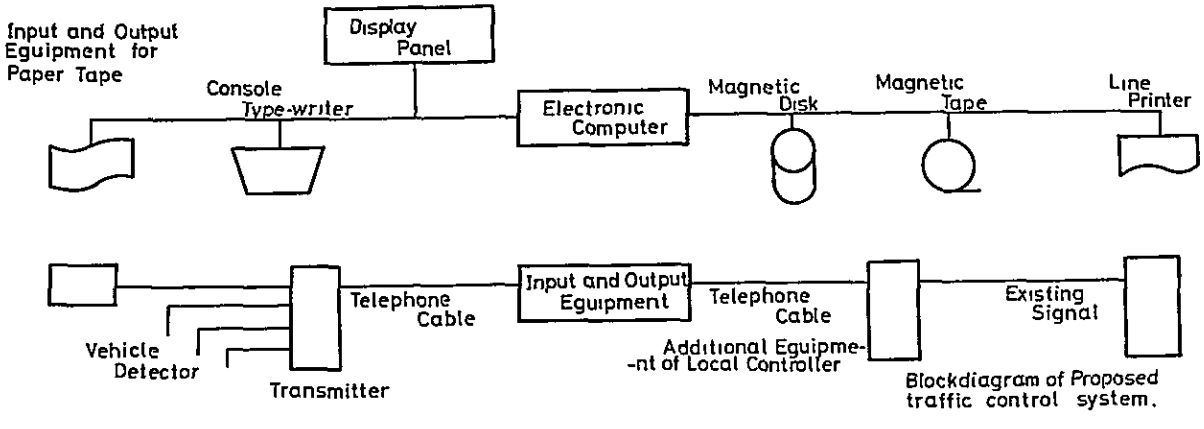


Fig. 5-3-9 Block Diagram of Proposed Traffic Control System

In the roadway a looptype or ultrasonic-wave type vehicle detector is installed, which generates a signal whenever the vehicle passes through. Detection signals from several vehicle detectors are collected by the transmitter and transmitted to the control center by telephone cable by means of multiplex transmission. These signals are read by the computer through input and output equipment at a rate of a dozen times a second, and the computer analyzes these signals to obtain traffic data such as traffic volume or intensity of congestion at each intersection.

At the intersection, meanwhile, the existing signal is equipped with additional equipment, a local controller which is connected to the computer via telephone cable. The computer controls the traffic signal switch through input and output equipment, telephone cables and additional equipment of the local controller. When one pulse is sent out by the computer, the light color of the signal is advanced by one. To ensure the accuracy of the operation, the state of lighting of the signal is reported back to the computer, and the computer, by reading this data, supervises the response of each traffic signal to instructions.

The duration of the signal light and the time difference between each neighboring intersection are adjusted from time to time by the computer on the basis of traffic data. Analytical method of detection signals transmitted by vehicle detectors and the method of corresponding the traffic data obtained by the analysis of signals to the switching of signal apparatus are all determined by the program of computer. Accordingly, any control method may be put into actual use depending on the programing. However, a more complicated control method requires more complicated programing and therefore, programs are packaged by class and function of control method. Combination of programs is determined automatically in accordance with the traffic data and the control corresponding to each situation is provided. The purpose of traffic control is to reduce the number of stoppages or shorten the waiting time when the traffic is not heavy, to prevent delays when the traffic is jammed and to promptly alleviate the congestion once it occurred. The computer, while collecting traffic data and controlling signals on the one hand, extracts various data from the line printer in preparation for a future analysis. The data for analytical purpose may be stored in magnetic tape, and if an analytical method is given to the computer as a program, the computer may be able to make an analysis of this data when it is not fully occupied. The result of such an analysis may be utilized as data for the improvement of the control system and as statistical data on traffic.

From the console typewriter, traffic conditions, particularly the message of abnormality is put out to aid the traffic controller. The controller, on the other hand, may give various instructions to the computer or make inquiries to it.

Even when the computer ceases operation due to mechanical trouble or for other reasons, the input and output equipment still transmits synchronous pulse to the traffic signal and the system operates as a simple coordinated signal. When there is any abnormality in the transmission system, the system operates as an independent constant cycle signal.

With this system, not only additional installation and removal of vehicle detectors or signals are easily accomplished but the system may be introduced in stages in accordance with the size of the area to be covered and the

type of control method. For instance, the first step may be the automation of the information center for collection of traffic information only and thereafter the crossings may be placed under the control of a computer one after another in the order of importance and the system may be expanded to the coordinated control system and further to the area control system. A display panel provided in the Control Center indicates the traffic situation of the city and the operation of traffic signals, the data obtained by the computer. Also by providing television cameras at key points of the city, the traffic officer is able to observe and assertain with his own eyes whether the control by means of computer is carried out properly. Fig. 5-3-10 shows a typical example of a layout of a control center equipped with a computer, display panel, television set, other control equipment and a telephone for the transmission of information.

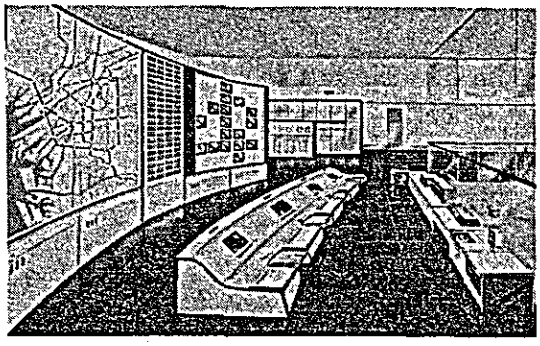


Fig. 5-3-10 Control Center

5-3-3. Partial Improvement of At-Grade Intersection

Each intersection must be in the shape best suited to the traffic requirements of that particular section. Points to be given special attention in improving each intersection are listed below.

a) The number of lanes designed to correspond with the traffic for left-turn, straight forward, and right-turn.

b) Pedestrians' crossings designed for safe and prompt crossing.

c) Determination of reasonable signal indications.

d) Construction of underpasses (or footbridges) for pedestrians at T shape intersections and deformed intersections to enhance traffic capacity.

e) Removal of rotary.

Several intersection improvement plans are shown in Fig. 5-3-11 and Fig. 5-3-12.

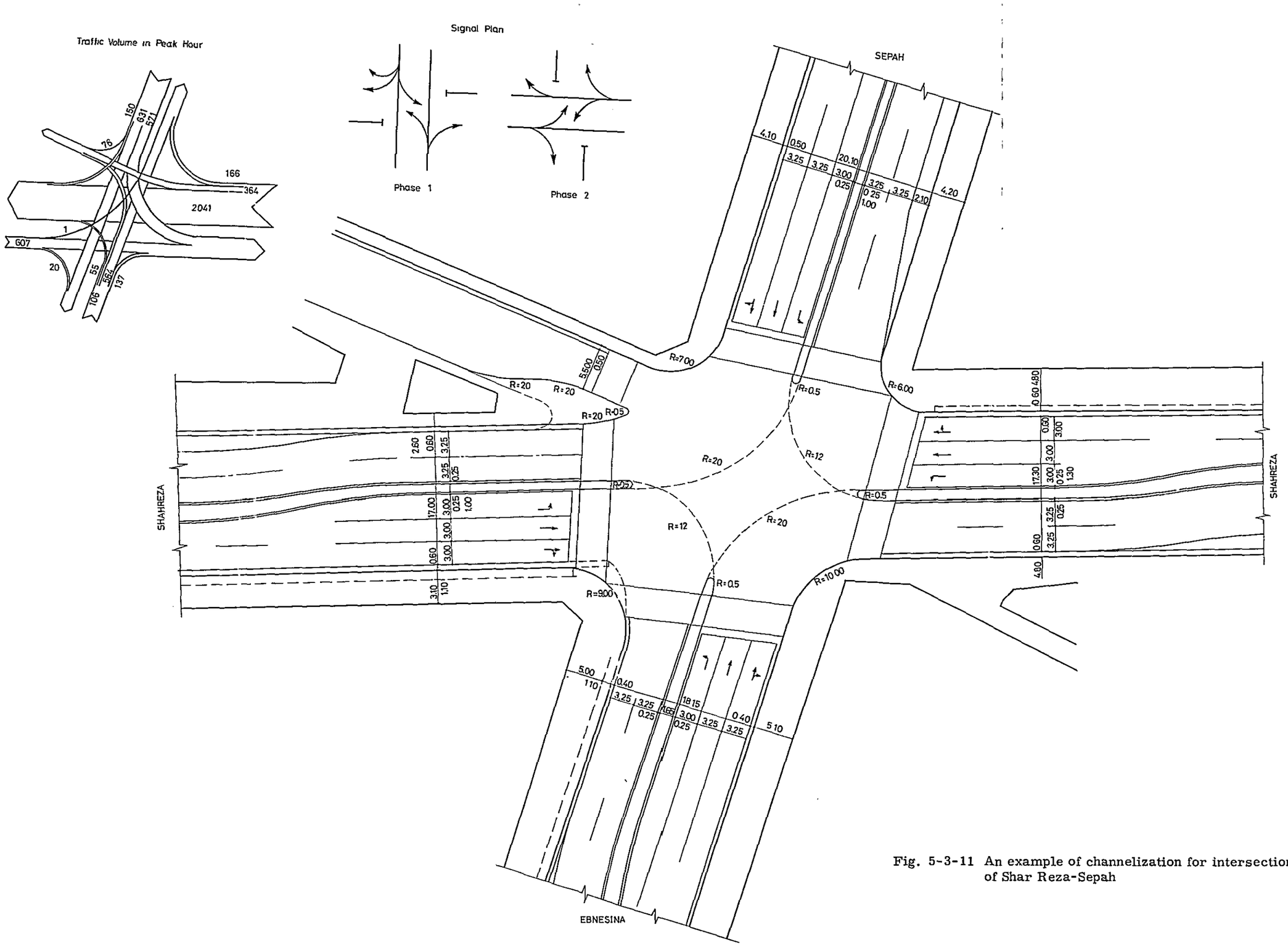


Fig. 5-3-11 An example of channelization for intersection of Shar Reza-Sepah

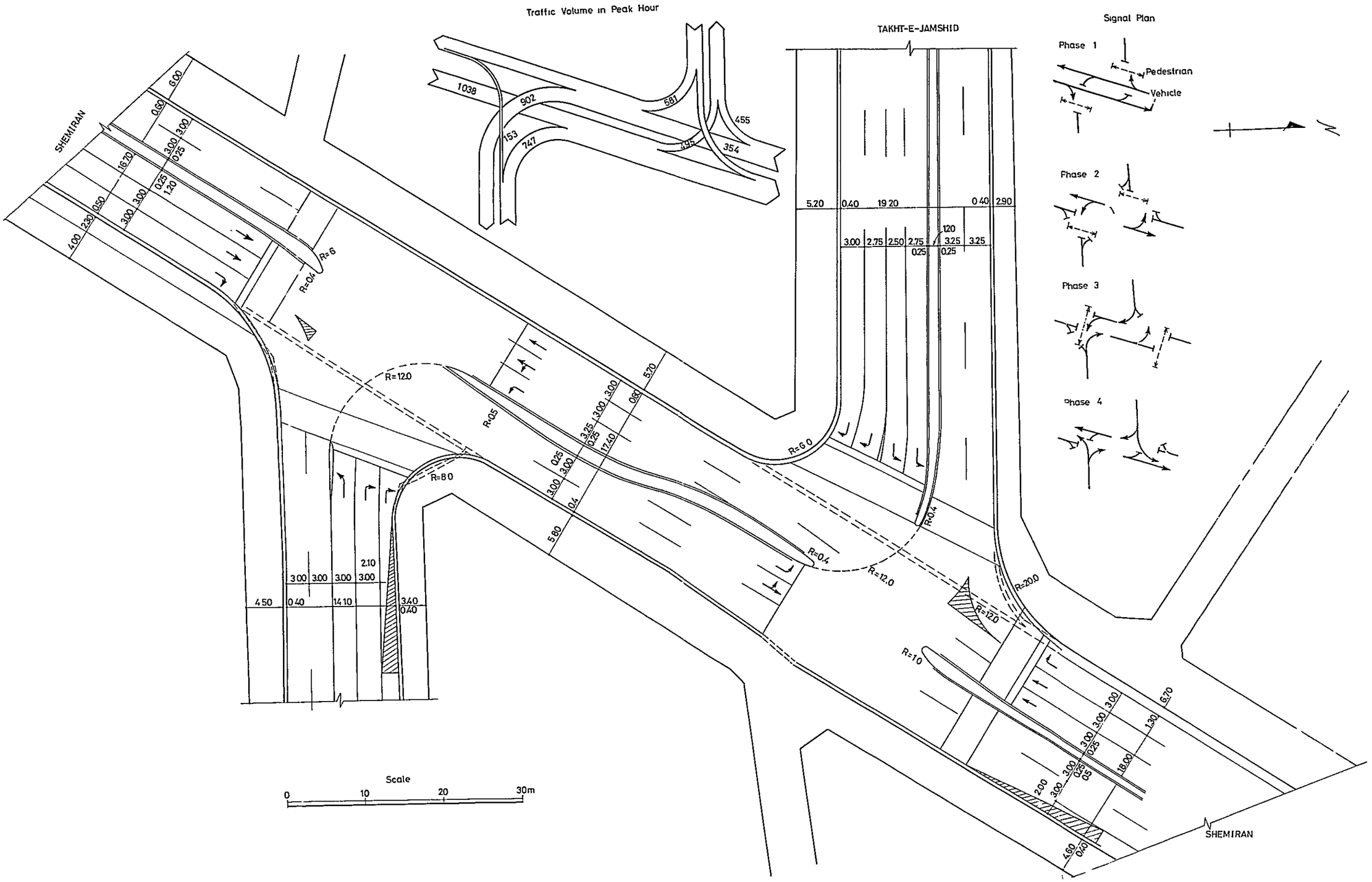


Fig. 5-3-12 An example of channelization for intersection of Takht E Jamshid-Shemiran

5-3-4. Multi-purpose Utilization of a Bus Terminal

A new high Bus Terminal Building shall be built in the present bus terminal area to improve the efficiency of the present conditions of bus operation ation which is the only means of mass transportation for the people and necessary parking lots shall be available within the building.

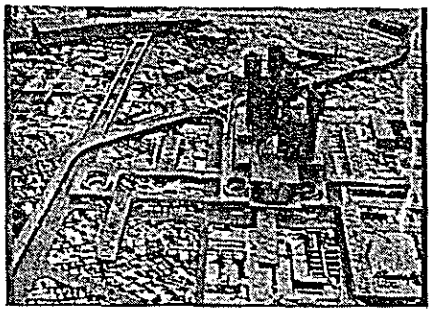


Fig. 5-3-13 Model of a terminal building directly connected to expressway

5-3-5. Estimate of Required Costs

The cost required for grade separation work and traffic control systems using a computer is roughly estimated as follows:

1) Construction of grade separation

Grade separation for one intersection	70,000,000 rial
Five intersections in Shahreza Street	350,000,000 rial

2) Area and coordinated traffic control

The total cost required for 70 intersections is estimated at 110 million rial and its breakdown is as shown in Table 5-3-1:

Table 5-3-1 Estimated cost of the Teheran city area control system

Number of intersections to be placed under control.....	70	
Electronic computer	One set	32,000,000 rial
Display panel	One set	4,000,000 rial
Central transmission and receiving equipment	One set	10,000,000 rial
Local transmission and receiving equipment	80 units	4,000,000 rial

Signal controller (control equipment)	..... 70 units,	28,000,000 rial
Vehicle detector	.....200 units	12,000,000 rial
TV set	..... 15 sets	15,000,000 rial
Others	.....	4,200,000 rial
Total		110,000,000 rial

5.4 Effects of Improvement Work

The effects of grade separation of intersections, systematization of traffic signals and partial improvement of existing intersections may ; (1) decrease traffic accidents, (2) increase traffic capacity, (3) increase travel speed of vehicles and (4) decrease fuel consumption.

5-4-1. Effects of Grade Separation of Intersections

The comparison of the traffic capacity of Shahreza-Ferdowsi intersection with and without grade separation (Fig. 5-3-6) is shown in table 5-3-2.

Table 5-3-2 Traffic capacity of intersection (Number of vehicle/hr)

Name of street	Present(Total of both directions)	After improvement (Total of both directions)	Rate of Increase
Shahreza	3,500	8,800	251%
Ferdowsi	3,200	5,800	181%
Total	6,700	14,600	218%

Computation was made on the basis of 1,500 vehicles for one lane per green light hour a 90 second signal cycle and 5 vehicles making a left-turn per signal cycle. The present traffic capacity shown is based on the result of actual traffic surveys.

5-4-2. Effects of Coordinated Control and Area Control

If the area traffic control system is installed in Teheran, economical effect is estimated at 51 million rial annually.

In the case of Tokyo, an increase of the average travelling speed was 11-30% (for example 7 lane roadways) with coordinated control systems and about 14% with plane controls. If these examples are taken into consideration, the increase on the average travelling speed in the areas with coordinated and area control systems in Teheran was assumed to be 10% at peak hours and 5% at off-peak hours.

Table 5-3-3

Conditions:

Traffic volume: (within the controlled area) ... 1,000,000 cars km/day

Travelling speed:

Present ..... 20 km/hr at peak hours
30 km/hr at off-peak hours

After control system installed .... 22 km/hr at peak hours
31.5 km/hr at off-peak hours

Rate of traffic concentration at peak hours 30%
(2 hours in the morning and 2 hours in the evening)

Time benefit: One rial for one vehicle per minute (Time benefit per vehicle presently adopted in Japan)

Number of applicable days per year: ..... 320 days

Effects calculated on the basis of above assumption are as follows:

Table 5-3-4

Reduction in time for one vehicle to travel one km

Peak hours: 3 min - 2.7 min = 0.3 min

Off-peak hours: 2 min - 1.9 min = 0.1 min

Reduction in total hours for all vehicles per day:

100,000,000 x 0.3 x 0.3 + 100,000,000 x 0.7 x 0.1 = 160,000

Total annual time benefit:

160,000 x 1 rial x 320 = 51 million rial

5-4-3. Effect of Partial Improvement of At-Grade Intersections

Most intersections requiring improvement are either multi-leg intersections or deformed intersections and the purpose of improvement work is either for the prevention of accidents of the enhancement of traffic capacity. Here, only the effect on the reduction of accidents will be dealt with Table 5-3-5 shows the number of accidents before and after the improvement work such as the channelization, installation of channelized traffic markings and constrstruction of grade separation (underpass or pedestrian bridge) at 7 intersections in Tokyo.

Table 5-3-5

	Before improvement (for 6 months)	After improvement (for 6 months)
Vehicle versus personal	14	0
Between vehicles	102	46
Vehicle only	2	3
Total	118	49
Rate of decrease (reduction)		58.9%

According to the above table, the number of accidents decreased by about 60%. Since the number of accidents decreased by 69 during a six month period, the number per year will be 138. Assuming the mount of damage caused by one accident is 40,000 rial, the effect by the decrease of accidents after improvement work is estimated at 5.5 million rial.

PART II TEHERAN TRANSPORTATION SYSTEM

(PROPOSAL WITH COMBINATION OF LADDER AND CIRCULAR CITY PLANNING)

CONTENTS

CHAPTER 1 APPROACHES TO PROBLEMS IN LARGE CITIES

Problems in Modarn Urban Transportation

Large cities of the world, while playing an important role as the center of politics, economics and culture of the country, are still maintaining outdated system of production, distribution, consumption, administration and education, and have allowed the influx of population almost planlessly. As a result, commuting traffic has come to be in the extreme confusion and the speed of traffic has dropped. This is not only the loss of time but a great disadvantage to the city economically and socially.

This stringent traffic situation in large cities is now at such stage that its solution could not be sought through the mere improvement of transport facilities. Enhancement of transport capacity may only result in inviting disorderly more concentration of population into the city. For this reason, the powerful policy to cope with this situation is to effectuate the National Comprehensive Development Plan and Metropolitan Development Plan in order to ease the over-burden pressures on large cities, at the same time, to carry out the urban renewal and reorganization to improve the structures of cities.

The establishment of modern transport system, such as urban expressways, rapid transit of railways, subways and monorail will be the powerful countermeasures. For this purpose, there will be a requirement for a huge amount of capital investment but this spending is unavoidable to maintain activities of modern cities. For the procurement of required fund, special measures will have to be taken by the central government.

For commuting traffic, in particular, adequate transport should be planned positively by placing emphasis on the enhancement of public mass transport facility. As the cost of transport is expected to increase further in the future, the commuting fares should be adjusted appropriately on the "Burden by Users" principle.

However, for the portion beyond the capability of commuter's burden, subsidy from the Central Government will be necessary.

Traffic system in large cities are generally taken up in conjunction with the increase of population within the city area. The area to be covered by the urban traffic system should extend to a radius of at least 30 km from the city center in major cities, and comprehensive traffic system consistent with the overall land use plans in the region must be worked out and put into practice. General tendency of the major cities of the world is that the dwellers expands in the outlying area and their working places are even concentrating in the core city, particularly the center of the city. Because of increased number of dwellers in outlaying area, the volume of commuting traffic has been increasing at the rate far greater than that for increase of population. Also in the center of the city, such functions as politics, business, and commerce have expanded disorderly, so the vehicular traffic in the center of the city is now in the extreme confusion. To ease further increase of traffic in those cities, some countermeasures are being taken to check the concentration of population on the major cities, for example, by reassigning work places on the nation-wide scale.

However, the results of these countermeasures applied in the free countries so far, only show the increase of traffic volume at an unexpectedly high rate.

Particularly, the rate of increase in vehicular traffic has far exceeded that of the capacity of facilities, and the steadily worsening traffic jam presents a serious problem to all large cities of the world.

Concentration of Population on Large Cities

The increased population of the country must be given opportunities to work anywhere. It is natural that these people move to the place where new jobs are available to them. With the growth of economy, the share of the primary industry decreases while that of the secondary and tertiary industries increases on the contrary, and the majority of these industries seek their locations in the city area to benefit, each other, from the concentration of industries. Especially, in the capital city of the nation, industries are advantageous in ontaining informations and advanced technologies and in securing services from related industries, subcontractors and sales network.

The increase of population is particularly noticeable in the nation's capital city and local central city. In the case of manufacturing industry, plants are usually located in rural area but head offices are mostly located in the center of large cities. This is a normal condition with the most of large enterprises. The expansion of a certain industry in the local area also follows, at the same time, that of the head office in the capital city, must not be over looked.

Large cities of the world such as Tokyo, New York, London and Paris failed to check the concentration of population in spite of many legal restrictive measures and aids for the dispersion of population, and the only successful city is Moscow. At the end of this century 90% of the total population of the world are expected to dwell in the city area or in its vicinity.

Today may well be called the age of urbanization.

The city is the manufacture of culture, and the history of mankind is the history of the city. Today's world civilization evolves around the city. The city until yesterday had a great significance as the place of economic development, but today the city has come to be the place of social development. Young generations are fascinated in the city where they can enjoy without traditions or native custom of rural area. For instance, 70% of the population transferring to Tokyo annually are the young generation having a low tax-bearing capacity. The large cities are growing while absorbing these populations. These small income earners converge on densely populated housing districts seeking their works and houses and are becoming the elements for the increase of slum against the will of the city administration. Moreover, they soon begin gaining income higher than that of those remaining in the rural area and are able to enjoy the life of the city. Therein lies a charm of town life.

In human society, the people seeks the association with other people and masses to form a group, thus creating civilization. Building a town and growing it to a gigantic city is the inevitability with human beings for the progress of man's civilization. The large city appeals to the people by offering greater opportunities of employments. These attractiveness of large city is the main factor for the explosive increase of city population. Unless political measures guranteeing higher standard in rural life are taken, influx of population into the large city will not be weakened.

For the Sound Growth of Teheran

Under the Fourth 5-year plan for the period of 1966 to 1972, Iran's national economy is growing favorably.

Industrial investments will have to be based on an extensive planning and will be required to increase its share. This, in turn, will becoma a major factor for the acceleration of urbanization.

The population of Iran which was 26,676,000 in 1967 is expected to grow to 30,329,000 in 1972 and to about 50,000,000 in 1991. Per capita income which stood at $220 in 1967 is expected to grow to $307 in 1972. However, per capita income in Teheran is said to have already reached $600 level, 3 times that of the average in the whole country. Centralization of wealth is already seen in Teheran and the people seeking this wealth is continuously flowing into the city area.

In consideration of the above fact, if we are to expect Teheran, as the capital city of the nation, to make sound growth economically and socially, there must be provided a powerful political measure. Under the Fourth 5-year Plan, the following measures are being carried out vigorously.

(1) Additional establishment of factories in and around Teheran is to be avoided to the extent possible.

(2) Several large industrial bases are to be developed in rural area.

In spite of these measures, however, concentration of population in the tertiary industry will still continue in parallel with the enhancement of economic power of Teheran. Large cities of the world are now screaming with the burden of explosive population in the tertiary industry and hustling about to find a means to cope with this situation.

For the sound growth of Teheran, we consider it prerequisite that a careful and well balanced land use plan for the great metropolitan area extending to a radius of 50 km or 100 km is worked out. For this purpose, young engineers, adaptable to the new age, responsible for the future of the country, hsould be given opportunities to understand the world's trend and grasp the propects of nations future economical and social development, to formulate a Master Plan for the Great Teheran for themselves. In such a way, Teheran city will be able to learn valuable lessons at the expense of a small amount of survey cost, which many countries of the world have finally learned through the repetition of costly trial and error. Otherwise, Teheran will have to pay high cost in compensation for the mistakes mistakes in the same way as other countries did.

It is our pleasure to be able to extend our cooperation on every opportunity to the construction of new Teheran city.

CHAPTER 2 CITY PLANNING

2.1 Basic Plan

2.1.1 Population Plan

(1) Iran

The population of Iran in 1966 was 25.781 million. It is still increasing at such a high annual growth rate of 2.8%. Prospect of high growth of young labor force, which is the "key" to high economic growth of Iran, is one of the factors that enhance the potentiality of Iran for further advance.

Comparison of this trend with 1956 Census by region is shown in the Table 2-1-1.

Table 2-1-1 Population increase by Ostan in Iran

(unit: thousand persons)

	A 1966	B 1963	C 1956	A-B	Relative	A-C	Relative
Ost. Teheran	5,161	4,814	2,930	347	12.65	2,231	35.36
" Ghilan	1,755	1,470	1,630	285	10.39	125	1.98
" Mazan daraa	1,843	1,601	1,472	242	8.83	371	5.88
" East Azarbaijan	2,603	2,702	2,142	99	3.62	461	7.31
" West Azarbaijan	1,088	796	721	292	10.65	367	5.82
" Kermanshahan	1,867	1,694	1,377	173	6.31	490	7.77
" Fars	1,701	1,611	1,321	90	3.28	380	6.02
" Khuzestan	2,472	2,446	2,069	26	0.95	403	6.39
" Kerman	1,127	878	789	249	9.08	338	5.36
" Khorasan	2,516	1,895	2,008	621	22.65	508	8.05
" Esfahan	2,004	1,825	1,514	179	6.53	490	7.77
" Kordestan	624	546	55	78	2.85	69	1.09
" Sislan Baluchestan	504	245	428	259	9.45	76	1.20
Total Ostan	25,264	22,523	18,955	2,742	100.0	6,309	100.0
Nomads	517						
Iran	25,781						

During the past 10 years the population of Iran increased by about 6.309 million. This is equivalent to about 33% of the population in 1956. According to the table, the Ostans in which the population increased at the rate higher than that of natural increase might be said, there were also a social increase, and vice versa. The social increase were in only 3 Ostans. Teheran, West Azarbaijan and Kerman. On the share of each Ostan in total increase of

6.309 million, Ostan Teheran has the largest share of 35%, but the share of other Ostans where there have been a social increase is such small percentage of 5-6%.

Assuming that the population of Iran in 1991 reaches 50 million with the present rate of increase, the population of Ostan Teheran is expected to increase by 8.4 million to 13.6 million in that year.

At present, the government is adopting a policy to avoid the concentration of population as much as possible by enforcing a measure for the dispersion of heavy and chemical industries. This measure is considered appropriate for the advancement of underdeveloped region. When the production efficiency of industrial enterprises and their merits of close location to the consumption market are taken into consideration, it is quite natural that Ostan Teheran will maintain a key industrial area also in the future.

Based on this point of view, if part of the increased population of 24 million in 1991 is to be allocated to Ostan Teheran at the share of 20%, much lower than the present share of 35%, the population of Ostan Teheran in 1991 will be around 10 million.

Assuming the Metropolitan area within a radius of 30 km from the center of Teheran is to accommodate 6 million, distribution of 4 million in Karaj and Qazvin and their outlying areas may be conceived. Judging from the broad backland area in Qazvin, this region is expected to have more accommodation capacity. To prevent further concentration of population on Teheran, there must be a vigorous city development policy for these regions.

In the region covering Teheran, Karaj and Qazvin, a linkage of major cities, each having a population of more than one million, forming a large industrial belt area may be conceived. As a result, the need for a large, high speed transportation system linking this belt area with Teheran will be felt more keenly.

(2) Teheran Metropolitan Area

In the past 30 years the population of Teheran has been growing at such a high rate of doubling in every 10 years and it will reach 6 million at the least by 1991, even with a fairly strong population restraint measure. Distribution of population within the Metropolitan area will extend to Tajrish in the north. Rey in the south, Karaj in the west with Karaj road and the Super Expressway. Around the junctions, urban expressways or subways cross each other, there will be sub-centers in the outlying area, there will be a commodity circulation center and industrial area in the south.

Employed population, ratio of woman will increase gradually with the progress of modernization of every aspect of the life. Assuming the percentage of employed woman in the total adult women in 1991 is 20% and that of man is 50%, slightly higher than the present rate, the employed population in 1991 will increase to 210,000.

2.1.2 Land Use and Development Plan

(1) Function Assignment Plan

Examples of the world show that the city that has the function of

capital city and the largest population in the country is always increasing its population at the highest rate in the country and there is no difference between capitalist countries and socialist countries. Tokyo, London, Paris, Moscow and and Peking have the function of capital city and are the largest city in their countries, and each has the highest rate of population increase.

It may be said that the growth of Teheran in the past had also followed the pattern similar to this trend.

Increase of population in Tokyo has been brought about by the con centration of non-production sectors such as the head offices of enterprises, financial institutions, insurance and tertiary indstries including service industry, etc. This phenomenon is a typical example of concentration of centralized management functions which can exist only on a great deal of information. In addition, decision-making functions of enterprises which so far were in other large cities have now been transferred to Tokyo. This is because Tokyo offers opportunities for obtaining more accurate, abundant and creative information.

Further growth of population in Teheran will be brought about mainly by the concentration of these management functions. Since these functions share the benefit of the concentration each other, they have a strong tendency to flock in the center of the city.

Judging from the characteristics of the central management functions and information industries, the concept of city pattern, that Teheran is to be divided into 10 zones and each zone is to be developed to have its own city center, may be said to have been formulated for the accommodation of central management functions and information industries in a distorted form (the pattern is shown in Fig. 2-1-1).

Following chart shows the general idea of the assignment of functions recommended for Teheran by Japanese Mission. (Fig. 2-1-2)

According to this concept, the ever increasing central management functions are to be accommodated mainly in the existing city center but at the same time, every effort is to be made for the establishment of sub-centers and new an administrative center to prevent traffic congestion in the city center. Entering of heavy trucks into the city center may be restrained by dealing a large quantity of bulky cargos at the distribution centers provided at the east, west and south entrances of the city. Light industry district is to be established in the south and heavy industry in the southwestern area. A large scale housing district having its commercial center is to be established in the area extending in the north. Housing areas, in and around the city center and sub-centers, will inevitably have a dense population because of multi-story buildings but adequate space for green zones such as parks, etc. is to be secured.

In the suburbs, particularly in the south, a green zone is to be provided, which may also play a role of an anti-sandywind forest.

City functions of Teheran expected to grow further may be largely classified into the function inherent to the capital city and the largest city of the country and general functions inherent to major cities.

Fig. 2-1-1 The Concept of City Pattern with 10 Zones
(Linear City Planning in Part I)

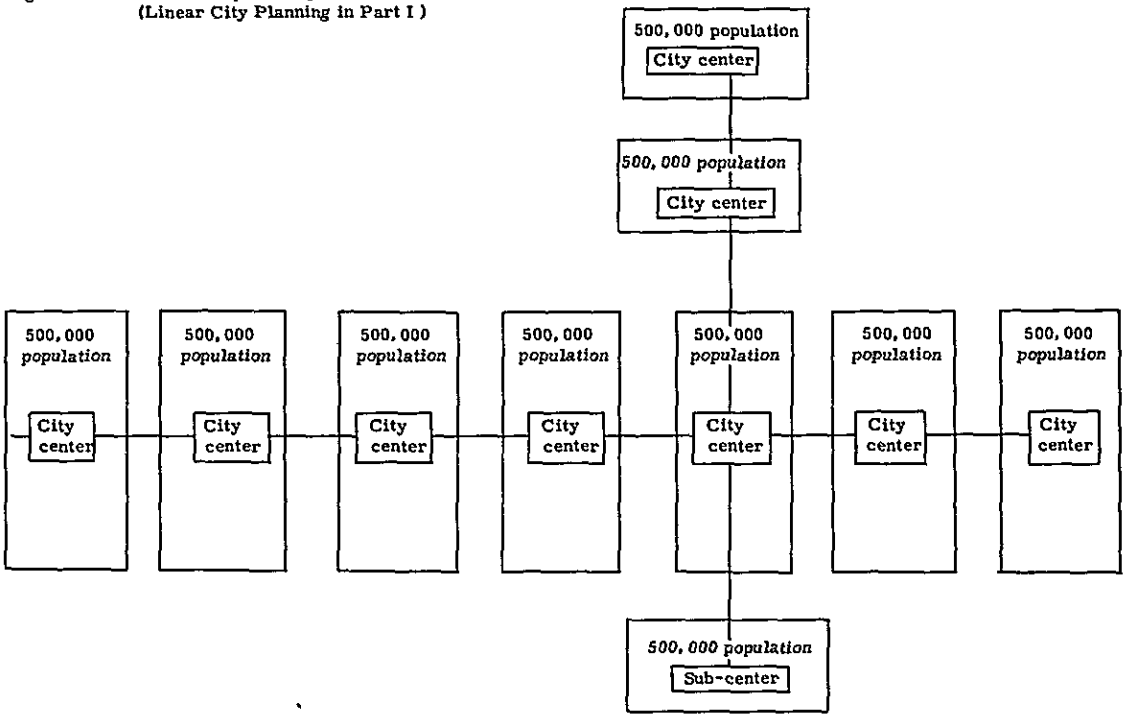
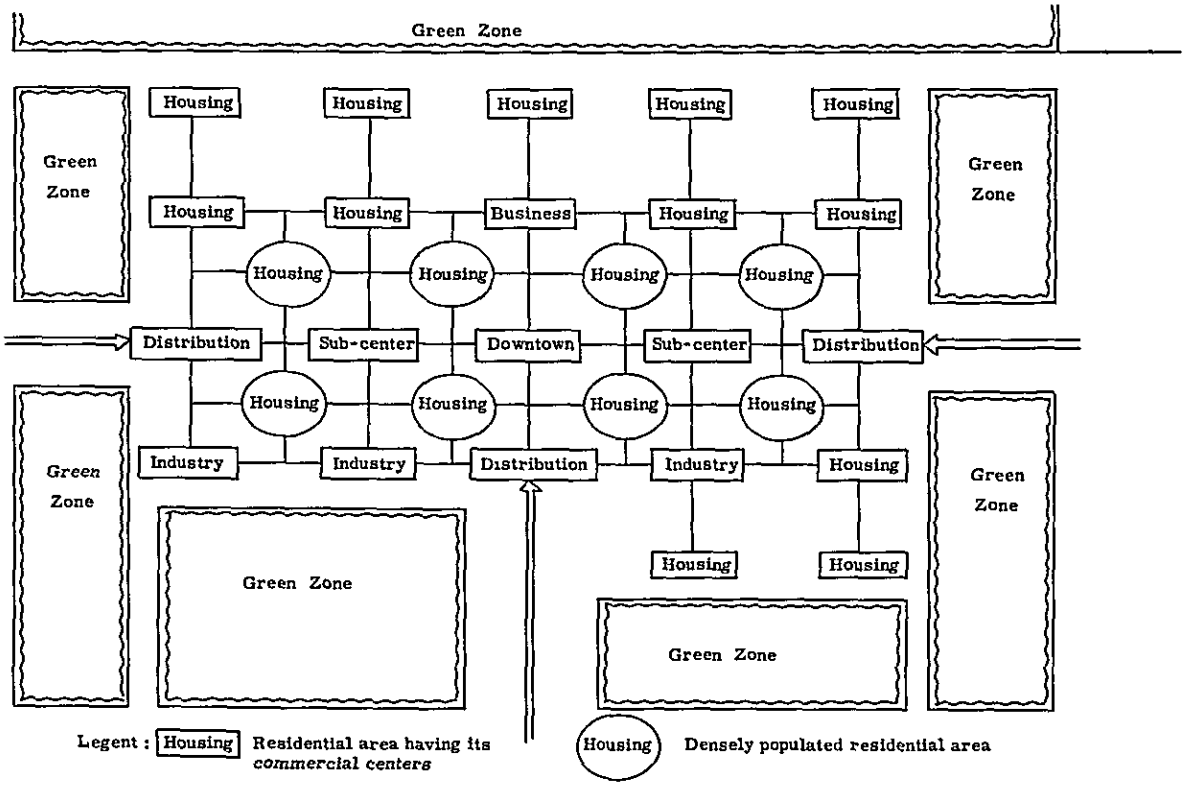


Fig. 2-1-2 The Concept for Assignment of Functions in Teheran City



The following is a list of these functions:

Functions inherent to the capital city and the largest city of the country

International functions:	Foreign legation, international organizations, international airport, branch office of foreign enterprise, international tourist agencies.
National functions:	Administrative, legistrative, judicial and national defense functions
Business functions:	Main store or head office of enterprise of all industries having decision making functions and serving the entire country
Higher educational and research functions:	University, research institutes
Cultural and service functions:	National theater, classical art and public entertainment, art museum, museum, national treasury house

Functions inherent to large cities

Commercial functions:	Service industries for nation-wide coverage, wholesale, business, special commodities
Industrial functions:	Industries in consumption area
Lodging and touring functions:	Sight-seeing, conference hall, tentative centralized business

As for international functions, international conference hall, protocol hall, guest house, foreign legation district and international sport ground must be newly provided in addition to international airport which is to meet the requirement of the age of SST. Branch offices of foreign enterprises and international tourist agents are expected to be in the same district as the business function in the city center.

As for national functions, although, at present, functions are scattered in and around the city center, concentration of all national functions into an administrative district will be advantageous in the exchange of information and communication. For this reason, the new administrative center is recommended for the site of national functions. (Central Administrative District Plan in Tokyo, Fig. 2-1-3).

Business functions will remain in the present city center. There is a plan to provide sub-centers to form a multi-core city pattern, so that the expansion of city center would not increase bottlenecks of traffic.

Higher education and research functions are expected to make a rapid progress in the future. On the assumption that the population of Iran is 50 million in the future and the number of college students will account for about

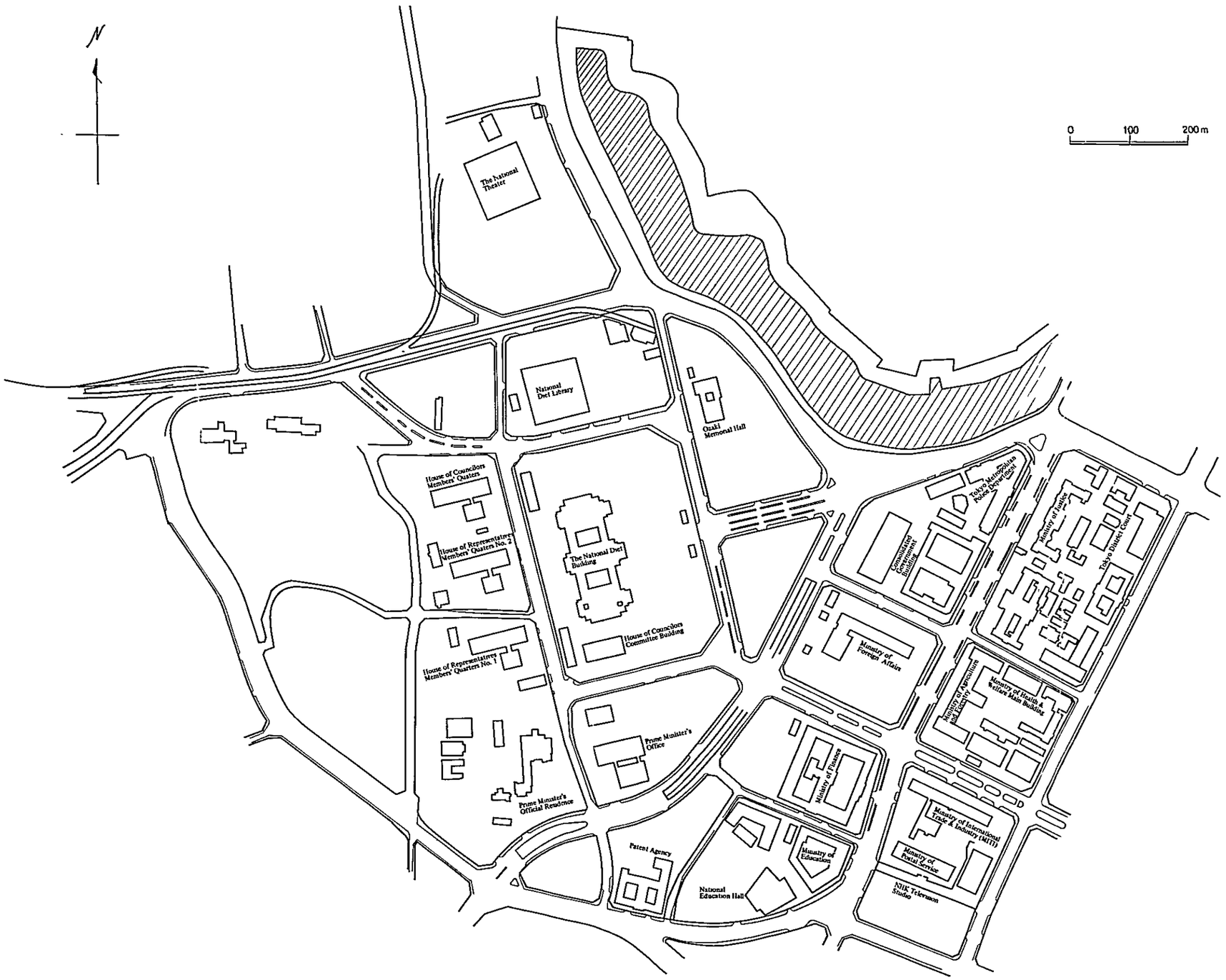
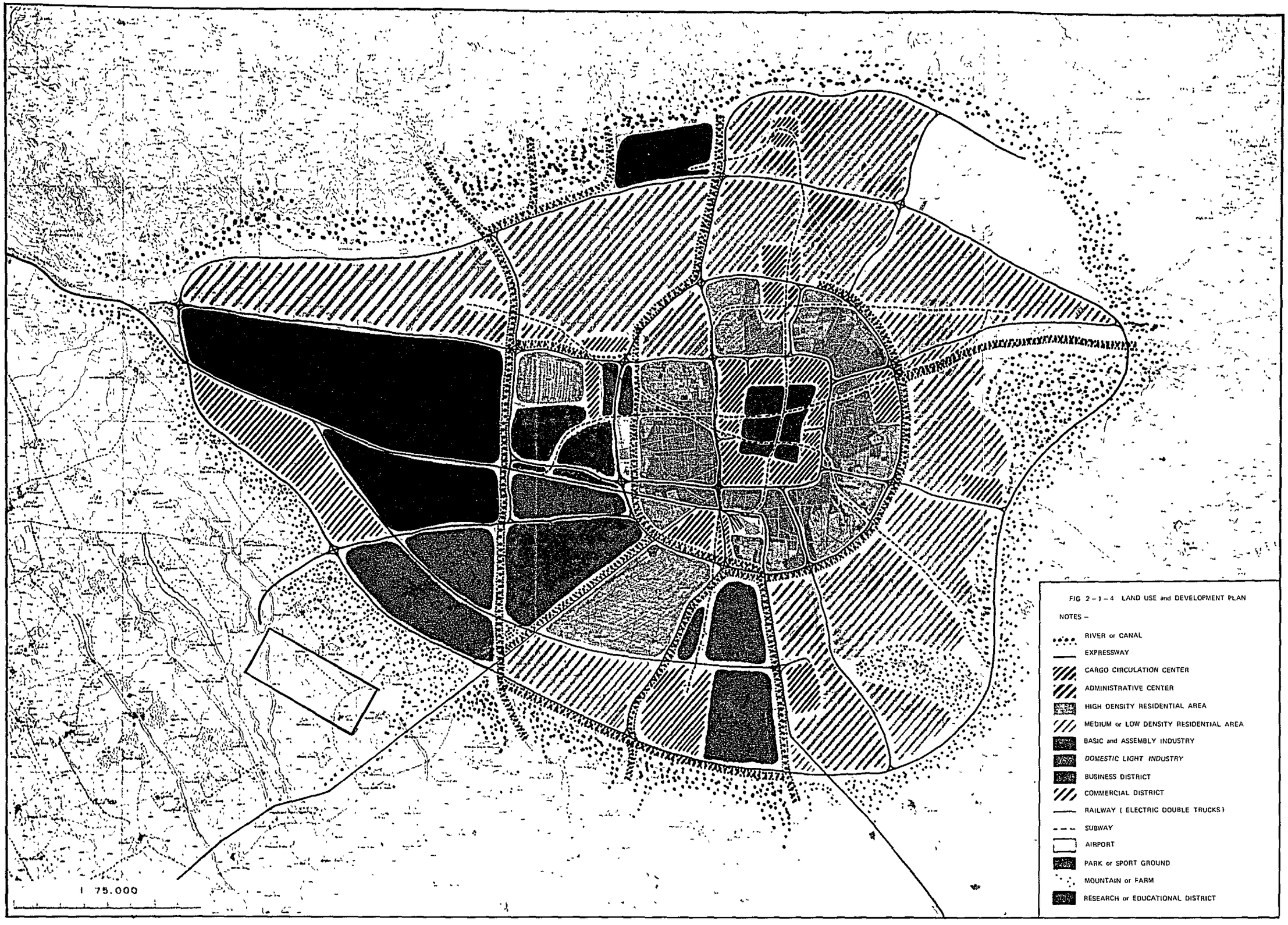


Fig. 2-1-3 Central administrative district plan in Tokyo


1 75,000
FIG 2-1-4 LAND USE and DEVELOPMENT PLAN
NOTES –
RIVER or CANAL
EXPRESSWAY
CARGO CIRCULATION CENTER
ADMINISTRATIVE CENTER
HIGH DENSITY RESIDENTIAL AREA
MEDIUM or LOW DENSITY RESIDENTIAL AREA
BASIC and ASSEMBLY INDUSTRY
DOMESTIC LIGHT INDUSTRY
BUSINESS DISTRICT
COMMERCIAL DISTRICT
RAILWAY (ELECTRIC DOUBLE TRUCKS)
SUBWAY
AIRPORT
PARK or SPORT GROUND
MOUNTAIN or FARM
RESEARCH or EDUCATIONAL DISTRICT

20% of the population of the same generation, the number of college students will be about 800,000, with the addition of researchers, will reach one million. Since the capital city is to accommodate about 50% of this figure, there will be a need for providing universities and research institutes for 500,000 of students and scholars. For this reason, an educational district is to be designated.

Because of a short history of Teheran, cultural service functions are seemed not enough provided. There will be a need for providing facilities which bring people close to classic art such as an Iran's traditional art museum. Western art museum, Oriental art museum or integrated art museum. In consideration of the access of the people to these facilities, it is advisable to plan these facilities in the vicinity of new administration center, also for promoting the dignity of the administrative center.

As for the commercial functions, Bazar is now playing an active role, but its relative importance is gradually decreasing. For example, such advanced industrial products as automobile, electronics and electric equipment seem to have already formed their own distribution channel independent from Bazar. The Bazar is expected to exist as distribution channel for commodities. However, for the distribution of modern industrial products, a completely new distribution channel having its base in the distribution (circulation) center will take the place of Bazar. New distribution centers will be provided near the trunk expressway in the west, south and east.

Industries in the city may be largely classified into the manufacturing industry located in a consumption area and the high skill-need industry. The former includes automobile assembly industry and electric manufacturing industry such as washing machine and television set, and the latter includes manufacturing of precision parts, toys. Since these industries require less water for their operation, and cause less environmental pollution but can add high value, they are suitable for the large cities. Unless the establishments of industries in the city area, through proper judgement in selecting industries, such measures will only lead to the obstruction in the progress of Iran's industrization.

These industries are to be planned in the south but light industries are to be planned in the east and large scale assembly industry is to be planned in the west.

Among service functions, the present soccer stadium located in the center of the city is often causing traffic confusion, therefore, it should be relocated to the suburb, in conjunction with mass transport facilities such as subways. It will be necessary to provide several soccer stadiums around the Olympic Stadium in the west and in the green zone in the south.

For lodging and tourist facilities, since Teheran is also the summer resort for the people in the south, the number of rooming tourists is also expected to increase. Also, with the increase of business activities, demands for small conference halls will be increased and such establishment as hotels, etc. will come to play an active role in providing conference rooms as well as lodging facilities.

Accordingly, a group of hotels having the above functions will have to be located in or around the city center and sub-centers. Their role will be that of the so-called business hotel.

(2) Land Use Plan

Based on the above concept for the assignment of functions, the land use plan has been worked out as shown in Fig. 2-1-4.

(A) New Business District and City Center

A new administrative center is to be formed by using the space of 40 km^2 in the Abbas-Abad. Cultural functions as well as national administration, legislation, judicial bodies and Teheran City Authority are to be assigned in and around this district to form a key project not only for Teheran but for the creation of the capital city as a symbol of Iran.

Business district deploying around Takhte-Jamshid is expected to accommodate many head office functions for country-wide service like NIOC head office. This district is expected to have many multi-story buildings and the average volume index is expected to reach 400% - 500%. To prevent further deterioration of the environments of densely populated area, it will be necessary to convert this district to a high-story building district and at the same time, to provide guidance on building plan to secure vacant lot in consideration of sunshine and lighting.

The commercial center extending from Bazar to Ferdowsi is expected to strengthen the characteristics of Ferdowsi for high-class shopping center and that of Bazar for popularity. For daily shopping, there will be a shopping center provided in the center of each new housing district to fulfill the daily demands.

Business district, even expand its area, will be inadequate to accommodate business functions and workers for the 5 million inhabitants in the future. To accommodate these central management functions without distorting their specific characters, development of the sub-centers while maintaining organic relations with the city center, will be an effective measure. Needless to say, that there is a need for providing adequate means of transportation and communication such as rapid transit railways betwen sub-centers and city center.

(B) Residential Districts

The population flowing into the Teheran Metropolitan Area in the 10 year period from 1956 to 1966 reached about 1.5 million and doubled the total population within the metropolitan area. This rapid increase of population not only brought about the expansion of the city area but has come to demand qualitative change of the housing supply system. It presents supply of housing on large scale housing project, multi-story buildings. There has come to be a pressing need for a basic plan to incorporate such housing project in the city planning.

For new housing district, a hilly district, north of Karaj Road in the west of Teheran, will be most actively developed. Because of peculiarity of climate in Teheran, the hilly area in the north offers cool weather in summer, the greatest advantage in the living condition. This district is expected to be a major housing area for the residents commuting to the city center, with the progress of improvement of major transport facilities such as subways ys and expressways. Employees of business activities in the city center, because of their relatively short working hours and non-physical labor, may endure commuting between the places of work and their residences.

The area within a radius of 500 m from a subway station, walkable distance, will be best utilized as densely populated housing area as well as local commercial district. For the area outside this range, passengers will probably use buses or automobiles or combination of these means and subways for commuting.

In relation to the assignment of industries, meanwhile, the light industrial district in the south is expected to accommodate mostly machinery and parts manufacturing industries which require intensive labor force and small scale industries including cottage industries. Employees in these industries will work for long and irregular hours and commuting over a long distance between the place of works and their homes will be burden for them. It will be necessary, therefore, to provide housing for these employees in the south in the vicinity of the light industrial area. Because of some cottage industries operating within this area, a mixed use of the area for light industry and housing will be unavoidable to some extent.

(C) Industry

For basic industries such as oil refinery and petrochemistry, assignment of industry has already been made to Esfahan and Abadan for the establishment of industrial bases under the national industry assignment project.

Establishment of such large scale assembly industries as automobile industry and electric industry in the district beyond the distance of 120 km from Teheran is being encouraged by providing preferential treatment to these industries. Locating industries in such remote area has resulted in the increase of transport cost for shipping the products to the great consumption area of Teheran and raised the price of product by several per cent. Because of geographical advantages of the area around Teheran, closeness to the great consumption area and convenience in obtaining abundant information as technical data, there still exist potentialities for the concentration of industry on this area. For these heavy industries, the western zone along the Karaj Road, where heavy industries have already been established in part, will be most advantageous judging from the accessibility to other industrial districts. On the other hand, the light industries such as automobile and electric parts manufacturing, sewing and printing, which require intensive labor force but do not require a large scale equipment and have their main sale markets in large cities, will concentrate on Teheran.

It will be necessary, therefore, to allow these light industries to remain in Teheran to a certain extent. For the site of these industries, outlying district in the south will be most appropriate.

(D) Distribution Center

As such business as wholesale market, warehouse and truck terminals are now scattered in Teheran and heavy trucks connecting them make traffic difficulties in the city, they should be accommodated in new buildings provided on the outskirts of the city comprising only related industries. In this distribution center, space for truck terminal, cargo warehouse, wholesale market, office building, parking lots, and storage area is to be provided. In view of progressed modernization of distribution system, the establishment of new distribution centers at this opportunity is considered most appropriate.

Distribution centers in the west and south have special significance for circulation of industrial products, and fresh foodstuff, etc.

Industrial products, raw materials, construction materials, foodstuff, consumables will be transported to this distribution center via National highways and state railways, sorted out and required materials will be hauled into the city by appropriate means of transportation.

(E) Green Zone

In addition to the proposed Olympic Stadium and the afforestation program in the west, formation of green belts along the bank of rivers and in the canal bed within city area will be most effective as a means of supporting systematic afforestation of the city area. To meet the increase of population and the growth of demands for recreational facilities in the future, improvement of sport ground such as soccer ground will also be necessary.

In the desert, south of the city area, a large scale afforestation program along with the improvement of canals will contribute to providing recreational facilities.

2.2 Traffic Planning

2.2.1 Traffic Demands

(1) Forecast of Traffic Demands

The Teheran Metropolitan Area, with its vast land, water resources, transportation situation, availability of labor force, market situation and information service, has an advantage over other districts and its population is expected to exceed the 10 million mark in about 20 years.

Characterizing Teheran for the tertiary industry and Karaj (1.5 million population) and Qazvin (2.5 million population) for manufacturing industries, it will be inevitable that a fairly large portion of urban industries will be located in the vicinity of Teheran from the standpoint of profitability of enterprise and providing international competitive power.

Fixing the total future population at 6 million, forecast of urban traffic demands is to be made on the basis of reasonable land use plan for assigning that population and buildings to 23 divided zones. Using numerical relationship, Gravity Equation, between traffic generation in each zone which can be calculated following the flow chart (Fig. 2-3-1 in Part I) and distance between each zone, person's trip number between each zone have been computed with the coefficients of Gravity Equation gained in the Origin-Destination survey in Hiroshima city, Japan.

With 31 million unlinked person's trips as the controlled total in correlation with the other characteristics of Teheran, number of trips between each zone have been computed through iteration mehtod by a computer. Table 2-2-1 shows traffic between Origin-Destination by classifying the zone into (A) existing city area, (B) suburbs of existing city area and (C) outlying new sub-center area.

Table 2-2-1 Estimated Trip Number

Unit: Trip/day

O \ D	A	B	C	Total
A	11,998,714	3,789,657	1,384,471	17,172,842
B	3,789,657	4,401,283	1,318,223	9,509,163
C	1,384,471	1,318,223	1,674,749	4,377,443
Total	17,172,842	9,509,163	4,377,443	31,059,448

(2) Modal Split by Means of Transportation

Modal split of traffic volume, share between the means of transportation, may depend on purpose of trip, traveling time, fare, comfortability and custom. The sharing rate, applicable to Teheran is shown in Table 2-3-2 in Part I.

Of the total person's trips between zones, the number of person's trips concentrating on the business district of the city center is 5.9 million, of which 3.5 million is by transport facilities or other than foot passengers. Assuming the rate of concentration in a peak hour is 25%, the number of trips dependent on transport facilities in a peak hour will be 880,000. If this figure is to be distributed to subways and automobiles, the number of trips by passenger cars and buses is estimated at 600,000 and by subways at 280,000.

Also, with the expansion of the city area and the change of riding habit, the commuting traffic is expected to depend on the rapid transit railways, and the business traffic, is expected to make a positive use of expressways.

2.2.2 Basic Policy of Traffic Planning

City functions of Teheran, the capital city of Iran, are diversified. The city is expected to shift gradually from the present single core pattern to multi-core pattern, and to take its course to the west and south, in view of the expanse of land, water resources, and convenience of traffic to Esfahan and Qazvin.

There will be a need for an urban transport systemwhich will be able to satisfy all of these requirements, and also a frame work for the future growth of the city. This system must always be able to serve for business and commutation, which are the main objects of the urban traffic. There will be a need for planning of trunk road such as expressways for business, circulation center for commodities, terminal buildings for parking, and subways for commuting. Implementing those projects, it will be necessary to secure, in advance, spaces to accommodate transportation facilities in the newly developed area, to make redevelopment plan of the built-up area of the city with the construction plan of new urban expressways and rapid transit railways.

For this reason, a master plan must be worked out for 10 year and 20 year periods respectively. In the Master Plan, the traffic system, a combination of circular and ladder pattern, is desirable, because it will contribute to the redevelopment of the built-up area of the city, and the establishment of new city centers and sub-centers and commodity circulation centers, traffic terminal buildings.

2.2.3 Proposals for the Rapid Transit and Urban Expressway Network

Under the rapid transit projects (Chapter 4) both the subway construction of subways and improvement of State Railway may be conceived. A network of subways, which is capable to provide a direct service to the expanse of the business district in the present city center, the Mehrabad Airport around which may become one of sub-centers in the future, sub-centers in the south and east and the administrative center in the north, within a walking distance from the nearest stations is desired. This rapid transit network must be in a structure which enables mutual train operations with the State Railway.

This network should also connect the residential districts to the business districts as directly as possible by the adoption of the Turner system which enables passengers to go any destination by only one transfer.

For this reason, four rapid transit railways, Route 1, 2, 3 & 4, are hereby recommended. Route 1 originates at the present Central Station of the State Railways, links the present city center with Abbas-Abad, and Tajrish and reaches the proposed new university. Route 2 has connection to the State Railway in the south of Mehrabad Airport, runs through sub-city center, which will be a future business district, the present city center and finally reaches Teheran pars. Route 3, for the convenience to the new residential district in the west, originates in Kan through the new sub-city center and the present city center,, and finally reaches the residential district in the southwest. Route 4 originates in the commodity circulation center planned in the south, runs through the present city center and Abbas-Abad and finally reaches Teheran pars.

The urban road network consists of the urban expressways, trunk streets, and traffic terminals (Chapter 3).

Under the urban expressway network plan, there are the Central District Ring Expressway, the Suburban Ring Expressway which pass around the outskirts of the present city area and provide a linkage for the groups of sub-city centers, and the Outer Ring Expressway which passes around the outskirts of the future city area. These three Ring Expressway are to be provided with Radial Expressways to be connected each other to increase efficiency of the network. In the city center and sub-centers, connection to various traffic terminals are to be contemplated.

Under the trunk street improvement projects, from improvements of level crossings to the construction of multi-lane streets, prior to those improvements, effective signal operations, traffic regulations and restrictions should be enforced vigorously. For this purpose, such improvement works as the conver version of rotary squares into regular intersections and the establishment of facilities for pedestrian's crossing without injuring roadside trees are recommended.

CHAPTER 3 EXPRESSWAYS

3.1 Expressway Network Pattern

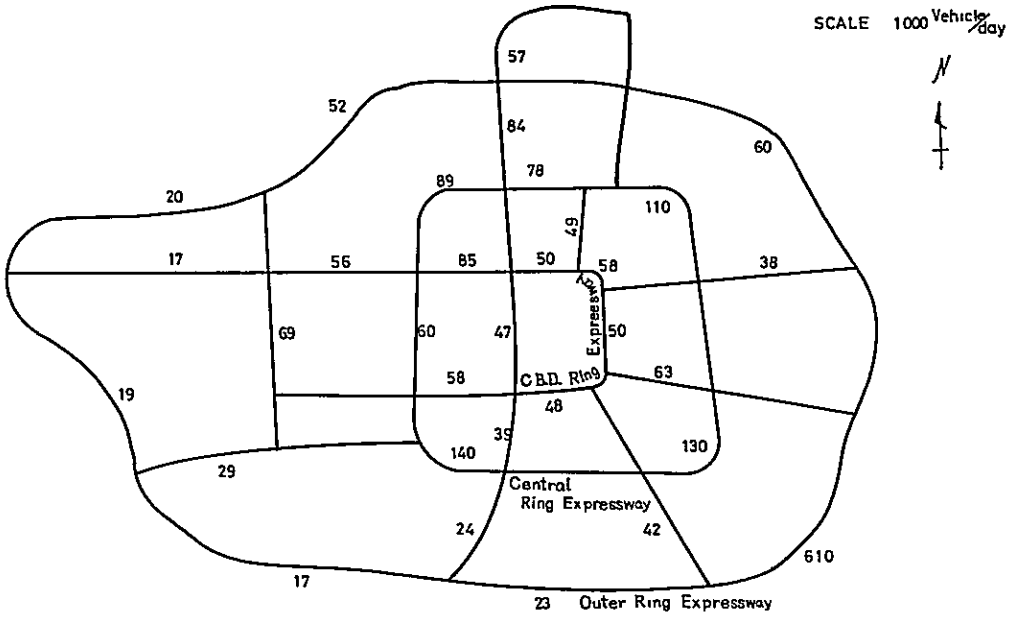


Fig. 3-1-1 Road network pattern

The pattern of expressway network suggested in Part II places the emphasis on securing smooth communications by providing an effective linkage between the present city center and new sub center planned in the western region as previously mentioned in Chapter 2. For this purpose, C.B.D. Ring Expressway is to be provided around present Central Business District and the planned new sub-city center.

As this C.B.D. Ring Expressway forms a large ring having a total length of 27 km, a cross-over expressway across the middle of the ring to increase the efficiency of expressway network is also provided.

In the outer edge of the planned new outlying city areas, an Outer Ring Expressway is to be built with the aim of providing connections to the inter-city highways converging on Teheran and the linkage to the planned commodity distribution center.

In future, the city area of Teheran will cover a vast land area, so,this Outer Ring Expressway is expected to form a ring having a radius of 10-15 km and a total length of 100 km. Between C.B.D. Ring Expressway and Outer Ring Expressway, Central Ring Expressway which links the new administrative district in Abbass-Abad with sub center must be newly added. And those three Ring Expressways are linked one another by Radial Expressways.

The city structure suggested in Part II emphasizes the concentration of commercial and business activities mainly on the present city center and the planned sub center. The future activities of Teheran will depend on the traffic capacities of above mentioned three Ring Expressways.

3.2 Assignment of Traffic Volume

Computations of traffic assignment over the whole trunk street and expressway network was made in the same manner as that used in Part I. The importance of the Central Ring Expressway may be conceived also from the resultant traffic volume of computation shown in Fig. 3-1-1.

3.3 Outline of Planned Routes

i) C.B.D. Ring Expressway

This is the expressway which encircles present city center and the planned new sub center. The east half of this C.B.D. Expressway will have one-way operated three lanes running over the existing streets by elevated structure, almost in the same route as suggested in Part I. The section linking the present city center with the projected sub center, in the west half of this Ring Expressway is to be of two-way operated 6 lanes.

ii) Central Ring Expressway

This is a 6 lane Ring Expressway having a radius of about 6 km around the present city center. It runs through south of Abbass-Abad, Narmak and the Central Station of the State Railways and overlaps the west part of C.B.D. Ring Expressway. Elevated structure may be unavoidable in some part of the city area but the banking should be adopted as much as possible to save construction cost.

This route is to provide a linkage between inter-city trunk highways converging on Teheran, each other.

In the future, this Central Expressway is expected to play an important role as a Ring Expressway running through the built-up area of expanding Teheran Metropolitan Area.

iii) Outer Ring Expressway

This is the route which will become indispensable in the future for Teheran Metropolitan Area with population of 6 million. It provides a linkage between inter-city highways each other, and at the same time connects directly to the commodity distribution centers and truck terminals to alleviate traffic congestion within the city area. This expressway is to have 6 lanes.

iv) Radial Expressways

The aforementioned three Ring Expressways to be linked each other by 4 lane Radial Expressways as shown in Fig. 3-1-1 and they are composing expressway network, which will play a important role in the city traffic.

3.4 Estimated Construction Cost

The total length of the planned expressways including Ring and Western Suburban Expressways is 310 km and because they are longer than those described in Part I, the total construction cost is estimated at 61,000 million Rials.

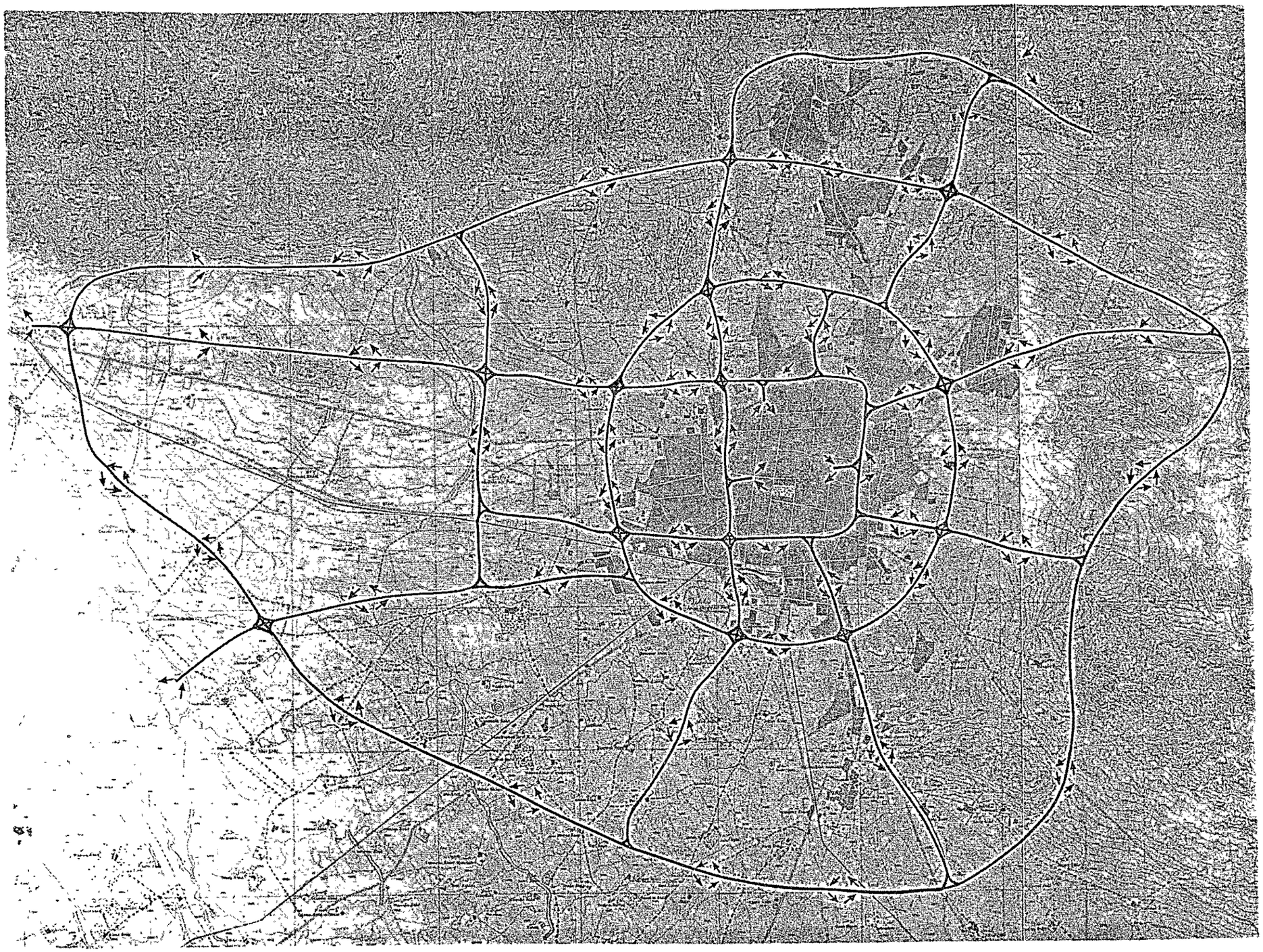


Fig. 3-1-1 Road Network Pattern

3.5 Priority in the Start of Work

The route to be constructed first is the east half of C.B.D. Ring Expressway corresponding to Part I, and cross-over expressway in the center of the C.B.D. Ring Expressway and Radial Expressway No. 1 which is the extension of the cross-over expressway.

The next phase will be the Central Ring Expressway and its inner Radial Expressways.

For the Outer Ring Expressway and Radial Expressways which are outside of the Central Ring Expressway, it is advisable to make pre-arrangements for the acquisition of land and legislation of restrictive measures on building construction in preparation for the construction of those Expressways, as soon as possible.

CHAPTER 4 RAILWAYS AND MONORAILS

4.1 Urban Transit Network

As stated in Part I of this report, the urban transit system in many cities in the world was first developed with the aim of alleviating surface traffics in the center of the city. However, when the residential districts gradually expanded from the center of the city to the suburban areas and further to the suburbs following the growth of the city, a means of commuting became a pressing need and the construction of large scale railways began as a means of mass transportation. In Teheran also the construction of an urban transit system must not be aimed only at alleviating surface traffic but must be planned in conjunction with the future city plan, land usage and road projects.

As regards residential districts, the hilly area north of Karaji road to the west of Teheran is expected to be developed most intensively as a new housing area. The area in and around Teheran Pars to the east of Teheran is now being developed. An administrative center is being projected for Abbass-Abad, sub-centers are expected to be developed in the Mehrabad Airport area, other sub-centers are being planned for the south and east, and distribution centers are being planned for the west, south and eastern areas. The area in the south is also expected to be developed eventually following environmental improvement. All of these potentialities must be taken into consideration in projecting the railway network.

In determining the railway network the most effective method will be to consider the Iranian State Railways as part of the network, after improvement; for this project in particular, such a plan will not only accelerate construction work but will also contribute to the reduction of the construction costs.

In consideration of the above facts, the following lines are recommended.

No. 1 Line and No. 2 Line

Both routes take the same course in some sections as explained in Part I, No. 1 line starts from the State Railway Central Station, extends north along Hayyan street, crosses the No. 3 line on Sepah Street, crosses the No. 2 line on Saadi Street, there extends north and crosses the No. 4 line in Abbass-Abad where a new administrative center is being planned, and finally reaches Tajrish which is expected to be the sub-center in the north in the future. As is seen from the above, this line is connected to each of the proposed lines and it not only runs through the center of the city from south to north linking the government office district, business centers, shopping areas and bazar but extends to the area now being developed in the north. This line is considered as the necleuss of the projected railway network.

The No. 2 line starts from a new station which will be provided on the improved line of the State Railway south of Mehrabad Airport, runs under the airport, passes south of the new downtown area expected to be created in the vicinity of the airport, heads east on an elevated structure in some sections and then goes underground, crosses the No. 3 line on Tarasht Street and the No. 4 line on Simetri Street, proceeds east along Shah Street, passes north of Istanbul Street (the shield tunneling method is to be used for this section), crosses the No. 1 line on the Saadi street, runs along Mehran street and then passes under the No. 5 Radial

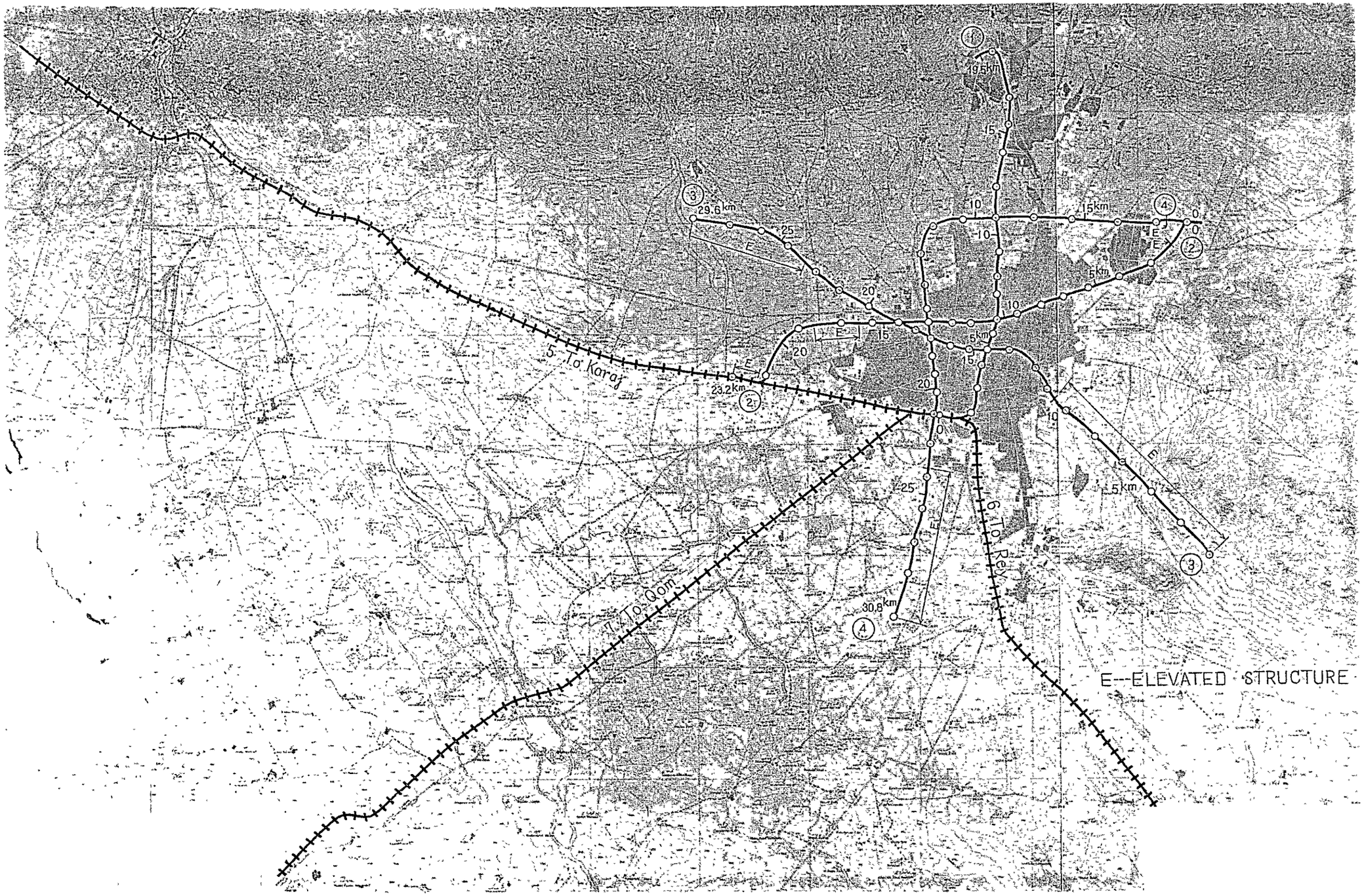


Fig. 4-1-1 Subway network in Teheran

Road under the Highway Project (the road starting from Emamiya and running north of Dowshan Tappel Airport), and extends east to reach Teheran Pars and connects with the starting point of the No. 4 line. Accordingly, it will be necessary for the construction of this line to be coordinated with the highway project in respect to the timing of the work.

No. 3 Line

As previously stated, the residential area is expected to expand northwest of Teheran. This line starts south of Kan on an elevated structure, goes underground in the vicinity of Hasan Abad and Tarasht, runs north of the new city center, proceeds southeast along Tarash Street, crosses the No. 2 line, which runs along Shah Street south of Eisenhower Street, corsses the No. 4 line which runs along Simetri Street, runs east to cross the No. 1 line, passes through Amirkabir Street and Shambaz Street, runs on elevated structures after passing Dolab and proceeds southeast along Kharrasan Street. It is advisable to complete the section up to Dolab during the first phase, and extend the line step by step in the future. This line is expected to be the busiest line in the future.

No. 4 Line

This line originates in Teheran Pars, runs west and crosses the No. 1 line in Abbass-Abad, runs down south at Youset-Abad after passing Pahlavi Street, passes through Amira Bad, runs south along Amirabad Street, Crosses the No. 2 line on Shah Street, Proceeds along the Simetri Street, crosses No. 3 line which runs along Sepah Street, passes under the State Railways at the Central Station of the State Railways, runs over an elevated structure after passing the sub-city-center in the south, then again runs south to reach the proposed distribution center.

The total length of each line is shown in the table below. The total length of the four proposed lines is 103.1 km. Consideration was given in the design of the line alignment so as to make the expensive underground portion as short as possible and to limit the underground portion only to unavoidable cases and to bring the line to the surface as early as possible. Also, in consideration of the future growth of the city area, the surface portion was decided to be built on an elevated structure.

Table 4-1 Length of Each Structure (Unit: km)

Box section \ Route No.		No. 1 Route	No. 2 Route	No. 3 Route	No. 4 Route	Total length
Underground structure	Tunnel	19.5	19.4	13.8	22.3	71.0
	Shield tunnel	-	3.2	-	-	3.2
Elevated structure		-	4.6	15.8	8.5	28.9
Total length		19.5	23.2	29.6	30.8	103.1

4.2 Estimated Transport Capacity

As stated in Part I, the total number of journeys made by railway estimated on the basis of the results of trial calculations made in Chapter 2 is approximately 4.65 million a day.

Broken down, the route in the eastern direction, starting from the north of Mehrabad Airport and reaching Hasan Abad and Kan via the sub-city-center planned for Tarash, is expected to have about 920,000 journeys, next the route in the northern direction linking Abbass-Abad with Tajrish is expected to have 900,000 journeys, the route in the eastern direction reaching Teheran Pars 580,000 journeys, the route in the southeastern direction covering Dolab and Mesager-Abad 640,000 journeys, the route in the southern direction along the State Railway including Rey 620,000 journeys and the route within the downtown area about one million journeys.

A distribution of these figures amongst the subway lines and the improved li lines of the State Railways shows the following daily transport capacity:

Subways

No. 1 line	950,000
No. 2 line	890,000
No. 3 line	1,150,000
No. 4 line	780,000

Improved lines of the State Railways

5. For Karaji	380,000
6. For Rey	360,000
7. For Qom	150,000

Remarks: The number of passengers on the improved lines of the State Railways shown above only represents those travelling within the previously stated 23 zones and does not include passengers travelling from outside the zone.

4.3 Railway

As in Part I, this section will cover the entire subway route from the project plan to the construction costs.

As the design standards, the design of the tunnels and elevated structures, the construction and auxiliary facilities such as the electrical equipment are all the same as in Part I, please refer to Part I.

4.3.1 Operation Plan

The calculation of operating headways on the basis of the estimated transport capacity of each line gives the number of journeys to the center of the city on each railway line as shown in the table below. Judging from the fundamental concept of the city, the volume of transport concentrating on the center of the city is expected to increase rapidly and accordingly the size of the railway contemplated in Part II has to be larger than that envisaged in Part I. Consequently, the number of cars required for each line will be as follows:

Line	Operating Number of Cars	Number of Cars to be maintained
No. 1 line	208	239
No. 2 line	232	267
No. 3 line	360	414
No. 4 line	240	276
Total	1040	1196

Table 4-2 Maximum Planned Transport Capacity and Minimum Operation Headways

Route		Total Traffic Volume per Day Unit:1000	Volume of Traffic in one Direction per Day Unit:1000	Traffic Volume per hour during Rush Hours (one way) Unit:1	Planned Transport Capacity Unit:1	Capacity Efficiency Per cent	Car Formation Number	Minimum Operating Headway Min.	Number of Trains Operated Per hour Number
Subway	No. 1	950	475	47,000	28,800	163%	8 cars	2-1/2	24 trains
	No. 2	890	445	44,000	28,800	153 "	8 "	2-1/2	24 "
	No. 3	1,150	573	57,000	36,000	160 "	10 "	2-1/2	24 "
	No. 4	780	390	34,000	21,600	157 "	6 "	2-1/2	24 "
Improved lines of Iranian State Railways	5 Karaj	380	190	-	-	-	-	-	-
	6 Rey	360	180	-	-	-	-	-	-
	7 Qom	150	75	-	-	-	-	-	-
Total		4,660	2,330	-	-	-	-	-	-

Table 4-3 Operating Speed and Running Time on Each Subway Route

Items	No. 1 Line	No. 2 Line	No. 3 Line	No. 4 Line
Length of line	19.5 km	23.2 km	29.6 km	30.8 km
Number of stations (both terminals included)	16	17	22	23
Junction stations	3	3	3	3
Others	13	14	19	20
Average distance between stations	1.24 km	1.45 km	1.41 km	1.40 km
Total running time	37 m	39 m	46 m	49 m
Scheduled speed	32 km/hr	35 km/hr	38 km/hr	38 km/hr
Maximum speed	70 km/hr	80 km/hr	80 km/hr	80 km/hr

4.3.2 Estimated Construction Costs and Priority in Construction Work

Though the calculation of construction costs was made in the same manner as for Part I, the overall construction costs are higher than those estimated in Part I due to the additional construction costs of the No. 4 line which, under this plan, takes the same course as in Part I from Teheran-Pars up to Yousef Abad but requires an underground structure for the section from Yousef Abad up to the vicinity of Teheran Central Station. The construction cost costs for each line are shown in Table 4-4.

Priority in the construction work for the proposed lines is almost identical to that proposed in Part I. However, the elevated structure in the south-eastern section of the No. 3 line and that in the southern section of the No. 4 line will probably be constructed in the last stage depending on the progress of development in the respective areas.

Table 4-4 Itemized Construction Costs of Each Route

Classification	Route No. 1 19.5 km	Route No. 2 23.2 km	Route No. 3 29.6 km	Route No. 4 30.8 km	Total 103.1 km
Cost of:					
Structure works	6,400	5,370	5,050	6,100	22,940
Buildings & interior finishings of stations	250	250	290	300	1,090
Tracks	230	270	340	360	1,200
Electrical equipment	1,370	1,420	2,130	1,820	6,740
Car sheds	710	4300	830	740	2,710
Cars	1,820	2,030	3,150	2,100	9,100
Administration	650	590	710	690	2,640
Total	11,430	10,360	12,500	12,110	46,400

4.4 Monorail

4.4.1 Planned Transport Capacity of Monorail

Similar to Part I, the monorail project for Route 1 and Route 2 envisaged in this part may be shown as follows. The location of route for two proposed lines remains the same as in Part I.

Truck structure also remains the same as in Part I. Transport demand for the rush hours is estimated far greater than that envisaged in Part I.

	Part I	Part II
Route 1	35,000 persons/Hr	47,000 persons/Hr (135%)
Route 2	31,000 persons/Hr	44,000 persons/Hr (142%)

The train operation plan is as shown in Table 4-7-6 in Part I.

The planned transport capacity of monorail is shown in the following Table 4-5, which replaces the planned transport capacity of subway for Route 1 and Route 2 shown in Table 4-2 (of Part II).

Table 4-5 Planned Maximum Transporting Capacity at Rush Hours

	Route	Total person trip/day unit; 1000	Person-trips/day (in one way) unit; 1000	Persons/hour (in rush hour; one way) unit; persons	Planned maximum transporting capacity persons/hr. unit; persons	Riding efficiency %	Cars/train cars	Minimum operating head min; sec.	Operating trains/hour trains
Monorail	No. 1	950	475	47,000	26,500	178	8	2m30s	24
"	" 2	890	445	44,000	22,080	199	8	3m00s	20
Subway	" 3	1,150	575	57,000	36,000	160	10	2m30s	24
"	" 4	780	390	34,000	21,600	157	6	2m30s	24
Improved state railway	for Karaj	380	190	-	-	-	-	-	-
	for Rey	360	180	-	-	-	-	-	-
	for Qom	150	75	-	-	-	-	-	-
Total		4,660	2,330	-	-	-	-	-	-

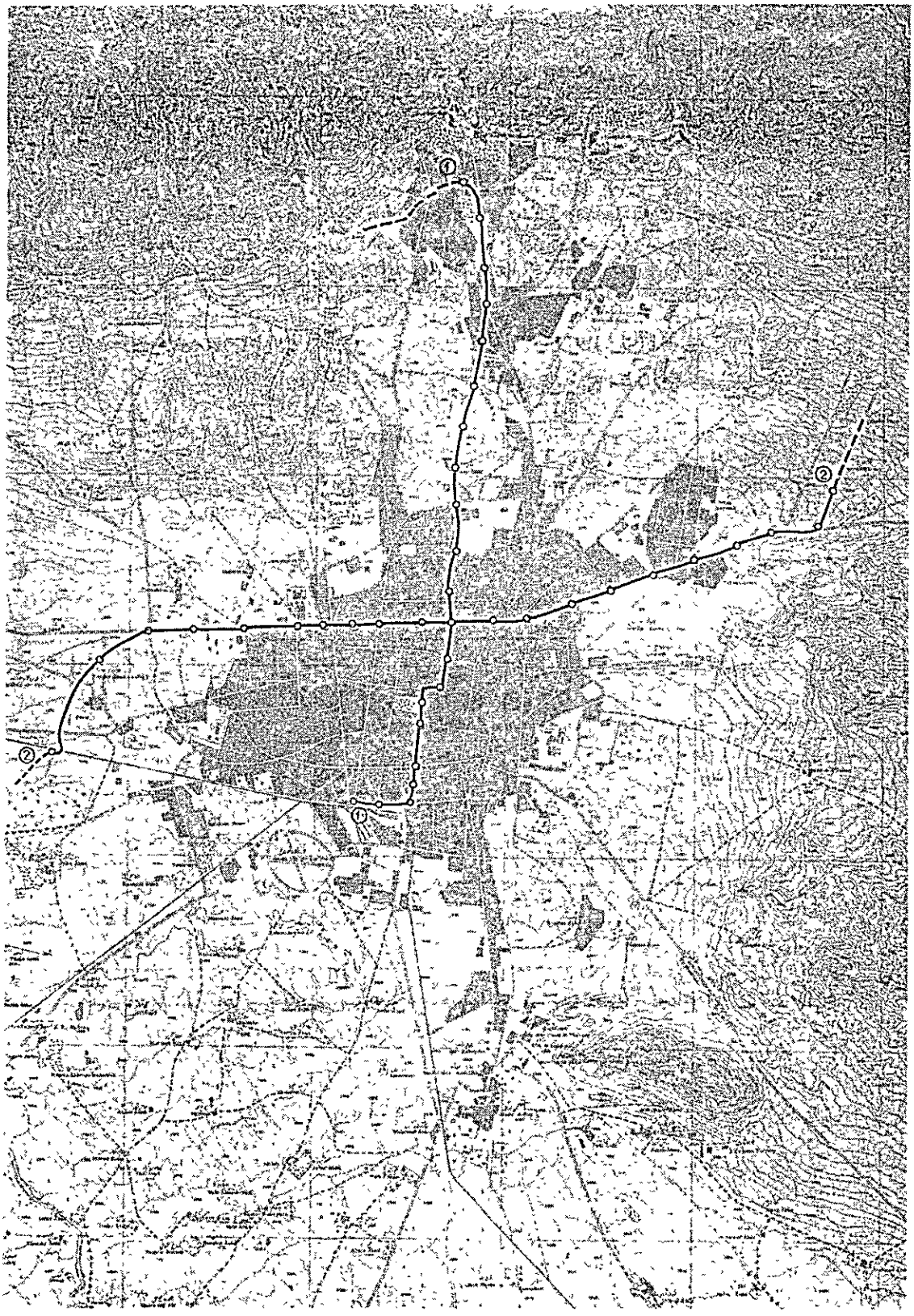


Fig. 4-4-1 Monorail network of Teheran City

4.4.2 Estimated Construction Costs of Monorail

Calculation of construction costs was made in the manner similar to that employed in Part I.

However, because of a greater transport demand envisaged in Part II, the number of rolling stock will inevitably increase and as a result, the investment for other related facilities will have to be increased accordingly.

Table 4-6 shows an estimated construction cost of the proposed monorail.

Table 4-6 Construction Costs of Proposed Monorail

	Route 1		Route 2	
		M.Rial		M. Rial
Construction of Track	km 19.0	1,594	km 23.1	2,192
Station facilities	station 21	450	station 21	520
Power facilities	km 19.0	618	km 23.1	662
Signal and communication facilities	complete 1	366	complete 1	344
Car shed	complete 1	560	complete 1	520
Rolling stock	car 304	2,614	car 258	2,219
Administration expenses	complete 1	287	complete 1	339
Total		6,489		6,796

Errata

Page	Line	Error	Correct
69	Table 4-6-2	L=15 km 40 km/hr	L=15 km, 40 km/hr L=17.3 km, 60 km/hr
92	31	for negative, and the	for negative.
99	20	live	line
	21	lives	lines
	30	signal warning devices	signal devices
	31	signs	public address system
100	13	Small scale subway	Small scale station
	14	Large scale subway	Large scale station
101	38	6.8.1.5	6.8.1. (E)
104	2	thettrain	the train
106	35	control system:	control:
107	2	Simplification	Arrangement
108	33	generating	dynamic
	36	generating	dynamic
110	16	2.88	2.87
	18	4.15	4.145
	19	3.68	3.65
113	31	by Di, the number	by Di, the number of cars to be maintained by N, the number
120	Table 4-6-6	reals	rials
		Route No.1 29.5 km	Route No.1 19.5 km
		" No.3 32.2 km	Route No.3 32.2 km
		10,860	10,840
		Car sheds	Car sheds and work shops
222	Table 4-4	-	(unit: million rials)
		22.940	22.920
		4300	430