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JAPAN INTERNATIONAL
COOPERATION AGENCY(JICA)

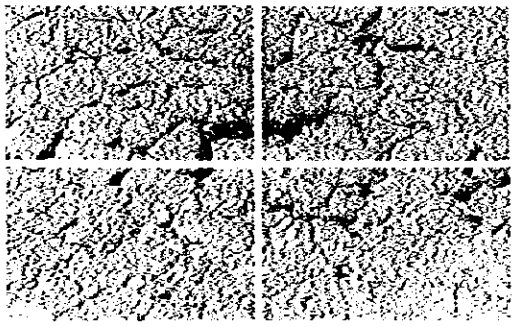
GENERAL DIRECTORATE OF HIGHWAYS
MINISTRY OF PUBLIC WORKS AND SETTLEMENT
THE REPUBLIC OF TURKEY(KGM)

THE STUDY ON ARTERIAL HIGHWAY MAINTENANCE IN THE REPUBLIC OF TURKEY

FINAL REPORT

MAIN REPORT

VOLUME ❷



JULY 1998

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The following foreign exchange rate is applied in the study:

US$1.00 = 242 170 Turkish Lira (as of March 1998)

PREFACE

In response to a request from the Government of the Republic of Turkey, the Government of Japan decided to conduct "The Study on Arterial Highway Maintenance" and entrusted the study to the Japan International Cooperation Agency (JICA).

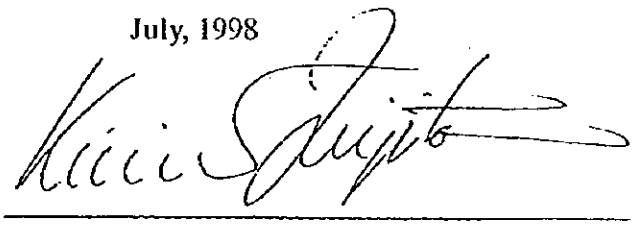
JICA sent to Turkey a study team headed by Mr. Takao INAMI, and composed of members of Oriental Consultants Co., Ltd. and Japan Overseas Consultants Co., Ltd. from March 1997 to May 1998.

The team held discussions with the officials concerned of the Government of Turkey, and conducted three(3) field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Turkey for their close cooperation extended to the team.

July, 1998



Kimio Fujita
President
Japan International Cooperation Agency

Letter of Transmittal

Mr. Kimio Fujita,
President
Japan International Cooperation Agency
Tokyo, Japan

We are pleased to submit to you the study report on Arterial Highway Maintenance Study.

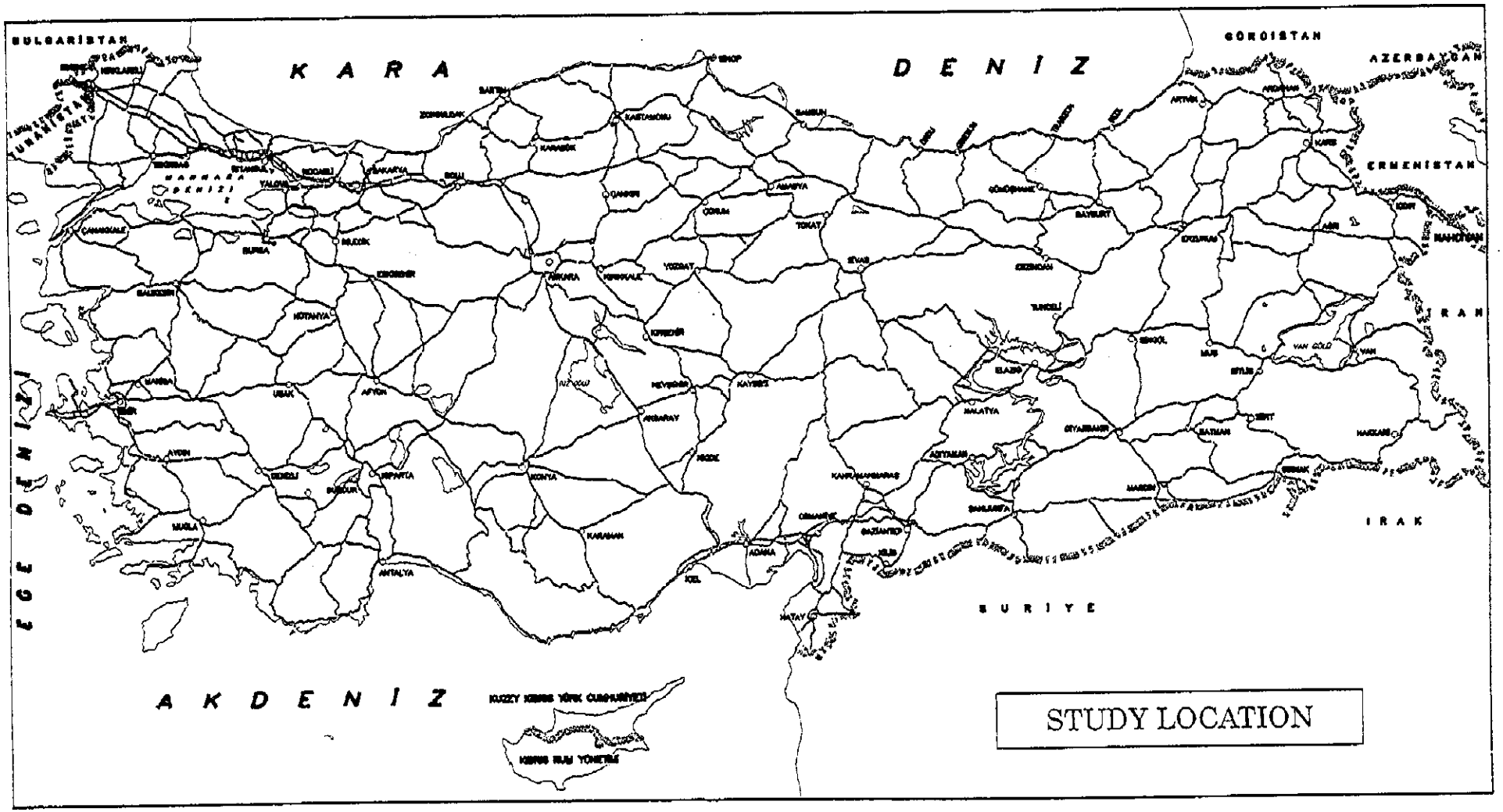
This study was conducted by Oriental Consultants Company Limited, in association with Japan Overseas Consultants Company Limited under a contract to JICA, during the period of March 1997 to July, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Turkey and formulated the Road Maintenance System in Turkey.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Public Works and Settlement. We would also like to express our gratitude to the officials concerned of the Arterial Highway Maintenance Study, the Embassy of Japan in Turkey and the JICA Turkish Office for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,
July 1998

Takao INAMI
Project manager,
Study Team on the Arterial Highway
Maintenance in the Republic of Turkey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SURİYE
A K D E N İ Z
EGE DENİZİ
STUDY LOCATION

PROJECT SUMMARY

1. COUNTRY	The Republic of Turkey
2. NAME OF STUDY	The Study on Arterial Highway Maintenance
3. COUNTERPART AGENCY	General Directorate of Highways, Ministry of Public Works and Settlement
4. OBJECTIVES OF STUDY	① To develop Road Maintenance Manuals ② To formulate an implementation plan for a road maintenance management system

1. STUDY AREA : All state and provincial roads in Turkey

2. DAMAGE TYPE AND PRELIMINARY ROAD INSPECTION

① Inspection for damage was carried out for the following road structures:

- Embankment - Shoulder - Pavement
- Slope - Retaining Wall - Ice & Snow Control Facilities
- Drainage (Side Ditch, Culvert, Gully)

② A preliminary road inspection was carried out on a 2000km study route using a standard inspection sheet. The results of the preliminary road inspection were recorded on a computerized database specifically developed for this project.

3. DETAILED INSPECTION AND REPAIR WORK DESIGN

① Detailed inspection was carried out on 40 sections that were selected based on the results of the preliminary road inspection. The 20 sections from these 40 sections were selected in order to carry out supplementary surveys (soil surveys and topographic survey) and repair work design.

② The design of the repair work methods, used to draw up the road maintenance manuals, were based on the results of the detailed inspection and supplementary surveys.

4. DEVELOPMENT OF ROAD MAINTENANCE MANUALS

The following 2 manuals were prepared:

① Management and Inspection Manual

② Evaluation and Repair Work Manual

The main features of the manuals are as follows:

① In the future management system, it was recommended that responsibility be shifted to Division or Sub-Division offices and to private companies.

② A range of simple to highly technical inspection methods were proposed according to the maintenance budget availability.

③ It was recommended that the causes of damage be analyzed in selecting the repair method.

④ A range of repair work methods were introduced.

5. FORMULATION OF IMPLEMANTATION PLAN

The 2 000km study route was divided into 18 sections in order to develop the following implementation plan:

Sub-Division	NPV US$ million	EIRR (%)	B/C Ratio	Priority	Sub-Division	NPV US$ million	EIRR (%)	B/C Ratio	Priority
Antalya	199.57	136.5	15.9	2	Bolu	197.82	120.6	28.0	5
Burdur	277.44	156.8	18.3	1	Kirikkale	94.67	36.9	11.5	17
Afyon	108.17	44.2	13.7	15	Corum	238.30	104.15	32.3	7
Bursa	36.15	62.0	16.4	13	Amasya	69.17	110.0	18.6	6
Iznik	30.8	134.0	31.1	3	Samsun	356.87	125.4	21.2	4
Bilecik	55.52	49.8	13.2	14	Ordu	118.49	81.1	10.5	10
Eskisehir	97.74	64.5	17.1	12	Giresun	145.76	102.6	13.3	8
Polatli	166.63	35.9	11.1	18	Akcaabat	149.27	69.4	9.0	11
Kizilcahamam	132.43	36.9	11.5	16	Rize	143.99	97.6	12.7	9

6. RECOMMENDATIONS

The recommendations of the Study Team are as follows:

① Road maintenance management should include all aspects of a road and not only pavement.

② Thorough analysis of the causes of damage is necessary.

③ The maintenance manual should be used to provide a uniform road maintenance management system.

④ The maintenance budget should be increased.

⑤ Meteorological data should be recorded.

⑥ A review of design and construction (including the supervision system) should be carried out.

⑦ The greening of roads should be promote.

OUTLINE OF THE STUDY

The Study on Arterial Highway Maintenance in the Republic of Turkey
Study Term : March 1997 – July 1998
Counterpart Agency : General Directorate of Highways, Ministry of Public Works and Settlement (KGM)

1. Introduction

1.1 Background

The General Directorate of Highways (KGM) is a body responsible for the construction and maintenance of around 60 000km of state and provincial road. While the organization is keeping up with its tasks well, it is crucial that KGM become even more cost-effective to meet the demands being made upon it by both the government and the citizenry. To achieve this goal, the standardization and systematization of road management are indispensable. Therefore, the aim of "The Study on Arterial Highway Maintenance" is to assist KGM in creating the most cost-effective road management system possible by designing the most appropriate process for standardization and systematization, which will include the introduction of more systemic methods, a more rational budget allocation, and a plan to maximize highway maintenance effectiveness.

1.2 Study Objectives

The study objectives are:
(1) to develop road maintenance manuals, and
(2) to formulate an implementation plan for a road maintenance management system

1.3 Study Roads

Study roads consist of state and provincial roads, excluding bridges and tunnels. These roads are dealt with by the study in the following way:

(1) Development of the road maintenance manuals	: all state and provincial roads
(2) Preliminary road inspection and evaluation	: approx. 2 000km
(3) Detailed inspection and evaluation	: approx. 40 road sections (approx. 40 km)
(4) Design of repair work	: approx. 20 road sections (approx. 20km)
(5) Implementation plan	: approx. 2 000km

1.4 Study Procedure

The study is comprised of two (2) stages.
(1) First Stage : Execution of a preliminary road survey and the development of a database
(2) Second Stage: Execution of a detailed inspection, the development of a road maintenance manual, and the formulation of an implementation plan

2. Preliminary Road Inspection

2.1 Inspection Items

The following table shows the 9 types of damage considered by the study.

Damage Types	Description
Embankment	(1) Submerge (2) Collapse
Pavement	(1) Settlement (2) Cracking (3) Potholes (4) Rutting (5) Wave
Gulley	(1) Accumulation of debris (2) Settlement (3) Collapse
Shoulder	(1) Washing out
Side ditch	(1) Accumulation of debris (2) Settlement (3) Collapse
Retaining wall	(1) Cracking (2) Settlement (3) Collapse
Snow & ice control facilities	(1) Collapse
Slope	(1) Landslide (2) Rock Avalanche (3) Collapse of protection wall (4) Cracking (5) Erosion
Culvert	(1) Accumulation of debris (2) Settlement (3) Collapse

The study does not consider bridges, traffic safety facilities, and tunnel maintenance systems.

2.2 Inspection Sheet

Inspections were carried out using an inspection sheet. The inspection sheet was prepared to have the following characteristics;

(1) be easy,
(2) display each item to be inspected,
(3) display each type of damage,
(4) be designed so that 1 sheet is for 1 km of road, and
(5) provide basic data on road characteristics, site conditions, and traffic volumes.

2.3 Evaluation of Damage

In order to judge the necessity of repair work, damage and deterioration were categorized into the following three ranks:

"A" : Major damage. Damage is serious and the cause of the problem obvious. Remedial action must be taken as soon as possible.

"B" : Medium damage. Damage noted but an investigation is required into the cause of the problem before any remedial work can be proposed.

"C" : Minor damage. Damage noted but not serious and does not warrant any remedial action. Monitoring is to be continued.

2.4 Development of Database

A database program was developed to manage the data obtained from the preliminary road inspection. The purpose is to enable the data to be recorded, amended, accessed and extracted by KGM maintenance staff. It is also a very useful tool for road managers to gather detailed information about the roads under their control.

3. DETAILED INSPECTION

3.1 Objectives of the Detailed Inspection

The detailed inspection was carried out based on the results of preliminary road inspection with the following objectives:

(1) To collect data and information to analyze the causes of damage.
(2) To determine the damage type and level.
(3) To identify the repair method.

3.2 Inspection Method

The detailed inspection was carried out using simple methods and equipment in order to stay within the current budget available for maintenance work. The results of the inspection were indicated on the inspection sheets.

3.3 Inspection Sheet

The detailed inspection was executed using an inspection sheet for each inspection item. The inspection sheets were prepared to have the following characteristics:

(1) be easy to use,
(2) show each of item to be inspected, and
(3) show the types of damage.

3.4 Supplementary Surveys

The following supplementary surveys were carried out by local consultants in order to analyze the causes of damage:

- Soil survey (boring, CBR test, laboratory test, core sampling of pavement)
- Topographic Survey (Cross section)

4. Preliminary Design of Repair Work

The typical repair methods for each design item are shown in the table below.

Items	Repair Method	Purpose
Pavement	Sealing/Filling	- to prevent water penetration from crack and regain pavement strength
	Patching	- to prevent widening the damage from existing pothole and prevent the water penetrating to lower layer
	Milling and Overlay	- longer term repair to remove the materials and provide a new road surface for improvement ride condition
	Overlay	- longer term repair to improve surface ride quality
	Reconstruction	- permanent repair
	Surface treatment	- to improve surface texture
Embankment	Refill Embankment	- to lift the road surface above the normal flood level
	Improvement of culvert	- to increase discharge capacity by the removal of debris and sediment from the culvert inlet
Shoulder	Asphalt kerb or kerb ditch	- to prevent the shoulder washing out by surface water
Slope	Recutting/Refilling	- to recover the slope stability
	New or Additional Slope drainage	- to prevent the slope from scouring and eroding by water
	Slope protection vegetation, crib, shotcrete, gabion)	- to protect the slope surface from eroding and weathering by surface water
	Weight shifting	- to prevent the embankment slope from slipping
	Structural support	- to keep slope stability and prevent the slope from the rock avalanche or any soil sliding
Other structure /Retaining wall /Drainage/Gully /Side ditch /Culvert	Sealing/filling	- using synthetic resin or cement mortal, to seal or to fill into the crack or depression to keep structural capacity
	Partial/overall reconstruction	- to regain adequate structural strength
	Reinforcement to increase the structure strength	- to reinforce to increase the structural strength

5. Environmental Study

The overall environmental impacts, based on the repair work design for the 20 sections,have been assessed using the JICA Guideline. They are as follows:

(1) Social Environment : Traffic/Public Facilities (2) Natural Environment : Soil Erosion
Waste Coastal Zone
(3) Pollution : Air Pollution Fauna and Flora
Water Pollution
Noise and Vibration

6. Formulation of Road Maintenance Management System

To achieve the road maintenance management system for the target year 2015, it was recommended that the following steps be carried out:

(1) For the most part, continue with the present system for the immediate future.
(2) However, modify the present system as quietly as possible in order to give the Maintenance Department responsibility for all work, including overlaying and reconstruction.
(3) Decentralize decision making by transferring more responsibility to Divisions and Sub-Divisions over a period of time.
(4) Finally, move to privatization by employing private sector consultants and contractors to carry out all the maintenance functions (including inspections, design, supervision and works inclusive of winter maintenance).

7. Development of Maintenance Manual

The Maintenance Manuals comprise the following documents:

(1) The Management and Inspection Manual
(2) The Evaluation and Repair Work Manual

The main features of the manuals are as follows:

(1) In the future management system, it was recommended that responsibility be shifted to Division or Sub-Division offices and to private companies.
(2) A range of simple to highly technical inspection methods were proposed according to the maintenance budget availability.

(3) It was recommended that the cause of the damage be analyzed in selecting the repair method.
(4) A range of repair work methods were introduced.

8. Design Methods

In the main report, the design methodologies for slopes, drainage, and snow and ice control are explained.

Design Items	Contents of Report
Slope	· Preparatory survey (Soil and geological survey, Topographic survey, Hydrological survey) · Slope gradient for each soil condition and road structure · Countermeasures for slope damage · Construction method
Drainage	· Preparatory survey (Weather, Topographic and site survey, Soil and ground water survey) · Calculation of discharge volume · Calculation of allowable discharge capacity · Drainage system (Surface drainage, Slope drainage, Structure drainage, under-ground drainage)
Snow and Ice Control	· Preparatory survey (Weather conditions, Road surface conditions, Traffic conditions) - Snow and ice control measures · Snow removal operation · Ice removal operation · Snow drift control facilities · Avalanche control facilities

9. Traffic Demand Forecast

Traffic demand for the road links on the 2 000km route considered in the preliminary road inspection is forecasted using a model composed of the following three basic components:

- vehicle-km prediction models by vehicle type
- traffic flow processing ratio for road links
- traffic diversion factor

10. Implementation Plan

10.1 Case Study

Case studies were carried out for the following 6 road sections using the World Bank's HDM III model:

1. Burdur 2. Afyon 3. Iznik 4.Eskisehir 5. Amasya 6. Rize

10.2 Economic Evaluation of the Study Road

An implementation plan was formulated by dividing the 2 000km of road examined in the preliminary road inspection into 18 sections. The results of the economic evaluation and project prioritization for these 18 sections are shown in the following Table.

Sub-Division	NPV US$ million	EIRR (%)	B/C Ratio	Priority	Sub-Division	NPV US$ million	EIRR (%)	B/C Ratio	Priority
Antalya	199.57	136.5	15.9	2	Bolu	197.82	120.6	28.0	5
Burdur	277.44	156.8	18.3	1	Kirikkale	94.67	36.9	11.5	17
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Kizilcahamam	132.43	36.9	11.5	16	Rize	143.99	97.6	12.7	9

11. Recommendation

The recommendations of the Study Team are as follows:

(1) Road maintenance management should include all aspects of a road and not only pavement.
(2) Thorough analysis of the causes of damage is necessary.
(3) The maintenance manual should be used to provide a uniform road maintenance management system for all of Turkey.
(4) The maintenance Budget should be increased.
(5) Meteorological data should be recorded.
(6) A review of design and construction (including the supervision system) should be carried out.
(7) The greening of roads should be promoted.

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LIST OF ABBREVIATIONS

KGM	: The General Directorate of Highways
JICA	: Japan International Cooperation Agency
SAP	: Southeast Anatolia Project
AADT	: Average Annual Daily Traffic
TCCD	: State Railways Administration
CBGB	: Cement Bound Granular Base
TL	: Turkish Lira
PSI	: Present Serviceability Index
EIA	: Environmental Impact Assessment
S.P.T.	: Standard Penetration Test
GNP	: Gross National Product
NPR	: Nominal Protection Rates
TUSIAD	: Turkish Industrialists and Businessmen's Association
EIRR	: Economic Internal Rate of Return
NPV	: Net Present Value
B/C Ratio	: Benefit Cost Ratio

CHAPTER I

GENERAL

CHAPTER 1 GENERAL

1.1 The Study

1.1.1 Background

The highway sector plays a dominant role for the transportation of goods and people in the Republic of Turkey. This is expected to increase very rapidly in the future since the country is upholding the policy of integration with the European Union. The Turkish economy must sustain and increase its competitiveness in the international market and to provide a safe and secure mode of transport is one of the direct means of achieving this goal. International transportation is expected to increase both in terms of volume and weight while the Turkish economy is struggling to increase its share in the international market. The Turkish government has been pursuing two goals to secure good road infrastructure; one is by maintaining the present asset in as good a condition as possible; and the other is constructing a network of motorways along the most heavily congested routes. The pace of construction for the latter is slowing down recently due to tightness in the economic situation of the country. The former, however the importance of maintenance is well recognized, is also neglected due to the fact that the concept of maintenance in which the continuation of inspection, maintaining data, timely budget allocation for maintenance work, and such is not understood by the officials concerned.

The General Directorate of Highways (KGM) is a body responsible for the construction and maitenance of around 60 000km of state and provincial road. While the organization is keeping up with its tasks well, it is crucial that KGM become even more cost-effective to meet the demands being made upon it by both the government and the citizenry. To achieve this goal, the standardization and systematization of road management are indispensable. Therefore, the aim of "The Study on Arterial Highway Maintenance" is to assist KGM in creating the most cost-effective road management system possible by designing the most appropriate process for standardization and systematization, which will include the introduction of more systemic methods, a more rational budget allocation, and a plan to maximize highway maintenance effectiveness.

1.1.2 Study Objectives

The objective of the study is to prepare recommendations on road maintenance, which are divided into the following sub-objectives and to transfer technology to KGM through the Study (hereinafter "maintenance" includes inspection and repair):

(1) to develop road maintenance manuals, and
(2) to formulate an implementation plan for a road maintenance management system

1.1.3 Study Roads

Study road consist of state and provincial road, excluding bridges and tunnels. These roads are dealt with by the study in the following way:

(1) Development of the road maintenance manual	: all state and provincial roads
(2) Visual inspection survey and evaluation	: approx. 2 000km
(3) Detailed investigation and evaluation	: approx. 40 road sections (approx. 40 km)
(4) Design of repair work	: approx. 20 road sections (approx. 20km)
(5) Implementation plan	: approx. 2 000km

1.1.4 Study Procedure

The study is comprised of two (2) stages; (1) First Stage; The Visual Survey is carried out; (2) Second Stage; The road maintenance manual is developed and the implementation plan is formulated. The detailed activities for each stage are as follows:

1. First Stage: Ececution of a preliminary road survey and the development of a database

(1) Collection, review and analysis of the relevant data and information
(2) Conduct of visual survey
(3) Development of the database of visual survey results
(4) Analysis of present road maintenance problems

2. Second Stage: Execution of a detailed inspection, the development of a road maintenance manual, and the formulation of an implementation plan

(5) Conduct of detailed survey and supplementary survey
(6) Design of repair works
(7) Environmental impact assessment
(8) Development of road maintenance manual
(9) Formulation of road maintenance management system
(10)Formulation of socioeconomic framework
(11)Traffic demand forecast
(12)Conduct of Feasibility study (Case study)
(13)Implementation Plan

A general flow chart of this Study is shown in Fig.1.4.1. The first of the study commenced in March 1997 and was completed in August 1997. The second stage of the study commenced in October 1997 and was completed in June 1998, including the preparation of the final report of the study.

1.1.5 Study Organization and Participants

The study is being carried out by the JICA Study Team, which is comprised of members of Oriental Consultants Co., Ltd. (OC) and Japan Overseas Consultants Co., Ltd. (JOC), which is organized by JICA, and the Turkish counterpart team organized by their government. The

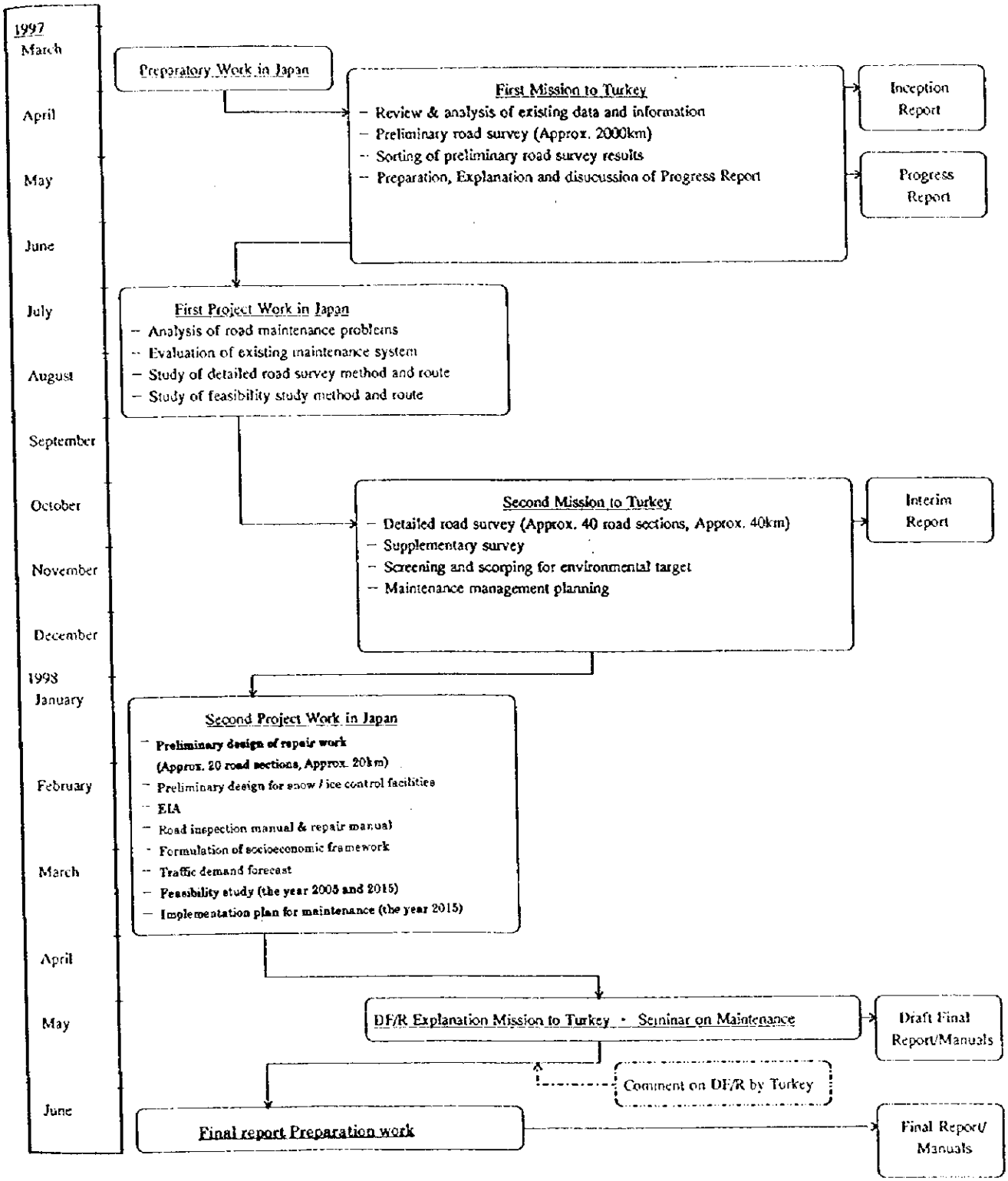

Fig. 1.4.1 Study Flow Chart

JICA Study Team is headed by Mr. Takao INAMI of OC. For the duration of the Study the following committees are set up.

- JICA Advisory Committee
- Turkey Steering Committee

The Study organization is shown in Fig.1.5.1.

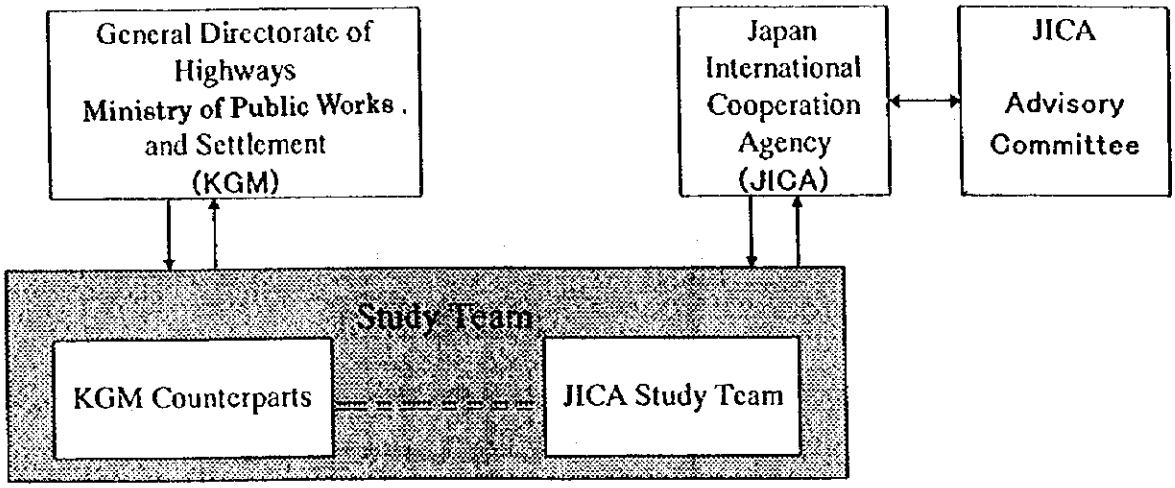

Fig.1.5.1 Study Organization

The members of the Turkish counterpart team, steering committee, JICA Study Team and JICA advisory committee are as shown below:

(1) Members of the Counterpart Team

For Maintenance	
Mr. Riza SARIKAYA	Dir. of Maintenance Div.
Mr. Mustafa KARLIER	Dep. Dir. of Maintenance Div.
Mr. Merih BUYUKLU	Survey and Education Engineer
Ms. Tijen OKTEN	Maintenance Engineer
For Traffic	
Mr. Sabri YILDIZ	Dir. of Traffic Div.
Mr. Muge KAHRAMANGIL	Traffic Research Chief
Mr. Turgay COLAK	Traffic Survey Engineer
Project Officer	
Ms. Muneyver ATASARAL	Dep. Head of Maintenance Department
Senior Highway Engineer	
Ms. Tugba KIPER	Dir. of Photogrametry and Geodesy Div.
Mr. Ismail TUMAY	Dir. of Highway Design Div.
Mr. Salih AKSOY	Dir. of Soil Mechanics and Tunnels Div.

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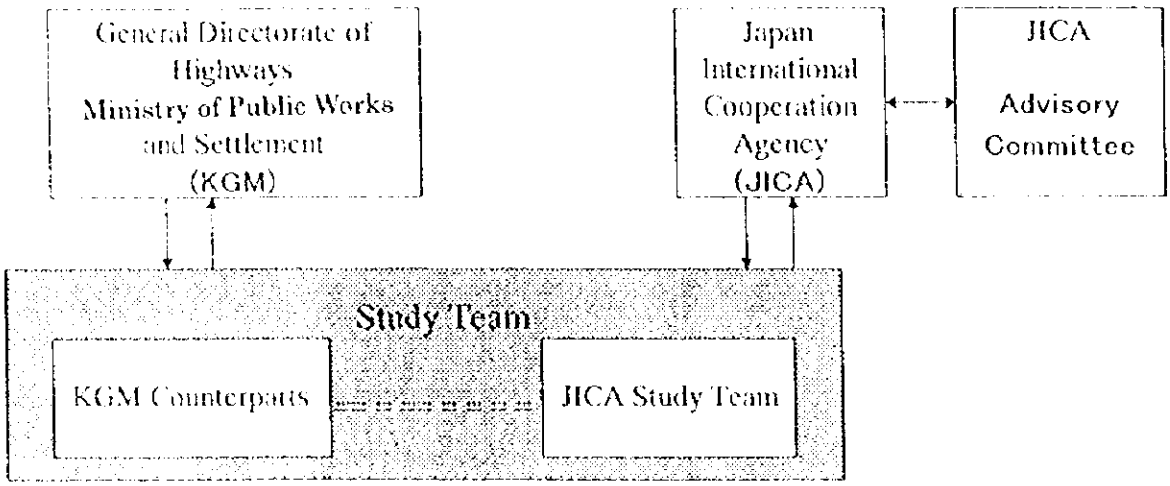

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For Maintenance

Mr. Riza SARIKAYA	Dir. of Maintenance Div.
Mr. Mustafa KARLIER	Dep. Dir. of Maintenance Div.
Mr. Merih BUYUKLU	Survey and Education Engineer
Ms. Ilgen OKTEN	Maintenance Engineer

For Traffic

Mr. Sabri YILDIZ	Dir. of Traffic Div.
Mr. Muge KAHRAMANOGLU	Traffic Research Chief
Mr. Turgay COLAK	Traffic Survey Engineer

Project Officer

Ms. Muneyyer ATASARAL	Dep. Head of Maintenance Department

Senior Highway Engineer

Ms. Ilgiba KIPER	Dir. of Photogrametry and Geodesy Div.
Mr. Ismail UCMAY	Dir. of Highway Design Div.
Mr. Salih AKSOY	Dir. of Soil Mechanics and Tunnels Div.

Road Maintenance / Rehabilitation Engineer

Mr. Rize SARIKAYA	Dir. of Maintenance Div.
Mr. M. Aydin ONAL	Dir. of Pavement Div.

Environmental Specialist

Mr. Gurkan DEMIREL	Dir. of Environmental Impact Assessment

Construction Planning Specialist

Mr. Guralp SERHAT	Dir. of Planning Div.

Construction Cost Estimate Specialist

Mr. Yasar MANGALOGLU	Dir. of Transportation and Cost Analysis Div.

Inspection Specialist

Mr. Hasan YILMAZ	Chief Maintenance Engineer of 4th Div.
Mr. Zubeyde VARAN	Maintenance Engineer in 4th Div.
Mr. Ali KAN	Chief of Central Maintenance Branch of 4th Div.

Person to be get in touch during the site visits

Mr. Lutfu VUR	Chief Engineer of Maintenance of 3rd Div.
Mr. Hasan YILMAZ	Chief Engineer of Maintenance of 4th Div.
Mr. Hasan KAPTAN	Chief Engineer of Maintenance of 7th Div.
Mr. Necati CAKIROGLU	Chief Engineer of Maintenance of 10th Div.
Mr. Mustafa GUNDOGAN	Chief Engineer of Maintenance of 13th Div.
Mr. Veli OFLAZ	Chief Engineer of Maintenance of 14th Div.

(2) Members of the Steering Committee

Mr. Ismail TANYALDIRIK	Deputy of Director General
Mr. Salih IRMAK	Head of Maintenance Department
Ms. Munevver ATASARAL	Dep. Head of Maintenance Department
Mr. Rize SARIKAYA	Dir. of Maintenance Div.
Mr. Sabri YILDIZ	Dir. of Traffic Div.
Mr. Ertan SAIT	Dir. of Bridge Maintenance Div.

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Mr. Chai Seng Chiew	Pavement/Drainage Engineer
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Dr. William HAYES	Transportation Planner
Mr. David McEWEN	Economic Evaluation Specialist
Mr. Yoshitoshi KOBASYASHI	Environmental Specialist
Mr. Masataka FUJIKUMA	Pavement Engineer

Mr. Tetsuya SATO Project Coordinator

(4) Members of the JICA Advisory Committee

Mr. Toshiharu YASUI Head of Committee
Mr. Kazuya SASAKI Member of Committee

1.2 Objectives and Target of Road Maintenance

1.2.1 Concept of Road Maintenance

The concept of a maintenance system is primarily to improve the efficiency of working by delivering the appropriate level and availability of resources to meet the requirements of keeping the roads safely open to traffic. A continual maintenance programme to ensure the design life is safeguarded, is an economic way to protect the vast infrastructure investments of the nation. In an environment where financial resources are a strain to the highway authority, this is particularly valid for developed countries, meeting the ever demanding road user requirements requires an even more systematic and efficient approach to the management of maintenance work.

The study team will draw from their wealth of experience in having had first hand working knowledge of the established concepts from various developed countries. We will also be researching into the existing practice in Turkey. With this in mind, a concept of maintenance that is most appropriate for Turkish conditions will be formulated.

1.2.2 Objectives of Road Maintenance

KGM has more than 60 000km of highways under their responsibility. Hence the objectives of a maintenance system are:

- to establish a system for inspection and evaluation of conditions of the road network
- to establish a complete condition inventory of the road network
- to establish a system to prioritize the maintenance work load
- to establish standard repair techniques

From experience the majority of the problems faced within maintenance work stems from poor design, poor construction and inadequate level of supervision during construction and from the lack of and delay in maintenance repair. The Study Team will therefore deal with the problems presented as fait accompli on the 2000km of existing network of highways. We will recommend solutions which can be practically applied, within the limitation of available financial and human resources in KGM.

Due to the lack of time in this study, the Study Team will only be focusing on the maintenance aspects of work as defined in the minutes of meeting dated 09th April 1997. The scope of the works had been agreed with our counterparts from the KGM General Directorate. Where specific problems outside the scope of this study are presented to the Study Team by the KGM engineers, solutions will be provided directly to those concern.

1.2.3 Target of Road Maintenance

It is not feasible, although it is ideal, for all the roads within the network to be maintained to a high standard. The target of the study is therefore to enable as much of the repair/ maintenance work so identified in the surveys to be prioritised and repaired to prevent it from deteriorating further and leading to more expensive maintenance liabilities. Safety of the road users will be the prime consideration when deciding on the priority of maintenance work. The maintenance system will also be a means of keeping track with the existing conditions and the rate of deterioration can be studied/ monitored for future benefits.

Having spoken to our counterparts at KGM, we understand that there is a backlog of maintenance work due to budgetary inadequacy. Therefore there is a need to get a maintenance management system into place such that all the maintenance work can be recorded, prioritised and a maintenance strategy formed. It is also very important that this information can be easily accessed and the presentation easily understood. As more funds become available, the list can be worked through to reduce the backlog.

CHAPTER 2

GENERAL APPRECIATION OF TURKEY

CHAPTER 2 GENERAL APPRECIATION OF TURKEY

2.1 Natural Condition

1) Location

Turkey is located at the point where the three continents making up the old world, Asia, Africa, and Europe are closest to each other, and straddles the point where Europe and Asia meet. Geographically, the country is located in the northern half of the hemisphere at a point that is about half way between the equator and the north pole, at a longitude of 36 degrees N to 42 degrees N and a latitude of 26 degrees E to 45 degrees E. The surface area of Turkey is 814 578 sq. km, of which 790 200 are in Asia and 24 378 are located in Europe.

2) Climate

Turkey is generally divided into seven regions: the Black Sea region, the Marmara region, the Aegean region, the Mediterranean region and the Central, the East and Southeast Anatolia regions. The uneven north Anatolian terrain running along the Black Sea resembles a narrow but long belt. This region covers approximately 1/6 of Turkey's total land area and this area includes Rize which has heavy rainfall up to 2 000 mm. Although Turkey is situated in a geographical location where climatic conditions are quite temperate, the diverse nature of the landscape, and the existence in particular of the mountains that run parallel to the coasts, results in significant differences in climatic conditions from one region to the other While the coastal areas enjoy milder climates, the inland Anatolian plateau experiences extremes of hot summers and cold winters with limited rainfall. Fig. 2.1.1 shows the geological and climate regions in Turkey and each regional temperature, average rainfall and humidity is shown in Table 2.1.1. Fig. 2.1.2 shows the annual hours of sunshine.

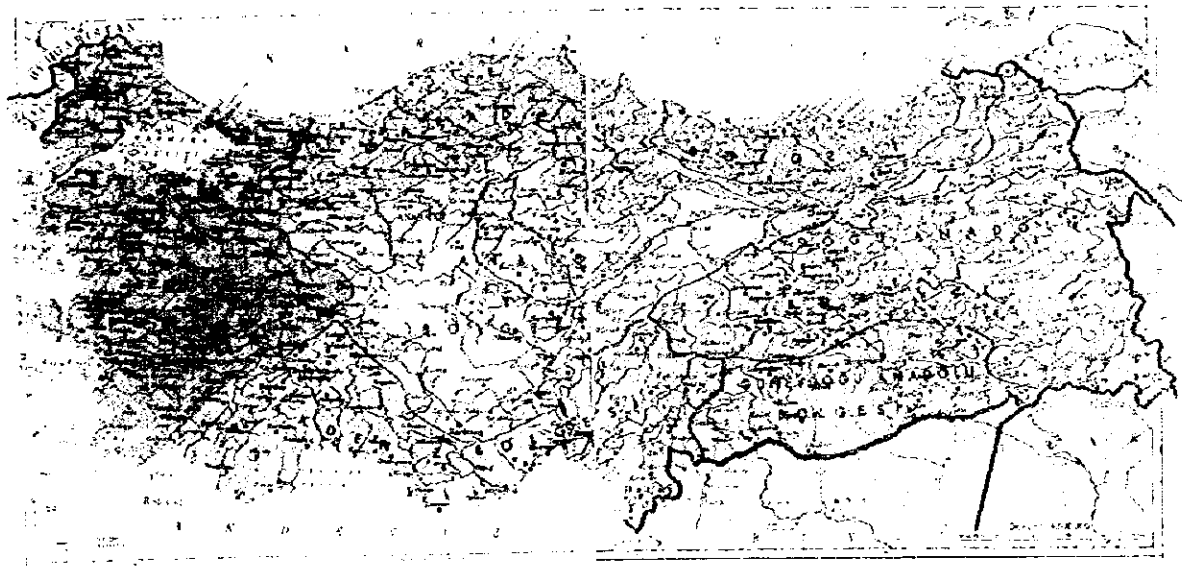


Fig. 2.1.1 Geological and Climate Regions of Turkey

Table 2.1.1 Regional Temperatures, Average Rainfall and Humidity

	Average Tem(C)	Highest Tem(C)	Lowest Tem(C)	Average Nem(%)	rainfall (mm)
Mediterranean	17.2	34.5	-11.0	65	873.3
E.Anatolia	8.1	38.3	-35.0	62	436.1
Aegean	14.3	41.0	-17.5	64	709.5
S.East Anatolia	16.0	45.1	-18.3	54	545.8
Central Anatolia	10.7	40.0	-29.1	63	374.6
Black Sea	12.5	39.2	-16.0	72	913.5
Marmara	14.2	41.0	-18.5	72	623.1

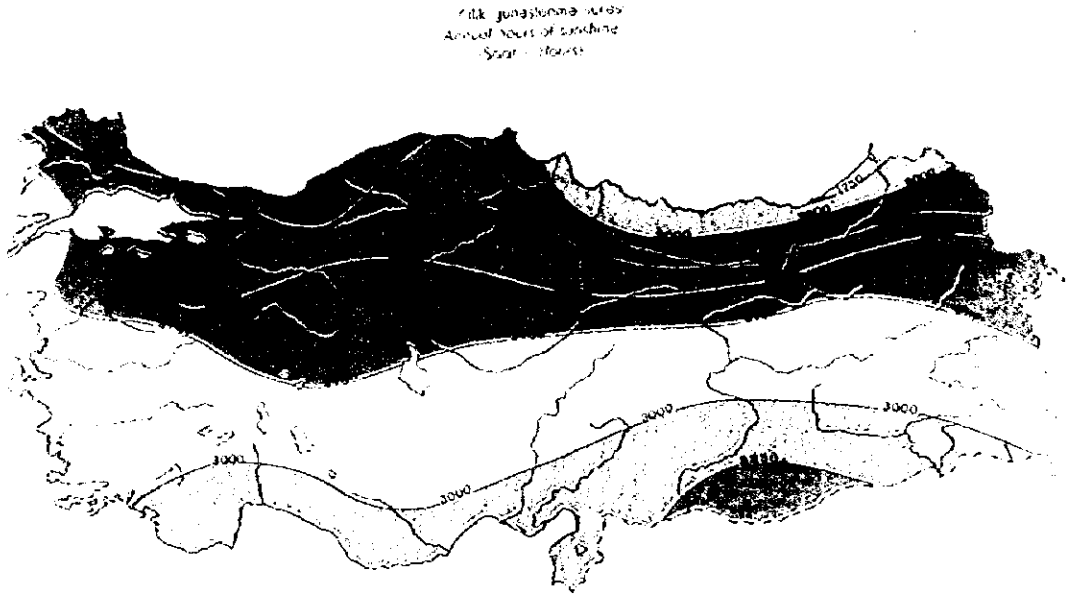


Fig. 2.1.2 Annual hours of Sunshine

3) Geology

Turkey has complex mosaic comprising of rock association from the oldest Precambrian rocks to the Tertiary formation (refer to Fig. 2.1.3). Turkey is located in the Alpine - Himalayan belt and has experienced a very complex tectonic evolution, involving multiple N - S convergence during the Mesooic and the Tertiary ages. Ketin (1966) grouped these associations into four major belts, the Pontides, the Anatolides, the Taurides and the Border folds as shown in Fig. 2.1.4. These belts extending in an east-west direction are characterized by the distinct stratigraphic sequences, indicating different geologic settings. During the Upper Miocene of the Tertiary Period, the collision of the Arabian plate with the Eurasian plate led to the lateral tectonic extrusion of the Anatolian block and formation of large strike-ship faults such as the North Anatolia Fault and East Anatolia Fault.

Volcanic activities occurred in the Tertiary-Quaternary Periods and which formed four major distinct volcanic provinces, with numerous smaller volcanic centers scattered throughout Anatolia. The Central Province includes most widely known " Cappadoccia region ".

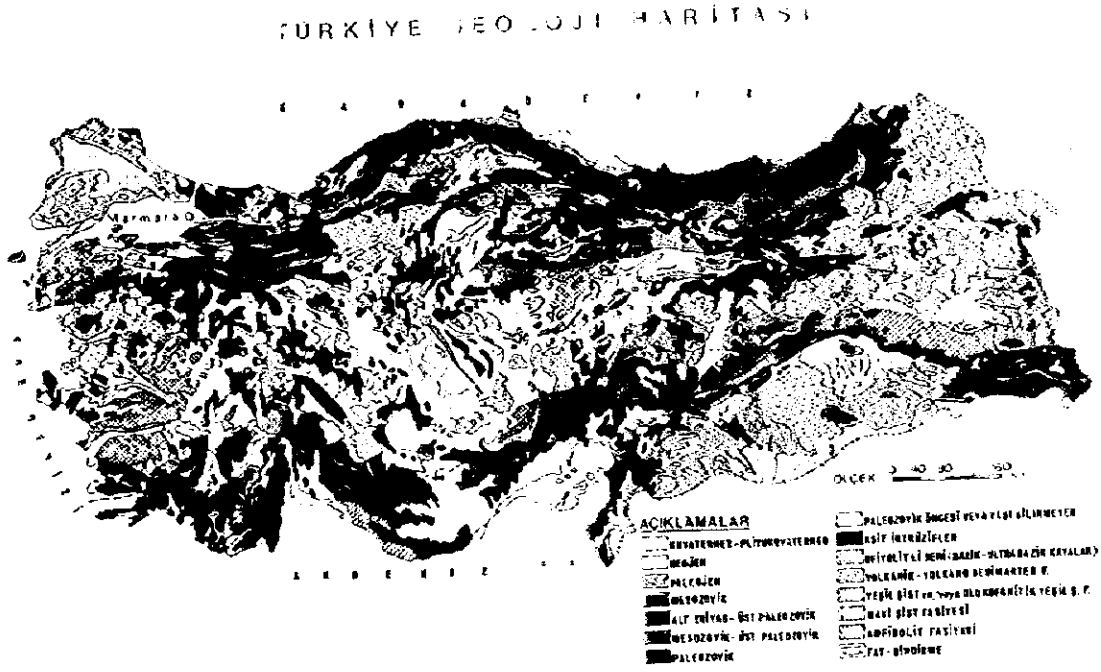


Fig. 2.1.3 Geological Map of Turkey

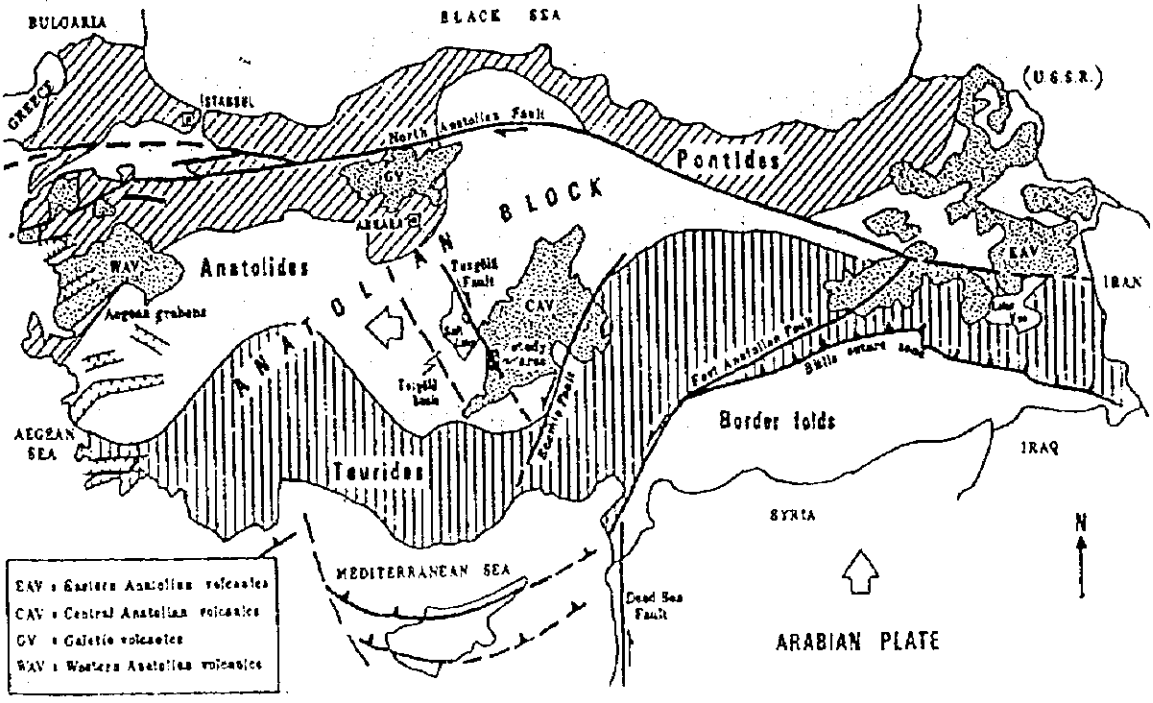


Fig. 2.1.4 Simplified Geological Map Showing Major Tectonic Units and the Volcanic Provinces of Neogene - Quaternary Age

4) Earthquake

Turkey is one of the most active earthquake zones in the world. Fig. 2.1.5 shows earthquake records between 1901 - 1996. The seismic coefficients shown in Fig. 2.1.6 are used by KGM to design road and structure.

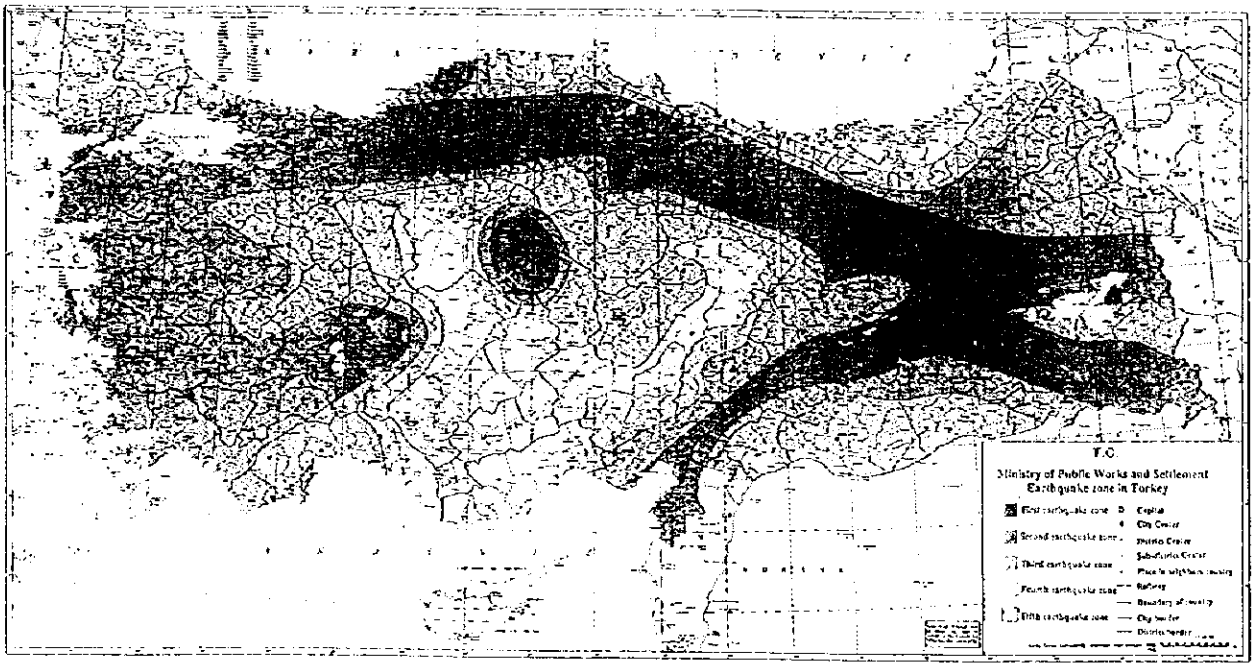
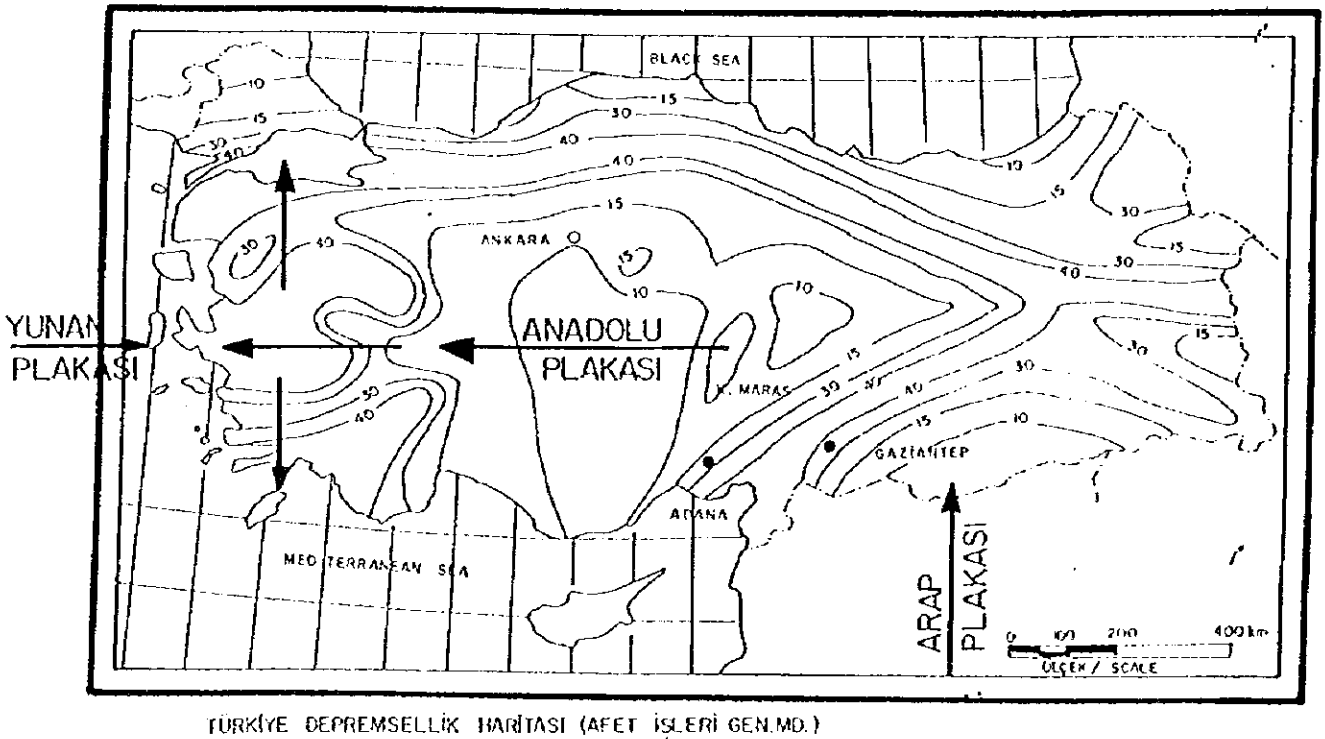


Fig. 2.1.5 The Map of Earthquake Risk in Turkey



TÜRKİYE DEPREMSELLİK HARİTASI (AFET İŞLERİ GEN.MD.)

Fig. 2.1.6 Seismic Acceleration Map

2.2 Socioeconomic Conditions

2.2.1 Social Conditions

1) Population

According to the 1990 census, Turkey has approximately 57 million inhabitants, 41% of whom live in the countryside. According to the 1995 census, Table 2.2.1, the population is forecast to increase to 60 million. The major cities are: Istanbul (7.4mil.); Ankara, the capital (3.2mil.); Izmir (2.7mil.); Adana (1.9mil.); Antalya (1.1mil.); and Bursa (1.6mil.). Fig. 2.2.1 shows the Change of population, and the density of population in Fig. 2.2.2

Table 2.2.1 Overall Results of Population Censuses, 1927 - 1990

. Nüfus sayım sonuçları, 1927-1990
Overall results of population censuses, 1927-1990

ım tarihleri sus dates	Nüfus Population	Yıllık nüfus artış hızı Annual increase rate ‰	İl sayısı Number of provinces	İlçe sayısı Number of districts	Bucak sayısı Number of sub-districts	Köy sayısı Number of villages	Yüzölçümü Area km² (1)	Nüfus yoğunluğu Population density
10.1927	13 648 270	-	63	328	699	39 901	762 736	18
10.1935	16 158 018	21.10	57	356	809	34 067	762 736	21
10.1940	17 820 950	19.59	63	370	890	33 134	767 119	23
10.1945	18 790 174	10.59	63	396	910	33 153	767 119	24
10.1950	20 947 188	21.73	63	422	947	33 305	767 119	27
10.1955	24 064 763	27.75	66	493	930	33 857	767 119	31
10.1960	27 754 820	28.53	67	570	893	34 548	772 091	36
10.1965	31 391 421	24.62	67	571	898	34 740	774 810	41
10.1970	35 605 176	25.19	67	572	885	35 110	774 815	46
10.1975	40 347 719	25.00	67	572	887	35 228	774 815	52
10.1980	44 736 957	20.65	67	572	887	35 268	774 815	58
10.1985	50 664 458	24.88	67	580	(2) 880	35 151	774 815	65
10.1990	56 473 035	21.71	73	829	(3) 688	35 545	774 815	73
1995 (5)	62 526 000	21.71	79	847	(4) 682	36 433	774 815	81

Yüzölçümler Harita Genel Komutanlığı'nca hesaplanmıştır.
1985 Genel Nüfus Sayımı gününde dokuz bucağın merkezi yoktur.
1990 Genel Nüfus Sayımı gününde yedi bucağın merkezi yoktur.
1.7.1995 günü itibariyle onbir bucağın merkezi yoktur.
Nüfus 1.7.1995 yıl ortası tahminidir. İl, ilçe, bucak ve köy sayıları 1.7.1995 günü idari bölünüşe göre düzenlenmiştir.

(1) The area of Turkey is calculated by the General Commandership of Cartography
(2) During the 1985 General Population Census 9 sub-districts did not have centers.
(3) During the 1990 General Population Census 7 sub-districts did not have centers.
(4) After 1.7.1995, 11 districts does not have centers.
(5) Estimated population of midyear 1.7.1995. The number of provinces, districts, sub-districts and villages are designed according to administrative division

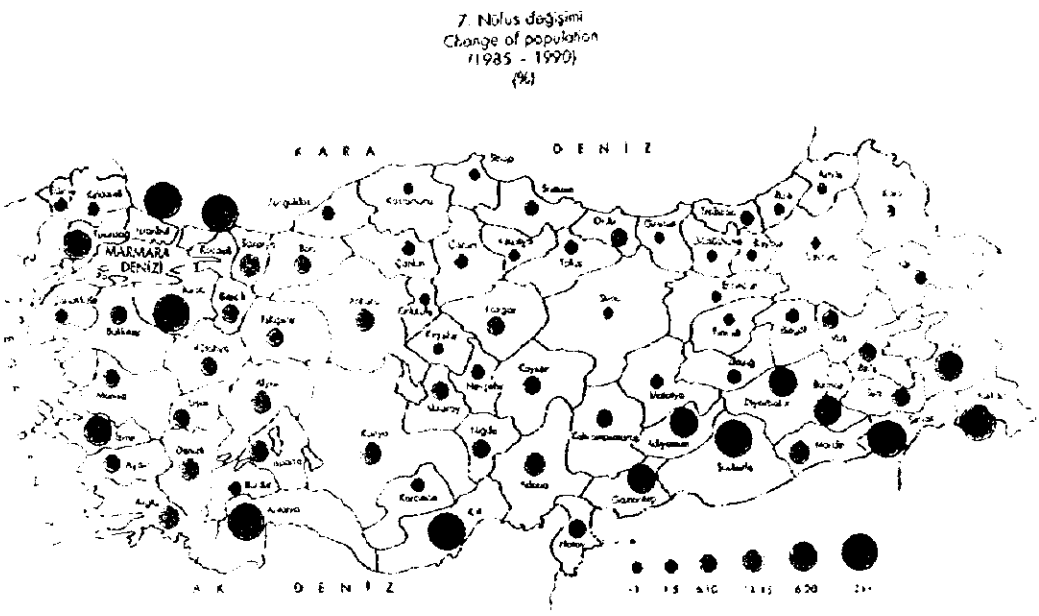


Fig. 2.2.1 Change of Population in Turkey

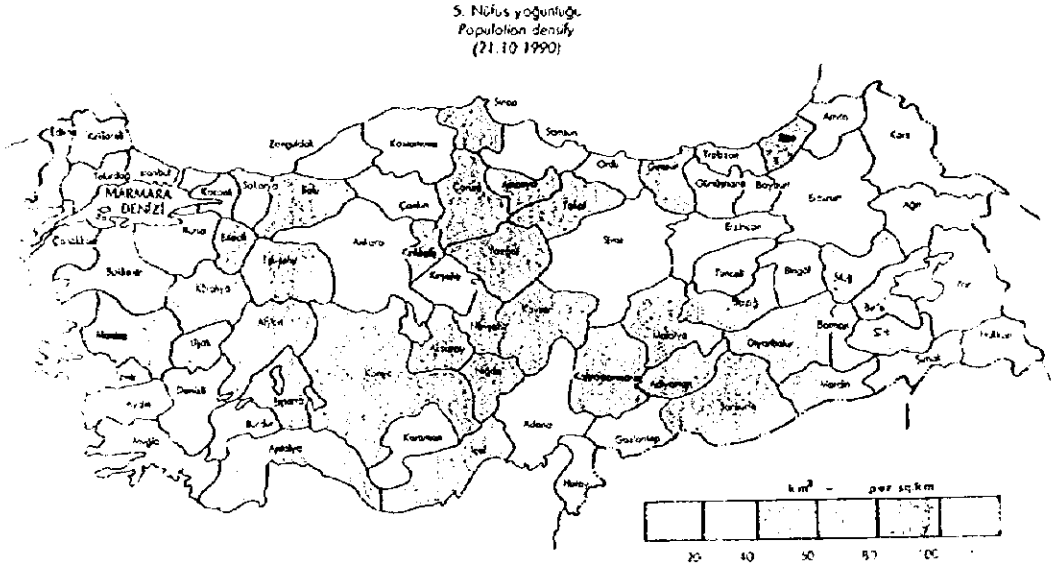


Fig. 2.2.2 Population Density

2) Language

The Turkish language belongs to the Ural-Altaic group and has an affinity with the Finno-Hungarian languages. Turkish is written with the Latin alphabet and is spoken by some 150 million people around the world.

3) Religion

Although Turkey is 99% Moslem, it is a secular state that guarantees complete freedom of worship to non-Moslems.

4) Political structure

The Turkish Republic is based on a secure, democratic, pluralistic and parliamentary system, where human rights are protected by law and social justice. The National Assembly is elected by popular vote and the nation is governed by the Council of Ministers. Turkey is a member of NATO, and an associate member of the European Union.

2.2.2 Economic Condition

The Rate of growth of gross national product is shown in Fig. 2.2.3 (At current prices), Fig. 2.2.4 (At constant prices,1987) and the principle products of Turkey are listed below.

(1) Agriculture : This plays a very important role in the Turkish economy. The main crops are wheat, rice, cotton, tea, tobacco, hazelnuts, and fruit. Sheep are Turkey's most important livestock, and Turkey is one of the major cotton and wool producers.

(2) Industry : Industry is developing rapidly and is directed mainly towards the processing of agricultural products, metallurgy, textiles, and the manufacture of automobiles and agricultural machinery.

(3) Natural Resources : The principal minerals extracted are coal, chrome (an important export), iron, copper, bauxite, marble and sulphur.

(4) Tourism : In recent years, Turkey has become a major tourist destination in Europe. With the rapid development of both summer and winter resorts, more and more people from around the world are able to enjoy the history, culture, and beautiful sites of Turkey. From swimming in the Mediterranean to skiing in Uludag, Turkey has something to offer every tourist.

(5) Southeast Anatolia Project (SAP) ; SAP is a multi-purpose, integrated development project comprising dams, hydroelectric power plants and irrigation facilities that are being built on the Euphrates and Tigris rivers. It will affect agriculture, transportation, education, tourism, health and other sectors. The Ataturk Dam, included in the project, is among the 10 largest dams in the world.

6) Foreign Trade

The foreign trade volume, which stood at $ 6 139.6 million in 1975 increased to $ 14 963 million in 1983, to $ 24 348 million in 1987, to $ 35 261 million in 1990 and to $34 645 million in 1991. Development has been observed in the export/import financing ratios since 1988. Table - 2.2.2 shows the annual amount of foreign trade and Fig. 2.2.5 shows selected countries by imports, Fig. 2.2.6 is by exports.

Table 2.2.2 Foreign Trade

Foreign Capital permitted to enter Turkey under Law no. 6224
by country of origin ($, million)

	1989 Foreign Capital	1990 Foreign Capital	1991 Foreign Capital	1992 (1) Foreign Capital
USA	130.74	119.47	456.39	28.46
Germany	124.04	142.94	185.01	96.61
France	251.51	655.28	246.09	133.24
The Netherlands	99.43	69.04	278.35	169.75
UK	286.75	271.99	69.28	37.54
Iran	5.10	5.49	3.23	1.21
Switzerland	157.98	109.60	104.20	33.00
Italy	89.25	63.73	190.30	11.58
Japan	71.71	100.19	54.57	10.88
Syria	4.39	10.78	3.80	0.28

Source: SPO
(1) : As of May 31, 1992

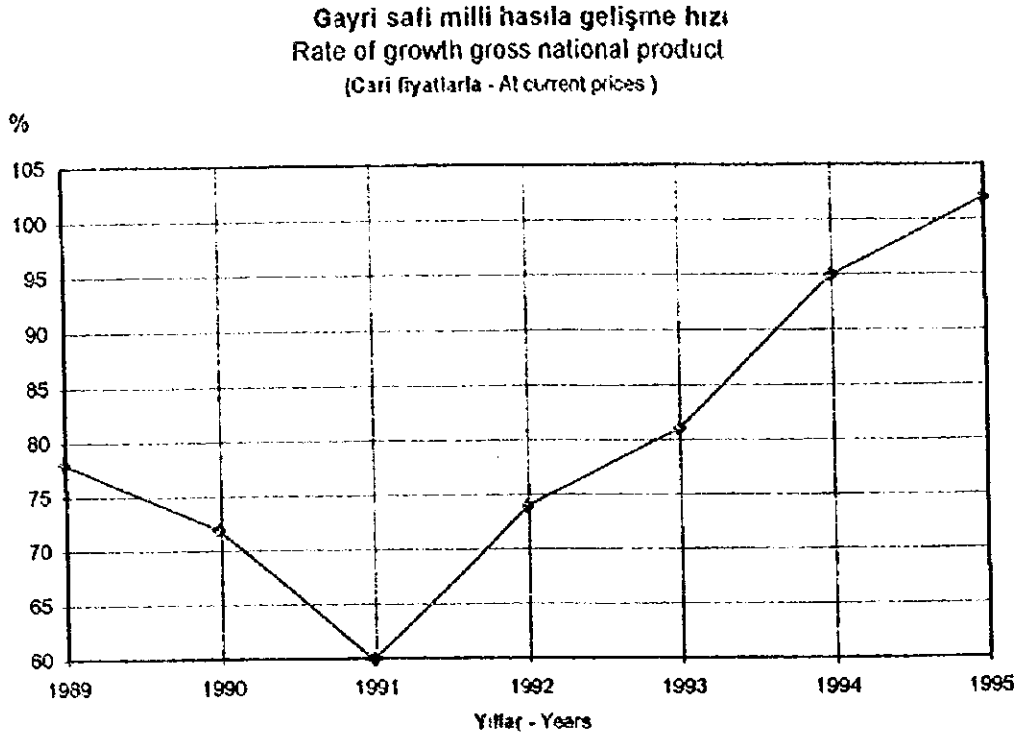


Fig. 2.2.3 Rate of Growth Gross National Product (At current prices)

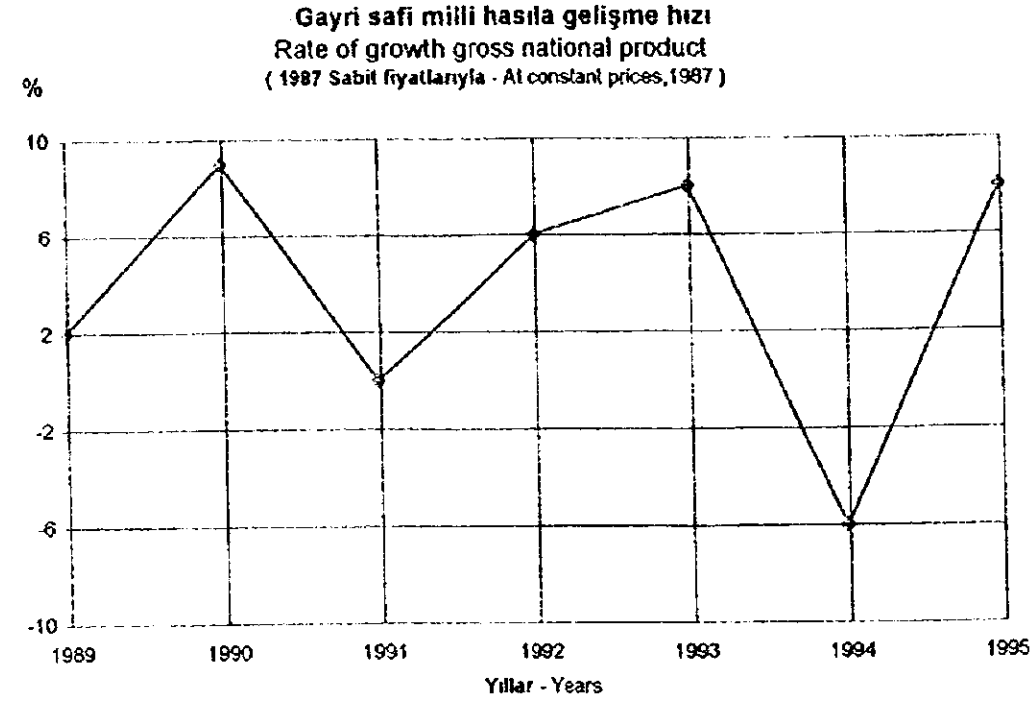


Fig. 2.2.4 Rate of Growth Gross National Product (At constant prices, 1987)

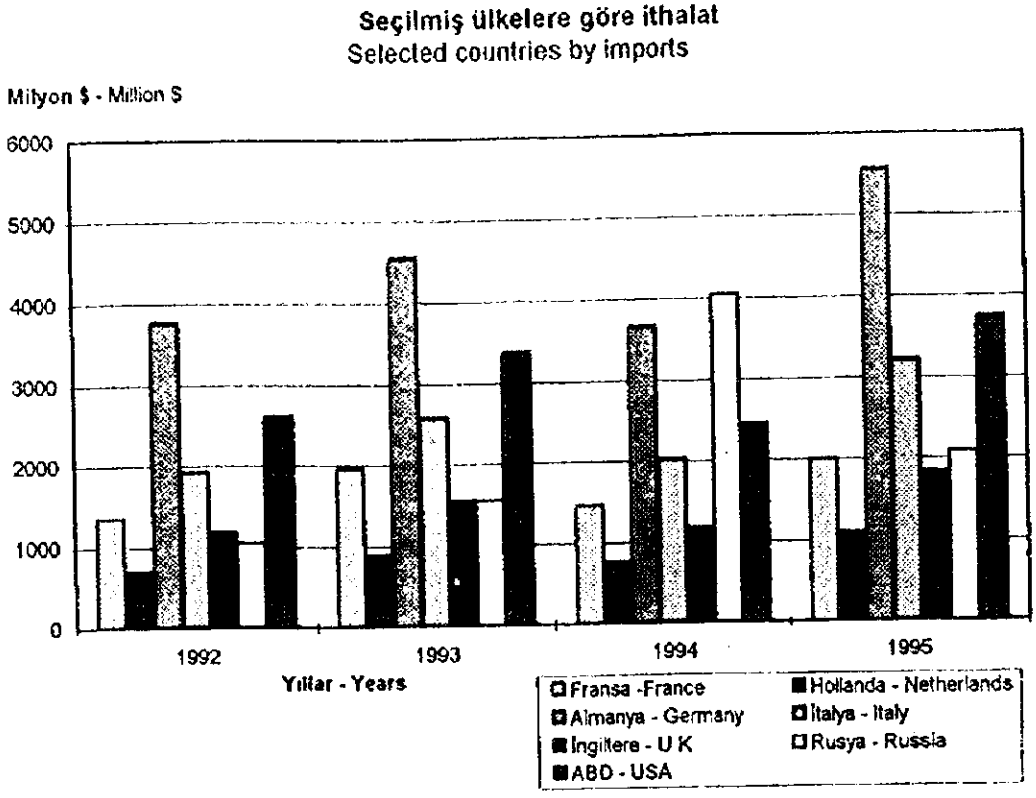


Fig. 2.2.5 Selected Countries by Imports

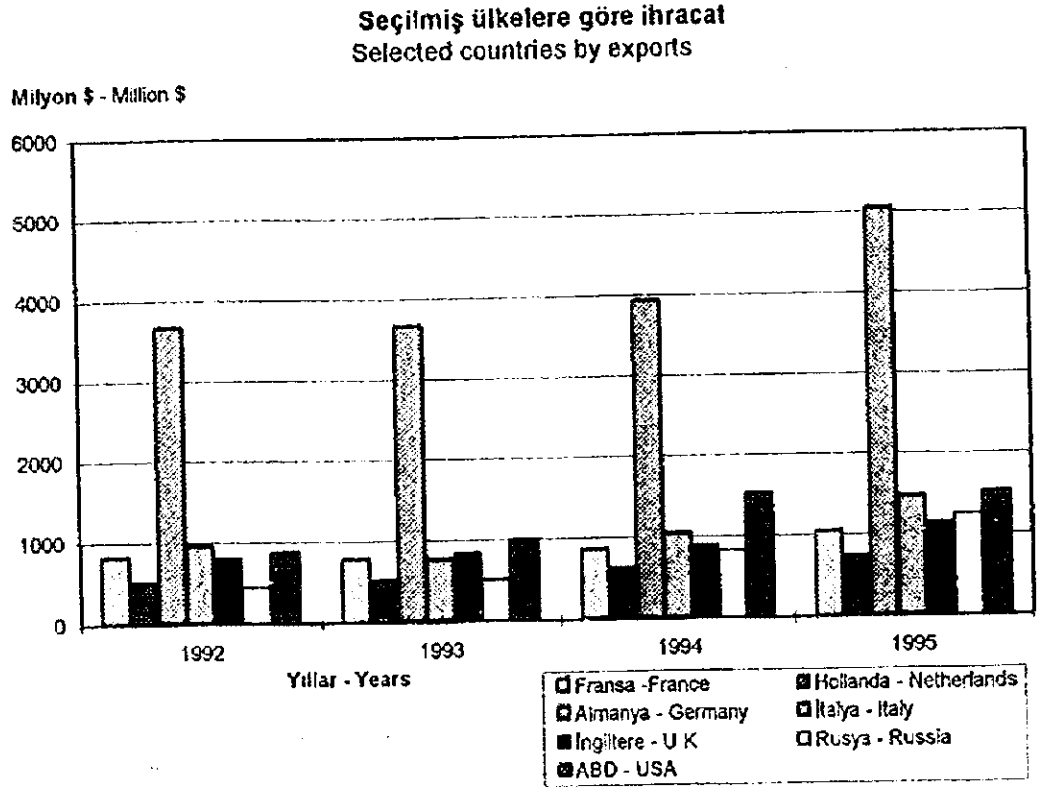


Fig. 2.2.6 Selected Countries by Exports

2.2.3 National Development Plans

The First Five year Development Plan, covering 1963-1967, was a success, achieving a growth rate of 6.7%.The Second Five year Development Plan for 1968-1972, attached more importance to the industrial sector and saw it as the workhorse of the economy. The growth rate achieved surpassed the targets set at 7.2%.

In the Third Five Year Development Plan, for 1973-1977, plans were made for a new, long period of 22 years. However, the oil shock of 1973-1974, when oil prices increased abnormally, had a negative impact on the economy of Turkey, as it did on others, leading to a high import bill and price increases in the local market, energy bottlenecks and falling production. Despite all this, however, the growth rate achieved during this plan period was 8.5%.

Following an interim plan for 1978, the Fourth Five Year Development Plan covering 1979-1983 was introduced, but it failed to prevent economic problems like a very severe foreign exchange bottleneck, huge external payments, a high inflation rate, public financing deficits, growing unemployment and a new devaluation of the Turkish Lira.

The fifth Five year Development Plan, for 1985-1989, provided support for the extension of the framework of Law, that is, the development of free zones and investments of Gulf countries in Turkey.

The Sixth Five Year Development Plan for 1990-1994, approved in the parliament, had the following strategy,

a. Rapid development with the growth rate of 5.5% in 1990 to 8.3% in 1994
b. More private sector investment
c. Increasing social welfare stimulating private consumption
d. A gradual decrease in the rate of inflation to 10% by 1994
e. Foreign exchange balance to be improved

2.3 Transportation

2.3.1 Road Transportation

Table 2.3.1 shows that road transport accounts for well over 90% of both domestic passenger-km and freight -km in Turkey, despite the fact that the road data does not include motorway movements.

Table 2.3.1 Freight-Km and Passenger-Km for 1995

Item / Mode	Freight Transportation		Passenger Transportation	
	Tonne-km ($x10^6$)	%	Passenger-km ($x10^6$)	%
Road	112 515	92.5	155 202	94.8
Rail	8.632	7.1	5 797	3.5
Sea	276	0.2	61	0.1
Air	231	0.2	2 666	1.6
Total	121 654	100.0	163 726	100.0

Notes:
All data relates to domestic movement of freight and passengers
Road data relates only to state and provincial roads, i.e., motorways are excluded.

Freight-km has grown by 80% between 1988 and 1995 (see Table 2.3.2).

Table 2.3.2 Growth in Freight-Km on Roads

Road Freight Transportation	
Year	Tonne-km ($x10^6$)
1988	62 480
1989	66 416
1990	65 710
1991	61 969
1992	67 704
1993	97 843
1994	95.020
1995	112 515

Table 2.3.3 Motor Vehicles by Class for 1986 to 1995

Year	Car	Minibus	Bus	Small Truck	Truck	Motorcycle	Special Purpose Vehicle	Road Construction Vehicle	Total
1986	1087234	97917	50798	224755	217111	327326	19448	50819	2075408
1987	1193021	106314	53554	233480	225872	369894	21236	55129	2258500
1988	1310257	112885	56172	240718	234166	420889	23301	58300	2456688
1989	1434830	118026	58859	248567	241392	472853	25060	60191	2659778
1990	1649879	125399	63700	263407	257353	531941	26519	63024	2981222
1991	1864344	133632	68973	280891	273409	590488	28606	66981	3307324
1992	2181388	145312	75592	308180	287160	655347	31158	72000	3756137
1993	2619852	159900	84254	354290	305511	743320	33703	79233	4380063
1994	2861640	166424	87545	374473	313771	788786	35495	83072	4711206
1995	3058511	173051	90197	397743	321421	819922	37272	87214	4985331
1996	3274156	182694	94978	442778	333269	854150	40212	95318	5317565

Data from '1996 Statistical Year Book' - State Institute of Statistics, Prime Ministry of the Republic of Turkey

Fig 2.3.1 Growth in All Vehicles

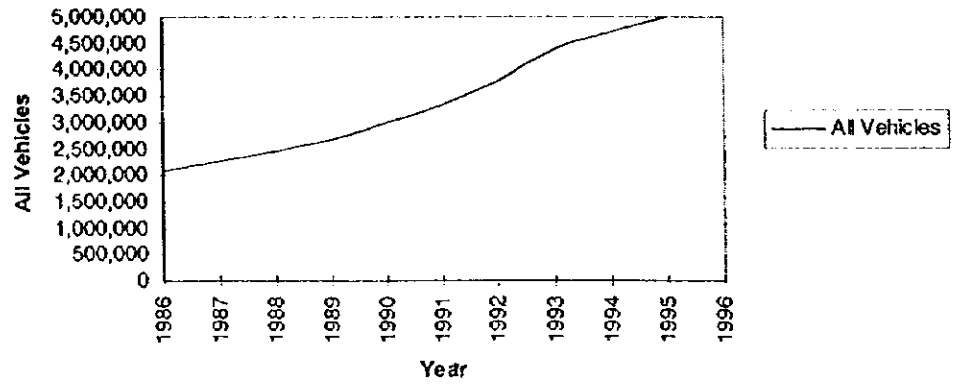


Fig 2.3.2 Growth in Heavy Goods Vehicles

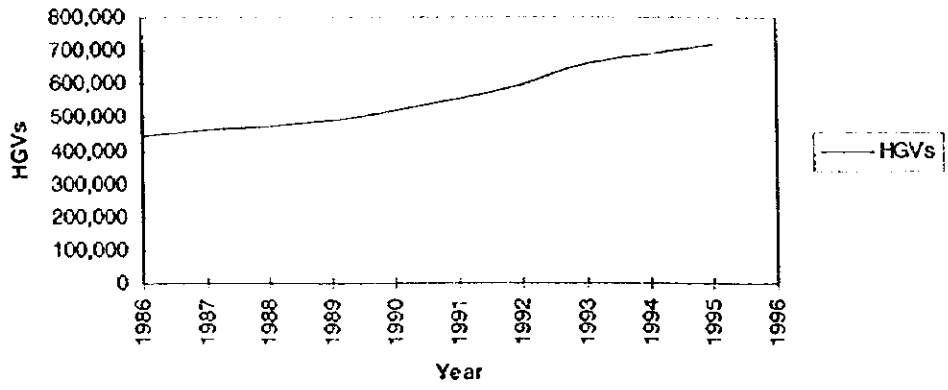


Table 2.3.3 shows the motor vehicles by class for the period 1986 to 1995. As can be seen from the tables and Fig 2.3.1 and 2.3.2, 5 million vehicles were registered in 1995 having seen a 140% growth in all vehicles and 63% in HGVs (Trucks and small trucks) in the period 1986 to 1995.

The vehicle mix has also changed over the period as is shown in Figs 2.3.3 and 2.3.4. With a 180 % growth in cars over the period, the proportion of HGVs in the traffic mix has fallen to 14% in 1995.

Fig 2.3.3 Vehicle Classification for 1986

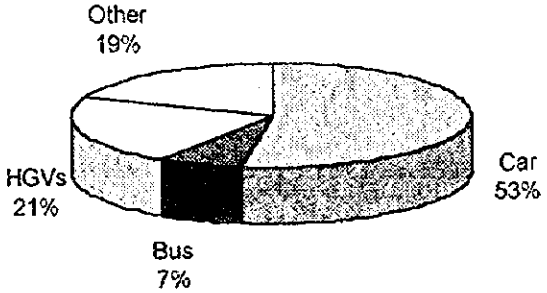
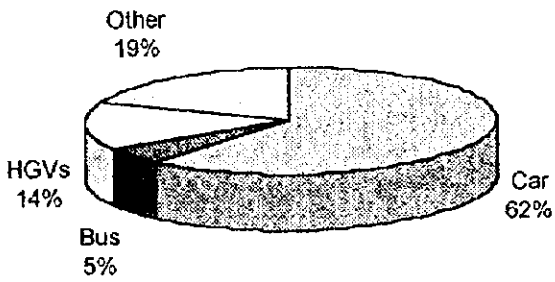


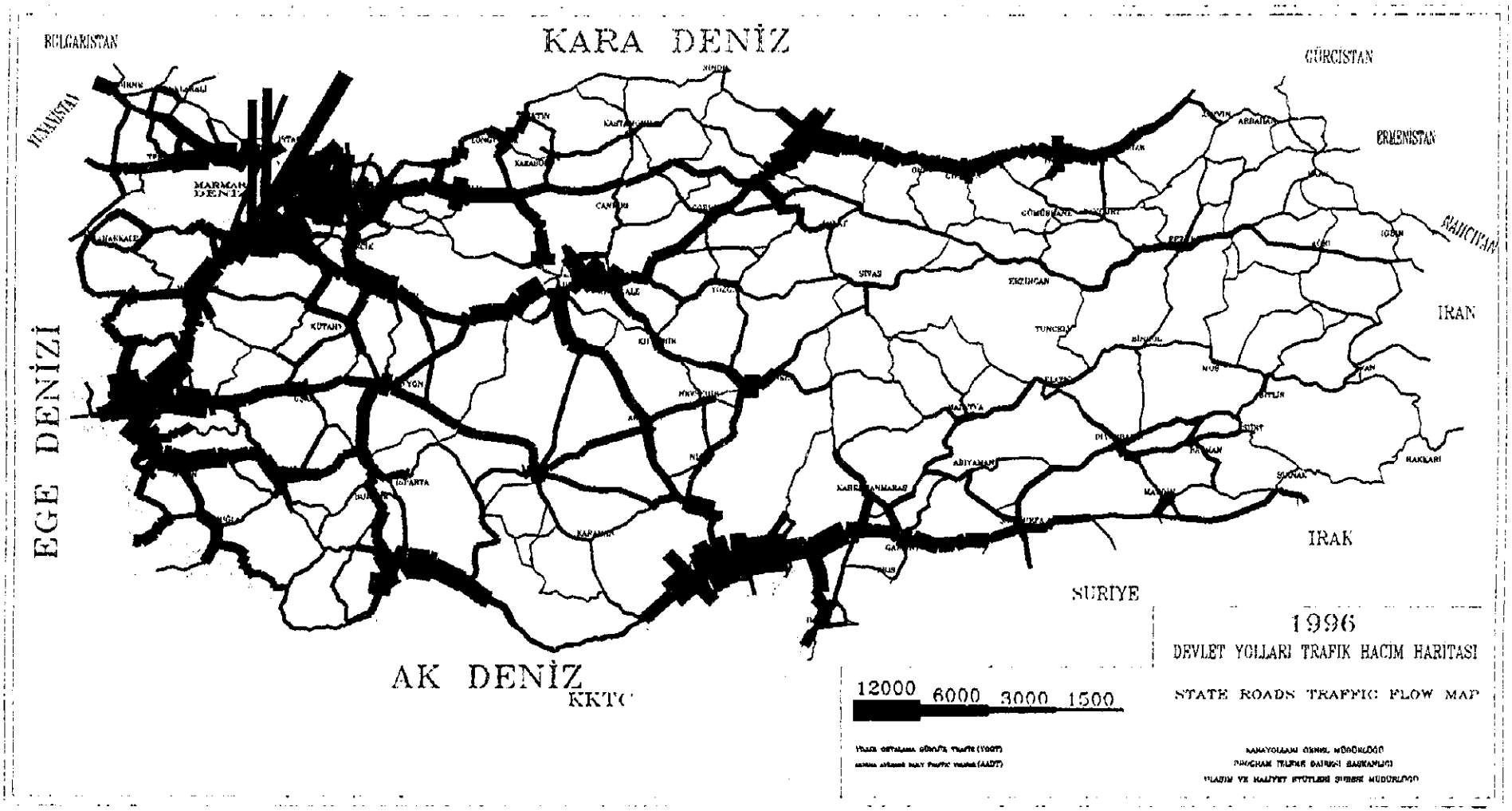
Fig 2.3.4 Vehicle Classification for 1995



In 1985 the permitted axle load was increased from 10 tonnes to 13 tonnes which has increased the potential for greater pavement damage. However, there are new moves toward reducing the permitted axle load to 11.5 tonnes. Axle load checks are carried out from time to time indicating a tendency to overload vehicles beyond the legal limit. Legislation is currently in force to fine both the owner and the driver for such offences in order to minimise pavement damage and so reduce road maintenance costs.

Traffic counts are carried out on a regular basis at 280 sites on a manual basis and at 187 sites on an automatic basis. Counts are carried out 4 times per year to enable seasonal variations to be accounted for in the calculation of average annual daily traffic (AADT) volume. The 1996 traffic flow map for all state roads in Turkey is shown overleaf. The main traffic corridors are:

Izmit region
Izmir to Izmit
Mersin to Gaziantep
Ankara to Izmit
Ankara to Afyon
Samsun to Trabzon
Bursa to Eskisehir
Izmir to Afyon
Ankara to Samsun
Ankara to Mersin


KARA DENİZ
BULGARISTAN
YUNANISTAN
GÜRCISTAN
ERMENISTAN
NAHÇIVAN
IRAN
IRAK
SURIYE
EGE DENİZİ
AK DENİZ
KKTC
MARMARA DENİZİ
1996
DEVLET YOLLARI TRAFIK HACIM HARITASI
STATE ROADS TRAFFIC FLOW MAP
12000 6000 3000 1500

2.3.2 Rail Transportation

The railway network is managed by the General Directorate of State Railways Administration (TCCD).

Table 2.3.4 Length of Track for 1991 to 1995

	Length of Track (km)				
Line Type\Year	1991	1992	1993	1994	1995
Non-electrified	9 598	9 380	9 380	9 293	9 373
Electrified	795	1 033	1 033	1 093	1 093
Total	10 393	10 413	10 413	10 386	10 466

A plan showing the railway network is shown overleaf. There are 10 500km of railway track in Turkey with 1 100km (10%) having been electrified. 300 km has been electrified since 1991(seeTable2.3.4).However, investment in the main intercity railway infrastructure has not kept pace with the growing economy and as a result this has restricted the transfer of freight from road to rail. The railways carry some 7.1% of domestic freight traffic (tonne-km) and 3.5% of domestic passenger traffic (passenger-km). Over the period 1991 to 1995, the number passengers dropped by 21% to 105 million riders; whereas, freight has stayed more or less constant at about 15 million tonnes (see Table 2.3.5).

Table 2.3.5 Railway Passenger and Freight Statistics for 1991 to 1995

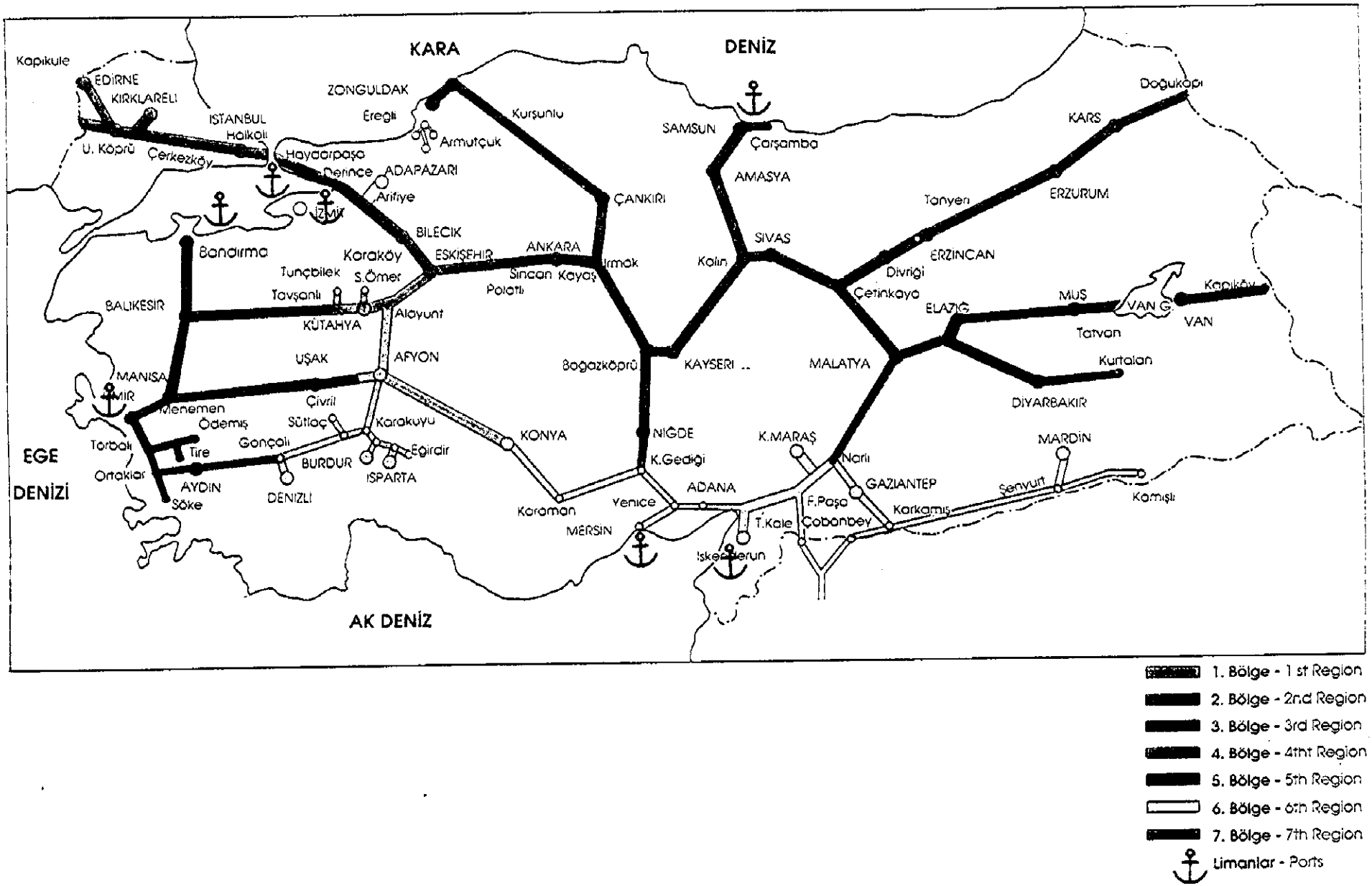
Item\Year	1991	1992	1993	1994	1995
Passengers (Number x10^3)	133 243	131 252	146 318	119 533	104 635
Freight (Tonnes x10^3)	14 847	15 748	15 794	14 655	15 271

In the Seventh Five Year Development Plan (1996 -2000), prepared by the State Planning Organisation, there are plans to extend electrification and to modernise locomotives and rolling stock.

2.3.3 Sea Transportation

Sea Transportation is controlled by the Turkish Maritime Authority. Turkey has coastline on the Mediterranean Sea, the Aegean Sea, the Sea of Marmara, the Bosphorous and the Black Sea. The main ports are at Istanbul, Izmir, Mersin, Iskenderum and Kocaeli (Izmit). As would be expected, only 0.2% of domestic freight is carried by sea but in terms of international freight some 79 million tonnes were carried in 1995 which is a considerable reduction over the 130 million tonnes carried in 1988. There are signs that freight traffic is picking up again

TCDD ŞEBEKESİ
NETWORK OF TCDD



after the decline in 1990. Container traffic has expanded dramatically from 267 000 containers in 1989 to 487 000 in 1994. Ro-ro (Roll on, Roll off) traffic between Turkey and Italy has also grown considerably as a result of road hauliers avoiding the war zone in Yugoslavia.

2.3.4 Air Transportation

There are 24 airports in Turkey with 14 having international status. The key airports handling over 1 million passengers per year are Istanbul (11.9 million), Antalya (4.7 million), Ankara (3.6 million), Izmir (3.0 million) and Dalaman (2.1 million). As was shown in Table 2.3.1, the proportion of domestic freight (tonne-km) carried by air is miniscule when compared with the road-based modes, 0.2% and 92.5% respectively.

Table 2.3.6 Air Passenger and Freight Statistics for 1988 to 1995

Item\Year	1988	1989	1990	1991	1992	1993	1994	1995
Passengers ($x10^3$)								
International	6 510	7 147	8 996	7 272	13 155	13 270	12 570	17 430
Domestic	4 327	4 697	4 634	3 748	3 340	7 394	8 764	10 319
Total	10 837	11 844	13 630	11 020	16 495	20 664	21 334	27 749
Freight ($x10^3$)								
International	154	177	202	172	267	326	340	405
Domestic	73	94	100	73	97	135	151	171
Total	227	271	302	245	364	461	491	576

Table 2.3.6 shows that there has been a growth of over 150% in both passengers and freight carried in the period 1988 to 1995 with Turkish Airlines making big strides in improving its international standing with the purchase of new aircraft.

In the Five Year Development Plan there are provisions to improve airport facilities at Istanbul and Antalya plus the intention to complete a number of additional regional airports.

2.4 Highways

2.4.1 The Road Network

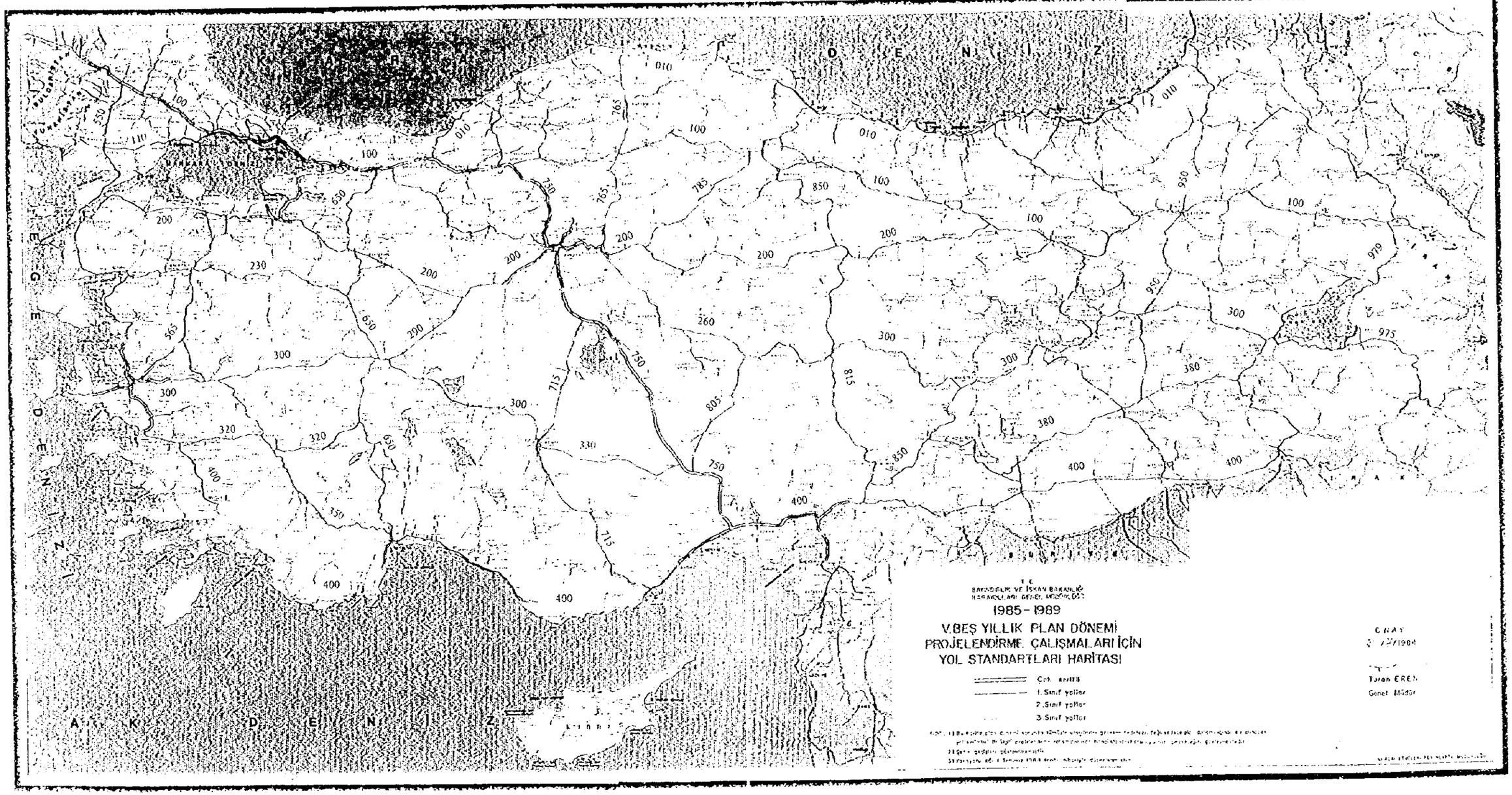
There are 380 000km of road in Turkey classified as motorways, state roads, provincial roads and village roads. Motorways, state roads and provincial roads are the responsibility of the General Directorate of Highways (KGM). Village Roads are the responsibility of the General Directorate of Rural Services and city streets are the responsibility of the relevant municipality.

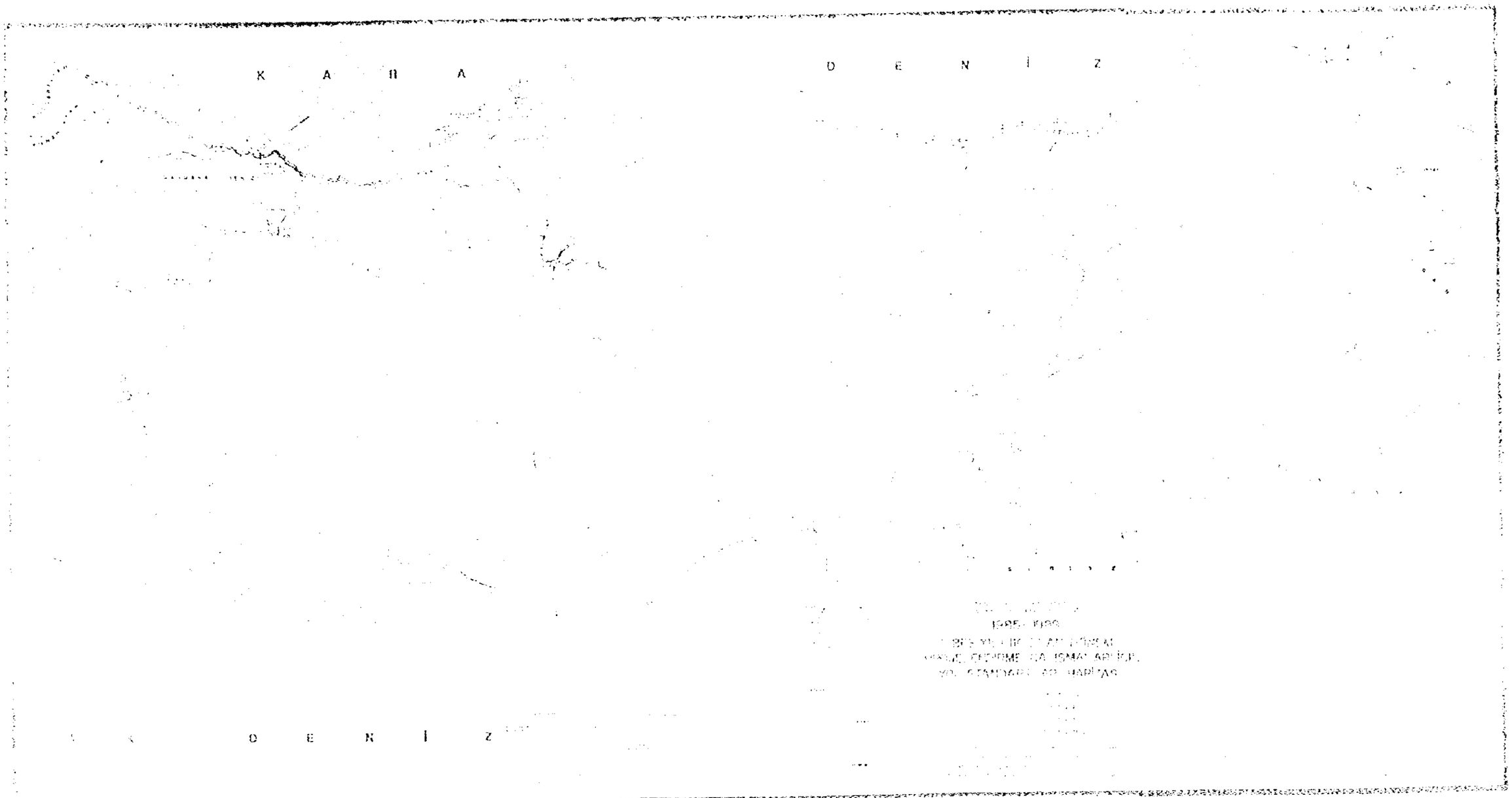
State roads are the primary intercity roads with the provincial roads linking the towns and smaller cities to the state road network. There has been no significant change in the length of the state or provincial roads over the last 15 years (see Table 2.4.1), both remaining at about 31 000km and 28 000km, respectively, since 1980.

Table 2.4.1 Highway Network by Road Class for the period 1950 to 1995

Year	Motorways	State Roads	Provincial Roads	Village Roads	Total
1950	-	24306	22774	-	47080
1960	-	26711	34831	-	61542
1970	-	35230	24390	-	59620
1980	27	32208	27851	76957	137043
1981	27	31976	28785	172103	232891
1982	27	31888	28824	268817	329556
1983	61	31953	29001	234145	295154
1984	81	31210	28087	243350	302708
1985	81	30982	28130	251209	310402
1986	95	30997	28305	257508	316891
1987	115	30986	28153	261558	320792
1988	138	31062	27853	269154	328184
1989	160	30999	27852	271511	330500
1990	281	31048	27504	297579	356291
1991	387	31149	27979	308597	368006
1992	757	31261	27960	308602	368210
1993	1070	31343	28499	326522	387121
1994	1167	31424	28346	327253	388093
1995	1246	31389	28443	320029	381028
1996	1405	31412	28813	320000	381630
1997	1523	31320	29516	319902	382261

In 1984, Turkey embarked on one of the biggest motorway construction programmes seen anywhere in the world. It commenced with the construction of the Second Bosphorous Bridge and it went on to complete 1200km in 10 years linking the Bulgarian border with the capital city, Ankara, apart from a short length of tunnel through the mountains near Bolu which is still under construction. Currently, there are some 1400km of motorway in operation all of which are operated on a toll basis by the KGM. The first privately operated motorway in Turkey is likely to be the Izmit Bay Crossing which is to be let on a Build Operate and


K U Z E Y
D O Ğ U
D E N İ Z
A K D E N İ Z
T.C.
BAYINDIRLIK VE İSKAN BAKANLIĞI
KARAYOLLARI GENEL MÜDÜRLÜĞÜ
1985 - 1989
V.BEŞ YILLIK PLAN DÖNEMİ
PROJELENDİRME ÇALIŞMALARI İÇİN
YOL STANDARTLARI HARİTASI
1.Sınıf yollar
2.Sınıf yollar
3.Sınıf yollar
Tahsin EREN
Genel Müdür


K A R A
D E N İ Z
K A R A D E N İ Z

Transfer (BOT) style concession contract. This contract is currently in the tender evaluation phase.

Table 2.4.2 Pavement Types by Road Class for 1996

Road Class Surface type\	Motorways (km)	State Roads (km)	Provincial Roads (km)	Total (km)	% of Network
Asphaltic Concrete	1 400	4 939	141	6 480	10.5
Surface Treated	-	25 013	21 621	46 634	75.7
Stone Block	-	37	68	105	0.2
Stabilised	-	1 012	4 995	6 007	9.7
Earth Roads	-	81	1 095	1 176	1.9
Primitive Roads	-	330	893	1 223	2.0
Total	1 400	31 412	28 813	61 625	100.0
% of Network	2.3	51.0	46.7	100.0	

Asphaltic concrete and surface treated account for 86% of the roads under KGM control with Surface Treated Roads making up by far the largest surface type with 76%. Table 2.4.3 shows the main pavement constructions currently in use.

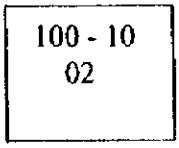
Table 2.4.3 Pavement Construction

Road Type Pavement Type\	Motorway (cm)	Asphaltic Concrete (cm)	Surface Treated (cm)
Surface Course	5	5	3 - 5
Binder Course	8	6 -8	-
Bituminous Base	12	8-14	-
Road Base	22 (CBGB)	-	20
Sub-base	28	20	20-40
Total	75	39-47	43 - 65

The motorways have their own specific pavement design incorporating CBGB (Cement Bound Granular Base). The Asphaltic Concrete pavement uses 3 layers of bituminous material on a crushed stone sub-base. The thickness of the upper layers is dependant on the design traffic loading. The Surface Treated pavement, which as stated previously is used on 76% of the State and Provincial Roads, uses a single bituminous layer on 2 layers of crushed stone.

The Road Referencing System

The road referencing system is as follows:-



100 - 10 is the section number along the road
02 is the kilometer number within the section

Roads are numbered from north to south and from east to west with increasing road numbers.

The international route number is usually given on the traffic signs together with the Turkish road number e.g. E5 (D-100).

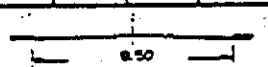
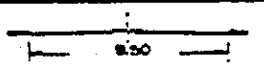
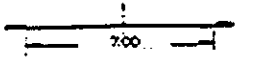
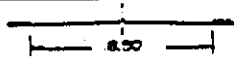
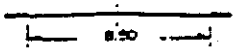
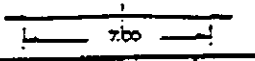
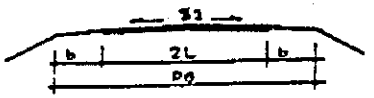
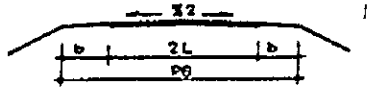
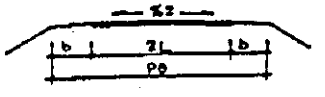
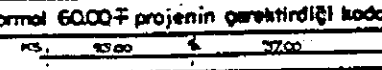
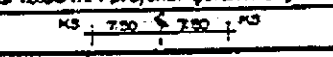
Geometric Design Standards

The design standards for state and provincial roads are divided into 4 classes. Classes 1and 2 are for state roads, 3 and 4 for provincial roads. Each of these classes is sub divided depending on the topography. Full details are shown overleaf.

KARAYOLU GEOMETRİK STANDARTLARI

KENT DIŞI
İKİ ŞERİTLİ YOLLAR

S1

PROJE ELEMANLARI		BİRİNCİ SINIF						İKİNCİ SINIF						ÜÇÜNCÜ SINIF					
Hizmet Seviyesi	HS (A,B,C,D,E,F)	D		D		D		D		D		D		D		D		D	
Trafik*	Yıllık Ortalama Günlük Trafik Y.O.G.T. (Taşıt/Gün)	12000		6500		4000		11000		5500		3000		8000		4500		2500	
	Proje Saatlik Trafiği P.S.T. (Taşıt/Saat)	1200		650		400		1100		550		300		800		450		250	
Topografik Model	TM (Dz, Dl, Dğ)	Düz		Dalgalı		Dağlık		Düz		Dalgalı		Dağlık		Düz		Dalgalı		Dağlık	
Proje Hızı	Vp (km/saat)	100	80	80	70	70	60	80	70	70	60	60	40	70	60	60	50	50	30
Minimum kurp yarıçapı	R (m)	400	250	250	200	200	150	250	200	200	150	150	60	200	150	150	90	90	(30)
Minimum klotoit parametresi	A (—)	160	130	130	120	120	100	130	120	120	100	100	60	120	100	100	70	70	30
Maksimum boyuna eğim	m (%)	4	4	6	6	7	7	5	5	7	7	8	8	6	6	8	8	9	9
Düşey kurp katsayısı L = GK	kapalı kurp Kk (—)	107-58	44-26	44-26	29-20	29-20	17-15	44-26	29-20	29-20	17-15	17-15	6-6	29-20	17-15	17-15	10-9	10-9	5-5
	açık kurp Ka (—)	51-35	30-23	30-23	22-19	22-19	16-15	20-23	22-19	22-19	16-15	16-15	8-8	22-19	16-15	16-15	12-11	12-11	7-7
Maksimum dever**	n (%)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Emniyetli duruş uzaklığı	Ld (m)	155	110	110	90	90	70	110	90	90	70	70	40	90	70	70	55	55	25
Emniyetli geçiş uzaklığı	Lg (m)	670	550	550	480	480	420	550	480	480	420	420	270	480	420	420	340	340	190
Serit genişliği	L (m)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.25	3.25	3.25	3.25	3.00	3.00	3.00	3.00	3.00	3.00
Banket Genişliği ***	b (m)	2.50	2.50	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00
Platform genişliği	PG (m)	12.00	12.00	11.00	11.00	11.00	11.00	10.00	10.00	9.50	9.50	9.50	9.50	8.00	8.00	8.00	8.00	8.00	8.00
Köprü genişliği Köprü proje yükü : H : 20 - S : 16	Kısa köprüler (0 - 45 m) Wk (m)																		
	Uzun köprüler (> 45 m) Wu (m)																		
Alt geçit (minimum h:5)	h (m)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Gabari																			
Kamulaştırma genişliği	Toplam Genişlik KG (m)	Normal 60.00 ∓ projenin gerektirdiği kadar						Normal 40.00 m. ∓ projenin gerektirdiği kadar						Normal 15.00 m. ∓ projenin gerektirdiği kadar					
	Ölçek Sınırlığı 1/2000 (m)																		

* Projelendirilen yolun yapımının bitiminden itibaren 20 yıl sonra ulaşılacağı hesaplanan trafik değeri.

** Kar ve Buzlanma olmayan kesimlerde % 10'a kadar artırılabilir.

*** Dağlık arazideki karşıdı kesitlerde banket genişlikleri iniş tarafında 50 cm fazla, yarma tarafında 50 cm eksik uygulanır.

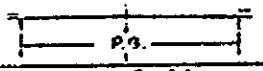
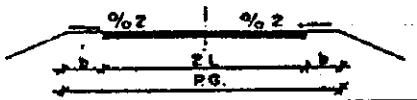
Karayolları Standartlar Kurulu tarafından hazırlanmıştır.

ONAY
4/7/1983

Turan ERİN
Genel Müdür

KARAYOLU GEOMETRİK STANDARTLARI

KENT DIŞI
İKİ ŞERİTLİ YOLLAR

PROJE ELEMANLARI			DÖRDÜNCÜ SINIF		
Hizmet Seviyesi		HS (A,B,C,D,E,F)	D	D	D
Trafik *	Yıllık Ort.Günlük Trafik	(Taşıt/Gün)	5200	3200	1200
	Proje Saatlik Trafiği	(Taşıt/Saat)	520	320	120
Topografik Model		TM (Dz,Dl,Dg)	Düz	Dalgalı	Dağlık
Proje Hızı		Vp (km/saat)	50	40	20
Minimum kurp yarıçapı		R (m)	90	60	20
Minimum klotoit parametresi		A (-)	40	30	15
Maksimum boyuna eğim		m (%)	10	12	16
Düşey kurp katsayısı L = G K	Kapalı kurp	Kk (-)	12	5	3
	Açık kurp	Ka (-)	12	7	4
Maximum dever **		n (%)	8	8	8
Emniyetli durus uzaklığı		Ld (m)	65	45	25
Emniyetli geçiş uzaklığı		Lg (m)	340	290	50
Şerit genişliği		L (m)	3.00	3.00	2.75
Banket genişliği		b (m)	0.50	0.50	0.50
Platform genişliği		PG (m)	7.00	7.00	6.50
Köprü genişliği Köprü proje yükü H:20 - S:16		(m)			
Alt Geçit (minimum h:5)		h (m)	5.00	5.00	5.00
Gabari					
Kamulaştırma genişliği		KG (m)	Minimum 15 m. ± projenin gerektirdiği kadar		

* Projelendirilen yolun yapımının bitiminden itibaren 20 yıl sonra ulaşılacağı hesaplanan trafik değeri.

** Kar ve buzlanma olmayan kesimlerde %10'a kadar arttırılabilir.

Not:Açımızda olmayan özel yol standartları ayrıca belirlenir.

Karayolları Standartlar Kurulu tarafından hazırlanmıştır.

ONAY

18/6/1993

Dinçer YİĞİT
Genel Müdür

2.4.2 Road Maintenance System

KGM Organisation

The current KGM organisation structure is shown overleaf. It consists of 12 Departments in the Headquarters, 17 Regional Divisions with 112 Maintenance Sub-Divisions and 357 Maintenance Workstations. There are also 3 Regional Supply Divisions.

The Headquarters Organisation

The Headquarters Organisation is responsible for the following :-

- ✓ Policy
- ✓ Strategy
- ✓ Planning
- ✓ Budget
- ✓ Financial Monitoring
- ✓ Research, Studies and setting Technical Standards
- ✓ Overseeing the work of private contractors
- ✓ Liaison with other Ministries

There are 12 Departments plus 3 Specialist Groups (see Fig 2.4.1) reporting through a Deputy Director General to the Director General.

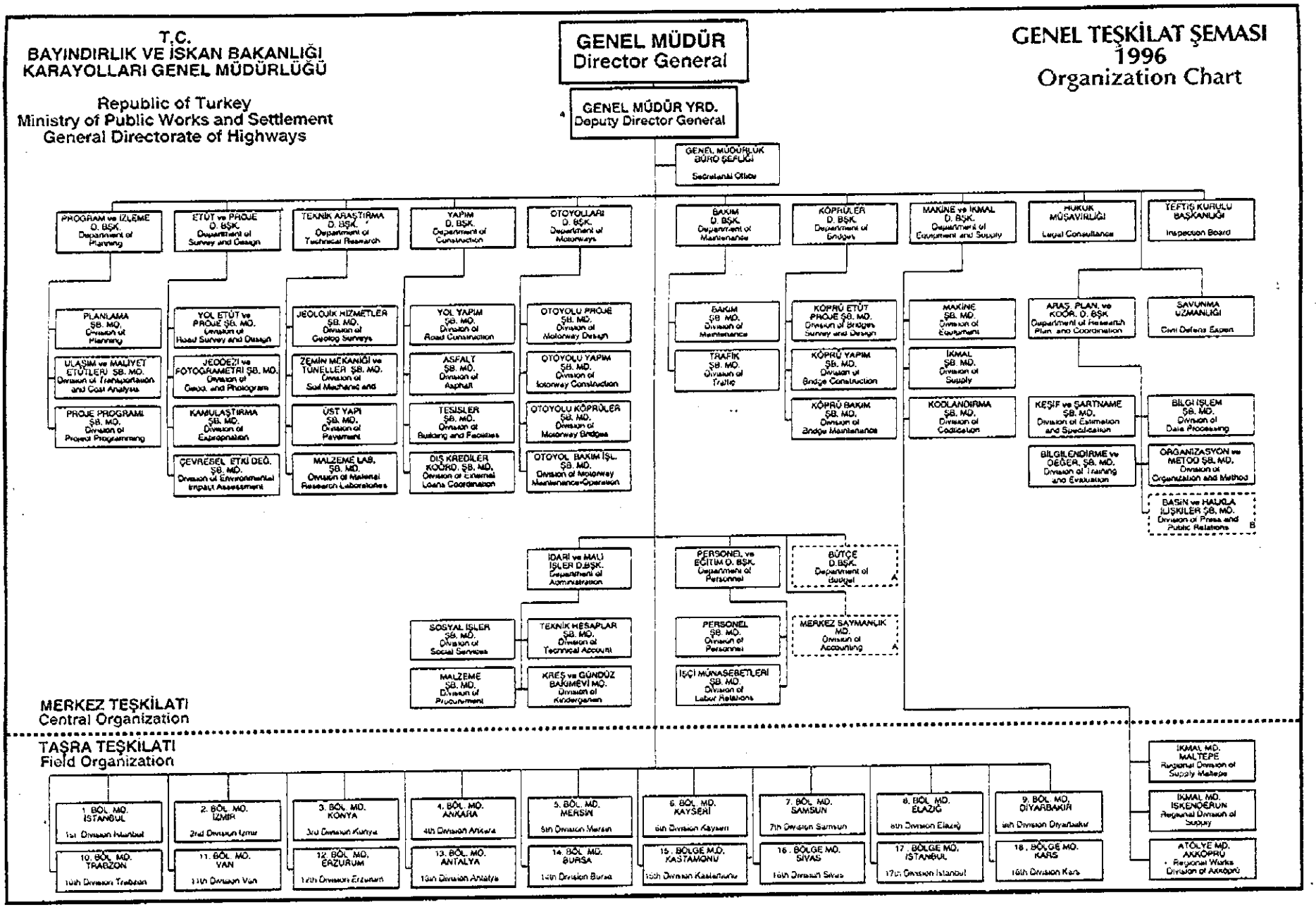
Each Department has a staff of 3 consisting of a Head of Department, a Deputy Head and a secretary. Each Department is supported by a number of Divisions providing the specialist personnel to deal with issues relevant to the particular Department.

Sample Organisation Charts for the Maintenance Division and Traffic Division are shown overleaf.

T.C.
BAYINDIRLIK VE İSKAN BAKANLIĞI
KARAYOLLARI GENEL MÜDÜRLÜĞÜ

Republic of Turkey
Ministry of Public Works and Settlement
General Directorate of Highways

GENEL TEŞKİLAT ŞEMASI 1996
Organization Chart



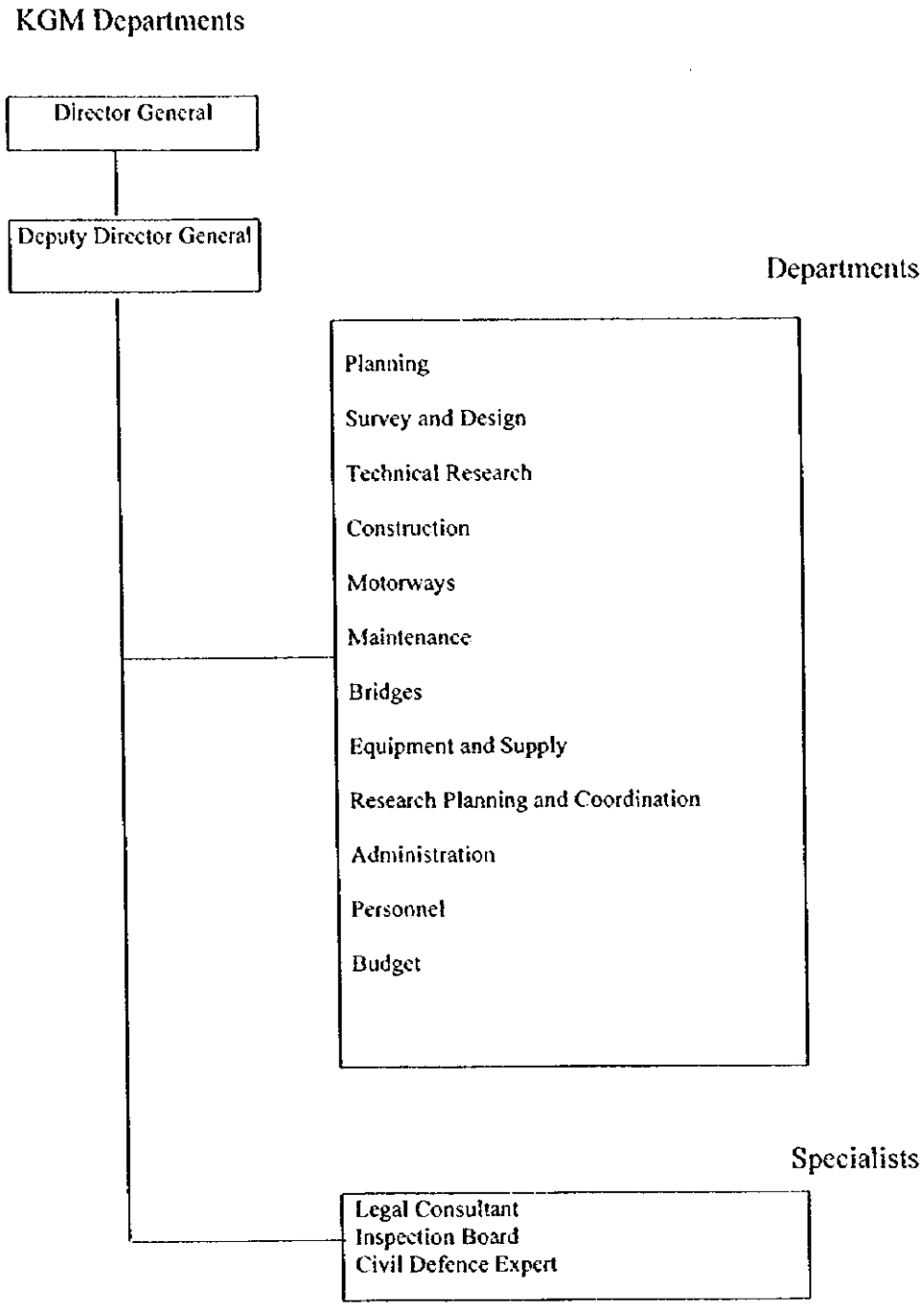
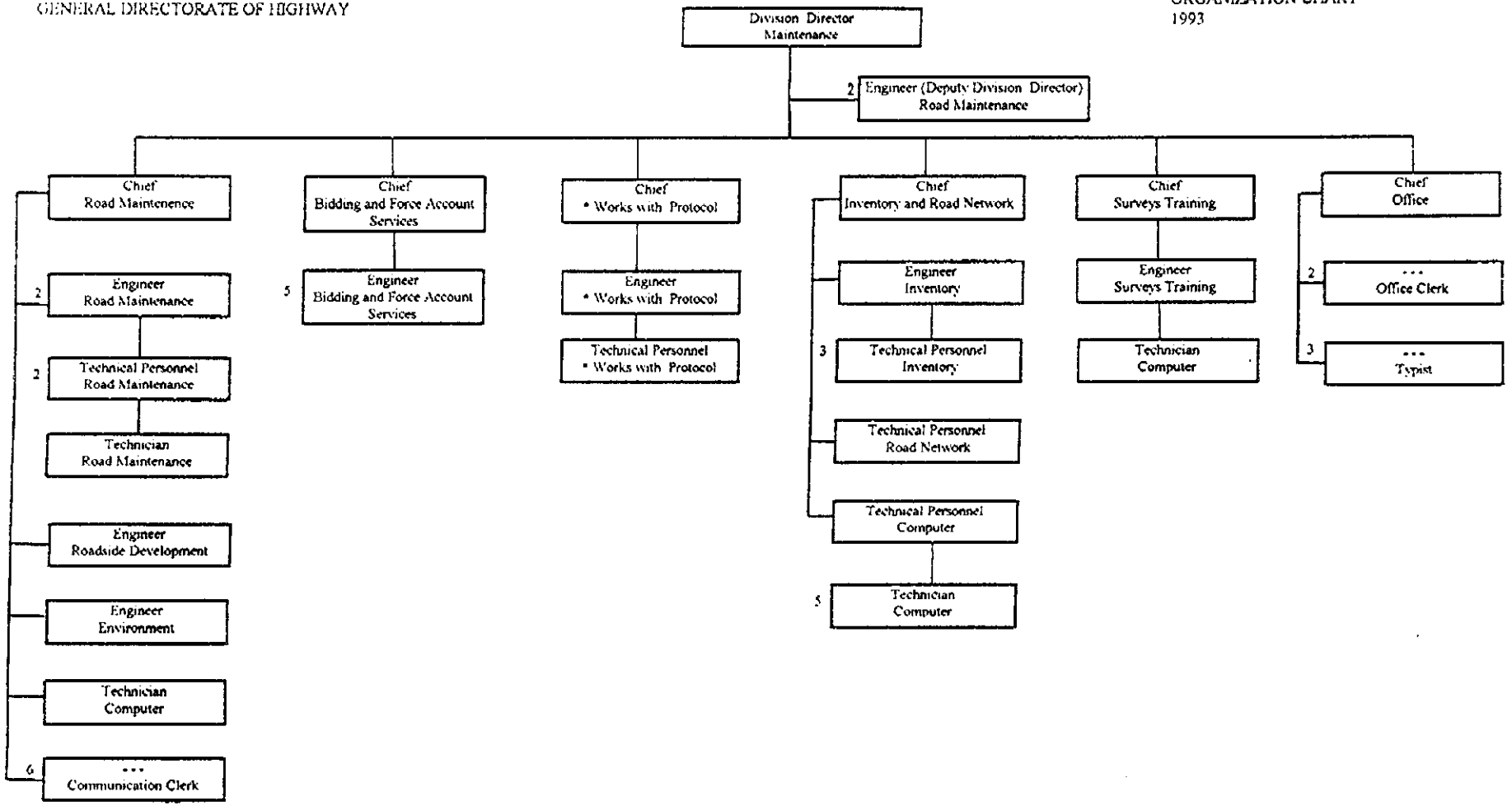


Fig 2.4.1 KGM Departments and Specialist Groups

REPUBLIC OF TURKEY
MINISTRY OF PUBLIC WORKS AND SETTLEMENT
GENERAL DIRECTORATE OF HIGHWAY

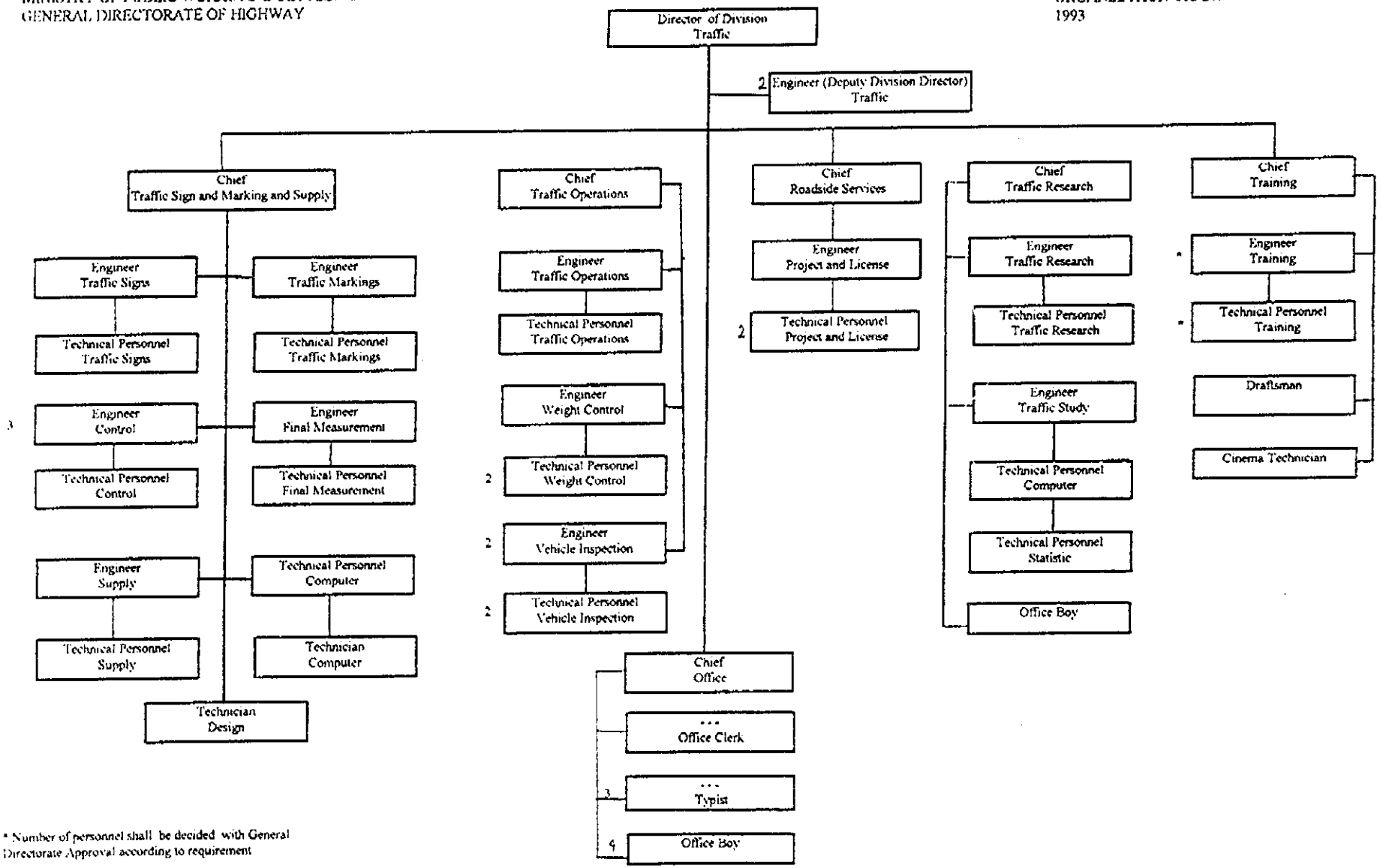
DEPARTMENT OF MAINTENANCE
DIVISION OF MAINTENANCE
ORGANIZATION CHART
1993



* Works with Protocol : Works performed under protocol signed with other state organizations

REPUBLIC OF TURKEY
MINISTRY OF PUBLIC WORKS AND SETTLEMENT
GENERAL DIRECTORATE OF HIGHWAY

DEPARTMENT OF MAINTENANCE
DIVISION OF TRAFFIC
ORGANIZATION CHART
1993



* Number of personnel shall be decided with General Directorate Approval according to requirement

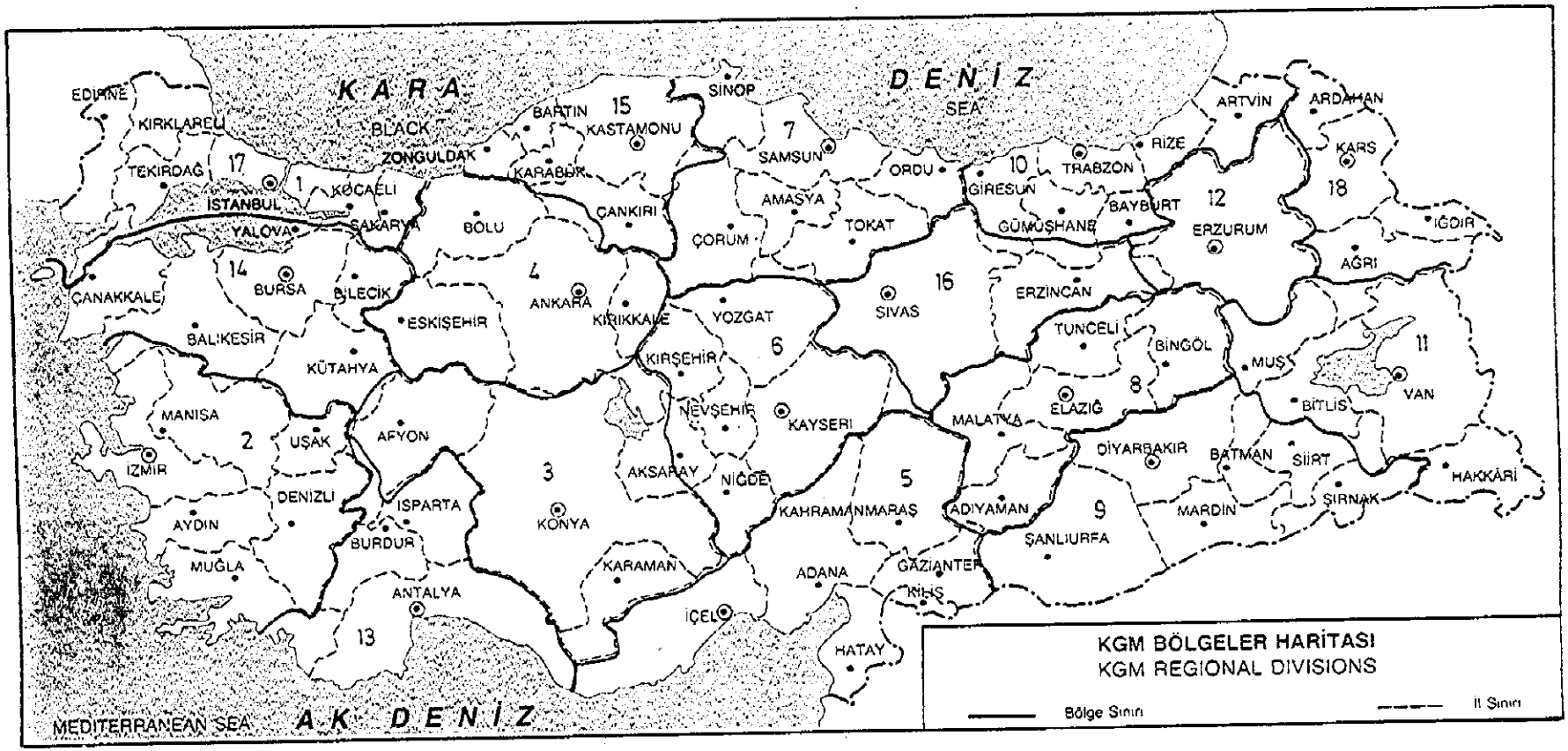
Regional Divisions

There are 17 Regional Divisions, with the 17th Division having specific responsibility for the 2 Bosphorous Bridges and associated motorways. A map of the Regional Divisions is shown overleaf.

Table 2.4.4 below shows that each Division is responsible for between 2400 km and 5200 km of roads. State Roads, which are the major intercity roads carrying the largest traffic volumes, account for between 1400 km and 2600 km per Division.

Table 2.4.4 Length of State and Provincial Roads by Regional Division (18.02.97)

Division Number and Name		State Roads (km)	Provincial Roads (km)	Total (km)
1	ISTANBUL	2185	1555	3740
2	IZMIR	2588	2638	5226
3	KONYA	2300	2301	4601
4	ANKARA	1878	1659	3537
5	MERSIN	2227	2563	4790
6	KAYSERI	1791	2110	3901
7	SAMSUN	2378	1957	4335
8	ELAZIG	1467	2548	4015
9	DIYARBAKIR	2054	1857	3911
10	TRABZON	1393	1028	2421
11	VAN	1419	1271	2690
12	ERZURUM	2645	878	3523
13	ANTALYA	1907	1441	3348
14	BURSA	2272	2424	4696
15	KASTAMONU	1485	1333	2818
16	SIVAS	1352	1390	2742
	TOTAL	31341	28953	60294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BALIKESİR
KÜTAHYA
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AYDIN
MUĞLA
ISPARTA
BURDUR
ANTALYA
ESKİŞEHİR
ANKARA
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KIRŞEHİR
NEVŞEHİR
KAYSERİ
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KAHRAMANMARAŞ
ADIYAMAN
GAZİANTEP
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MALATYA
ELAZIĞ
DİYARBAKIR
MARDİN
BATMAN
ŞIRNAK
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MEDITERRANEAN SEA
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KGM BÖLGELER HARİTASI
KGM REGIONAL DIVISIONS
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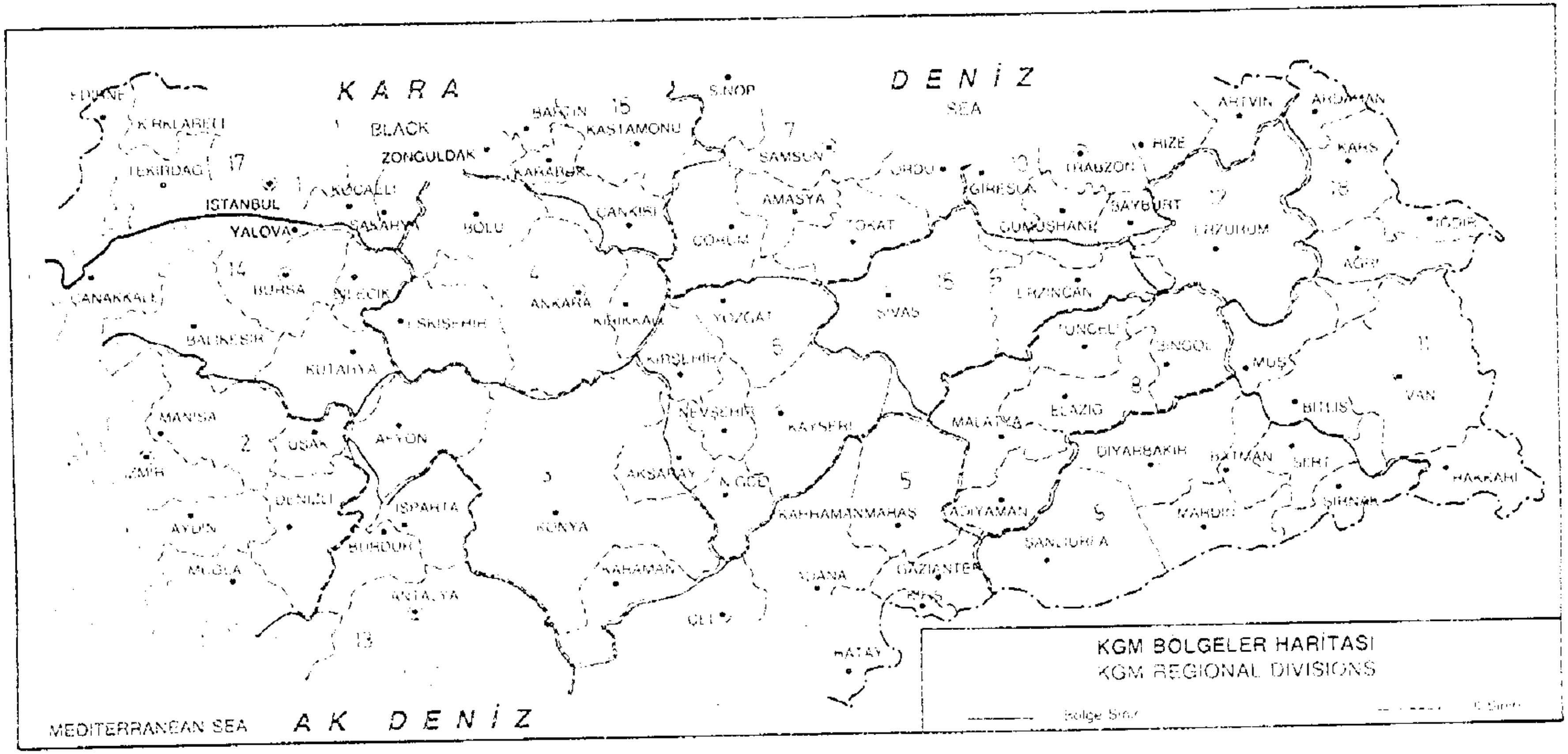
KARA DENİZ
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SAMSUN
AMASYA
TOKAT
SIVAS
YOZGAT
KAYSERI
KONYA
AFYON
BURSA
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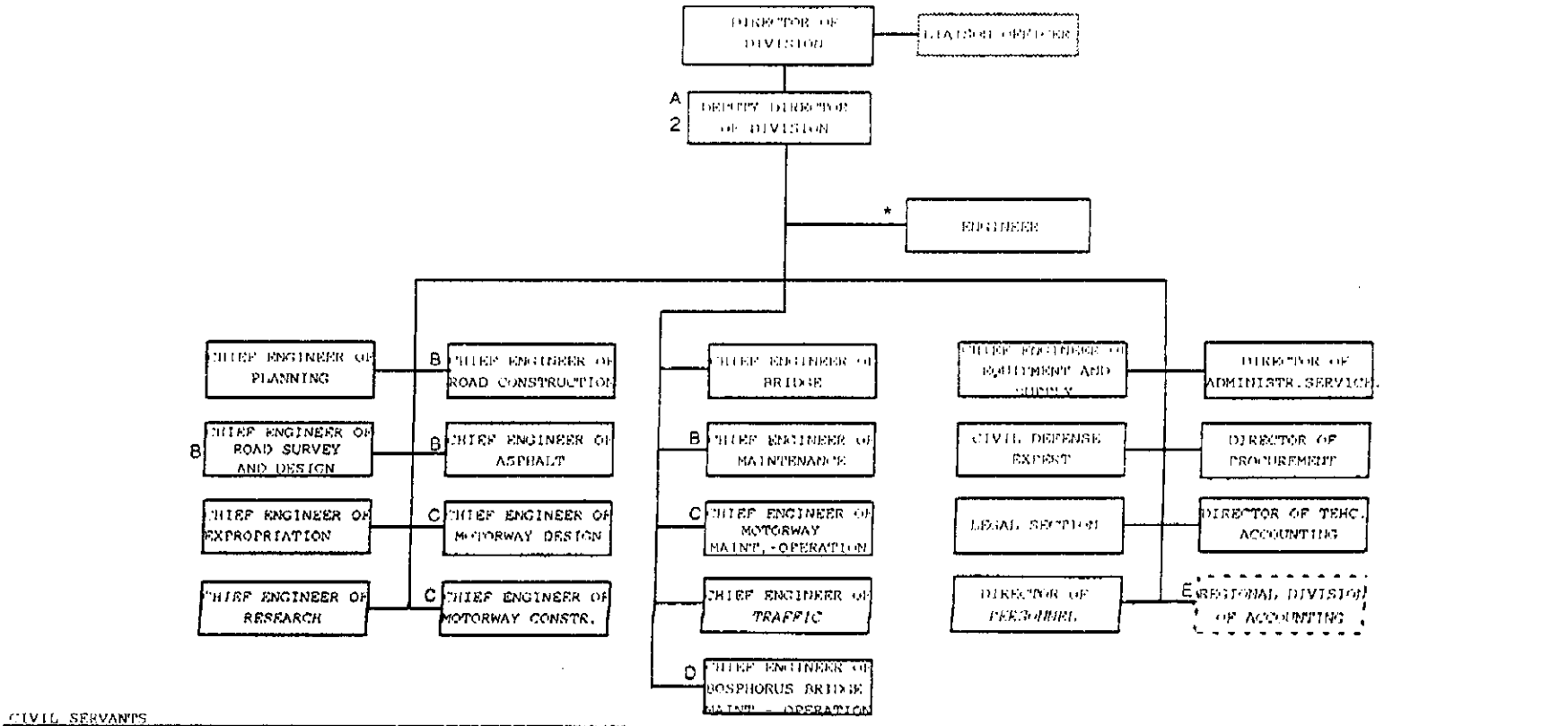
RIZE
ARTVIN
KARS
ADIYAMAN
KAHRAMANMARAŞ
GAZIANTEP
HATAY
ADANA

REPUBLIC OF TURKEY
MINISTRY OF PUBLIC WORKS AND SETTLEMENTS
CENERAL DIRECTORATE OF HIGHWAYS

TYPICAL ORGANIZATION CHART
OF DIVISIONS
1996



* The number of the personnel to be employed in this position is determined according to the need by the "Permission" of the General Directorate.

A-In the Division Directorates with motorways, the number of the personnel to be employed is 3.

B-Does not exist in the 17 th Division.

C-Exists in the Division Directorates with motorways

D-Exists in the 17 th Division (1 for the Bosphorus Bridge and 1 for the Fatih Sultan Mehmet Bridge.)

E-Works as the subsidiary personnel to the Ministry of Finance.

Each Regional Division is responsible for the overall planning and management of the road network maintenance under its jurisdiction based on the standards and guidelines set by KGM Headquarters. In addition, each Regional Division is also fully responsible for the administration, daily operation, control and management of its Maintenance Sub-Division offices and Maintenance Workstations.

A typical organisation chart for staff based at Regional Division Office is shown overleaf and the Regional Division, Sub Division, Workstation Organisation is shown in Fig 2.4.2

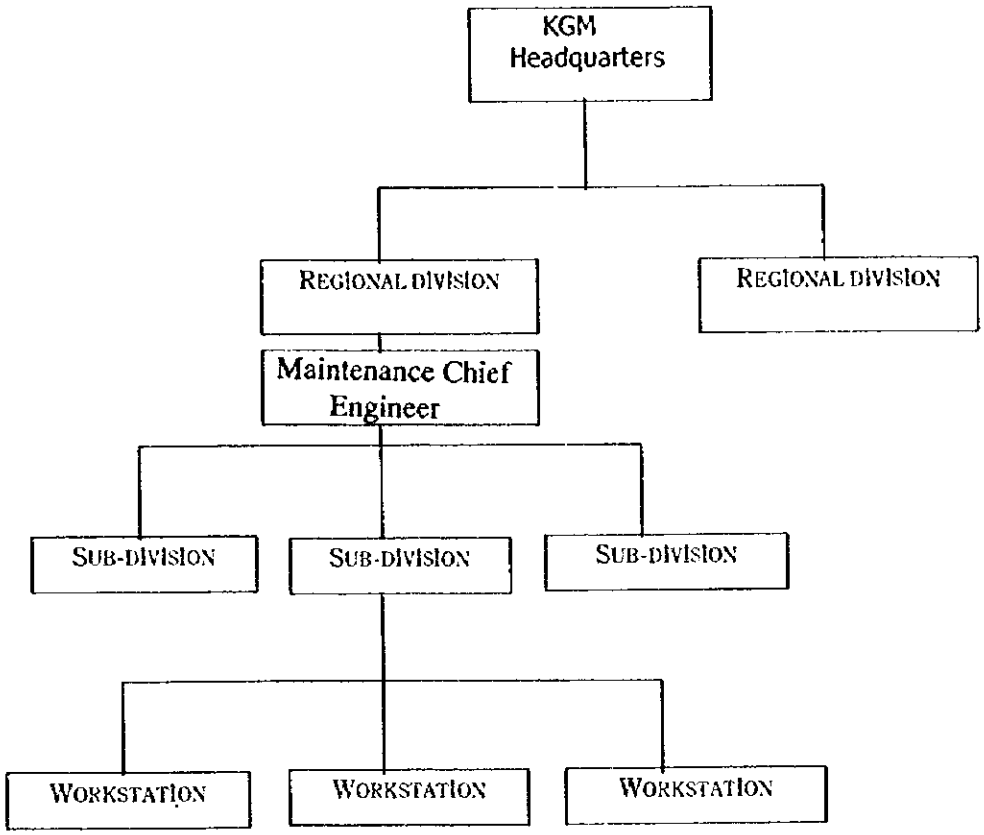


Fig 2.4.2 Regional Division, Sub-Division, Workstation Organisation

Sub Divisions

Table 2.4.5 shows how each Division is divided up into Sub-Divisions and Workstations. On average each Division has 7 Sub-Divisions each covering about 500 km of the road network.

The Sub-Division Headquarters is also a workstation and will have office facilities for the staff, garage facilities for the storage and maintenance of equipment, salt storage facility, bitumen tanks, surface storage for aggregates, fuel facility, spare part store and in some locations accommodation for visitors. The Sub-Division Depot covers a very large area.

The Sub- Division will carry out most of the equipment maintenance and repair work for all of its workstations, but anything major will be sent to the Division HQ.

Workstations

Each Workstation is responsible on average for about 120 km of the road network. They vary in size from the Sub-Division Headquarters which is very large, to medium size, which will have basic offices, small garage facility, covered salt store, petrol facility and then there are very small workstations which are no more than 2 portacabins providing very basic office, cooking and eating facilities but no garage, equipment or materials stores and very limited equipment.

Table 2.4.5 - Regional Divisions, Sub-Divisions and Workstations

Division	Length of road (km)	No. of Sub-Divisions	No of Workstations
1. Istanbul	3778	7	24
2. Izmir	5242	8	26
3. Konya	4909	8	30
4. Ankara	3519	7	26
5. Mersin	4777	8	25
6. Kayseri	3676	9	15
7. Samsun	4535	9	22
8. Elazig	4040	6	21
9. Diyarbakir	3989	7	12
10. Trabzon	2471	6	16
11. Van	2714	7	18
12. Erzurum	3486	8	26
13. Antalya	3335	6	16
14. Bursa	4693	8	21
15. Kastamonu	2926	7	20
16 Sivas	2746	5	19
Total	60836	116	337

The staff numbers vary from 6 to 8 at the smaller workstations to 20 to 30 at the larger workstations. The numbers increase considerably at some workstations to deal with the winter maintenance. This increase is mainly in machine operators and they come from the Asphalt Division, whose drivers are not so busy in the winter, and also from the Division HQ plus some temporary drivers and labourers.

The workstation activities cover the winter maintenance plus all routine maintenance including clearing of debris on the road, ditch and culvert cleaning, grading of earthworks, crack sealing, filling of potholes and surface patching works and grading of stabilised gravel

matters such as cleaning of traffic signs, road markings and the maintenance of traffic signals and lighting are also handled by the workstation team.

Personnel

The KGM employed 30 551 personnel in March 1997 of whom, 11307 (37%) were employed by the Maintenance Department.

Table 2.4.6 - Maintenance Department Personnel

HEADQUARTERS		DIVISIONS		TOTAL
Workers	Officers	Workers	Officers	
10	51	10370	876	
61		11246		11307

Table 2.4.6 shows the breakdown of the Maintenance Department staff. Of the Maintenance workers based in the Division, 7300 (70%) were permanent employees and the remainder were temporary. Of the workers in the Divisions 6600 (63%) dealt with Maintenance activities and 3800 (37%) were non productive support staff such as cooks, caretakers, boiler attendants. These figures include only 540 of the 1600 non machine drivers in the support staff figure.

The Maintenance Division has 386 engineers and technicians with 18 in Headquarters, 106 in the Regional Divisions and 262 in the Sub-Divisions.

Maintenance Budget

The maintenance and repair work for the State and Provincial Roads involves 4 Divisions (Maintenance Division, Traffic Division, Asphalt Division and the Pavement Division) from 3 Departments (Maintenance Department, Construction Department and the Technical Research Department) and includes work done by the in-house teams and work contracted out. The budget is in 2 parts; the in-house part (see Table 2.4.7) and the '113' Budget, which covers work tendered out to private contractors and also the purchase and delivery of materials from outside parties.

Table 2.4.7 shows the Maintenance budget for their in-house works for 1996. As can be seen from Fig 2.4.3, the labour cost is some 76% of the total budget reflecting the nature of their work which is very labour intensive.

Table 2.4.7 Maintenance Budget for in-house works for 1996 (x10^3 TL)

Item		Quantity	Cost (TL)	%
Personnel			7 950 257 813	76.5
Spare Parts and Building Materials			599 189 746	5.8
Fuel Oil			1 145 446 002	11.0
Telephone			17 256 461	0.2
Electricity			59 427 567	0.6
Water			35 209 797	0.3
Asphalt	tonne	64349	587 626 101	5.7
Salt	tonne	16432		
Aggregate	m3	824306		
Total			10 394 413 487	100.0

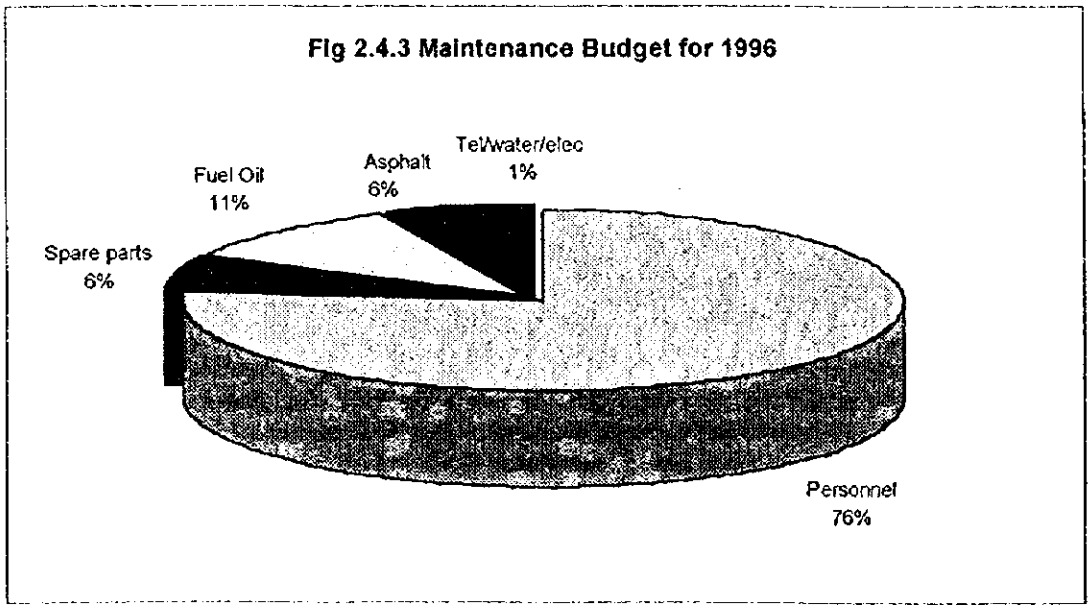


Table 2.4.8 shows the 113 budget for the period 1987 to 1997 and gives the start of year budget and the final amount paid in the year.

Table 2.4.8 113 Budget for 1987 to 1997

($x10^6$ TL)

Division / Year		Bitumen	Maintenance Division	Traffic Division	Bridge Maint. Division.	Asphalt Division	Total
1987	start	13597	17500	14700	3600	21700	71097
	end	13592	17500	14700	3600	21700	71097
1988	start	17850	19900	16700	4500	25800	84750
	end	17850	19900	16700	4500	25800	84750
1989	start	20000	25000	20000	5500	23810	94310
	end	20000	25000	20000	5500	23810	94310
1990	start	27000	30000	24000	6600	32400	120000
	end	23760	30000	23357	5808	28512	111437
1991	start	44000	48125	27460	8260	66340	194185
	end	44000	48125	27460	8260	66340	194185
1992	start	33610	91238	38105	11464	34000	208417
	end	34579	91238	38105	12800	34000	210722
1993	start	43650	137158	53156	16005	60431	310400
	end	79715	137158	53156	16005	60431	346465
1994	start	60000	194260	81000	24400	83860	443520
	end	64260	135982	71280	17080	42000	330602
1995	start	90550	300225	77000	26740	110000	604515
	end	507718	300225	77000	26740	110000	1021683
1996	start	200000	437950	118000	540000	169000	1464950
	end	200000	2419950	77000	540000	169000	1286225
1997	start	950000	1092500	190000	142500	3325000	5700000

To get the complete budget figure, the various elements must be added together.

1996 Budget Total ($x10^6$TL) (Excluding the bridge maintenance costs)

1. Maintenance Division in-house		10 394 413	
2. Maintenance Division 113		2 419 950	
3. Traffic 113		77 000	
4. Traffic in-house		816 100	(893 100-77000)
4. Asphalt Division		169 000	
5. Bitumen		200 000	
6. HQ Technical support		1 220 783	
7. Protocol costs		275 687	
Total	TL	15 572 933	($x10^6$ TL)

In addition to to the 'in-house' and '113' budget, there are some additional items to cover the cost of bitumen, 'HQ Technical support' refers to professional staff in Headquarters and the Regional Divisions and the 'Protocol' costs are to cover work on public utilities such as water, electric, gas and telephone.

In 1995, the Maintenance budget of 8 142 635 ($x10^6$ TL) was 20% of the total KGM budget for the year.

Each year the Regional Divisions review their road network to identify maintenance and repair works to put forward in the annual budget round. The maintenance and repair works are reviewed and costed by Maintenance, Asphalt and Research staff and the proposals are sent to Headquarter.

In the last 3 years, the Maintenance Department has only received between 10% and 16% of the 113 budget figure it requested because of constraints on the available funds. As a result of this, when the budgets are allocated to the Divisions, they have to review their scheme priorities to suit the available budget.

Road Condition Surveys

To determine the general condition of the Asphaltic Concrete pavement sections, the Technical Research Department uses a Profilometer which can travel at normal traffic speeds using infra-red technology to measure the surface profile. Last year nearly 5000km of the State Road and Motorway network were covered. Measurements are recorded at 100metre intervals and enable a Ride Number to be computed for each road section. Sections with a Ride Number below 2.5 are deemed to be in need of urgent attention. A weighting factor is applied and the road sections are listed in order of priority ranking. The priority sections are then subjected to a detailed investigation using the Falling Weight Deflectometer, Skid Tester, rut depth measurements, core samples and soil samples to enable the Research Department to investigate the problem and to design the appropriate repair works.

This method does allow the detailed investigation work to be focused on priority sections and may well detect problems at an early stage and certainly before any visual methods are likely to detect them. The Profilometer is not currently used on Surface Treated roads although one section was surveyed as a trial. This means that only about 16% of the State Road network will be covered by this method the remainder having to rely on more traditional methods. The Profilometer will also produce an International Roughness Index (IRI) as an alternative to the Ride Number.