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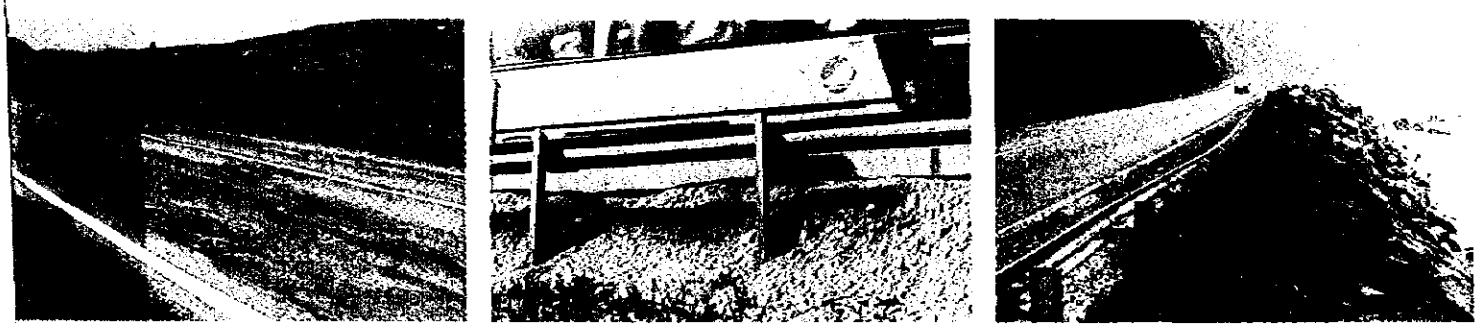
No. 12

JAPAN INTERNATIONAL
COOPERATION AGENCY(JICA)

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

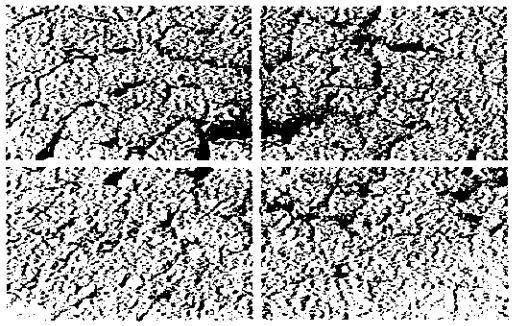


THE STUDY ON ARTERIAL HIGHWAY MAINTENANCE IN THE REPUBLIC OF TURKEY

FINAL REPORT

SUMMARY

VOLUME ❶



JULY 1998

ORIENTAL CONSULTANTS CO., LTD.
in association with
JAPAN OVERSEAS CONSULTANTS CO., LTD.

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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

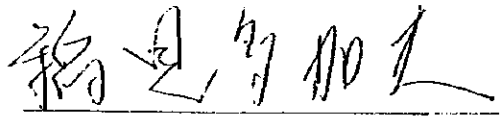
We are pleased to submit to you the study report on Arterial Highway Maintenance Study.

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.

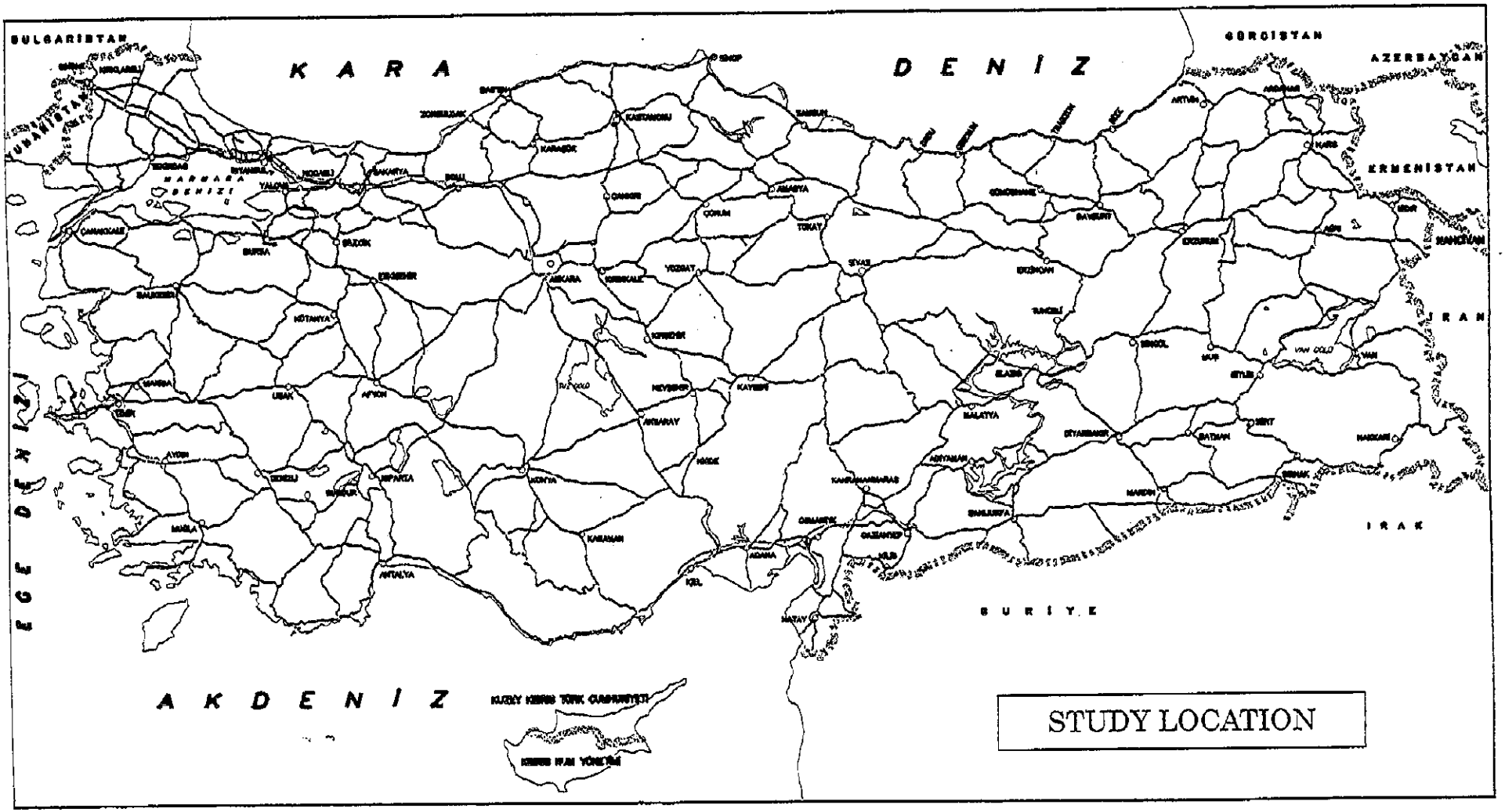
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Public Works and Settlement. We would also like to express our gratitude to the officials concerned of the Arterial Highway Maintenance Study, the Embassy of Japan in Turkey and the JICA 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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IRAN
IRAK
SURIYE
EGE DENIZI
AKDENIZ
MARMARA DENIZI
KUZEY KIBRIS TURK CUMHURIYETI
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	38.9	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.

Table of Contents

CHAPTER 1 INTRODUCTION

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 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 Maintenace" is to assist KGM in creating the most cost-effective road management system possible by designing the most appropriate process fo 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 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

1.4 Study Procedure

The study is comprised of two (2) stages. A general flow chart of the study is shown in Fig. 1.1.

(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

1.5 Study Organization and Participants

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. Rize 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. Munevver ATASARAL	Dep. Head of Maintenance Department

Senor 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.

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

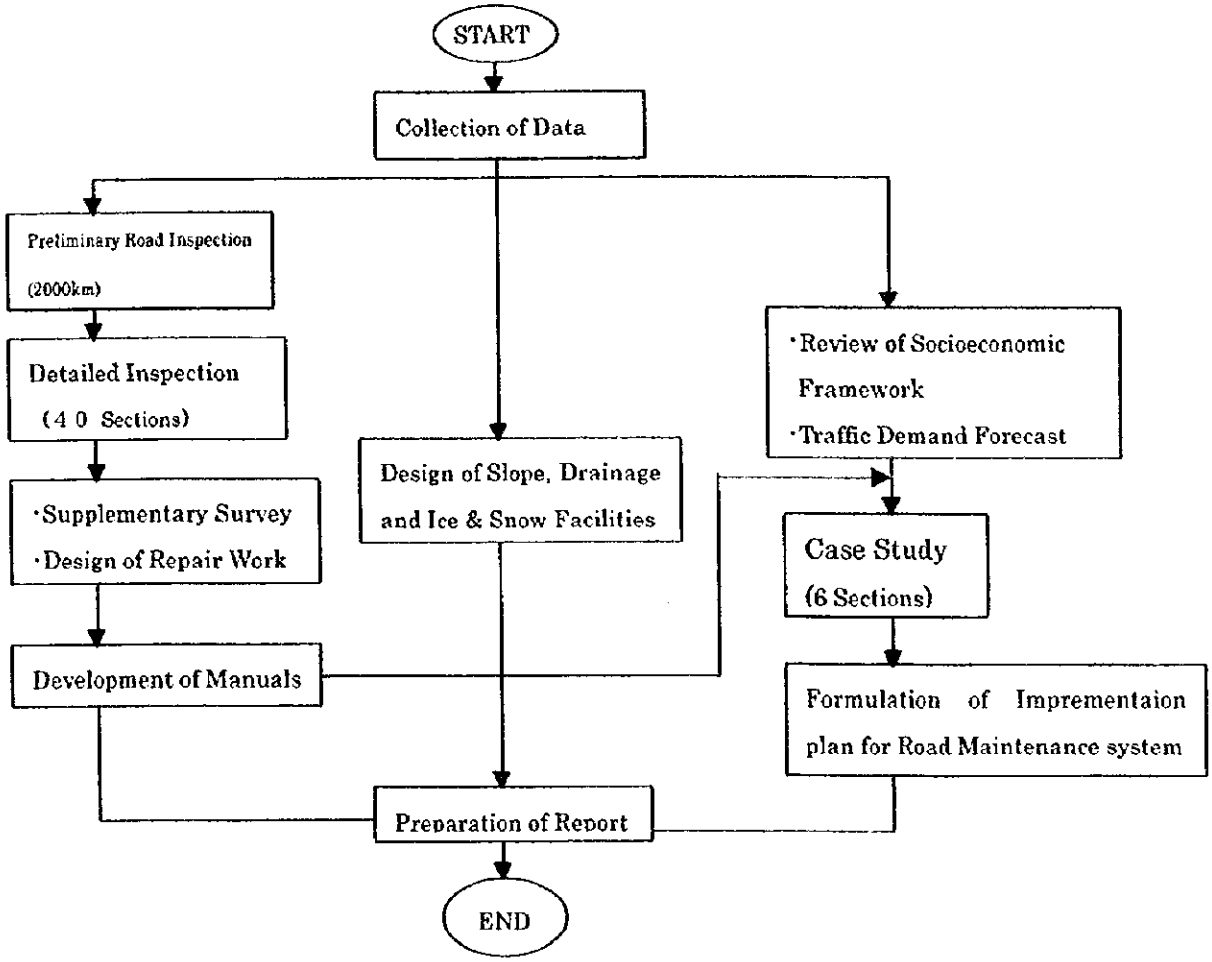


Fig. 1.1 Main Study Flow Chart

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.

(3) Members of the JICA Study Team

Mr. Akihiko HIROTANI	Project Director
Mr. Takao INAMI	Team Leader/Maintenance System Planner
Mr. John COOMBS	Road Repair work Planner/Pavement Engineer
Mr. Hiromichi ENOKIDA	Soil/Slope Engineer
Mr. Chai Seng Chiew	Pavement/Drainage Engineer
Dr. Masuyoshi MATSUDA	Snow/Ice Contingency Planner
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

CHAPTER 2 PRELIMINARY ROAD INSPECTION

2.1 Objectives of Inspection

The objectives of the road inspection are as follows:

(1) A road inspection of the selected routes was planned to survey the overall characteristics of the types and levels of road damage in Turkey.
(2) The inspection was also aimed at the technology transfer from the Study Team to the KGM counterparts.

2.2 Selection of Inspection Route

The study area includes approximately 60 000km of road throughout Turkey. The inspection routes, 1 939km, were selected according to the following concepts;

(1) To include the major damage types occurring in Turkey
(2) To include the main road elements (pavement, slope, drainage etc.) which are important for keeping a smooth traffic flow
(3) To include items based on the natural conditions (climate, topography, soil condition etc.) occurring in Turkey
(4) Following discussion between the KGM counterparts and the Study Team, the following inspection routes were agreed

Fig. 2.1 shows the inspection routes.

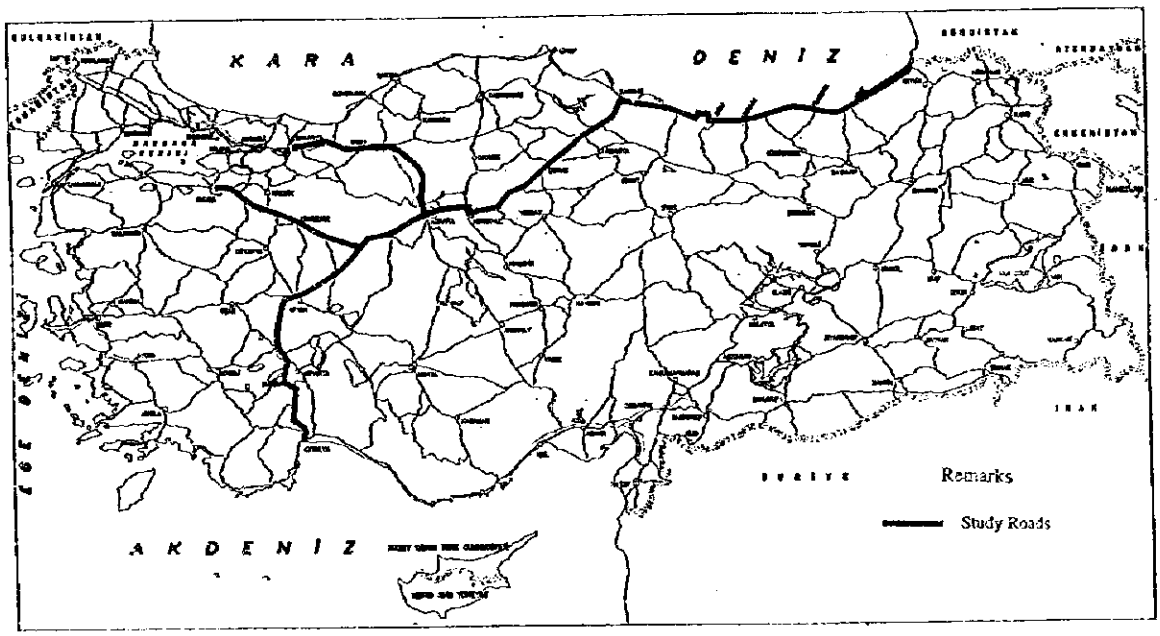


Fig. 2.1 Preliminary Inspection Route

2.3 Selection of Inspection Items

The types of damage for the inspection are classified into 9 categories, taking into consideration the structural, material and damage characteristics of the road component for maintenance. Below is the concept for selection of damage types:

(1) To include the major damage types in Turkey
(2) To include the main road elements to keep a smooth traffic flow
(3) To include items based on the natural conditions in Turkey

Table2.1 shows the damage types for the inspection.

Table 2.1 Damage Types

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 include the bridge, traffic safety facilities and tunnel maintenance systems.

2.4 Inspection Sheet

The inspections were carried out using the inspection sheet as shown in Table 2.2 The inspection sheet was prepared based on the following concepts;

(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.

2.5 Evaluation of Damage

In order to judge the necessity of repair work, observations of damage or deterioration are categorized into three ranks according to the following guidelines:

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

Table 2.2 Inspection Sheet

INVENTORY				
Key Identifer	Route	KGM-Division	Survey Category	Date of Survey
Road General	Sub-Division	Location km from		
	Road Class	Design Speed km/hr	No. of Lanes	
	Carriageway Width m	Shoulder Width m	Sidewalk Width m	
	Pavement (1)Concrete (2)Asphalt (3)Stone Block (4)Stabilized (5)Earth			
	Road Structure (1)Cut (2)Embankment (3)Cut & Embankment			
Site Conditions	Topography (1)Mountainous Terrain (2)Hill Terrain (3)Flat Terrain (4)Soft Soil Area			
	Land Use (1)Built-up Area (2)Residential Area (3)Public Area (4)Industrial Area (5)Farm Land (6)Forrest Land (7)Others ( )			
	Geology			

Traffic Volume in ADT	Passenger Car		Minibus		Bus		Small Truck		Truck		Total	

			Box Culvert			Embankment			Slope					Snow & Ice Control Facilities	Retaining Wall			Side Ditch			Shoulder	Gulley			Pavement					km
			Collapse	Settlement	Accumulation of Debris	Collapse	Submerge		Erosion	Cracking	Collapse of Protective Wall	Rock Avalanche	Landslide	Collapse	Collapse	Settlement	Crack	Collapse	Settlement	Accumulation of Debris	Washing Out	Collapse	Settlement	Accumulation of Debris	wave	Rutting	Potholes	Cracking	Settlement	

Pavement					Gulley			Shoulder	Side Ditch			Retaining Wall			Snow & Ice Control Facilities	Slope				
wave	Rutting	Potholes	Cracking	Settlement	Collapse	Settlement	Accumulation of Debris	Washing Out	Collapse	Settlement	Accumulation of Debris	Collapse	Settlement	Crack	Collapse	Erosion	Cracking	Collapse of Protective Wall	Rock Avalanche	Landslide

"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.

2.6 Results of Preliminary Road Inspection

The results of the preliminary road inspection are as follows:

1. Slopes
- Erosion : where slopes have not been covered by vegetation and have been eroded by surface run-off or rain or wave action along the coastal regions
- Landslide : slopes which are unstable either due to steep slopes or weak materials
- Cracking : developed from weathering of unprotected rock cuttings, slopes or unstable ground
- Rock Avalanche : rocks which have become unstable due to weathering
- Collapse of protective wall : walls constructed to arrest rock avalanche

2. Snow and Ice control facilities
- refers to the condition of the snow fences, snow walls etc

3. Retaining wall
- cracking :structural cracks on walls of stone, reinforced or unreinforced concrete construction
- settlement : excessive deformation due to underlying strata
- collapse : various failure modes

4. Side ditches/ verge drains
- Accumulation of debris : whether natural or man-made
- Settlement : obstructing flow
- Collapse : structural defects

5. Shoulders
- wash out : it is considered as the most serious problem

6. Gulleys
- Accumulation of debris : whether natural or man-made
- Settlement : obstructing flow
- Collapse : structural defects

7. Pavement
- Cracking : all types of surface cracks
- Settlement : resulting from visible and localised settlement of the earthworks
- Rutting : migration of asphalt in wheel tracks

- Undulation: affecting riding quality
- Potholes : Localised loss or peeling of asphalt surfaces

8. Embankments
- submerged : waterlogged due to non-existence of drainage facilities or blocked drainage system

9. Culverts
- Accumulation of debris : whether natural or man-made
- Settlement : Localised depression resulting in flow being obstructed
- Collapse : structural failure

2.7 Formulation of Database

1. Concept

With all the data available it is necessary to develop a database program to manage it. The concept is to enable the data to be recorded, amended, accessed and extracted as necessary. It is also a very useful tool for the network managers to gather detailed information about the roads under his control.

2. Objective

The objective of the database is essentially to store all the information that has been gathered to enable KGM maintenance engineers to:

- predict more accurately the damage profile of elements of the road
- easily analyse the extent of maintenance work in hand
- plan maintenance work accordingly
- record and to monitor the success of repair techniques and workmanship
- record and to monitor the suitability of repair materials

3. Input and Output Screen

The program was deliberately designed to be as simple and user friendly as possible. In this section various excerpts are presented to illustrate the program

The PRINT option on the MAIN MENU of the programme allows for a number of output possibilities.

CHAPTER 3 DATAILED 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 Selection of Inspection Section and Items

40 sections (40km) have been selected for detailed inspection based on the results of the preliminary inspection as shown in Fig. 3.1.

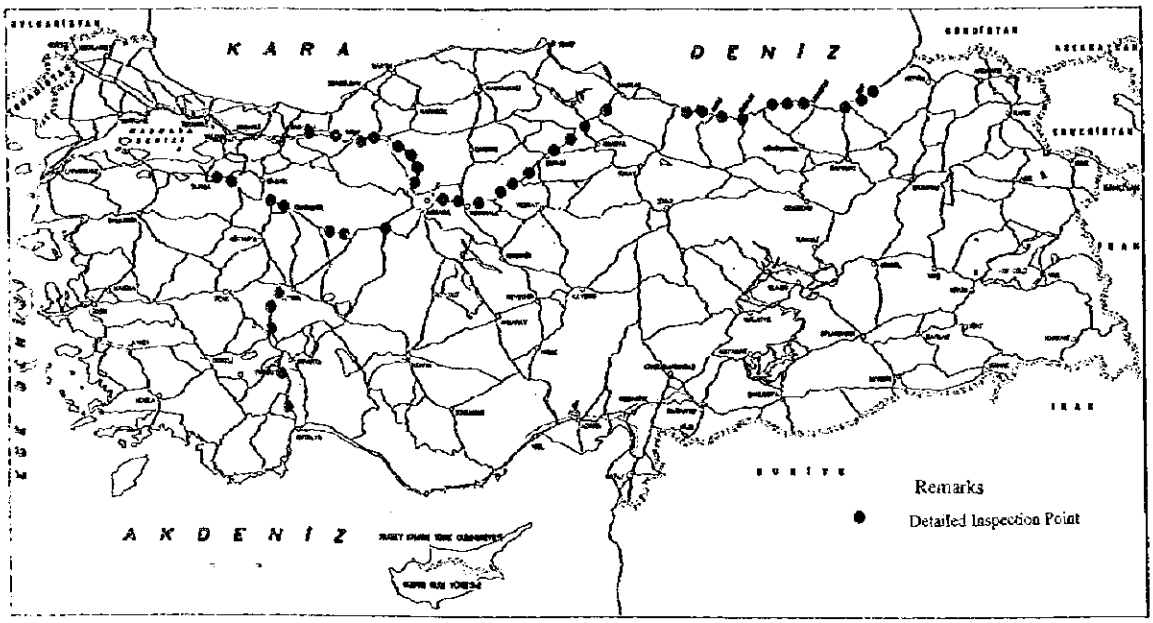


Table 3.1 Detailed Inspection Sections

3.3 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.

3.4 Inspection Sheet

The detailed inspection was executed out 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.

3.5 Supplementary Survey

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)

3.6 Results of Detailed Inspection

Main results of detailed inspection are as follows:

1. Pavement

The results of the pavement inspection are summarised in Table 3.1.

Table 3.1 Summary Cracking Ratio, Rutting Depth, Standard Deviation and PSI

Section . No.	Kilometre Post	Sub Division	Pavement Type	Pavement Results			
				Cracking Ratio %	Rutting Depth mm	Standard Deviation σ	PSI
100-10	40+800	17	As Con	36.2	7.8	14.3	1.59
650-09	17+400	31	Sur Tr	15.1	19.7	17.0	1.77
100-11	41+600	41	As Con	1.3	10.7	70.0	2.95
100-12	9+400	41	As Con	3.8	4.6	10.3	3.25
750-05	26+500	42	As Con	35.4	12.8	12.9	1.46
750-05	31+300	42	As Con	0.0	1.2	16.8	3.89
750-06	5+400	42	As Con	4.0	11.0	23.8	2.86
200-13	35+400	44	As Con	4.5	6.2	49.0	2.80
200-14	21+000	44	As Con	8.0	1.0	34.0	2.69
200-14	27+000	44	As Con	32.0	9.8	19.5	1.60
200-09	50+000	45	As Con	11.4	1.0	5.2	2.90
200-09	23+700	46	As Con	9.7	1.0	16.3	2.75
200-08	13+550	46	As Con	6.9	16.0	11.4	2.56
200-12	49+500	47	As Con	17.5	10.0	42.3	1.96
795-03	10+000	72	Sur Tr	25.0	24.0	14.8	1.07
190-01	11+400	73	Sur Tr	8.0	10.0	17.9	2.66
190-02	13+300	73	Sur Tr	38.0	13.2	8.3	1.46
795-04	15+000	73	Sur Tr	67.0	34.0	25.0	-1.24
795-01	61+500	75	As Con	69.0	14.0	43.7	0.25
010-18	24+950	77	Sur Tr	25.0	17.0	28.3	1.42
010-23	32+000	103	Sur Tr	16.4	21.0	19.7	1.59
010-19	17+600	104	Sur Tr	26.0	21.0	25.5	1.14
010-20	27+500	104	Sur Tr	15.0	8.0	17.8	2.33
010-21	8+750	105	Sur Tr	13.0	18.4	26.0	1.87
650-14	36+650	132	Sur Tr	0.0	12.2	10.1	3.75
650-12	36+200	134	Sur Tr	40.6	10.0	7.3	1.54
650-10	15+500	134	Sur Tr	24.9	14.1	14.6	1.73
200-06	12+100	143	As Con	18.7	10.4	14.0	2.14
200-07	41+700	144	As Con	0.0	48.8	6.9	-0.04
200-06	29+100	147	As Con	29.7	7.0	23.9	1.71

2. Slope and Shoulder

The majority of the damage encountered relates to the following problems :-

Erosion of the slope

- Landslide
- Rock avalanche

There were no recorded instances of collapse to protection wall or cracking to slope.

Detailed Inspection Sheet for: PAVEMENT Inspection Date: / / No.

				Director	Chief Eng.	Inspector
General Information	Route:	Location: km to km				
	KGM-Division:	Subdivision:				
	Road Class:	No. of Carriageways:	No. of Lanes:			
	Direction: to					
	Year of construction:					

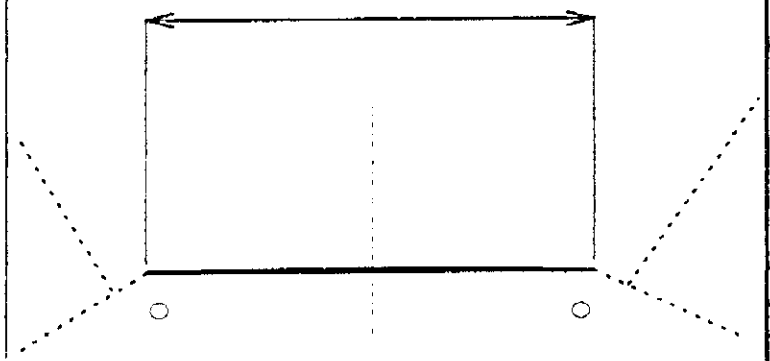
Inspection Items	Damage type	(1) Settlement (2) Cracking (3) Pothole (4) Wave (5) Rutting	Cracking Ratio	C = %
	Pavement	(1) Asphalt concrete (2) Surface treated	Rutting Depth	D = mm
	Topography	(1) Mount (2) Hill (3) Flat (4) Soft soil area (5) Other	Long. Rough.	σ= mm
	Soil type	(1) Rock (H or S) (2) Gravel (3) Sand (4) Silt (5) Clay (6) Other (	Pothole	Diameter = mm Depth = mm
	Drainage pipe	(1) Yes (diameter = mm) (2) None	PSI	$PSI = 4.53 - 0.518 \log \sigma - 0.371C - 0.00174D^2$ =
	Ground water	(1) Flow (2) Seepage (3) Wet (4) None	Index of PSI	
	Snow fall	(1) Yes (ave h= mm) (2) No		
	Chain abrasion	(1) Yes (ave d= mm) (2) No		

PSI	Required Scale of Rehabilitation
PSI < 1.0	Reconstruction
1.1 < PSI < 2.0	Overlay
2.1 < PSI < 3.0	Surface treatment
PSI > 3.0	Unnecessery to Repair

(1) Surface treated (2)Overlay (3) Reconstruction

Sketch — Road Section

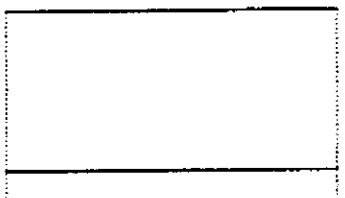
Survey Point: km+ m to m



Remarks:
A: Platform width
B:Carriageway width
C,D:Traffic lane width
H:Drain pipe
E: Shoulder width
F: Crossfall
G: Median width
(O): Survey Point

Coring Test Result

Pavement Composition



	Overlay	Surface Course	Binder Course	Bituminous course	Road base	Sub-base
Core No.1						
Core No.2						
Core No.3						
Core No.4						
Core No.5						
Core No.6						

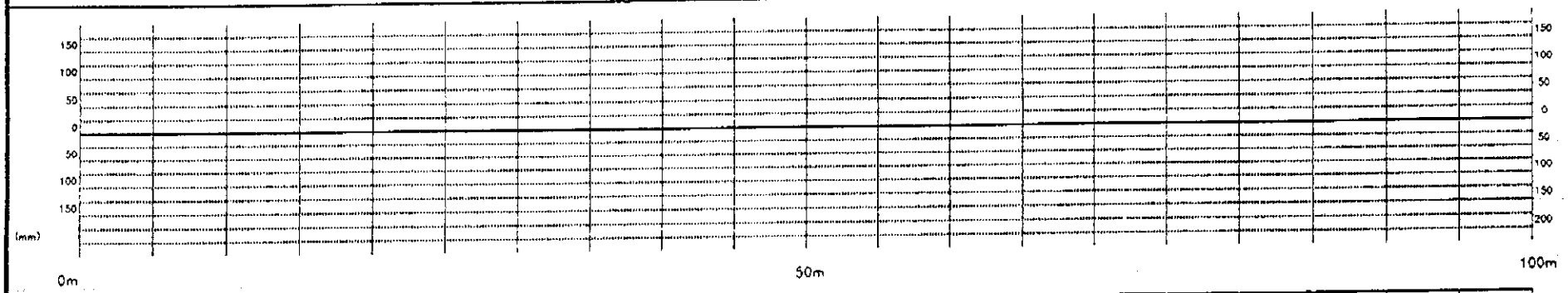
Detailed Inspection Sheet for : PAVEMENT

Inspection Date: / /

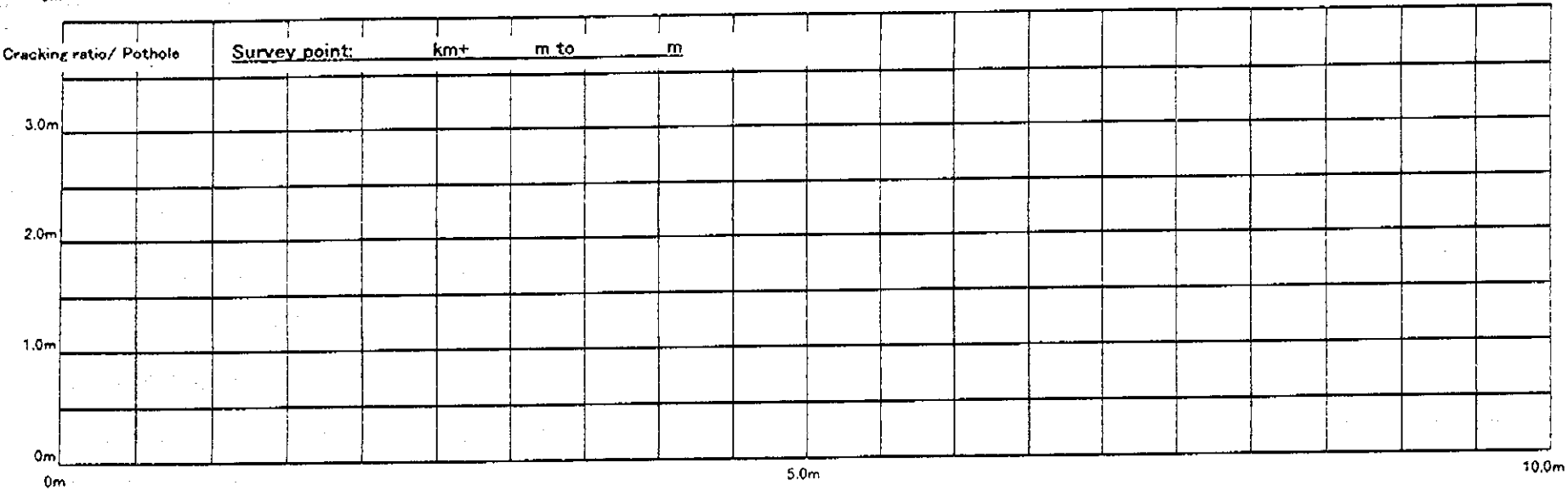
Calculation of cracking ratio / patching area	Calculation of rutting depth				Database for pothole				
	No.1	Depth:	No.6	Depth:	No.1	Depth:	Diameter	No.6	Depth: Diameter
	No.2		No.7		No.2			No.7	
	No.3		No.8		No.3			No.8	
	No.4		No.9		No.4			No.9	
	No.5		No.10		No.5			No.10	
Cracking ratio C = %	Average of Depth (mm)				Average of depth = mm			Average of diameter mm	

Longitudinal Roughness Survey point: km+ m to m

Standard Deviation of Roughness σ = mm



Cracking ratio/ Pothole Survey point: km+ m to m



3. Drainage and Culvert

Detailed inspection of drainage culverts was carried out in 5 sections. The majority of damage recorded consists of the accumulation of debris resulting in the blockage of these culverts. No instances of collapse or settlement were investigated during the detailed inspection phase.

Additionally culverts were inspected at each Sub Division to enable training in the use of the inspection forms to be given. No damage was recorded in these locations.

4. Side Ditch and Gully

Detailed inspection of side ditches and gulleys was carried out in 3 sections. The majority of damage recorded consists of an accumulation of debris in the side ditch channels. No instances of side ditch collapse or settlement were recorded during the detailed inspection phase.

5. Retaining Wall Inspection Results

(1) Of the inspected sections the most common damage recorded is from impact; both from vehicles and from rockfall which has caused collapse. In older walls the effect of weathering is causing mortar joints to crumble which in more serious cases is also leading to collapse of the upper courses of the masonry wall.

(2) In instances where the retaining wall acts as a barrier to prevent rock fall from reaching the carriageway, the rear of the wall is now full of rock debris. This is now causing a potential hazard as debris can fall directly onto the carriageway.

(3) In coastal regions the effects of sea erosion is having a severe effect on the stability of the retaining walls which has led to the partial collapse of some of these walls.

CHAPTER 4 PRELIMINARY DESIGN OF REPAIR WORK

4.1 Basic Process

The basic process of preliminary design of repair work is shown in Fig.4.1.

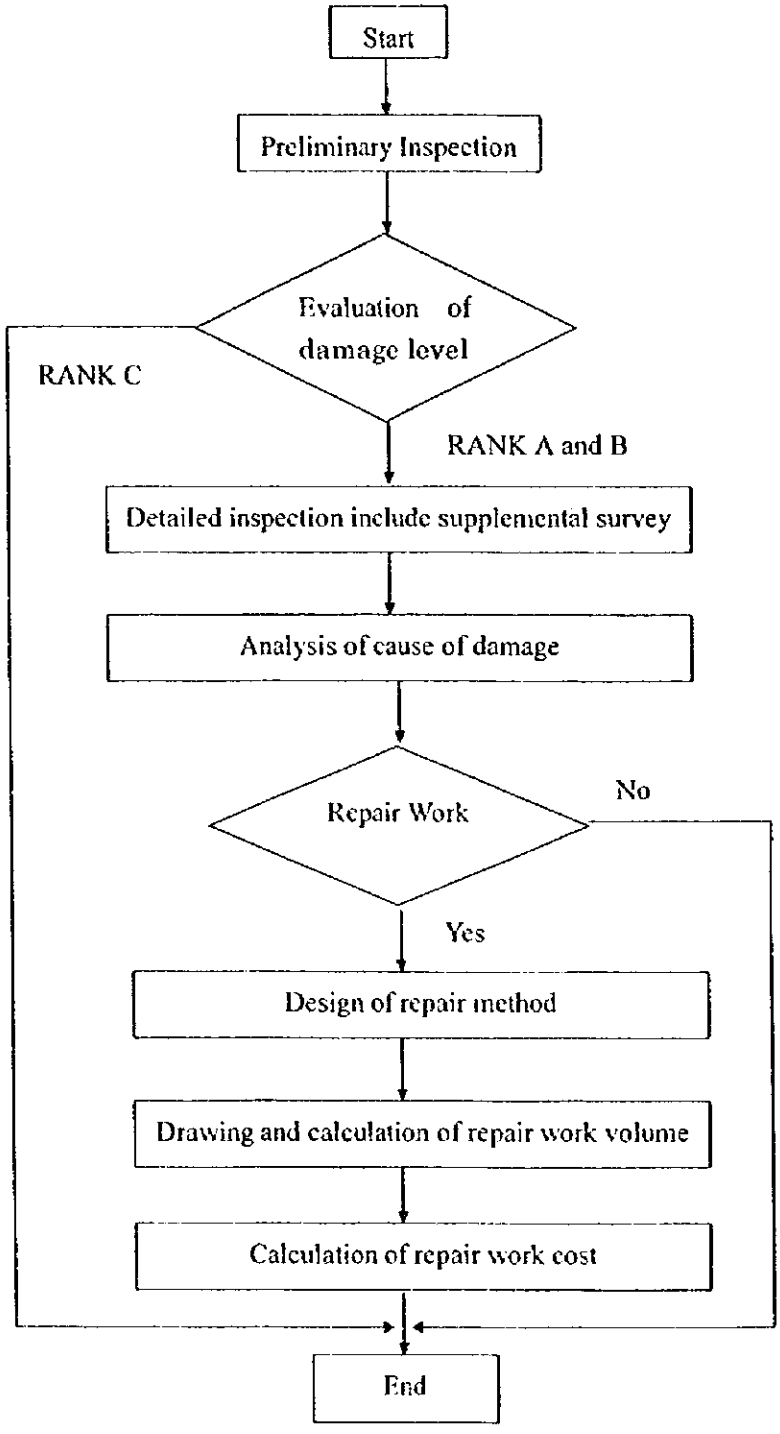


Fig. 4.1 The Flowchart for The Preliminary Design of Repair Work

4.2 Repair Method

The typical repair method for each design item is shown in Table 4.2

Table 4.2 The Summary of Repair Methods

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 of 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
	Additional or build Slope drainage	- to prevent the slope from scouring and eroding by water action
	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 rock avalanche or any soil sliding
Other structure /Retaining wall /Drainage /Gully /Side ditch /Culvert	Sealing/filling	- using synthetic resin or cement mortar, to sial or to fill the crak or depression to keep strctural capacity
	Partial/overall reconstruction	- to regain adequate structural strength
	Reinforcement to increase the structure strength	- to reinforce or to increase the structural strength

CHAPTER 5 ENVIRONMENTAL STUDY

5.1 Methodology for Environmental Consideration

The process of environmental consideration in the project cycle is shown in Fig.5.1.

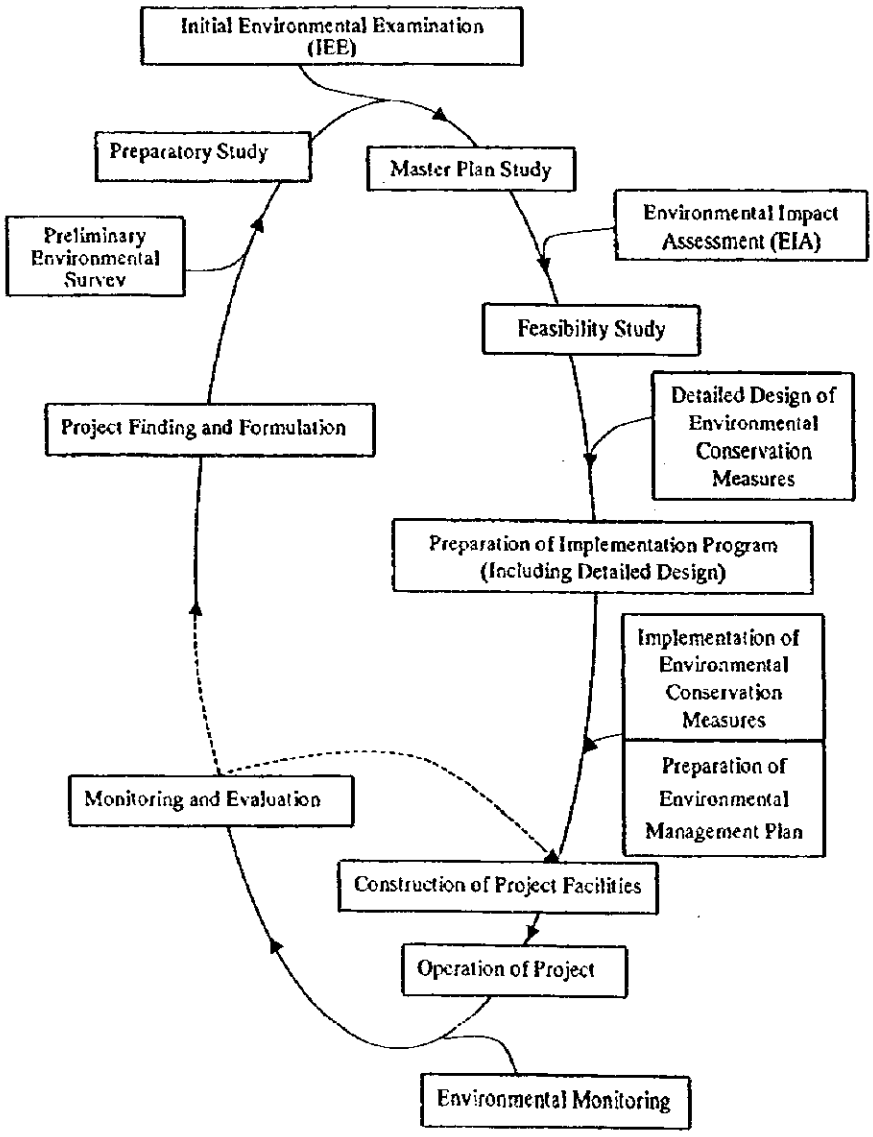


Fig.5.1 Flow Chart of Environmental Consideration in Project Cycle

5.2 Results of Environmental Assessment

The overall environmental impacts, based on the repair work design for the 20 sections, have been assessed using the JICA Guideline and the main environmental impacts are shown in Table 5.1.

Table 5.1 Overall Environmental Impact

No.	Environmental Item	Impacts	Reason
Social Environment			
1	Resettlement	None	-
2	Economic Activities	None	-
3	Traffic/Public Facilities	Minimal	Only during repair work period
4	Split of Communities	None	-
5	Cultural Property	None	Such properties are not observed nor reported nearby
6	Water Rights and Rights of Common	None	-
7	Public Health Condition	None	-
8	Waste	Slight	Small fragments by repair works
9	Hazards (Risk)	None	-
Natural Environment			
10	Topography and Geology	None	
11	Soil Erosion	Positive Impact	-
12	Groundwater	None	No deep excavation
13	Hydrological Situation	None	-
14	Coastal Zone	Positive Impact	-
15	Fauna and Flora	Negligible	Roads traverse mostly cultivated area. No nearby Natural Reserves etc.
16	Meteorology	None	-
17	Landscape	None	
Pollution			
18	Air Pollution	Positive Impact	Due to smooth running by vehicles
19	Water Pollution	Slight	Only during repair works
20	Soil Contamination	None	-
21	Noise and Vibration	Positive Impact	More smooth traffic after repairing
22	Land Subsidence	None	Except No.9 at Corum
23	Offensive Odor	None	

Due to the nature of the project, which requires only repair and rehabilitation work without new construction, the potential negative impacts by the works are considered minimal and could be offset by the positive economic and social impacts. Successful performance, however, will bring about benefits to traffic and related industries in the area concerned. It is essential to take precautionary measures for maintaining the present environmental condition, which is considered favorable in general.

However, it should be noted that the environmental parameters marked with small effect may threaten project sustainability if adequate countermeasures are not taken. Therefore, continuous and appropriate monitoring shall be required.

CHAPTER 6 FORMULATION OF ROAD MAINTENANCE MANAGEMENTS SYSTEM

6.1 Purpose

The Maintenance Management System must be able to maximise the use the available budget in maintaining the road and its associated infrastructure in a good condition for the road user.

6.2 The Future System

There are a number of options available to the KGM in looking to the future of Maintenance in Turkey. Consideration should be given to the fact that as the road network becomes complete, less money goes on new construction and hence more should be available for road maintenance. This requires that the maintenance system is efficient and geared up to dealing with the future demands in order to convince Ministers that more budget should be allocated to road maintenance.

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 inspection, design, supervision and works inclusive of winter maintenance).

The above would require more engineers to be moved to the Divisions and Sub-Divisions but provided they also controlled their own budgets, it would enable more decisions to be taken where the work is going on a day to basis.

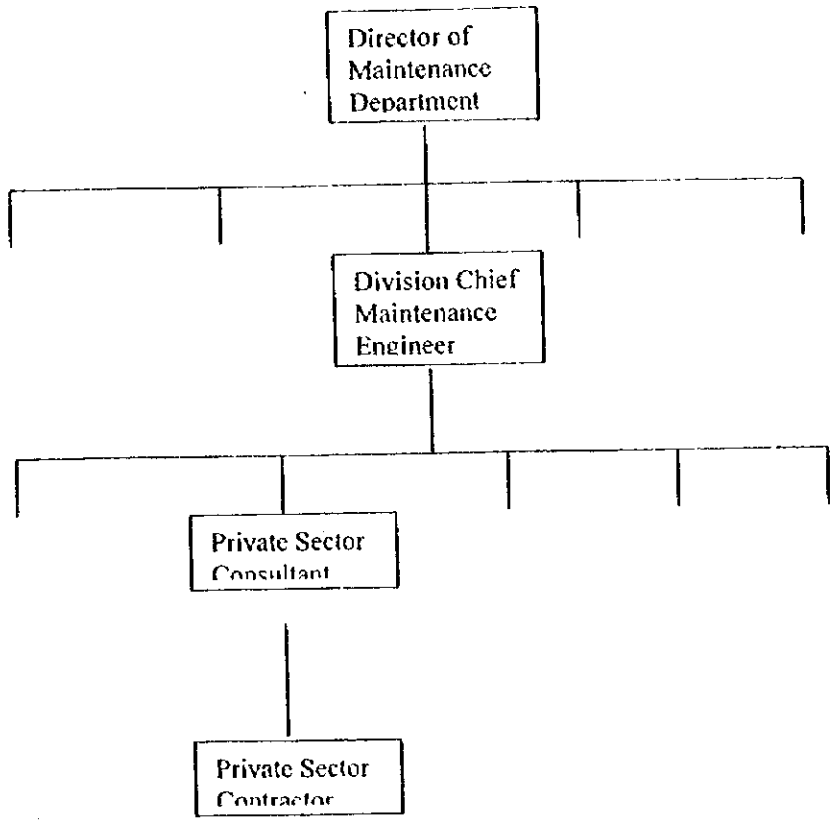


Fig. 6.1 Privatised Maintenance Organisation Chart

6.3 Materials and Equipment

(1) Materials

Materials for emergency repair works should be stocked to avoid delays when this situation arises.

Table 6.1 shows a list of the recommended materials to be available.

Table 6.1 Materials to be Available at Maintenance Stations.

Types of materials	Regions that are often affected by			
	heavy rain	ice and snow	Fog	others
Salt and grit		✔		
Sand bags	✔	✔		
Cement	✔	✔	✔	✔
Aggregates	✔	✔	✔	✔
light reinforcement	✔	✔	✔	✔
Bitumen	✔	✔	✔	✔
Paint	✔	✔	✔	✔
cold mix	✔	✔	✔	✔
safety fences	✔	✔	✔	✔

(2) Equipment

Table 6.2 shows a list of equipment to be available at the work stations.

Table 6.2 Equipment to be available at Workstations

Type of equipment	Regions that are often affected by			
	heavy rain	ice and snow	fog	others
snow ploughs		✔		
Detachable snow blades		✔		
Grader	✔	✔	✔	✔
Compressor	✔	✔	✔	✔
Portable concrete mixer	✔	✔	✔	✔
lorry mounted hoist	✔	✔	✔	✔
pickups/vans	✔	✔	✔	✔
Cars	✔	✔	✔	✔
trucks	✔	✔	✔	✔
Excavator	✔	✔	✔	✔
road sweeper/gully emptier	✔	✔	✔	✔
hand operated vibrating roller	✔	✔	✔	✔
Dowser	✔	✔	✔	✔
traffic management accessories e.g. cones, amber flashing lights, temporary works sign	✔	✔	✔	✔
pumps, hoses and accessories for water removal etc.	✔	✔	✔	✔
Assorted hand tools such as shovels, pick axes, ladder, 3-5 m tapes, etc.	✔	✔	✔	✔
Assorted personnel safety equipment such as reflective jackets, helmets etc.	✔	✔	✔	✔

CHAPTER 7 DEVELOPMENT OF MAINTENANCE MANUALS

7.1 Concept of Maintenance Manuals

The Maintenance Manuals comprise the following documents:

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

7.2 The Management and Inspection Manual

1. Management Manual

Part A of this document is the Management Manual. This discusses some ideas on a possible alternative maintenance management system. They are not recommendations but ideas for consideration and possible discussion based on experience in other countries around the world. The contents of the management manual are referred to in Chapter 6.

2. Inspection Manual

Part B of this document is The Inspection Manual. The key objective of the Inspection System, is to provide consistent and reliable data to those managing road maintenance. This will help them to make the most effective use of the available budget to keep the road and the associated facilities in a safe and sound condition for the road user and to achieve the optimum life from the road pavement.

Three types of inspection are proposed:-

1. Routine Inspection
2. Special Inspection
3. Detailed Inspection

7.3 The Evaluation and Repair Work Manual

1. Evaluation Manual

The main causes and effects of the damage for each inspection item are provided in the evaluation manual for guidance to maintenance staff. It is important that the staff have an understanding of these aspects as it helps in the decision making process particularly where further deterioration may result from no action and also where there is a potential accident situation.

2. Repair Manual

The repair methods for each inspection item are tabulated. These methods cover temporary short term and long term solutions. The methods include both basic and more advanced techniques using recent technology. The purpose of each repair is discussed and where appropriate the application and sketches of typical repairs are also included.

CHAPTER 8 DESIGN METHOD

The design of slope, drainage and snow and ice control facilities is an important role in securing safe traffic flow. This study recommends the basic design methods for slope, drainage and snow and ice control. The design methodology for each item is summarised in Table 8.1.

Table 8.1 The Design Methodology for Each Design Items

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

A model of road cross section drawing specified in the design Manual is shown in Fig. 8.1.

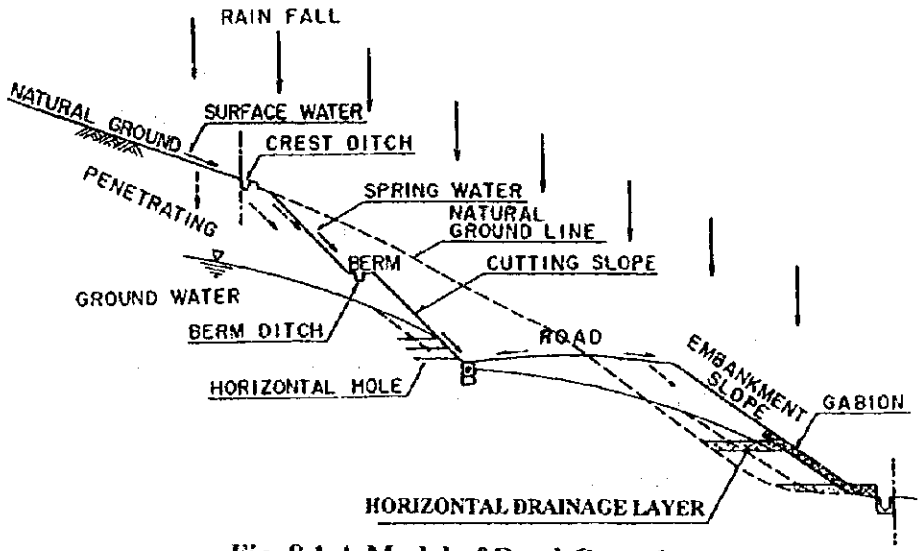


Fig. 8.1 A Model of Road Cross Section

CHAPTER 9 SOCIOECONOMIC FRAMEWORK AND TRAFFIC DEMAND FORECAST

9.1 Introduction

This section describes the socioeconomic framework as well as the traffic demand forecast used in the study. The socioeconomic framework focuses on the following three items:

- population
- economic growth
- vehicle ownership

These items are used in the traffic models as input at the provincial level. The key years for forecasting traffic demand are 2005 and 2015.

9.2 Socioeconomic Framework

9.2.1 Population Growth

Population projections vary but an accepted figure from the Seventh National Plan is that future population growth will average 1.6% per annum through the next few years. It is expected to come down further after that, so we have assumed a growth of 1.0% from 2005 to 2015. As for urban population, it will continue to grow. Already, it is more than 60% of the population, and it looks likely to be around 80% by the end of the study period.

9.2.2 Economic Growth

In the 1980s, the Turkish economy started to take off. GNP growth began to approach the sort of levels achieved by some of the East Asian 'Tiger' economies, certainly faster than the main European economies. The only large setback was in 1994 with a minus growth rate of about 6%.

However immediate economic prospects are coloured by the uncertainties that inevitably surround a coalition Government (three parties with differing views) and the probability of a new election in 1998. Despite this, the new fiscal and monetary policies of the 55th Government are seen as expansionary in the short term. The new Government revised the GNP growth target to 5.5-6.0% for 1997, and this looks likely to be achieved.

9.2.3 Vehicle Ownership Growth

Table 9.1 shows the motor vehicles by class for the period 1986 to 1996. As can be seen from the table, 5 million vehicles were registered in 1996 having seen a 250% growth in all vehicles in the period 1986 to 1996.

Table 9.1 Motor Vehicles by Class for 1986 to 1996

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 '1997 Statistical Year Book' - State Institute of Statistics, Prime Ministry of the Republic of Turkey

9.3 Traffic Demand Forecast for 2015

9.3.1 Model for Traffic Demand Forecasting

The traffic demand model is composed of the following three basic components that are executed in the order listed to arrive at future link flows:

- vehicle-km prediction models by vehicle type for each province
- traffic flow processing ratio for each of the road links in each of the provinces
- traffic diversion factor to take into account the effect of new or improved roads

9.3.2 Traffic Demand Forecast for 2015

The traffic demand forecast for 2005 and 2015 is shown in Fig.9.1 and Fig.9.2. The traffic demand predicted by the Study Team grew at a slower pace than that of KGM's, i.e., the Study Team's link flow values were on average 93% of those of KGM's values. This was due to the Study Team assuming a slower socioeconomic growth rate. Link flows are expected to grow at an average rate of 2 times between 2005 and 2015, with the most congested links near urban centers having traffic flows of 20 to 30 thousand vehicles/day/direction.

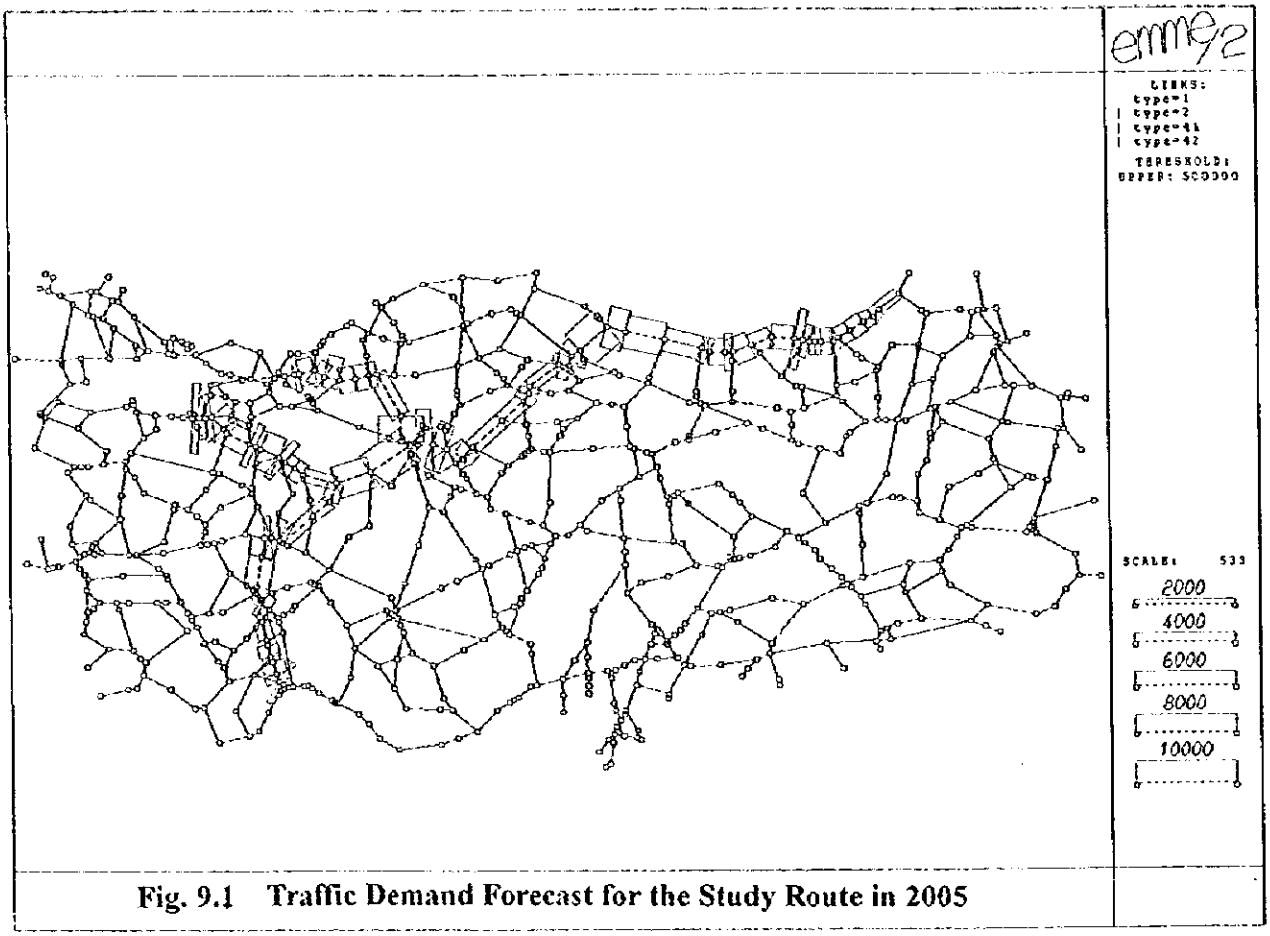


Fig. 9.1 Traffic Demand Forecast for the Study Route in 2005

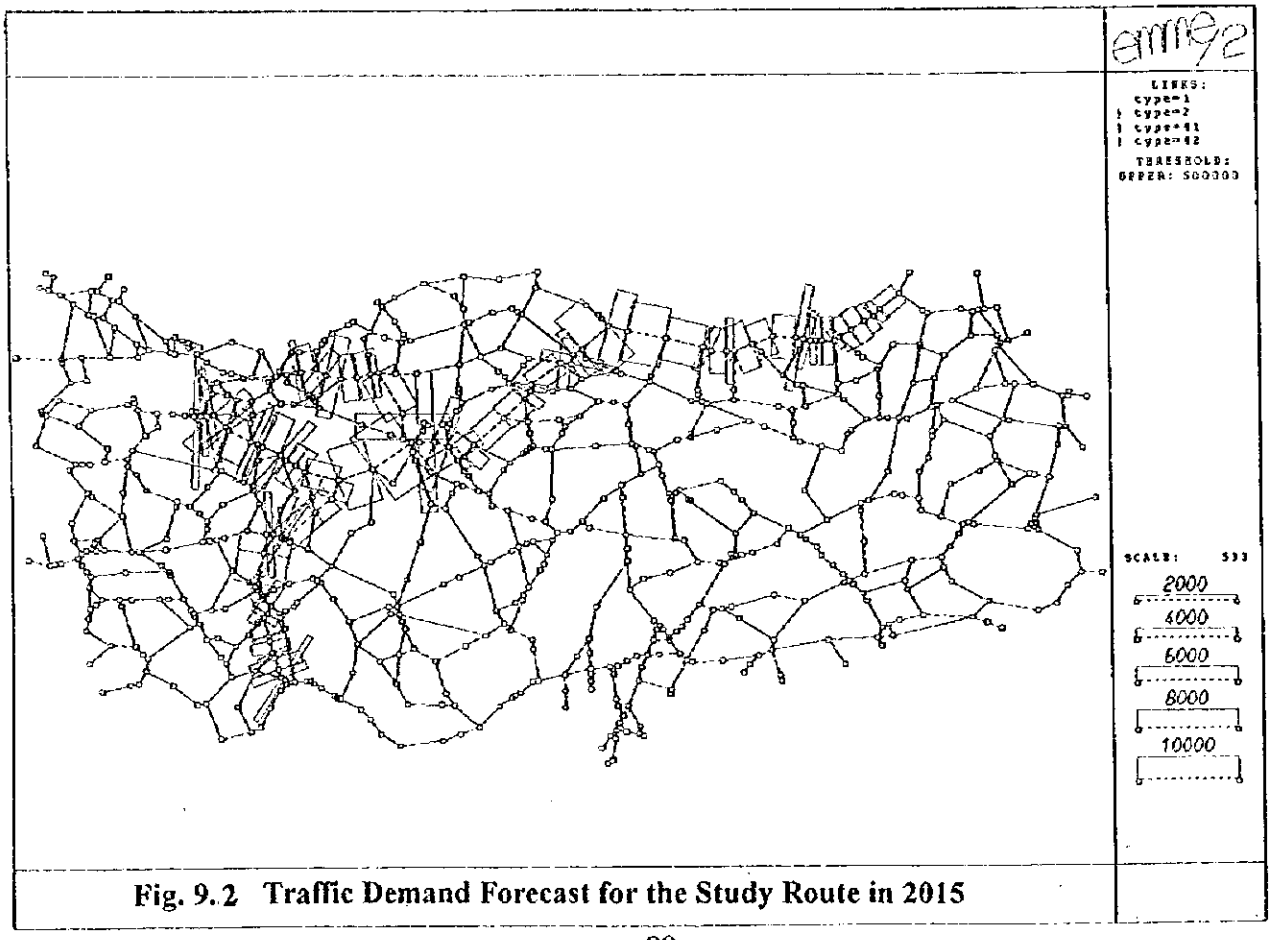
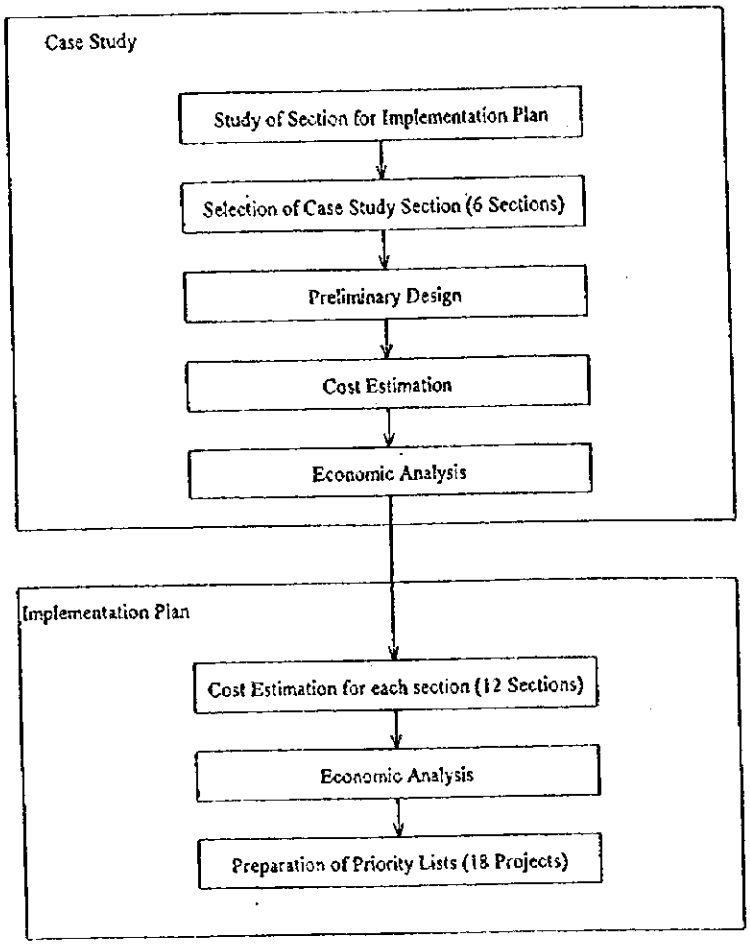


Fig. 9.2 Traffic Demand Forecast for the Study Route in 2015

CHAPTER 10 IMPLEMENTATION PLAN

10.1 Basic Process

The basic process of implementation for the preliminary inspection section is as follows:



10.2Case Study

(1) Selection of Case Study Sections
The six sections selected as our case studies are as follows:

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

The location of these sub-divisions is as indicated in Fig.10.1. Some of the reasons for selecting the above sub-divisions are as given below. These sub-divisions are considered to have:

- social economic importance
- a variety of study sub-divisions according to climate, topography, and population
- damage that will use typical repair methods
- cases that are in immediate need of repair
- characteristic damage
- significant inter city traffic flows
- represents each of the divisions through which the study route passes

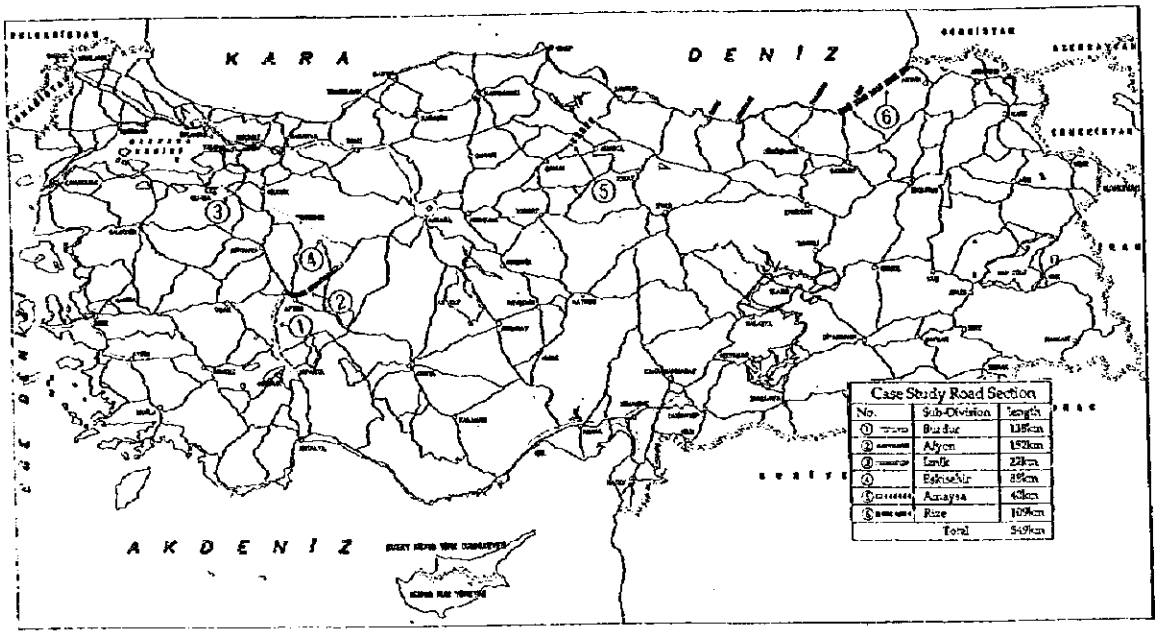


Fig.10.2 Location Map of Case Study Sections

10.3 Economic Evaluation of the Six Case Studies

(1) Approach to the Economic Evaluation and Feasibility Study

This new maintenance concept has been subjected, for feasibility assessment, to an economic evaluation. The methodology for this assessment has been to use the World Bank's HDM III model (Highway Design and Maintenance Standards Model) for estimating the Net Present Value (NPV), the Economic Internal Rate of Return (EIRR) , and the Benefit Cost Ratio (B/C Ratio) of the new maintenance concept.

(2) Economic Returns in 2005 and 2015

The detailed economic returns for the different Case Studies are shown in Table 10.1.

Table 10.1 Economic Returns for Six The Case Studies in 2005 & 2015

CASE STUDY	NPV US$ millions	EIRR	B/C RATIO
2005			
Burdur	148.45	155.8%	10.3
Afyon	12.47	16.1%	1.7
Iznik	9.69	132.1%	10.5
Eskisehir	15.06	52.4%	3.5
Amasya	25.65	96.6%	6.5
Rize	59.15	94.6%	5.8
2015			
Burdur	277.44	156.8%	18.3
Afyon	108.17	44.2%	13.7
Iznik	30.80	134.0%	31.1
Eskisehir	97.74	64.5%	17.1
Amasya	69.17	110.0%	18.6
Rize	143.99	97.6%	12.7

10.4 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 for these 18 sections is shown in the following Table 10.2.

Table 10.2 The Economic Returns (18 Sections)

SUBDIVISION	NPV US$ millions	EIRR	B/C RATIO
Antalya	199.57	136.5%	15.9
Burdur	277.44	156.8%	18.3
Afyon	108.17	44.2%	13.7
Bursa	36.15	62.0%	16.4
Iznik	30.80	134.0%	31.1
Bilecik	55.52	49.8%	13.2
Eskischir	97.74	64.5%	17.1
Polatli	166.63	35.9%	11.1
Kizilcahamam	132.43	36.9%	11.5
Bolu	197.82	120.6%	28.0
Kirikkale	94.67	36.9%	11.5
Corum	238.30	104.15	32.3
Amasya	69.17	110.0%	18.6
Samsun	356.87	125.4%	21.2
Ordu	118.49	81.1%	10.5
Giresun	145.76	102.6%	13.3
Akcaabat	149.27	69.4%	9.0
Rize	143.99	97.6%	12.7

10.5 Priority Lists

The order of priority for the 18 sections are in Table 10.3.

Table 10.3 Priority Lists

Priority ranking	Sub – Division Name	Sub – Division Number	Length of Road km
1	Burdur	134	138
2	Antalya	132	88
3	Iznik	147	22
4	Samsun	75	137
5	Bolu	41	124
6	Amasya	72	40
7	Çorum	73	159
8	Giresun	104	105
9	Rize	103	109
10	Ordu	77	108
11	Akçaabat	105	113
12	Eskişehir	46	88
13	Bursa	143	31
14	Bilecik	144	78
15	Afyon	31	152
16	Kızılcahamam	42	133
17	Kırıkkale	44	101
18	Polatlı	45	177

CHAPTER 11 RECOMMENDATION

This study has suggested a road maintenance system and methods for the design of slope, drainage and snow & ice control facilities. However, there are a number of areas where we believe certain changes would help to improve the maintenance of roads in Turkey. Therefore, the following points are concluded and recommended:-

1. Maintenance Management Items

For years, the budget for road administration has been restricted and priority has been given to pavement maintenance. Consequently, the maintenance of earthworks and drainage has suffered. Earthworks slips, falling rocks and block drainage have become serious problems. All problems must be investigated if a road is to be kept in good condition.

2. Analysis of Damage Cause

In the past, repair methods have been chosen without investigating causes of defects. Consequently, many repairs are superficial and the pavement soon fails again. This is uneconomical. Methods of repair must address and rectify the root causes of failures.

3. Uniformity of the Manual

Highway maintenance should be approached on a nation-wide basis with common objectives. This can be achieved, we suggest, by enforcing the use of a common manual for highway administration.

4. Review of Maintenance Budget

Investment in highway infrastructure is very important for the development of any country. Maintenance of smooth traffic flow is important. Consequently an appropriate budget must be allocated to highway administration.

5. Record of Meteorological Data

A full understanding of weather conditions is one of the important factors in planning, administration and design of highways. Therefore it is necessary to keep weather records in the future.

6. Review of Design and Construction including Supervision system

From our site studies of highway defects, our comments are as follows:-

(1) The maintenance of ditches and piped-drainage is inadequate
(2) Some slope faces are unstable
(3) The compaction of earthworks and pavement layers during construction is inadequate
(4) Earthworks contain large boulders not in accordance with the specification
(5) Temperature control during manufacture and laying of asphalt concrete is deficient.

7. Promotion of Greening on the Road

As part of the maintenance management, the greening on the medium and side walk are important matters for the following reasons:

- The landscape of the roads is improved.
- The driver has good visual conditions.
- The rest space is provided.