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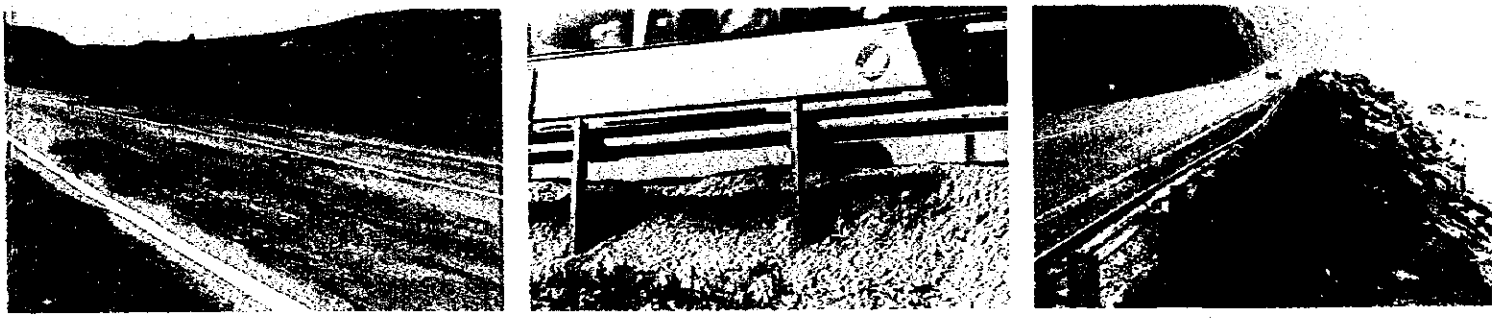
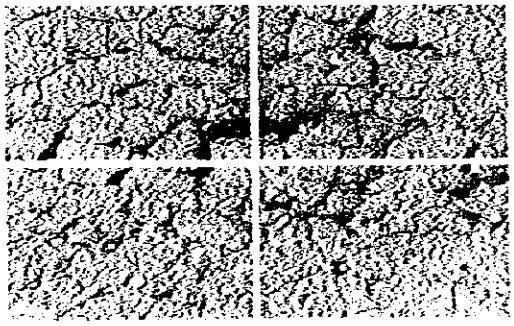
GENERAL DIRECTORATE OF HIGHWAYS
MINISTRY OF PUBLIC WORKS AND SETTLEMENT
THE REPUBLIC OF TURKEY(KGM)



THE STUDY ON ARTERIAL HIGHWAY MAINTENANCE IN THE REPUBLIC OF TURKEY

FINAL REPORT

MANAGEMENT AND INSPECTION MANUAL



JULY 1998

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JICA KGM THE STUDY ON ARTERIAL HIGHWAY MAINTENANCE IN THE REPUBLIC OF TURKEY FINAL REPORT MANAGEMENT AND INSPECTION MANUAL JULY 1998
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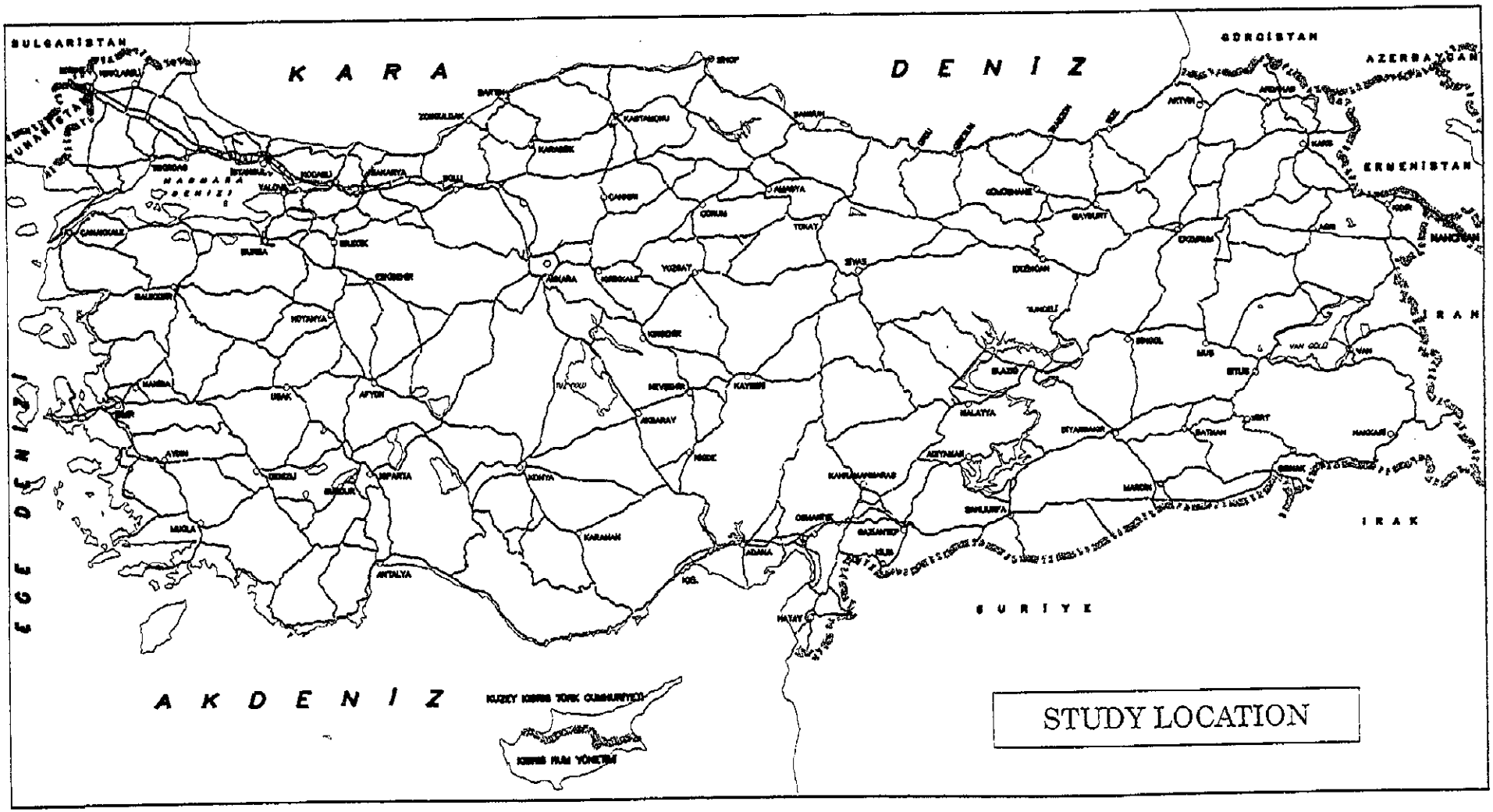
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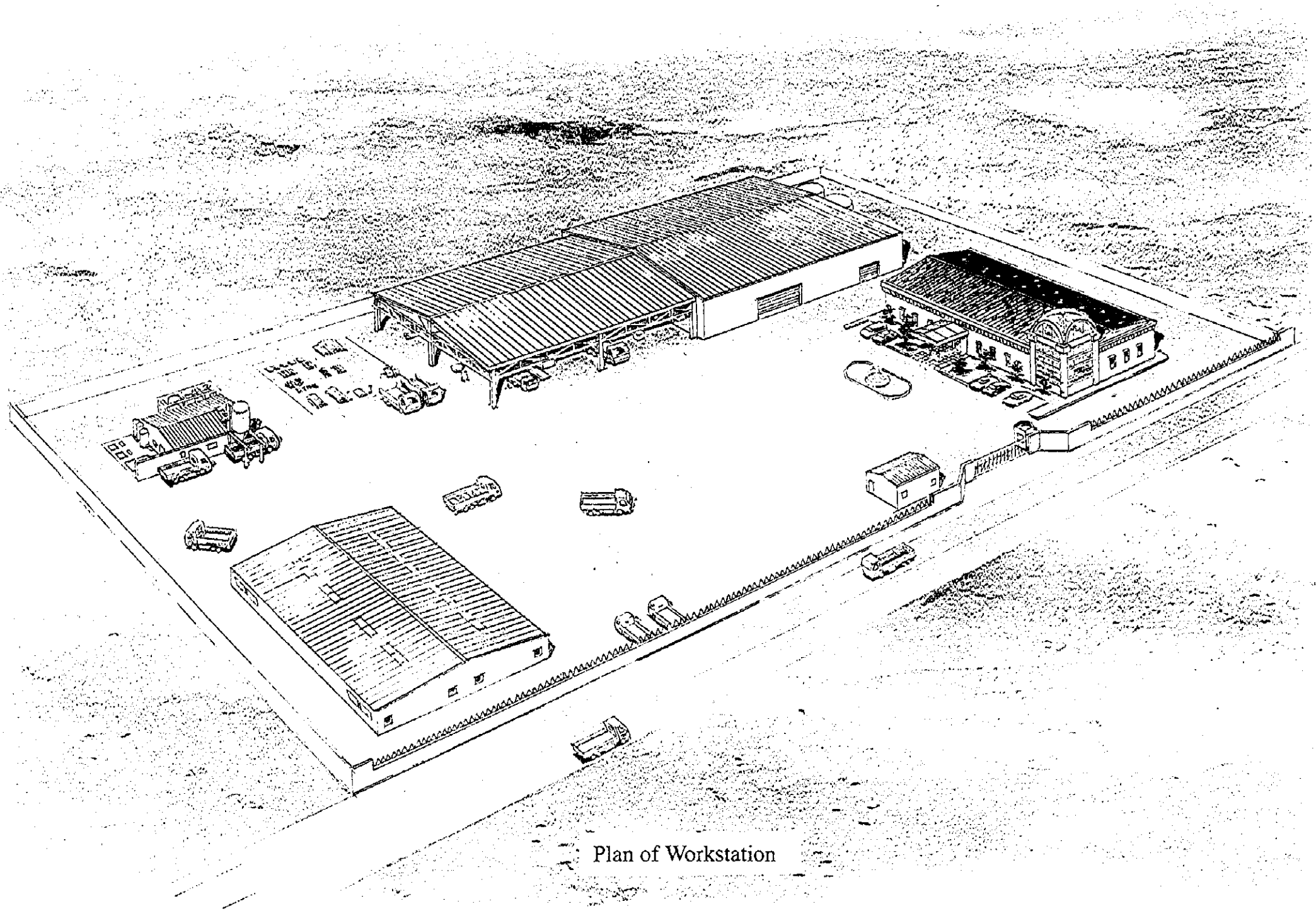
STUDY LOCATION

PART A MANAGEMENT MANUAL



Plan of Workstation

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PART A MANAGEMENT MANUAL

PART A MANAGEMENT MANUAL

CHAPTER 1 INTRODUCTION

1.1 General

This manual introduces the concept of an alternative management system for highway maintenance in Turkey. It looks at the organisation, staffing, materials and equipment needed to achieve this. It also looks at roadworks information systems which help the government to maintain the road and carry out essential works with minimum disruption to the user.

The ideas included in this manual are based on those successfully tried elsewhere but are included for discussion and development purposes only. The future needs of Turkey and some of the employment aspects need to be looked at very carefully before any these ideas can be developed into an implementation plan.

1.2 Purpose

The Maintenance Management System must be able to maximise the use of the available budget in maintaining the road and its associated infrastructure in a good condition for the road user. It should also aim to achieve the optimum life from the road pavement by carrying out routine maintenance and by ensuring good design, supervision and construction of any works. By maintaining a high quality road, travel speeds are higher and hence journey times are reduced providing a road user benefit which equates to a benefit to the national economy.

With the Winter Maintenance programme, the aim is to minimise delays to traffic on a road priority basis giving the highest priority to those roads carrying high traffic volumes which will generally give the highest level of benefit to the economy.

1.3 Programme

The Ministry of Public Works currently uses a Direct Labour Organisation for most of its maintenance work .This means that the labour force is directly employed by the Ministry. Major works such as overlay and reconstruction works are sometimes carried out by private contractors.

With the low wage costs in the government sector, this can be a very effective strategy if it is managed well.

The concept put forward here is for a phased move towards privatisation and to eventually have all maintenance work managed by private sector consultants and all works carried out by private sector contractors. The target year for achieving this is 2015 with a phased change over the years.

The proposals will need to have a thorough investigation and discussion with the Ministry to ensure that savings in cost or other clear benefits to Turkey are achieved through the change.

CHAPTER 2 ORGANISATION AND STAFFING

2.1 General

All organisations need to have clear chains of command and must identify the responsibilities at all levels in order to be able to manage the efficient use of labour, equipment, materials and facilities. Wherever possible the advantage of the economy of scale should be taken in rationalising facilities and working practices.

2.2 Organisation and Responsibilities

The organisation chart shown in Fig. 2.2.1 shows the final arrangement and responsibilities at each level.

(1) Maintenance Department

The Director of the Maintenance Department will continue to report to the Deputy Director General responsible for maintenance. His Department will be responsible for setting policy, strategy, co-ordinating the planning of works nationally and the setting of budgets.

The Department will also set the technical standards for work.

It is important that all the above are centrally controlled to provide uniformity throughout Turkey.

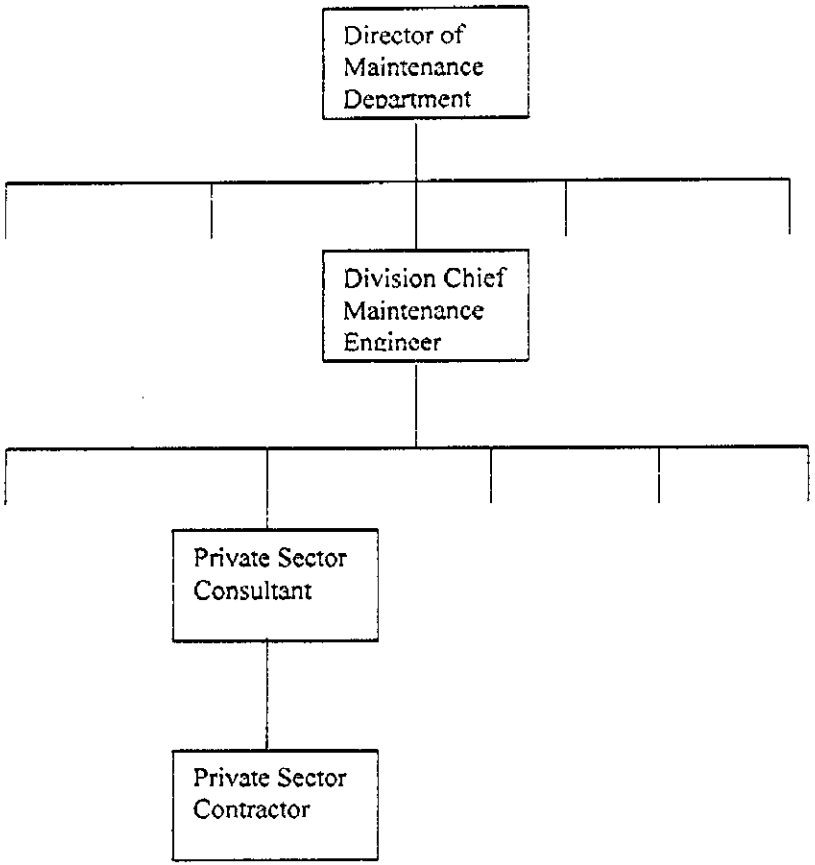
The Department will also provide advice and technical support to the Deputy Director General.

(2) Division

In the final arrangement, the Division will only have a relatively small team to let and oversee the private sector contracts. They will be responsible for monitoring performance against targets set in the contracts and for reporting back to Headquarters on performance issues.

In the period prior to privatisation, the Sub-Division maintenance teams will be divided into a 'Technical Team' performing the future role of the private sector consulting engineer and a 'Construction Team' performing the role of the private sector contractor(Fig.2.2.1).

The emphasis will be for more technical staff in the Sub-Divisions to identify and solve the problems at Sub-Division level. More engineers at this level we believe will provide a much better understanding of the pavement conditions and pavement deterioration which is crucial for selecting the correct pavement repair methods. They will still have the support of the Technical Research Department for difficult problems.



Responsibilities

Department

Policy, strategy, planning, budget
Technical standards
Advice to the Deputy Director General
Control of the Private Sector contracts

Divisions

Letting and overseeing the private sector contracts.

Private Sector Consultants

Inspections of the highway infrastructure.
Design, planning and supervision of maintenance Works
Managing the Private Maintenance Contract.

Private Sector Contractors

Routine and Winter maintenance work.
Carrying out overlay and reconstruction works.

Fig. 2.2.1 Privatised Maintenance Organisation Chart and Responsibilities

(3) Private Sector Consultant

The Private Sector Consultant and before them the 'Technical Team' at the Sub-Division will be responsible for carrying out all inspections of the highway infrastructure including roads and bridges. The combination of roads and bridges is particularly important in ensuring that wherever possible works are combined rather than having separate traffic management in operation for separate works.

They will also determine the cause of the damage, select the repair method and design the repairs. They will estimate the cost of the works, plan the works programme, instruct the private sector contractor (or 'Construction Team') and supervise the works.

They will prepare works forecasts for budget application purpose for the following year based on both short term and a 5 year rolling programme of major works, such as overlays and reconstruction.

The consultant (or 'Technical Team') will oversee the contract with the Private Sector Contractor (or 'Construction Team'). He will monitor performance, agree payments and report to the Divisional Chief Maintenance Engineer on a monthly basis.

(4) Private Sector Contractor

He is responsible for carrying out all Routine and Winter Maintenance works. The Routine works include crack sealing, pothole filling, patching and milling. They also include general cleaning of the road infrastructure and clearing debris from the road to maintain a safe passage for vehicles and so preventing costly accidents. He is also responsible for all overlay and reconstruction works.

2.3 Budget

Future Work Programme requirements will be determined at Sub-Division level and will be submitted for budget approval through the Division to Headquarters. The budget will be allocated to the Sub-Division and they will control the use of the budget as designated in the Planned Work Programme together with any ongoing changes that may be required during the financial year.

Where special repairs are required that would exceed the allocated budget, these funds are to be requested from Headquarters via the Division. A reserve budget should be held to cover unforeseen emergency repairs. To enable the works to proceed, the Sub-Division must use the funds from the annual allocation and this should be reimbursed following approval from HQ.

2.4 Contract Matters

The size and term of the contracts need to be examined to ensure that whatever is offered to the private sector is commercially viable. It is likely that the network size will be between 500km and 1000km and the contract term will be 3 to 5 years. This scale of contract will

enable the private sector to have a reasonable amount of time to develop a good commercial operation, to secure suppliers to the contract and to provide continuity of staffing and determine staffing levels for the amount of work required. These matters are always difficult to assess in the first stage of any privatisation and it is important to give a reasonable chance of success in the first stage.

In order to provide some contractual continuity for the client, it is essential that the contracts for the Private Sector Consultant and Contractor do not finish at the same time. It is preferable to extend the Consultant contract for 1 or 2 years to ensure a smooth handover to the new contractor and to continue the management in a consistent way.

Another crucial aspect of Private Sector contracts is the performance targets to be met and the penalties and liabilities of the parties to the contract. These must be considered very carefully to ensure good performance, quality of staff and workmanship. The penalties and liabilities must be sufficient for companies to take these contracts very seriously in order that the national economy benefits from good highway maintenance.

CHAPTER 3 MATERIALS AND EQUIPMENT

3.1 Materials

It is essential that certain materials in regular use are available to the workstations. This can either be through secured contracts with private suppliers to deliver as the work demands or through limited stockpiling at workstations or Sub-Divisions and re-supply to stockpile contracts.

Weather sensitive materials must be stored in a protected environment to avoid material wastage.

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

Table 3.1.1 shows a list of the recommended materials to be available.

Table 3.1.1 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	✔	✔	✔	✔

A balance must be achieved between the amount of material stored and the cost of the storage facility. It may well be cheaper for some materials not to be stored in large quantities but to get supplies as the work demands.

For winter maintenance, it is essential to store sufficient materials to be able to achieve the target level of road clearance. The amounts stored will be based on previous experience of the local conditions and up to date weather forecasts.

3.2 Equipment

Table 3.2.1 shows a list of equipment to be available at the maintenance stations. It may be possible to hire in some of this equipment as the work demands rather than to retain it taking up space and requiring vehicle maintenance.

Servicing equipment and the supply of parts may also be considered in terms of private contracts to compare with the prices of maintaining equipment by more traditional methods.

Specialist equipment may be retained and owned by the KGM but leased to the Private Sector Contractor for the duration of the contract and he will take on the maintenance liability. Other equipment could be sold off to companies wishing to buy it.

Table 3.2.1 Equipment to be available at Maintenance Stations

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.	✔	✔	✔	✔

Note
Equipment and Machinery may be hired or supplied by subcontractors undertaking the maintenance work.

Maintenance Depots may also be leased to the Contractor to bring in revenue to the Government. However, over time it may well be that some rationalisation of the depot locations will require some of the depots to be closed. This may present the opportunity to raise further funds through the sale of the land to developers.

CHAPTER 4 ROADWORKS INFORMATION SYSTEMS

4.1 Information from the Road Users

There are many professional drivers such as truck and coach drivers who are using the road network on a regular basis. It can be beneficial to the maintenance organisation to arrange for a free telephone line to a central number where information on road condition or delays due to roadworks can be reported. This can be a considerable aid to maintenance managers as this information comes from people actually using the facility.

Similarly local residents using sections of road on a regular basis may well be able to provide useful information to assist the management of traffic at roadworks or to identify new or potential damage.

Providing a free telephone line encourages people to use the line. This may still require government staff to visit bus, coach and truck companies to explain what they would like to here about and how they will deal with the matter. If these people can be made to feel that they would be helping the national economy and improving the road facility they are much more likely to co-operate.

4.2 Information for the Road Users

With regular works likely to be carried out on major roads throughout the year and with accidents and occasional emergency closures of raoads, it is important to provide the road user with as much notice as possible of such work. The following information should be given where traffic delays are likely:-

- Date of the start and finish of the work or
- Closure time and likely re-opening time
- Location of works/accident/closure
- Whether traffic delays are likely to occur
- Alternative routes where practical
- The reason for the works/closure

This information should be provided to radio, television and newspapers through a regular travel information section in the paper or a special slot in the news items on radio and television. This makes the road user aware of the works and other problems and they then feel that good information is being made available to them to make choices about their journey and the route for their journey.

This can be particularly important to professional truck drivers where the overall journey time is important. If he knows there is going to be delays on his usual route, he can plan a suitable detour or use the recommended detour route and avoid the delay. This again clearly helps the national economy of Turkey by ensuring that goods and people moving around the country suffer minimum delay.

As the police are generally responsible for traffic control, such information should be co-

ordinated with the Traffic Police Department.

Where necessary, detour signing should be put in place to aid the drivers in finding the alternative routes. The signing should be continuous for the complete length of the detour, particularly at intermediate junctions along the detour route, and should continue until the traffic reaches the original road.

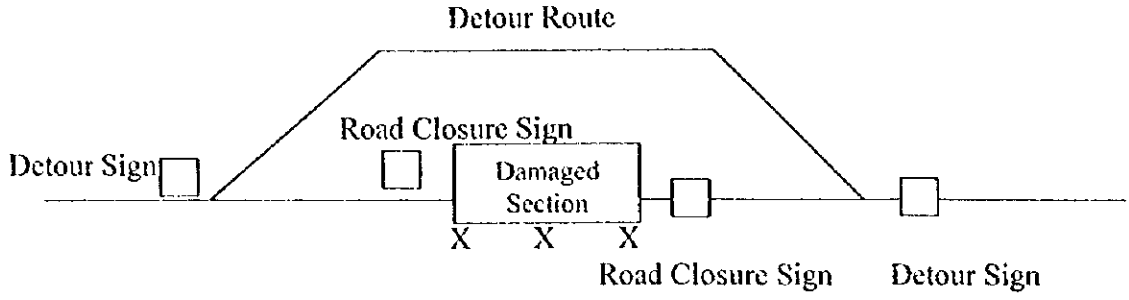


Fig. 4.2.1 Traffic Control for Detour Routes

Where the road is closed, appropriate signing and barriers must be put in place.

For road closures , Fig. 4.2.2 shows the procedure to be adopted to ensure the information is available to the road user and other agencies as quickly as possible.

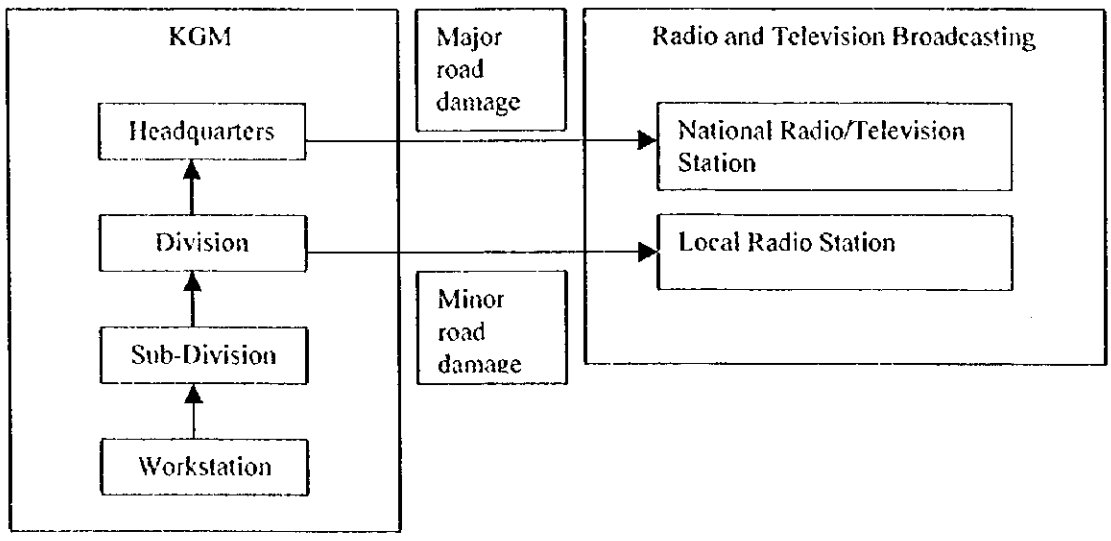
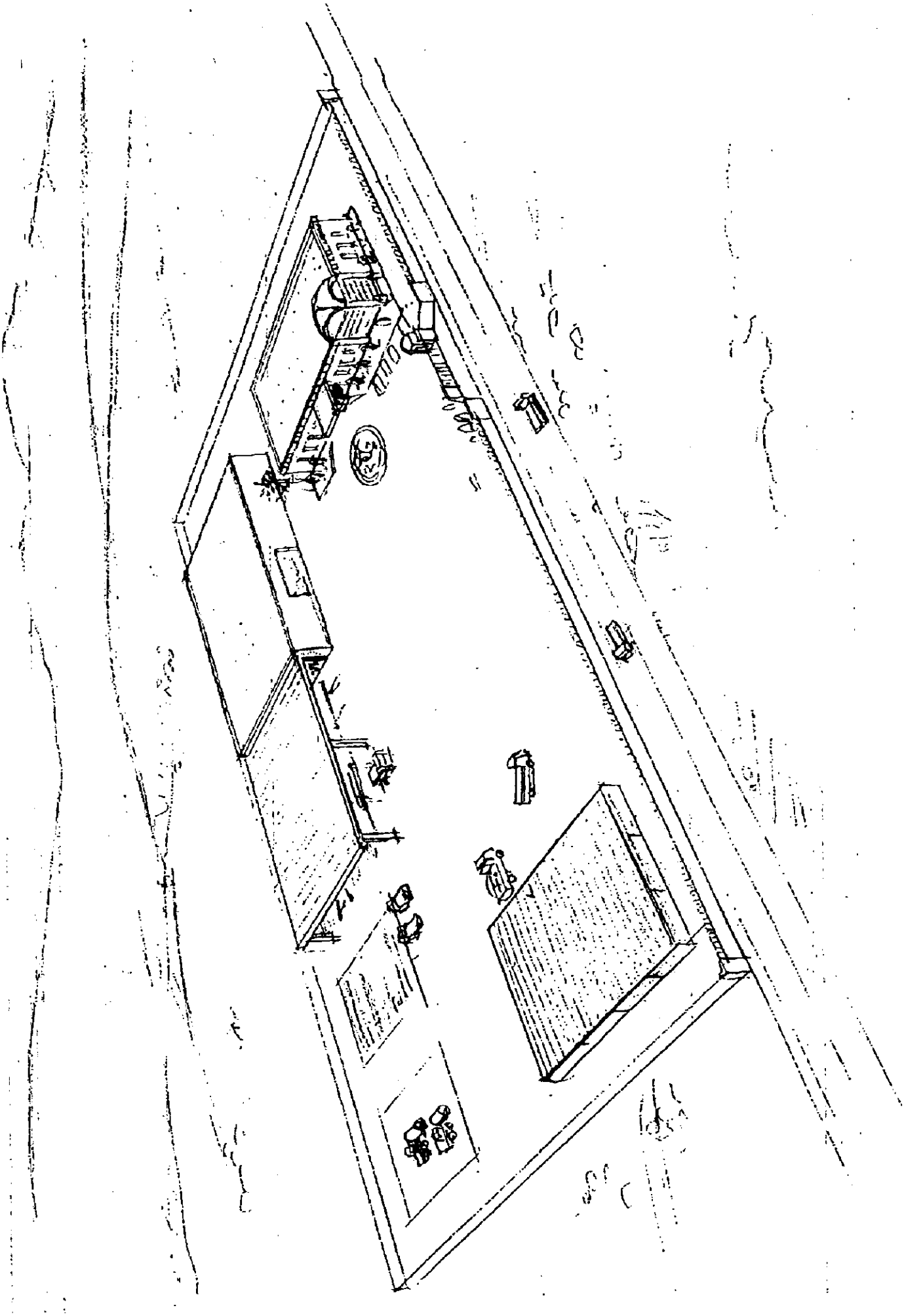


Fig. 4.2.2 Procedure for Transmission of Road Information to the Media

4.3 Real Time Data Collection Systems

Such systems are now in common use throughout the world to assist the maintenance manager particularly in the collection of meteorological data. During the winter season the timing of gritting and salting is critical to make the best use of the material in keeping the roads open to traffic.

With real time information systems, air and ground temperatures, snow and ice predictions can be fed to a control office minute by minute so the actual drop in temperature can be monitored and the gritting vehicles and drivers prepared. This can often prevent unnecessary gritting works or works being carried out too late both of which are ineffective and waste materials. Without the real time information the decision is left to a personal judgement on the part of the man on the spot without the knowledge of the wider picture from satellites and other relevant data available to the weather stations around the country.



PART B INSPECTION MANUAL

PART B INSPECTION MANUAL

Chapter 1 Introduction

1.1 General

This Inspection Manual has been produced for the General Directorate of Highways to assist in the continued improvement in the management of the Maintenance works on the 60 000 km of State and Provincial Roads in Turkey. It has been based on a knowledge of the existing systems, equipment, technology and budget restraints and is intended as a framework to develop common practices throughout Turkey. It has the flexibility to be changed and improved as the major maintenance issues are identified and also as more technology and equipment is made available.

1.2 Objectives

The key objective of any 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.

In order to manage the maintenance of the road network, it is important to have a systematic approach to inspections. This will provide information at regular intervals to establish a thorough understanding both of the existing condition of the road and of the rate of deterioration of the various elements of the road.

1.3 Definitions

Various definitions are used around the world in connection with maintenance works. The following definitions are used throughout this manual and its associated manuals:-

Maintenance Works
- road cleaning
- drainage cleaning
- vegetation control
- snow and ice control

Repair Works
- crack sealing
- pothole filling
- patching
- repairs to retaining walls
- repairs to drainage structures
- repairs to slopes
- repairs to embankment
- repairs to snow and ice facilities

Improvement Works

- pavement overlay
- pavement reconstruction

1.4 Structure of Document

Chapter 1 - provides a very brief introduction to the Inspection Manual and its objectives.

Chapter 2 - provides an overview of the Inspection System covering all aspects; inspection items, frequency, damage types, inspection types, the damage ranking system, the database, personnel and equipment, safety and traffic management, the road referencing system and the use of photographs.

This chapter should be read by those wanting to gain an overall appreciation of the inspection system.

Chapter 3 - explains the Routine Inspection system.

Chapter 4 - explains the Special Inspection system.

Chapter 5 - explains the Detailed Inspection system giving details for each of the inspection items: pavement, slope (cuttings and embankments), shoulder, drainage (side ditches, gullies and culverts), retaining walls, snow and ice facilities.

These sections will be used by those carrying out the inspections and should be read in detail to have a thorough understanding of the inspection requirements for each road element

Chapter 6 - introduces the new technology that is available.

CHAPTER 2 THE INSPECTION SYSTEM

2.1 General

Fig. 2.1.1 shows a flow chart for the inspection process. Visual inspections are carried out to produce a defect ranking for any defects observed.

From the visual inspections and the ranking system, the maintenance manager shall identify those defects requiring urgent repairs, those requiring non urgent repairs and those requiring a detailed inspection to decide on a treatment method.

All inspections are recorded on inspection sheets and the data from the visual inspections and the repair work programme is entered onto the maintenance database. The database will provide a tool for the maintenance manager to be able to monitor pavement performance, to identify problem areas and to assist in the planning of maintenance and repair works.

2.2 Inspection Items

This manual covers the following inspection items:-

- pavement
- slopes
- embankments
- shoulders
- retaining walls
- side ditches
- gullies
- culverts
- snow and ice control facilities

Details of the defects within each of the inspection items are given in Chapter 2.4.

2.3 Inspection Frequency

Inspection frequencies should be agreed between the Headquarters and Regional Divisions in order to ensure adequate coverage of the inspection items and to allow for regional variations in conditions and materials. Recommendations for the minimum inspection frequencies are included in Chapter 3.

Priority for the inspection programme should be given to the State Road network which carries the heaviest traffic flows and which is crucial to the economy of Turkey in being able to move people and goods around the country efficiently and without delay.

Work and inspection teams should make observations for defects whilst travelling through the road sections to pick up defects occurring between planned inspections.

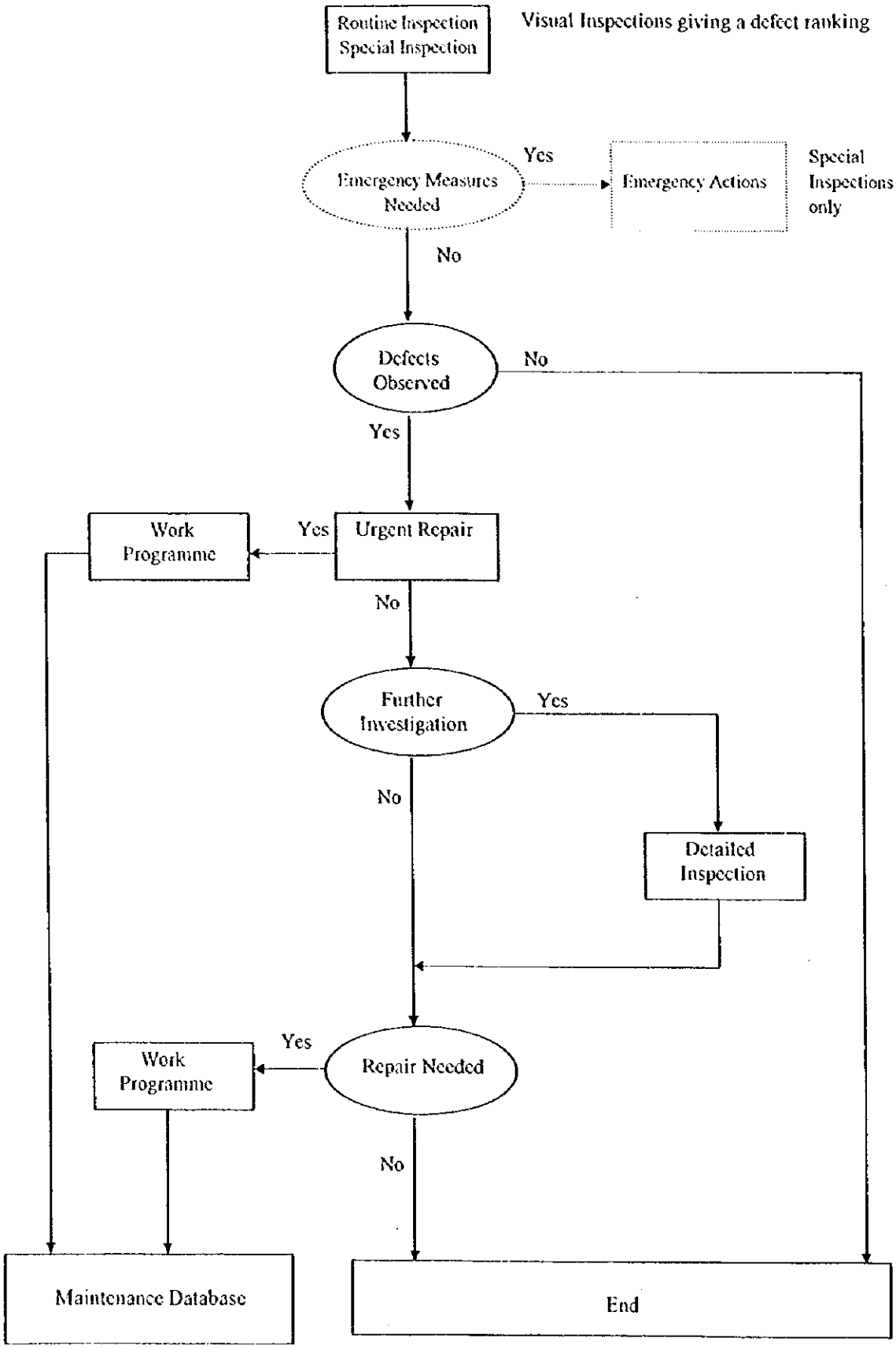


Fig. 2.1.1 Flow Chart for Inspections

2.4 Damage Types

Table 2.4.1 shows the damage types to be identified for each of the inspection items:-

Table 2.4.1 Damage Types

Inspection Item	Damage Type
Pavement	Settlement, Cracking, Potholes, Rutting, Wave
Slope	Landslide, Rock Avalanche, Collapse of Protection Wall, Cracking, Erosion
Embankment	Submerge, Collapse
Shoulder	Washing Out
Side Ditch	Accumulation of Debris, Settlement, Collapse
Gully	Accumulation of Debris, Settlement, Collapse
Culvert	Accumulation of Debris, Settlement, Collapse
Retaining Wall	Cracking, Settlement, Collapse
Snow & Ice Control Facilities	Collapse

2.5 Inspection Types

2.5.1 Introduction

The Arterial road network shall be inspected for the purposes of identifying urgent repair works or remedial measures required to keep the road in a safe condition and to identify maintenance work to be carried out. Where an inspection frequency is specified, this should be adhered to as closely as possible.

All personnel involved in inspection work shall be sufficiently competent for the task and shall receive suitable training to be fully conversant with the inspection procedures and safety requirements of The General Directorate of Highways (KGM).

2.5.2 Objectives

There are three types of inspection:-

1. Routine Inspection

The objective is to carry out a visual inspection of all elements of the road infrastructure at regular intervals, to identify defects and give them a damage ranking. The inspection results will be used to identify items to be included in the routine maintenance programme, items needing repair works or those needing a detailed inspection.

2. Special Inspection

The objective is to carry out a visual inspection following natural disasters such as floods, avalanches or earthquakes, or following an accident in order to maintain the road in a safe condition for road users.

3. Detailed Inspection

A detailed inspection is carried out to obtain sufficient information to establish the cause of a defect and to enable an appropriate repair method to be determined.

2.5.3 Routine Inspection

(1) Purpose

The purpose is to carry out regular inspections to keep the road infrastructure and all its elements in good condition, to identify defects at an early stage in order to avoid the spread of a defect and the possible premature failure of the item with costly consequences. The inspections will provide inspection data which can be used to plan the programme of further inspections, investigations and repair works as necessary.

(2) Method of Inspection

The inspection shall be carried out on foot. It is a visual inspection supplemented as necessary by the use of basic equipment e.g. tape measure, ranging rods and camera, to assist in recording the inspection.

(3) Maintenance Requirements

Defects shall be allocated to planned programmes of detailed inspections, maintenance works or repair works as appropriate. Priorities shall be considered along with access requirements, other works on the road network, traffic levels and the need to minimise traffic management in compiling the programmes of work.

(4) Data to be Recorded

Data shall be recorded on the standard inspection sheet and shall be in accordance with the requirements stated in Chapters 3.0 and 4.0 for each of the inspection items. The data will generally be the damage ranking such that decisions can be made on the appropriate course of action.

(5) Frequency

Routine Inspections shall be made in accordance with the planned programme of inspections and at the agreed frequencies. Priority shall be given to the State Road network in planning the programme of Routine Inspections.

2.5.4 Special Inspection

(1) Purpose

The special inspection shall determine the need for emergency measures, repair works or for a detailed inspection to provide additional information to enable decisions on the appropriate course of action to be taken.

(2) Method of Inspection

A Special Inspection shall be carried out on foot. It is a visual inspection and some basic equipment such as a tape measure, ranging rods and a camera should be used to assist in recording the inspection.

(3) Maintenance Requirements

Any obstruction, hazard or defect which is likely to create a danger to the public using the road or any defect which endangers the integrity of the item, shall if reasonably practical be corrected, made safe or otherwise protected.

Other defects shall be allocated to planned programmes of detailed inspections, maintenance works or repair works as appropriate.

(4) Data to be Recorded

Any defect observed shall be recorded on the standard inspection sheet in accordance with normal procedures.

(5) Frequency

A Special Inspection shall be carried out as and when the situation requires it.

2.5.5 Detailed Inspection

(1) Purpose

The purpose is to obtain sufficient information to establish the cause of a defect and to enable an appropriate method of maintenance or repair to be determined.

(2) Method of Inspection

Specific requirements for Detailed Inspections for each item are set out in Chapter 5.

(3) Maintenance Requirements

Requirements shall be determined following the evaluation of the data obtained from the Detailed Inspection.

(4) Data to be Recorded

Data shall be as stated in Chapter 5.

(5) Frequency

As required.

2.5.6 Supplementary Surveys

During the detailed survey, the maintenance engineer shall decide whether any supplementary surveys are required to gather additional information to assist in deciding on the cause of the defect and/or to assist in the design of the repairs. The surveys may include core sampling, CBR tests, cross sections and boreholes.

Some of these surveys will only be required for certain types of defects and recommendations are provided in Chapter 5.6 for each Inspection Item and for each damage type.

2.6 Damage Ranking System

In order to make the most effective use of the available budget, it is important to rank the damage using a system that is standardised across the country. This approach will provide a method to determine the necessity for and the priority of the works to be carried out which will be on a common basis. Three rankings shall be used:-

Rank A
- any defect which presents a hazard to traffic or which may cause a hazard e.g. deep potholes; deep ruts may hold water which could cause aquaplaning.
- any defect which if left will deteriorate rapidly.

Rank B - any non A ranked defect which requires further investigation to determine the cause of the defect.

Rank C - defects of a minor nature that cannot be categorised as A or B and which do not require remedial work but which require further monitoring.

2.7 Database

2.7.1 General

With a 60 000km road network, there is a vast amount of data to be collected on a regular basis from the inspection programme. In order to make effective use of this data, it is essential that it is managed efficiently to provide useful information to the network managers. This database should become a valuable tool in focusing attention on the priority sections and so making the most effective use of the available maintenance budget.

The database is available in Turkish and English and the screens are designed to be simple and self explanatory. There are facilities to record, add, view, edit and print the data in a range of formats to suit the needs of the managers concerned.

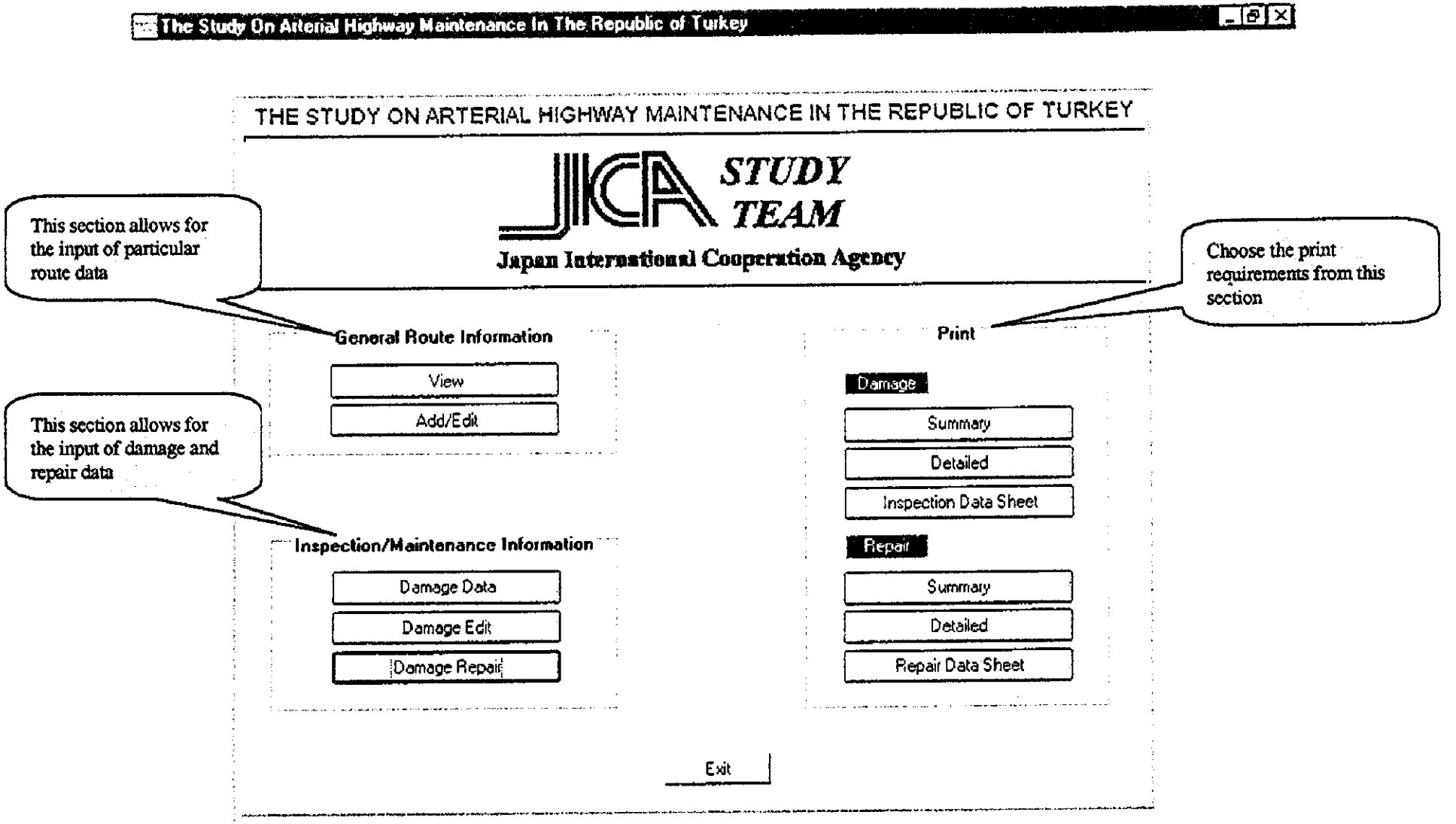
It covers all the inspection items listed in Chapter 2.2.

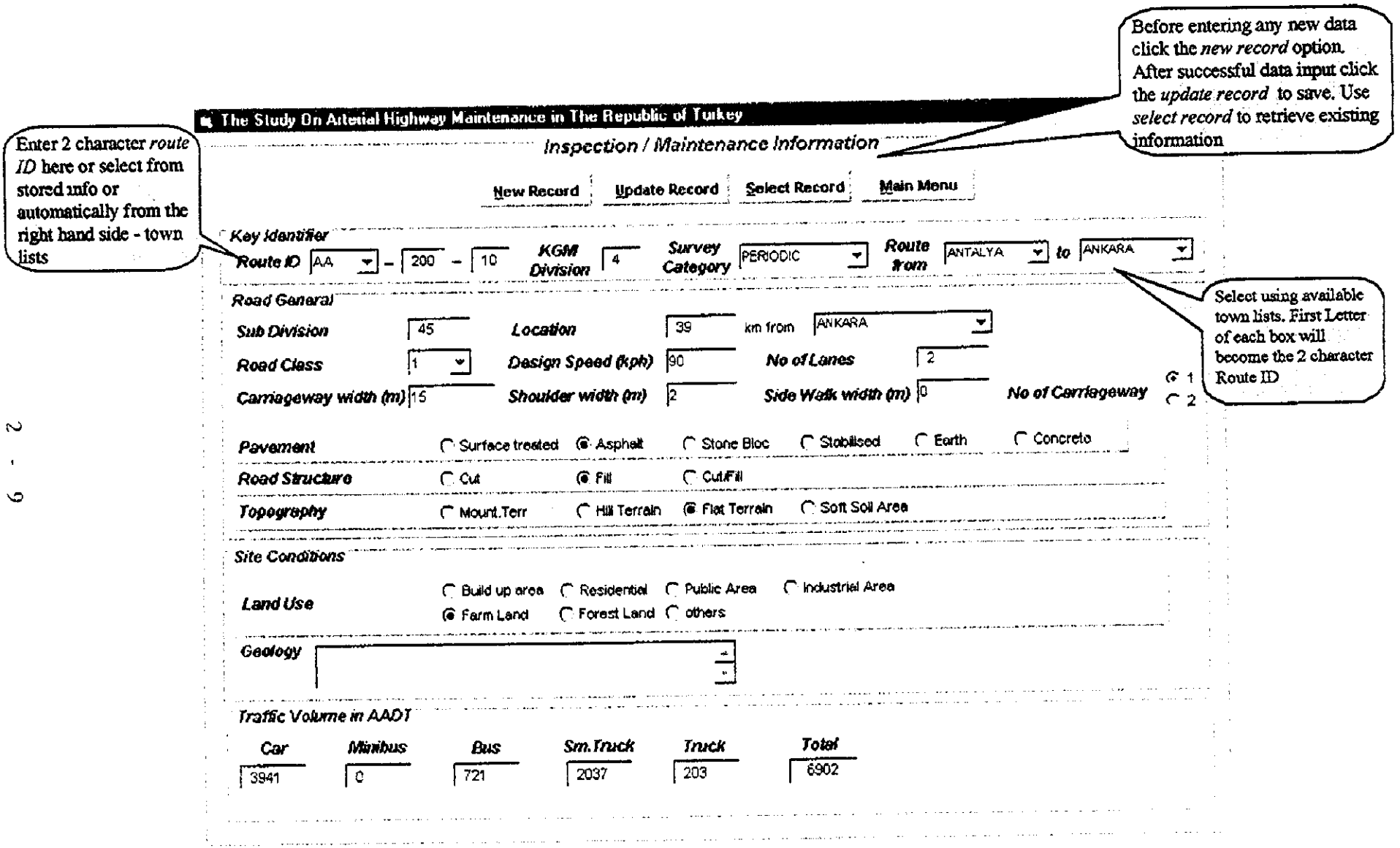
2.7.2 Data to be Recorded

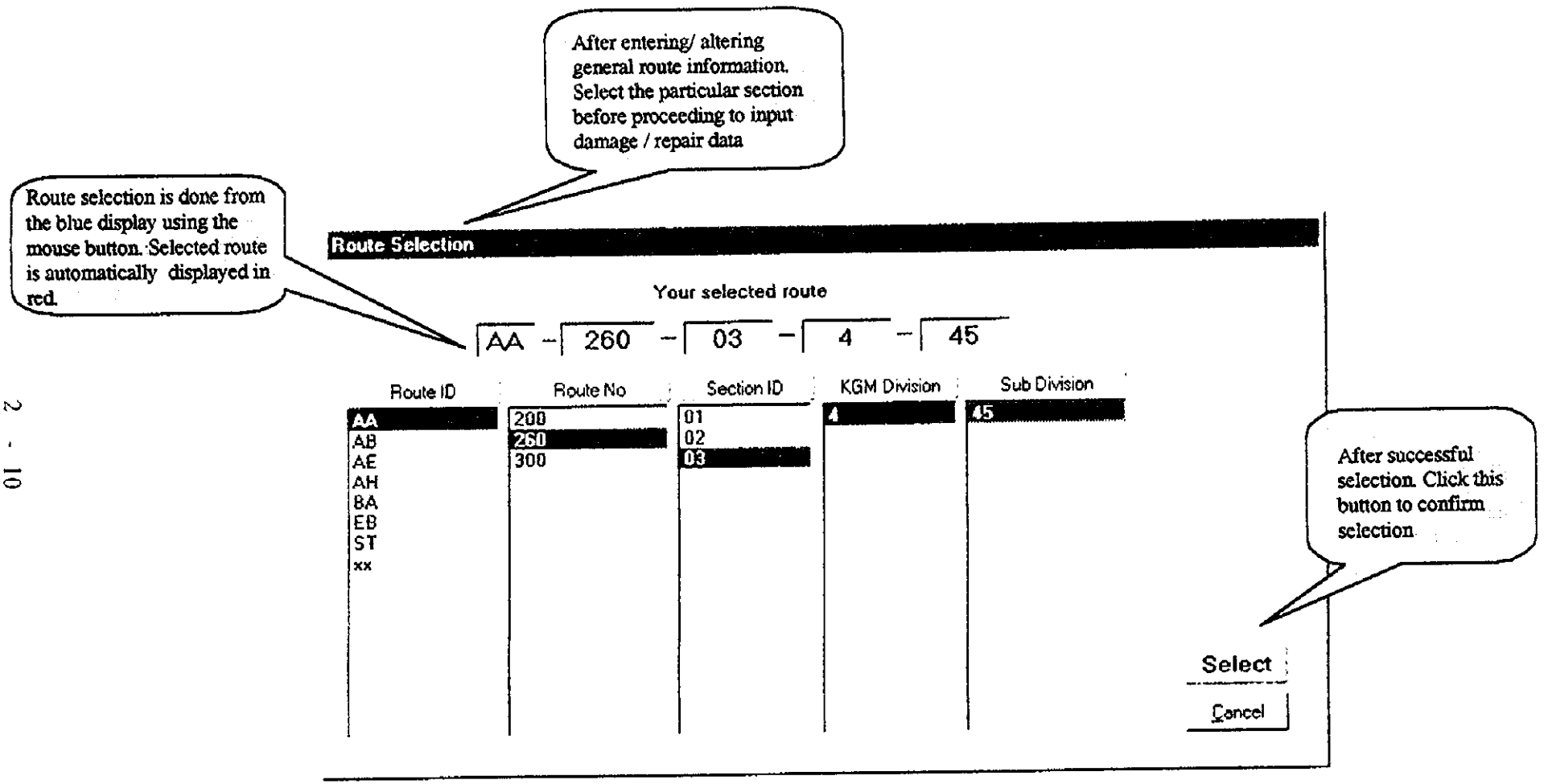
The data to be recorded is described in Chapters 3 and 5. Standard Inspection Sheets are included in the manual in order to provide a consistent approach to the collection and recording of data.

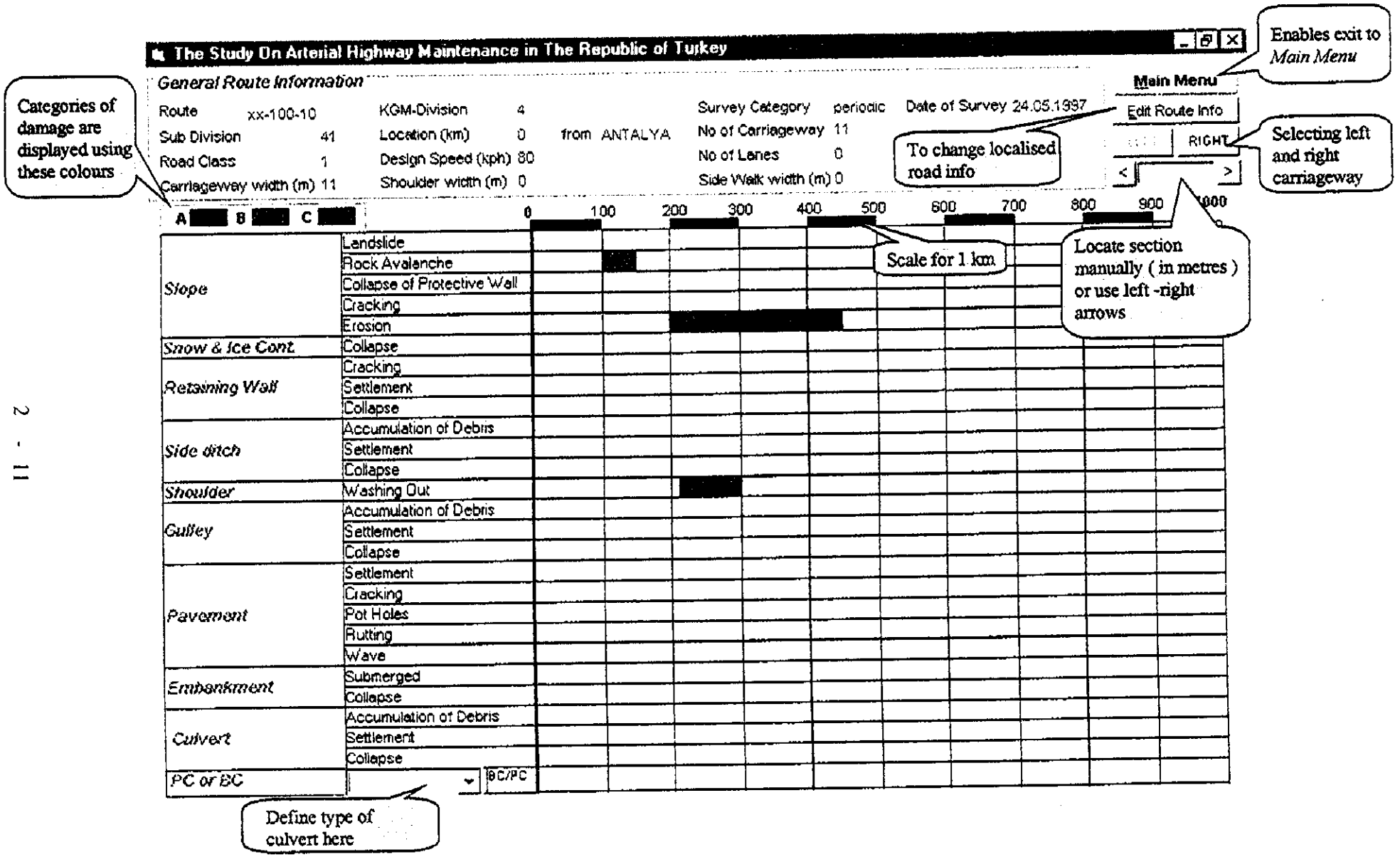
2.7.3 Input Screens

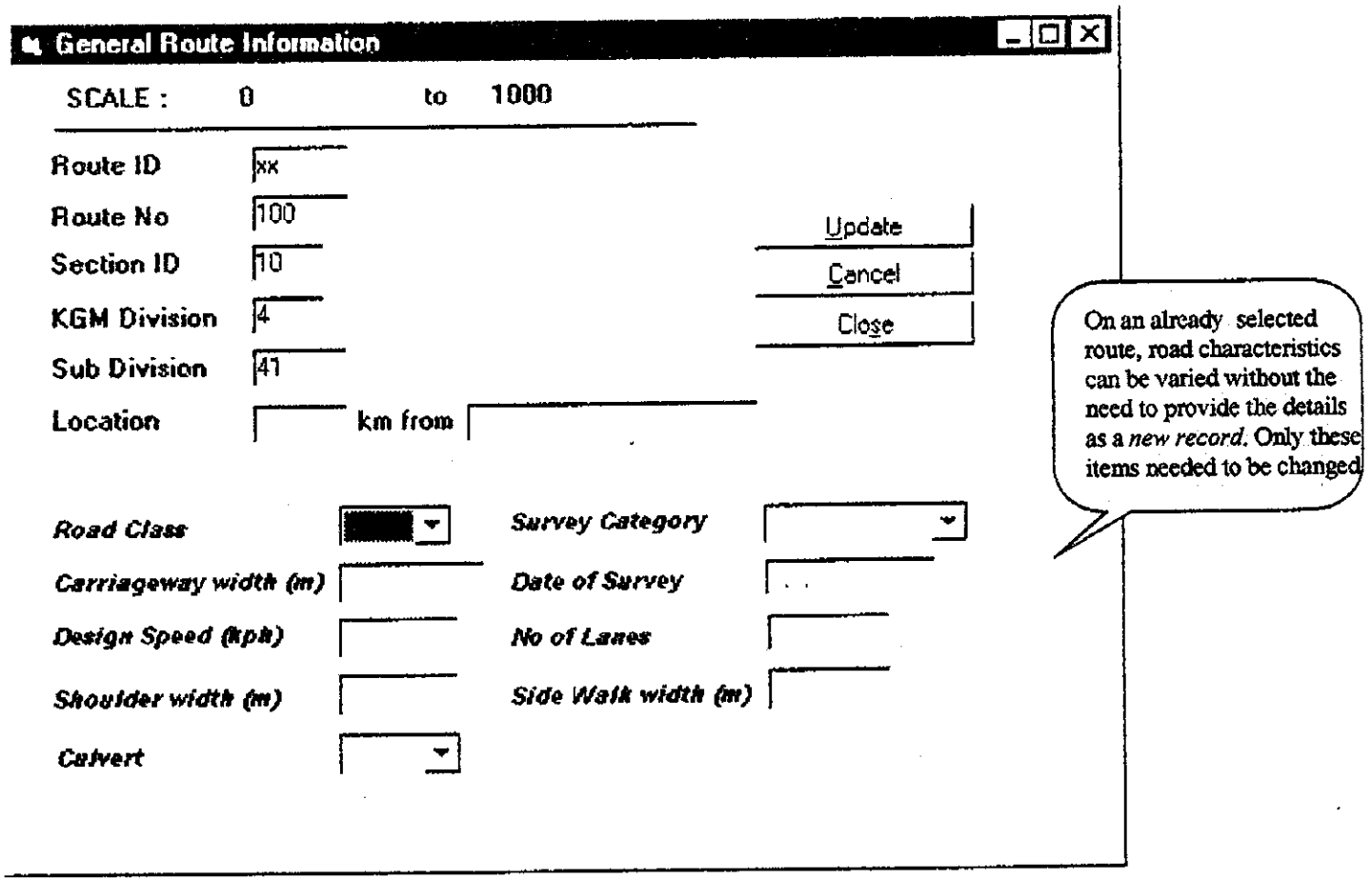
The following pages show the range of input screens available on the database software. The text in the yellow boxes is for explanatory purposes only.

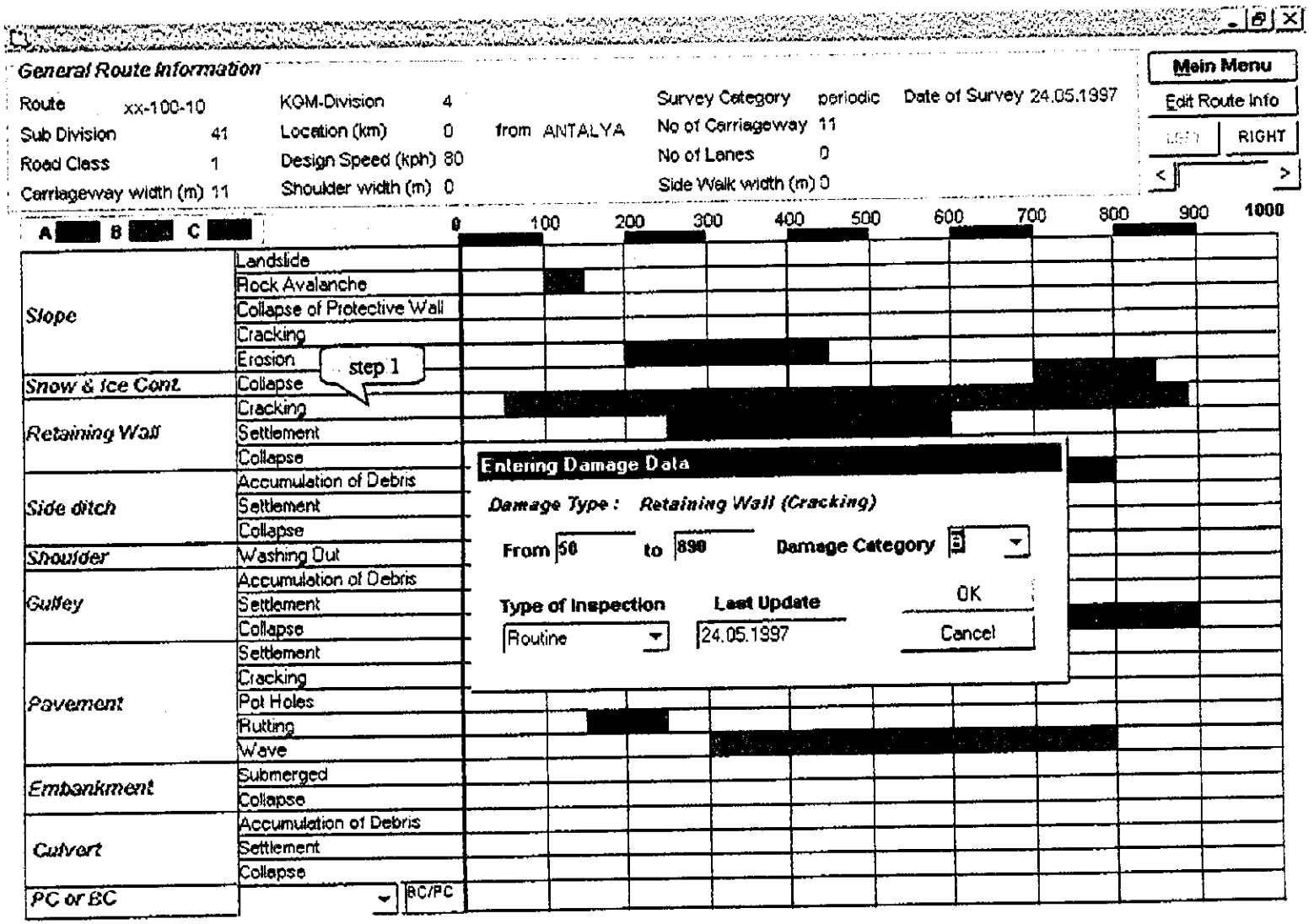

The Study On Arterial Highway Maintenance In The Republic of Turkey
THE STUDY ON ARTERIAL HIGHWAY MAINTENANCE IN THE REPUBLIC OF TURKEY
JICA STUDY TEAM
Japan International Cooperation Agency
This section allows for the input of particular route data
General Route Information
View
Add/Edit
This section allows for the input of damage and repair data
Inspection/Maintenance Information
Damage Data
Damage Edit
Damage Repair
Choose the print requirements from this section
Print
Damage
Summary
Detailed
Inspection Data Sheet
Repair
Summary
Detailed
Repair Data Sheet
Exit


Before entering any new data click the *new record* option. After successful data input click the *update record* to save. Use *select record* to retrieve existing information
Enter 2 character *route ID* here or select from stored info or automatically from the right hand side - town lists
The Study On Arterial Highway Maintenance in The Republic of Turkey
Inspection / Maintenance Information
New Record
Update Record
Select Record
Main Menu
Key Identifier
Route ID AA - 200 - 10
KGM Division 4
Survey Category PERIODIC
Route from ANTALYA to ANKARA
Select using available town lists. First Letter of each box will become the 2 character Route ID
Road General
Sub Division 45
Location 39 km from ANKARA
Road Class 1
Design Speed (kph) 90
No of Lanes 2
Carriageway width (m) 15
Shoulder width (m) 2
Side Walk width (m) 0
No of Carriageway 1 2
Pavement Surface treated Asphalt Stone Bloc Stabilised Earth Concrete
Road Structure Cut Fill Cut/Fill
Topography Mount.Terr Hill Terrain Flat Terrain Soft Soil Area
Site Conditions
Land Use Build up area Residential Public Area Industrial Area Farm Land Forest Land others
Geology
Traffic Volume in AADT
Car 3941
Minibus 0
Bus 721
Sm.Truck 2037
Truck 203
Total 6902


After entering/ altering general route information. Select the particular section before proceeding to input damage / repair data
Route selection is done from the blue display using the mouse button. Selected route is automatically displayed in red.
Route Selection
Your selected route
AA - 260 - 03 - 4 - 45
Route ID
Route No
Section ID
KGM Division
Sub Division
AA
AB
AE
AH
BA
EB
ST
xx
200
260
300
01
02
03
4
45
After successful selection. Click this button to confirm selection
Select
Cancel


The Study On Arterial Highway Maintenance in The Republic of Turkey
General Route Information
Route xx-100-10
Sub Division 41
Road Class 1
Carriageway width (m) 11
KGM-Division 4
Location (km) 0
from ANTALYA
Shoulder width (m) 0
Survey Category periodic
No of Carriageway 11
No of Lanes 0
Side Walk width (m) 0
Date of Survey 24.05.1997
Main Menu
Edit Route Info
RIGHT
Enables exit to Main Menu
To change localised road info
Selecting left and right carriageway
Categories of damage are displayed using these colours
A B C
0 100 200 300 400 500 600 700 800 900 1000
Scale for 1 km
Locate section manually (in metres) or use left -right arrows
Slope
Landslide
Rock Avalanche
Collapse of Protective Wall
Cracking
Erosion
Snow & Ice Cont.
Collapse
Retaining Wall
Cracking
Settlement
Collapse
Side ditch
Accumulation of Debris
Settlement
Collapse
Shoulder
Washing Out
Gulley
Accumulation of Debris
Settlement
Collapse
Pavement
Settlement
Cracking
Pot Holes
Rutting
Wave
Embankment
Submerged
Collapse
Culvert
Accumulation of Debris
Settlement
Collapse
PC or BC
BC/PC
Define type of culvert here


General Route Information
SCALE : 0 to 1000
Route ID xx
Route No 100
Section ID 10
KGM Division 4
Sub Division 41
Location km from
Update
Cancel
Close
Road Class
Survey Category
Carriageway width (m)
Date of Survey
Design Speed (kph)
No of Lanes
Shoulder width (m)
Side Walk width (m)
Culvert
On an already selected route, road characteristics can be varied without the need to provide the details as a new record. Only these items needed to be changed



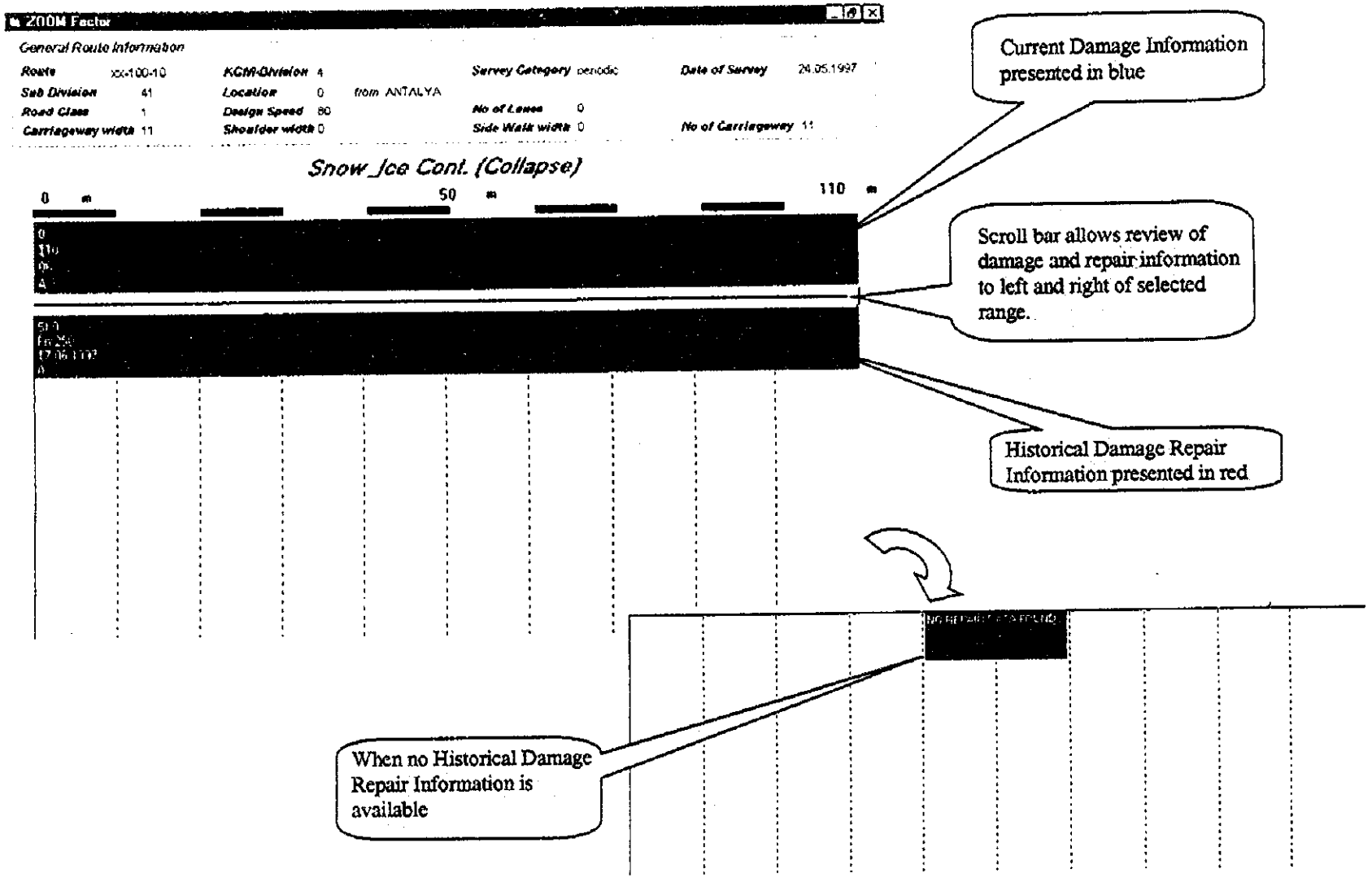
This is the screen when *Damage Data* option is selected.

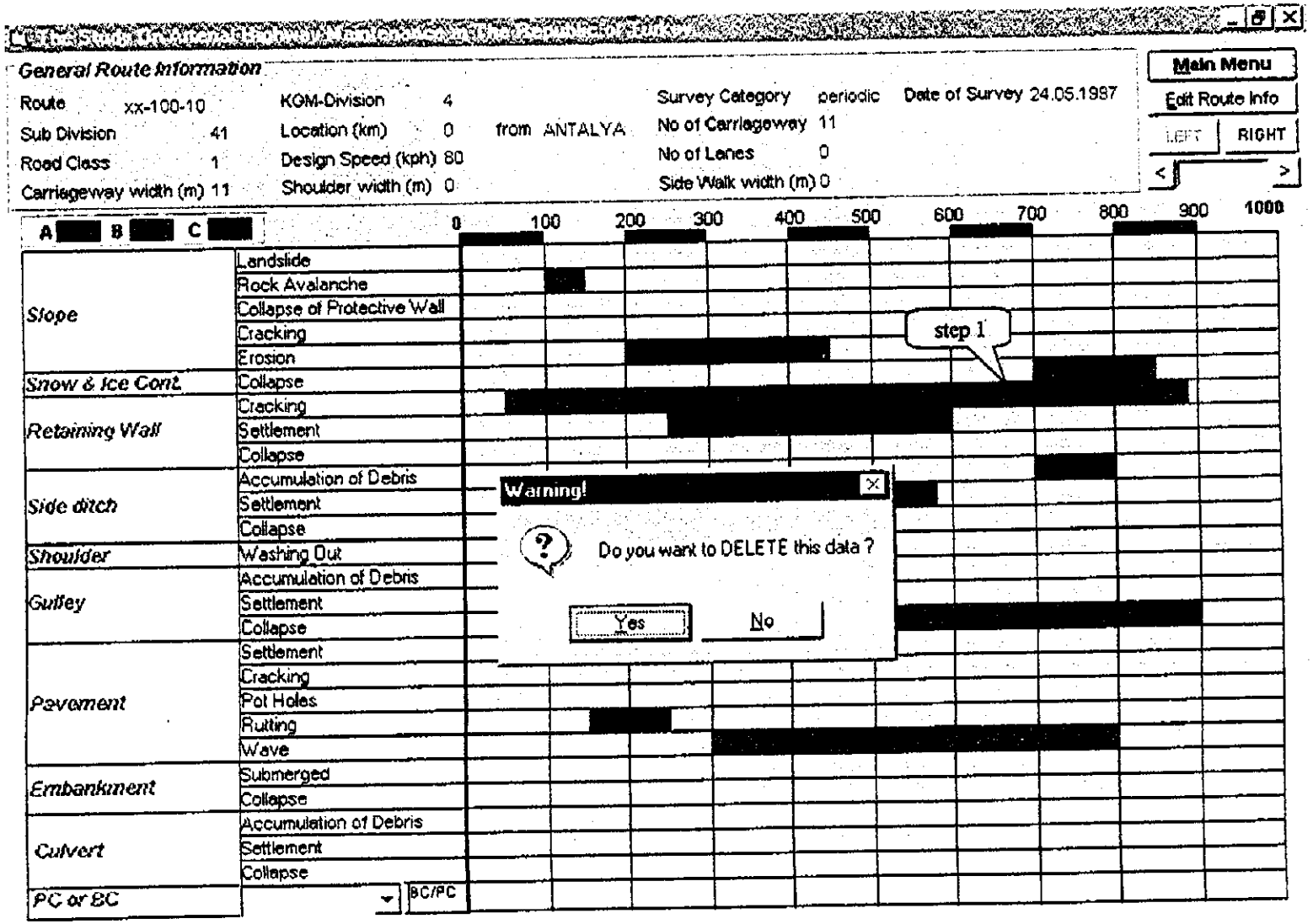
1 Point the cursor on the particular subject area where damaged data is to be stored. Click the mouse

2 The damage query will appear and reconfirming the selected subject.

3 Enter the damage data and confirm as appropriate.

4 Repeat step 1 to 3 as necessary.


ZOOM Factor
General Route Information
Route xx-100-10
KGM-Division 4
Survey Category periodic
Date of Survey 24.05.1997
Sub Division 41
Location 0 from ANTALYA
Road Class 1
Design Speed 80
No of Lanes 0
Carriageway width 11
Shoulder width 0
Side Walk width 0
No of Carriageway 1
Snow_Ice Cont. (Collapse)
0 m
50 m
110 m
Current Damage Information presented in blue
Scroll bar allows review of damage and repair information to left and right of selected range.
Historical Damage Repair Information presented in red
When no Historical Damage Repair Information is available



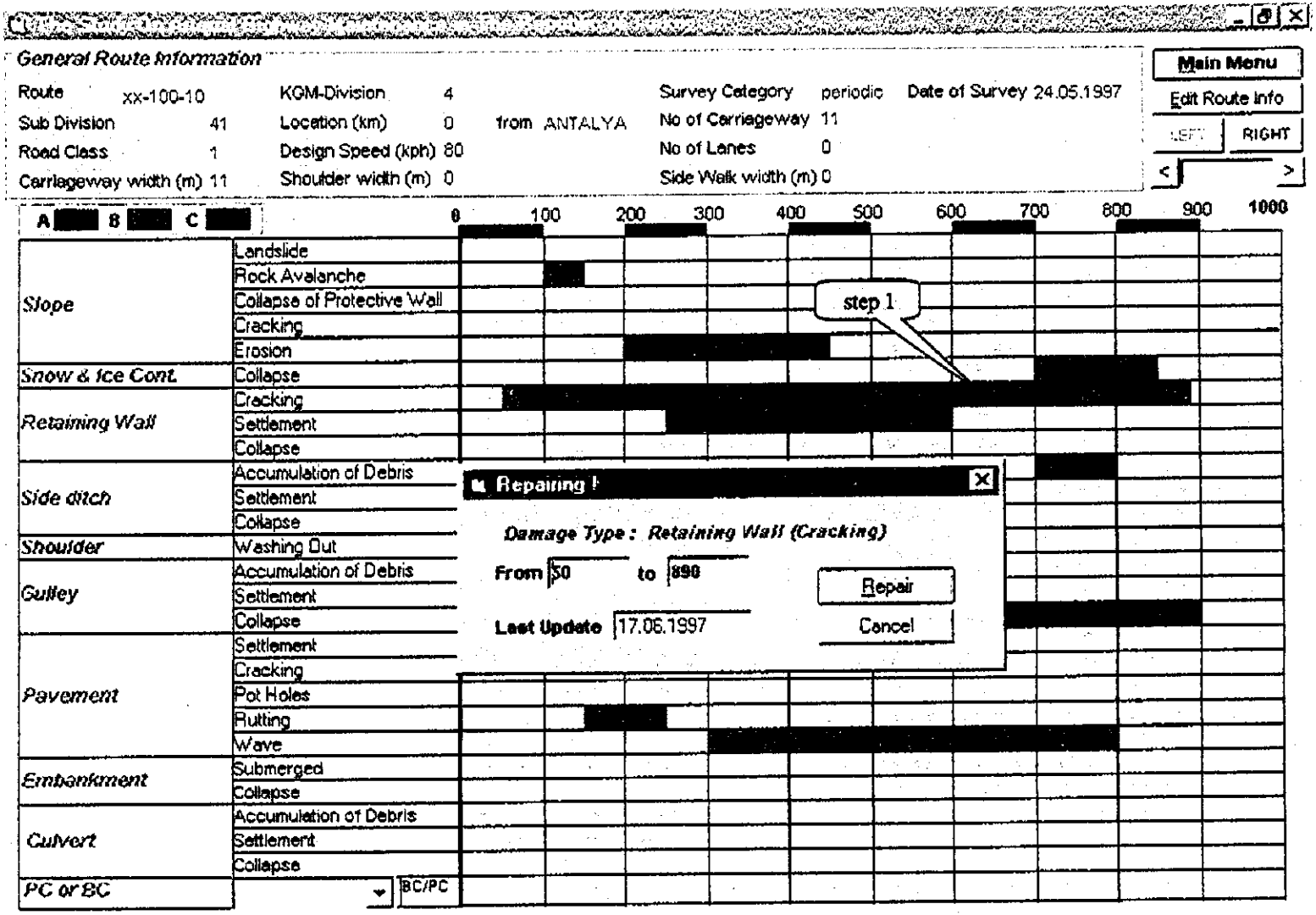
This is the screen when *Damage Edit* option is selected.

1 Point the cursor on the particular damage area which is to be edited. Click the mouse

2 The delete query will appear.

3 Confirm as appropriate.

4 Repeat step 1 to 3 as necessary.



This is the screen when *Damage Repair* option is selected.

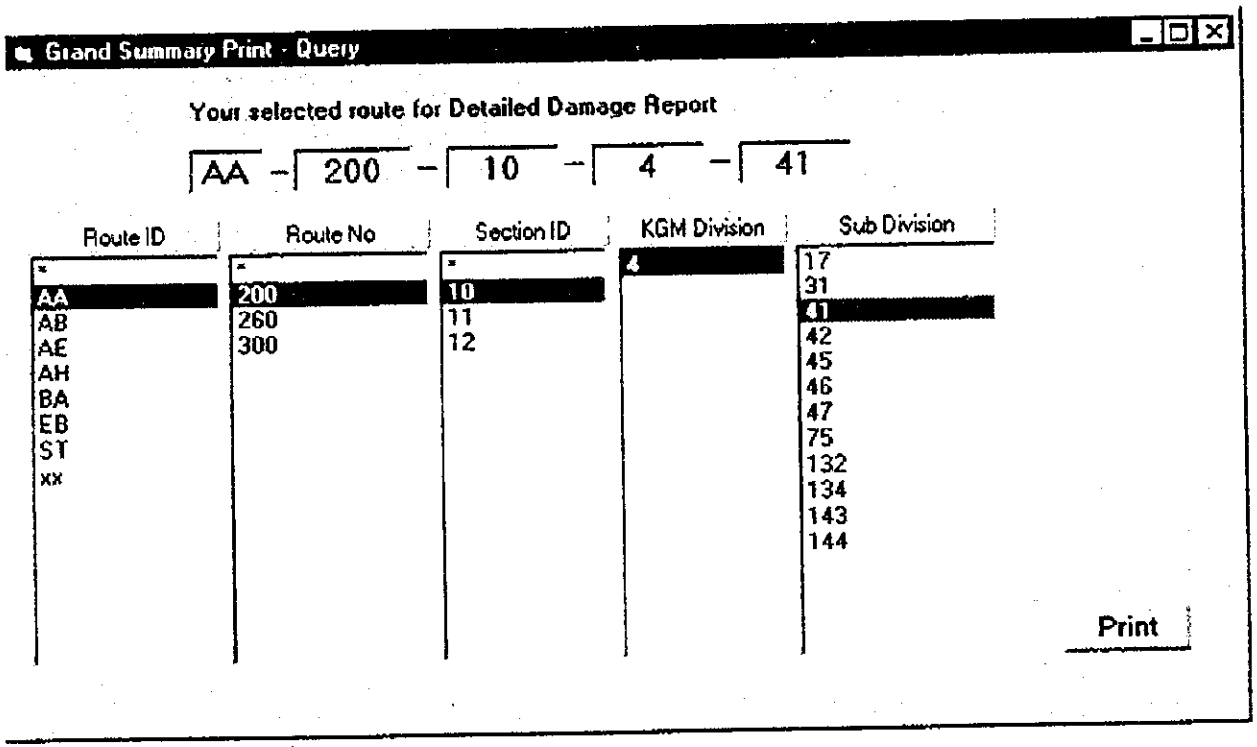
1 Point the cursor on the particular damage area which is to be repaired. Click the mouse

2 The repair query will appear.

Information will be transferred from the damage data to the repaired data.

3 Confirm as appropriate.

4 Repeat step 1 to 3 as necessary



There are various ways to print the information stored.

1 Print **all** in the database, select * from the *Route ID, Route No* and *Section ID*

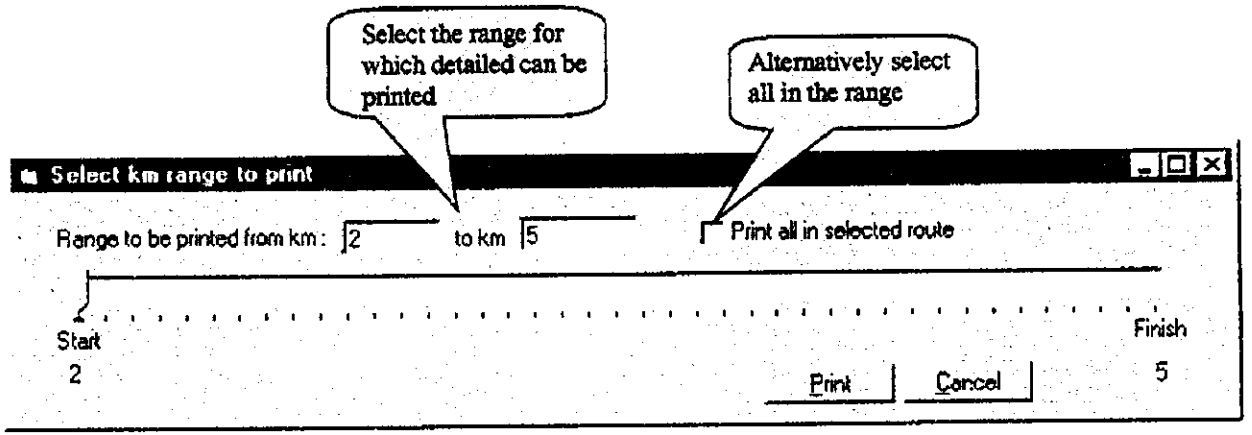
2 Print only a selected route ID, select a route ID from *Route ID* and select * from *Route No* and *Section ID*

3 Print only a selected route No, select a route No from *Route No* and select * from *Route ID* and *Section ID*

4 Print all routes in a Division only, Select * from *Route ID, Section No* and *Section ID* and *Division No.*

5 Print all routes in a subdivision, Select * from *Route ID, Section No* and *Section ID*, a *Div No.* and *Sub div No*

6 Print a specific route, select a route ID, section No, section ID, Div and Sub Div .


Select the range for which detailed can be printed
Alternatively select all in the range
Select km range to print
Range to be printed from km : 2
to km 5
Print all in selected route
Start
2
Finish
5
Print
Cancel

2.7.4 Output Screens

The 'Print' option on the main menu has 3 print options for Damage Data:-

GRAND SUMMARY
DAMAGE INFORMATION - DETAILED REPORT
VISUAL INSPECTION DATA SHEET

There are also 3 options for Repair Data:-

GRAND SUMMARY
REPAIR INFORMATION - DETAILED REPORT
VISUAL INSPECTION DATA SHEET

Examples of the output sheets for the Damage Data are enclosed on the following pages.

GRAND SUMMARY

Key Identifier	Route	AA - 200 - 10	KGM-Division	4	Survey Category	PERIODIC	Date of Survey	15.05.1197		
Road General	Sub Division	45	Location	39- 0						
	Road Class	1	Design Speed (kph)	90	No of Lanes	2				
	Carriageway Width (m	15	Shoulder Width (m)	2	Side Walk Width (m)	0	No of Carriageway	1		
	Pavement Type	(1) Surface Treate	(2) Asphalt	(3) Stone Block	(4) Stabilised	(5) Earth	(6) Concrete		2	
	Road Structure	(1) Cut	(2) Fill	(3) Cut/Fill					2	
	Topography	(1) Mount Terr	(2) Hill Terrain	(3) Flat Terrain	(4) Soft Soil area				3	

		CATEGORY OF DAMAGES			QUANTITY OF DAMAGES		
		A	B	C	A	B	C
Slope	Landslide						
	Rock Avalanche						
	Collapse of Protective Wall						
	Cracking						
	Erosion						100
Snow and Ice Cont. Fa	Collapse			1			
Retaining Wall	Cracking						
	Settlement						
	Collapse						
Side Ditch	Accumulation of Debris						
	Settlement						
	Collapse						
Shoulder	Washing Out						
Gulley	Accumulation of Debris						
	Settlement						
	Collapse						
Pavement	Settlement		9			7700	
	Cracking		6	2		13000	1300
	Pot Holes		6	3		13500	1600
	Rutting		6	3		13000	1600
	Wave		1			1000	
[illegible] Km	[illegible]						
Pavement	Wave	2	4	6	1200	3200	
	Rutting	2	9	3	500	13201	
	Pot Holes	3	10	3	600	13700	
	Cracking	1	7	2	300	11501	
	Settlement		8			8800	
Gulley	Collapse						100
	Settlement						
	Accumulation of Debris	1			300		
Shoulder	Washing Out			1			
Side Ditch	Collapse	1			100		
	Settlement						
	Accumulation of Debris						500
Retaining Wall	Collapse						
	Settlement						
	Cracking						
Snow and Ice Cont. Fa	Collapse			1			
Slope	Erosion		2			800	
	Cracking						1300
	Collapse of Protective Wall						1500
	Rock Avalanche						1500
	Landslide						6200
Embankment	Submerged		2			700	
	Collapse						
Culvert	Accumulation of Debris						
	Settlement						
	Collapse						

DAMAGE INFORMATION - DETAILED REPORT

Route ID	Route No.	Section ID	KGM Div.	Sub Div.	Sec. km.	Pavement			Gulley			Shoulder			Side Ditch			Retaining Wall			Snow & Ice Cont			Slope			Embankment			Culvert		
						A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
AA	200	10	4	45	0		30	8			1				1					1	1		1	8	38	14		2				
AA	200	11	4	45	0		14	4							1										13	5		1				
AA	200	12	4	45	0	4	37	12						2		1	2		1	2				4	38	20		2			2	
AA	200	12	4	47	0			2									1									3						
AA	260	01	3	31	0	8	49	10	1	1			1			11		2	2			2		14	95	9		1			1	
AA	260	02	3	31	0					1				1						1			1		1							
AA	260	03	4	45	0		26	3																	28	7						
AA	300	07	3	31	0	5	11	4					2	2			1			2				15	17	7						

2.7.5 Use of the Database

Inspection sheets are completed after each routine and special inspection. Where a computer is available in the Sub-Division, the data should be entered as soon as possible after the completion of the inspection. Where a computer is not available, the data should be retained on a file in the Sub-Division and every 3 months, this file should be taken to the division headquarters and entered onto the database held there.

Similarly, when repair works are carried out, the details of the repair should be entered in a similar way, to ensure that an up to date record is available at all times to the maintenance managers.

The maintenance managers should use the database to produce an annual report on the level of defects and repairs carried out and can use it to monitor the activity through the year.

2.8 Personnel and Equipment

All personnel involved in maintenance inspections should have adequate training in all the inspection procedures, recording of data and the safety of personnel working on the road network.

The equipment required for the various inspections will vary depending on the type of inspection and the items to be inspected. Chapters 3.2.4 and 5.4 indicate the specific items required for those inspections.

2.9 Safety and Traffic Management

Safety must be the primary consideration at all roadworks. The arrangements for inspections shall seek to minimise the disruption to traffic whilst ensuring adequate access for proper inspection and maintaining a safe working environment for the inspection personnel, the road user and the general public.

We have developed 5 standard layouts to deal with inspections and supplementary surveys based on experience in Turkey and internationally. The standard layouts are shown in Chapter 5.5 of the Inspection Manual.

2.10 The Road Referencing System

The road referencing system is as follows:-

A1 - 100 - 10 - 02

A1	is a 2 letter reference showing where the road is coming from and going to
100	is the road number
10	is the section number along the road
02	is the kilometre number within the section

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

The kilometre post referencing system is used by KGM personnel for work location purposes and with the addition of the 2 letter route identification, will be used as the location referencing system on all inspection sheets and in the Maintenance database.

Standard kilometre post

2.11 The Use of Photographs

Photographs should be used to record defects where it will assist those at the Sub-Division or where a record of the event is required.

Photographs should always include a scale such as a ranging rod with its red and white bands which are clearly visible and provide clear indication of size. This can be laid on the road surface or held against a culvert or slope.

Each photograph should be labelled with the date and location and should be held on file until the defect is repaired or until the Sub-Division engineer decides it can be discarded.

As the number of photographs will be considerable, an effective recording and reference system should be adopted to enable photographs to be located quickly and easily.

The following is provided for guidance in setting up a record system:-

(1) A standard photograph record sheet should be prepared (an example is provided in Appendix B).
(2) An Index of photographs should be prepared to enable the photographs to be located (an example is provided in Appendix B).
(3) The photographs should be placed in a file or album with the range of photograph numbers contained in that file clearly marked on the cover.
(4) The Inspection Sheet should be stored with the photograph so that all the relevant data is available in one location should the maintenance staff need to refer to it at any time.

CHAPTER 3 ROUTINE INSPECTION

3.1 General

The objectives, inspection items and defects are as stated in Chapter 2.

It is important to identify defects at an early stage so that repair works can be carried out and so prevent the further deterioration of the defect which might lead to more expensive repairs at a later date.

3.2 The Inspection Process

3.2.1 General

The Routine Inspection is a visual inspection carried out on foot. The aim is to identify a range of defects for the various inspection items and to allocate a defect ranking to enable any follow up work to be prioritised.

3.2.2 Inspection Plans

(a) Annual Plan
An annual plan should be prepared in order to ensure that all the inspection items within each Sub-Division are inspected at least at the frequencies shown in Table 3.2.1. The plan should ensure that the inspection workload is spread out over the year making allowances for the winter conditions in the region and also for the requirement to inspect certain items at certain seasons of the year. Priority should be given to the State Road network in planning the programme of inspections.

Table 3.2.1 Minimum Frequency of Routine Inspections for each Item

Item	State Roads	Provincial Roads
	Frequency	
Pavement	Weekly	Monthly
Slope	Weekly	Monthly
Embankment	Weekly	Monthly
Shoulder	Weekly	Monthly
Gully	Monthly	3 Monthly
Side Ditch	Monthly	3 Monthly
Culvert	Monthly	3 Monthly
Retaining Walls	3 Monthly	6 Monthly
Snow and Ice Facilities	6 Monthly	12 Monthly

(b) Monthly/Weekly Plan
A monthly or weekly inspection plan shall be prepared to allocate personnel, organise the inspection teams and the items and sections to be inspected.

3.2.3 Inspection Flow Chart

The Inspection flow chart is shown in Fig. 3.2.1.

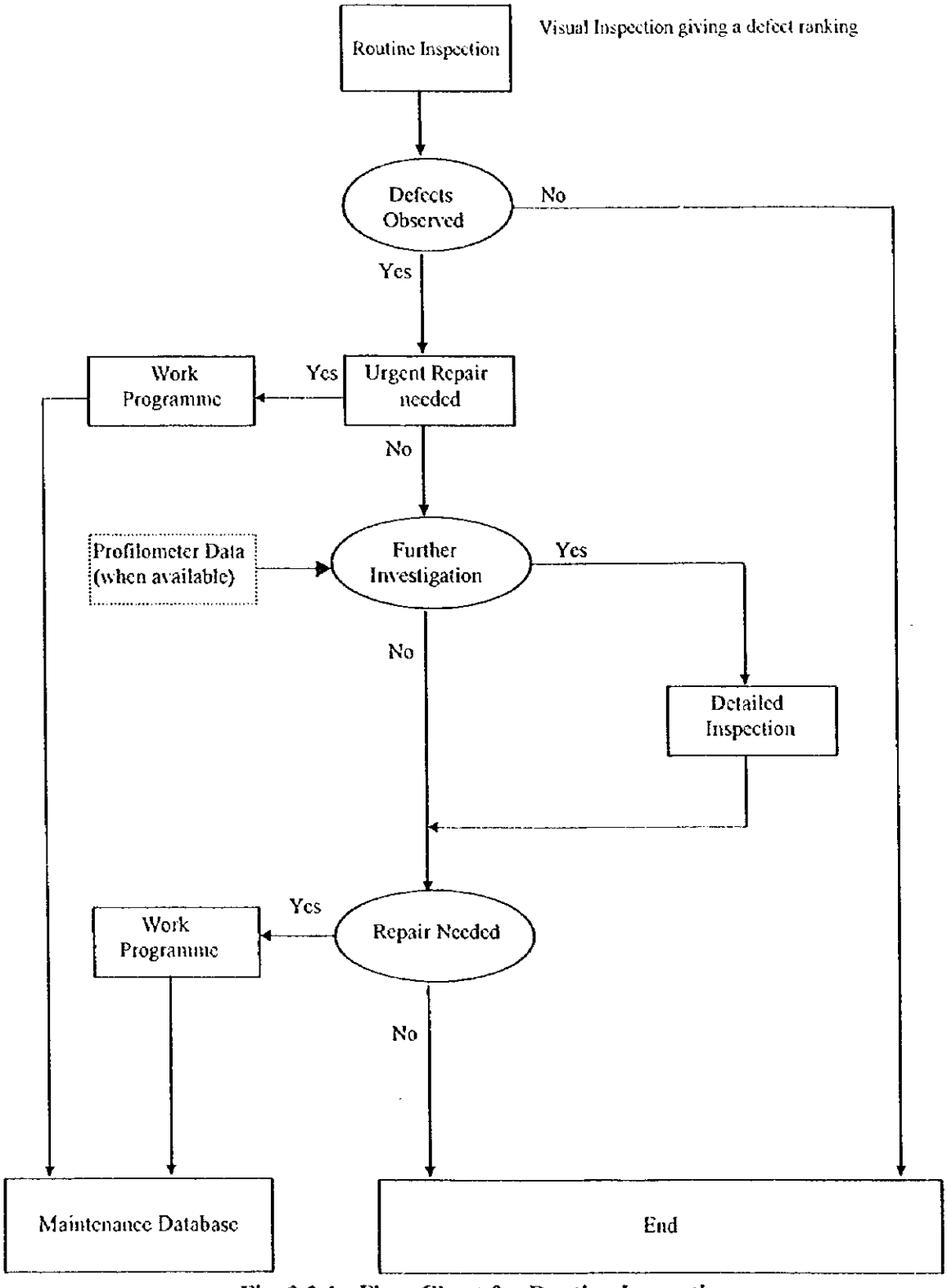


Fig. 3.2.1 Flow Chart for Routine Inspections

(a) Routine Inspection

A visual inspection is carried out allocating a defect ranking to any defects found. The defect and ranking are marked on the Visual Inspection Data Sheet.

(b) Defects Observed

Where no defect is observed, no further action is required.

(c) Urgent Repair

Any inspection sheet with an A ranked defect should be given to the maintenance engineer at the Sub-Division. He should visit the defect and decide on the appropriate course of action and prioritise any repair work necessary. Where the defect requires urgent repairs, these items should be included in the works programme as soon as possible. Urgent repairs should be considered both when the defect is a hazard to traffic using the road and if it might cause a rapid deterioration of the inspection item.

(d) Further Investigation

Where the cause of the defect cannot be identified, the inspector should discuss with the Sub-Division maintenance engineer the need for a detailed inspection. Where a detailed inspection is needed, it should be put into the inspection programme.

(e) Repair Needed

Where a repair is needed it should be included in the work programme.

(f) Work Programme

On completion of the repair works, the date and details of the repair are to be entered onto the maintenance database.

3.2.4 Personnel and Equipment

The Routine Inspections should be carried out by an experienced inspector familiar with the defects to be identified. He should receive some basic training in the completion of the inspection sheets, recording data and ranking the defects.

Table 3.2.2 Routine Inspection Equipment

Item	Check Box (✓)
Visual Inspection Data Sheets	
Ranging rods	
3m tape	
Camera	
Reflective jackets for each team member	
Pencils	
Clipboard	

Table 3.2.2 lists the inspection equipment that should be available for each inspection team.

3.2.5 Method of Inspection

(i) Based on the weekly or daily plan, the inspector should check the work scheduled for the day to ensure that the order of work makes the most efficient use of his time.

(ii) On arriving at the section or item to be inspected, the vehicle should be parked in a safe position at the start of the inspection section or adjacent to the item to be inspected. The hazard lights should be switched on and the roof mounted flashing light should also be switched on.

(iii) The inspector and any support staff should be wearing reflective jackets.

(iv) A visual inspection on foot of the scheduled items should be carried out. During the visual inspection, the inspectors should be looking for the damage types listed on the inspection sheet for that particular inspection item e.g. for gully, 'accumulation of debris', 'settlement' or 'collapse'.

(v) Whenever a defect is found, the inspector should complete the Visual Inspection Data Sheet as shown in Chapter 3.2.6.

The damage ranking entered onto the inspection sheet should be in accordance with the definitions stated below:-

A - any defect which presents a hazard to traffic or which may cause a hazard e.g. deep potholes; deep ruts may hold water which could cause aquaplaning.
- any defect which if left will deteriorate rapidly.

B - any non A ranked defect which requires further investigation to determine the cause of the defect.

C - defects of a minor nature that cannot be categorised as A or B and which do not require remedial work but which require further monitoring.

3.2.6 Reporting Procedure

A sample Visual Inspection Data Sheet is enclosed in Appendix A.

The top section of the sheet shows the general information which should be completed before the start of the inspection. This includes:-

Key Identifier

Route	- 200-13	states the km post reference before the inspection point
KGM Division	- 4	the Division number should be entered
Survey Category	- routine	states the type of survey, routine/special
Date of Survey	- 12.05.97	state day, month, year

Road General

Sub-Division	- 47	state the number of the Sub-Division
Location	- 8km from Elmadag	states distance from nearest large town (this is to help those who do not know the region)
Road Class	- 1	enter class 1 or 2 for State Roads enter class 3 or 4 for Provincial Roads
Design Speed	- 80	enter the design speed in km/hr, where known
No. of Lanes	- 2	enter 2, 3 or 4 (4 lanes represents a dual 2 lane road)
Carriageway Width	-	} These dimensions should be visually
Shoulder Width	-	} estimated at the site.
Sidewalk Width	-	} Where the constructed dimensions are known,
Pavement	-	} these should be entered.
Road Structure	-	}
		circle the relevant pavement type
		circle the relevant item

Site Conditions

Topography	-	circle the relevant terrain (this should be representative of the general terrain in this section of road)
Land Use	-	circle the relevant terrain (this should be representative of the general terrain in this section of road)
Geology	-	Where known or available
Traffic Volume	-	Where known

The inspection items are listed together with the defects to be identified for each item.

Each sheet represents a 1km section of road within the section identified in the 'Route' box at the top of the sheet. The kilometre reference should increase from left to right. Each sheet is divided into 100metre sections to assist in locating the defects.

Fig. 3.2.2 below shows a typical inspection section. The kilometres at the start and finish of the inspection section should be inserted in the 'km' box in the middle of the inspection sheet. In all cases, the left hand lane is on the left of the road when looking in the direction of increasing kilometre reference. For dual carriageways, the left hand carriageway is on the left when looking in the direction of increasing kilometre reference. Defect entries for the left hand lane or carriageway are entered on the top half of the inspection sheet and for the right hand lane or carriageway on the bottom half of the sheet.

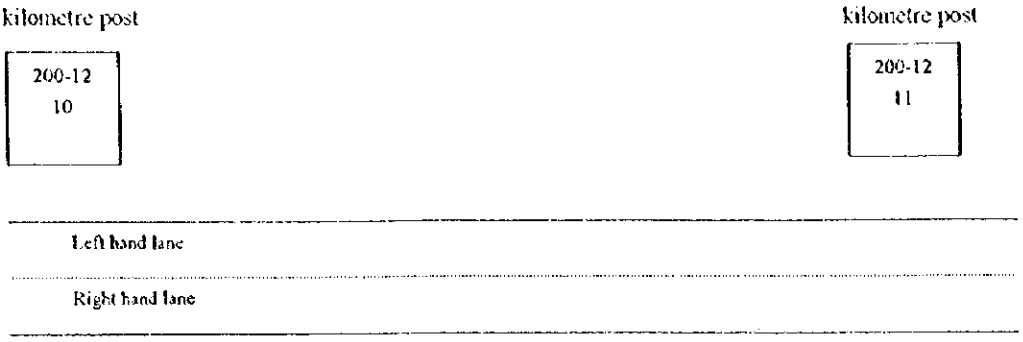


Fig. 3.2.2 Inspection Section Referencing

During the inspection, whenever a defect is located, the inspector should assess the extent of the defect, referring to the ranking in Chapter 3.2.5. The defect ranking should then be inserted on the standard Visual Inspection Data Sheet against the specific inspection item and defect and at the correct km point on the inspection sheet.

An example of a completed Visual Inspection Data Sheet is shown overleaf.

3.2.7 Actions to be Taken

Any obstruction, hazard or defect which is likely to create a danger to the public using the road or any defect which endangers the integrity of the item, shall if reasonably practical be corrected, made safe or otherwise protected. This might include displaying warning signs, coning off or fencing off to protect the public from the defect. If it is not possible to correct or make safe the defect at the time of the inspection, repairs of a temporary or permanent nature shall be carried out as soon as possible and in any case within a period of 24 hours. Temporary repairs shall be inspected regularly and a permanent repair shall be carried out within 30 days. Where further action is required, Sub-Division Headquarters should be informed.

Any inspection sheet with an A ranked defect should be given to the maintenance engineer at the Sub-Division. He should visit the defect and decide on the appropriate course of action and prioritise any repair work necessary. Where the defect requires urgent repairs, these items should be included in the works programme as soon as possible.

Urgent repairs should be considered both when the defect is a hazard to traffic using the road and if it might cause a rapid deterioration of the inspection item.

Priorities shall be considered along with access requirements, other works on the road network, traffic levels and the need to minimise traffic management in compiling the programmes of work.

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

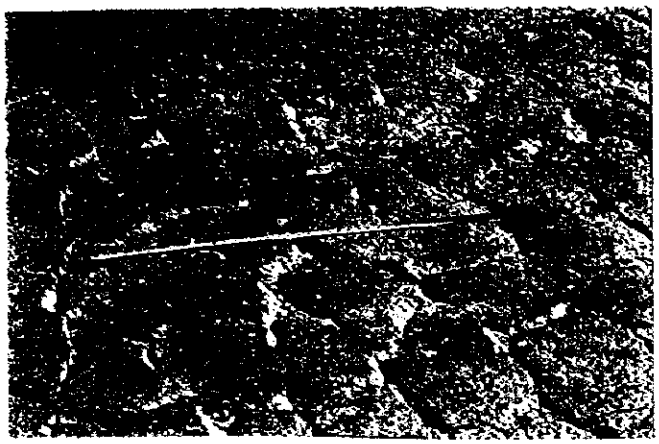
		Box Culvert			Embankment		Slope					Snow & Ice Control Facilities	Retaining Wall			Side Ditch			Shoulder	Gulley			Pavement					km	Pavement					Gulley			Shoulder	Side Ditch			Retaining Wall			Snow & Ice Control Facilities	Slope				
		Collapse	Settlement	Accumulation of Debris	Collapse	Submerge	Erosion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

3.3 Pavement

The pavement should be inspected from the edge of the road without encroaching onto the carriageway.

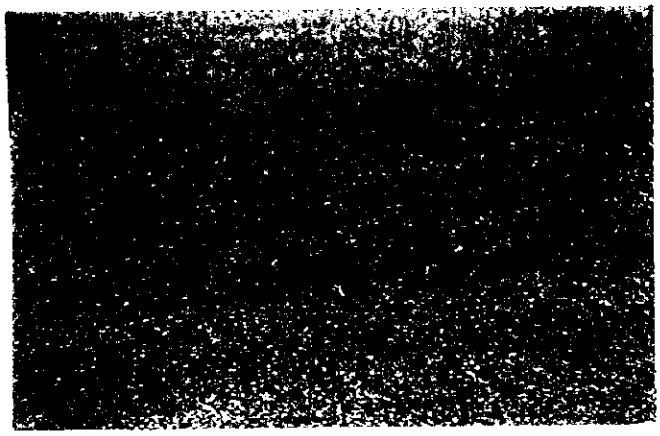
The following photographs show examples of pavement defects.

(1) Cracking

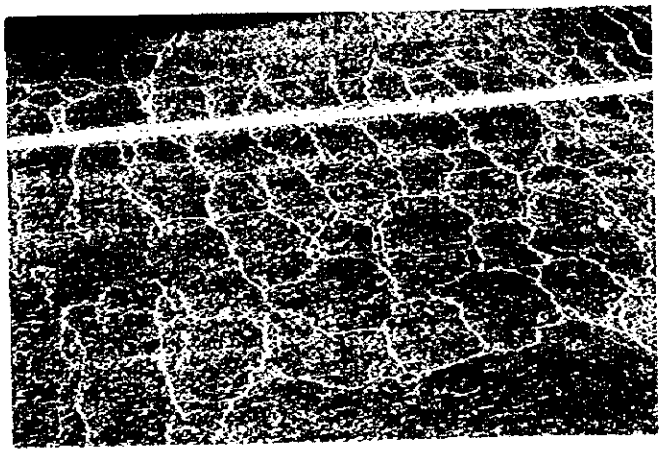


Alligator cracking (Crazing), Damage Rank A

Alligator cracking (Crazing), Damage Rank A

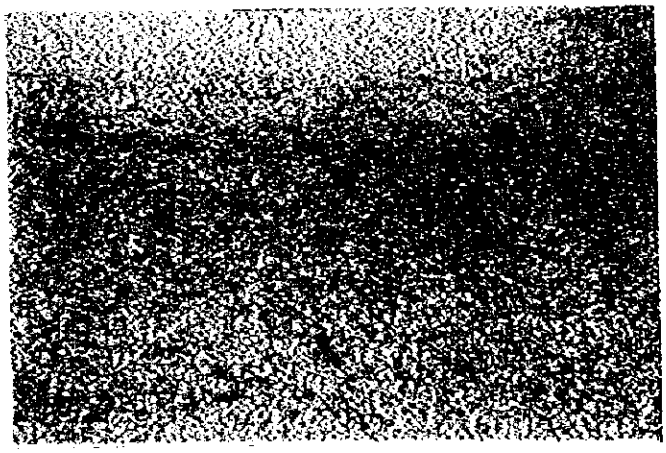


Alligator cracking (Crazing), Damage Rank A



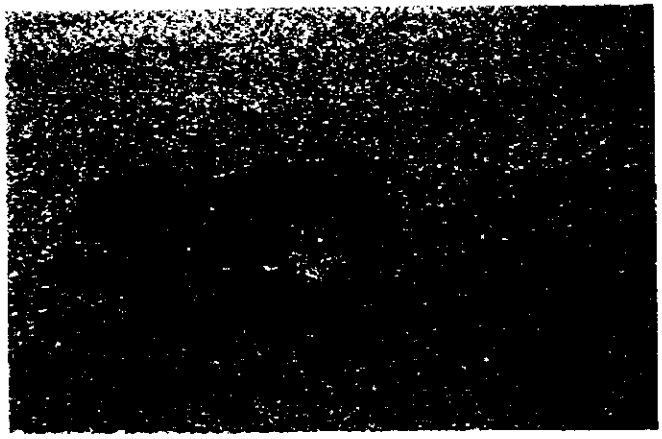
Alligator cracking (Crazing), Damage Rank B

Longitudinal Cracking, Damage Rank B



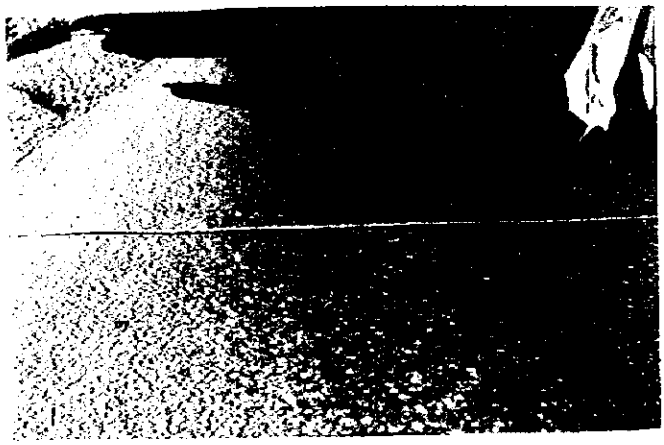
Longitudinal Cracking, Damage Rank C

(2) Pothole



Pothole, Damage Rank B

(3) Rutting

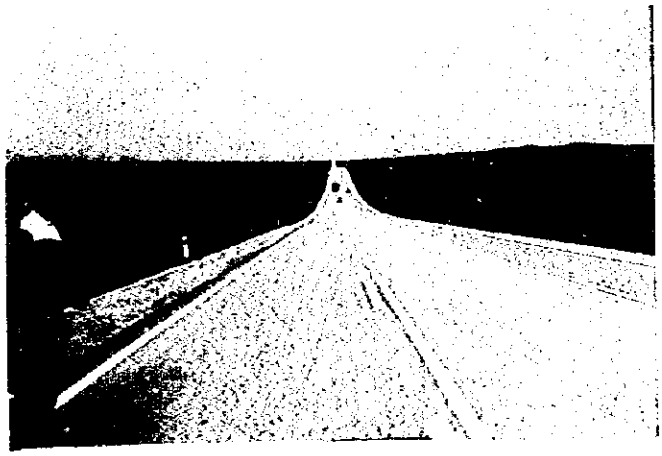


Rutting, Damage Rank B

(4) Settlement

Settlement, Damage Rank A

(5) Wave



Wave, Damage Rank C

3.4 Slope

Landslides, rock avalanches, collapse of protection wall and erosion can all be seen from the edge of the road at the toe of the slope. Cracking may not be so easy to detect and when an inspector suspects cracking has occurred, he should investigate the cutting slope more closely, provided it is safe to do so.

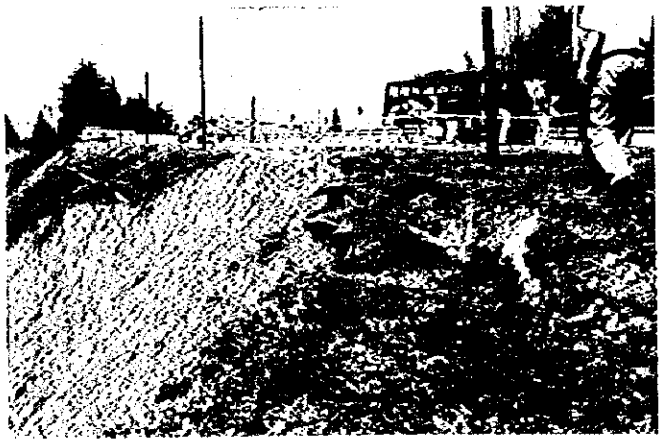
Inspections should follow periods of heavy rain, severe frosts or prolonged dry weather.

Slopes at an early stage of instability can often be identified by bulging of the slope profile at the bottom of the slope and very narrow tension cracks at the top. Shrinkage cracking, as a result of dry weather, will in cohesive soils provide access for water and may indicate slopes at

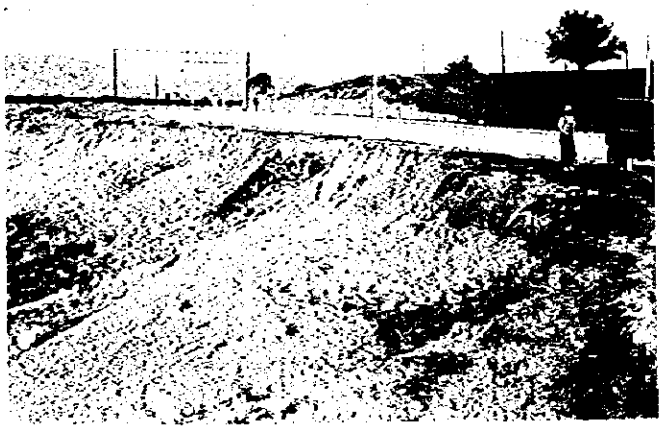
risk of failure. Early movements may be recognised by the presence of tension cracks at the back of the slip and from changes in ground profile. The cracks can be curved or straight in plan. Where rotational failure is developing, the profile will be depressed in the upper part of the slip and will bulge at the toe. Toe bulging may also occur with slab slides but the tension crack will usually be wider and the slope angle of the surface of the slipped material will tend to remain similar to that of the surrounding stable slope.

The following photographs show examples of slope defects:-

(1) Landslide



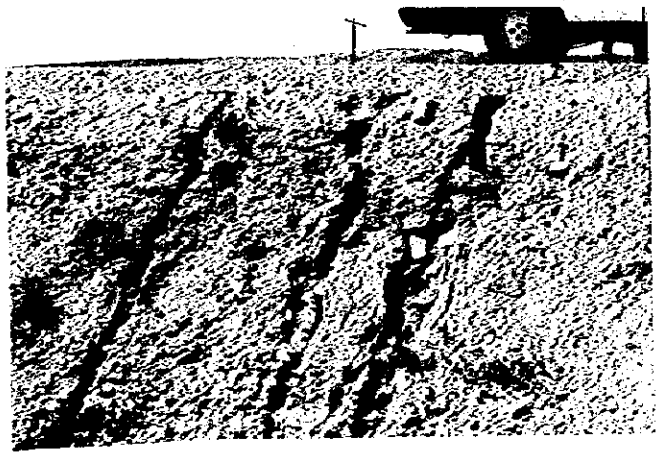
Landslide, Damage Rank A



Landslide, Damage Rank A

Rock Avalanche, Damage Rank C

(3) Erosion



Erosion, Damage Rank B

3.5 Embankment

Submerge (flooding) and collapse are defects which will be visible from the edge of the road.

Landslide, Damage Rank A

Landslide, Damage Rank B

(2) Rock Avalanche

Rock Avalanche, Damage Rank B

3.6 Shoulder

Washing out will be visible from the edge of the road. If left, this may cause a rapid weakening of the pavement through lack of edge support and through the ingress of water into the pavement layers.

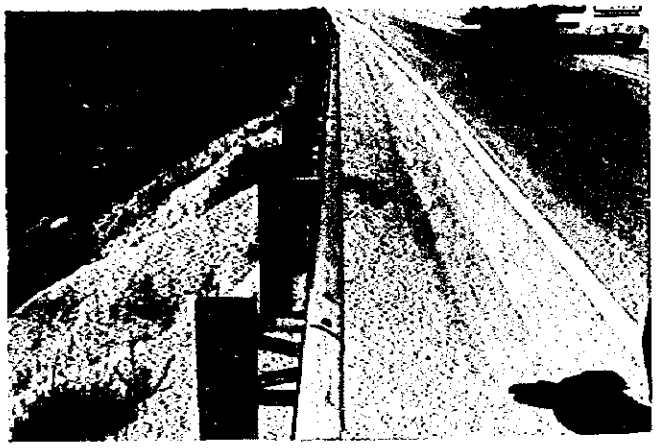
The following photographs show examples of shoulder defects:-

(1) Washing Out

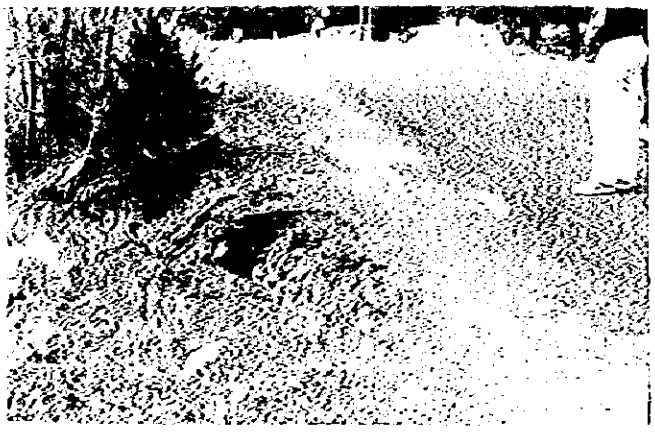
Washing Out, Damage Rank A

Washing Out, Damage Rank A

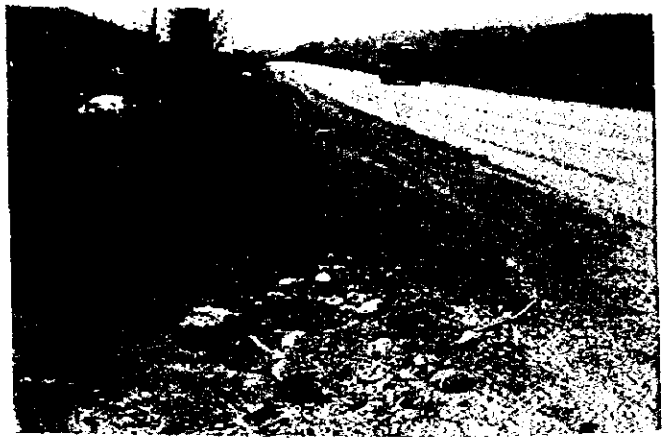
Washing Out, Damage Rank A



Washing Out, Damage Rank A



Washing Out, Damage Rank B



Washing Out, Damage Rank B

3.7 Side Ditch, Gully and Culvert

Accumulation of debris, settlement and collapse for side ditches and gullies can be seen from the edge of the road.

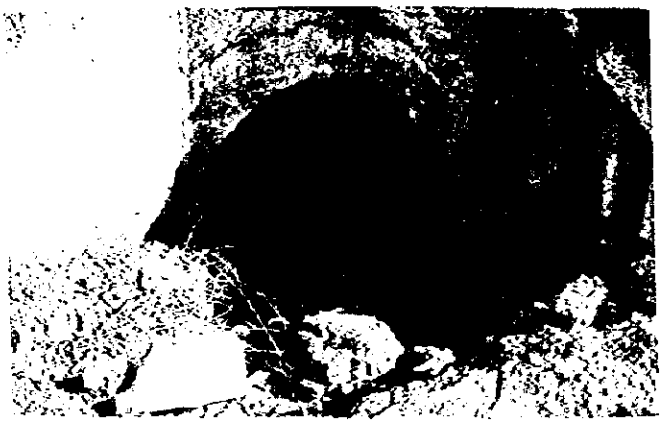
For culverts, it is important to get down to the culvert invert level at both the inlet and outlet to check for accumulation of debris and to look through the culvert to check for settlement or collapse.

Ditches can become overgrown with vegetation, silted up, blocked with debris, rubbish or bank erosion to the extent that the flow of water is impeded. Water is not in itself harmful unless stagnation occurs (resulting in a health hazard), flooding is caused, or a resulting higher water table adversely affects the road or other structural foundations.

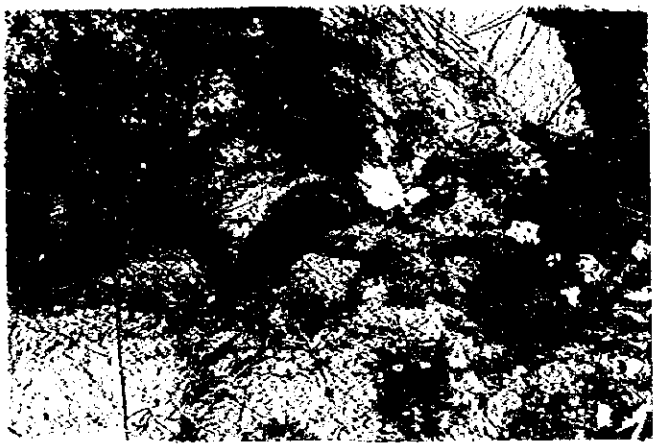
Maintaining an effective drainage system is one of the key factors in achieving the full design life of the road pavement.

The following photographs show examples of side ditch, gully and culvert defects:-

(1) Culverts, Accumulation of Debris

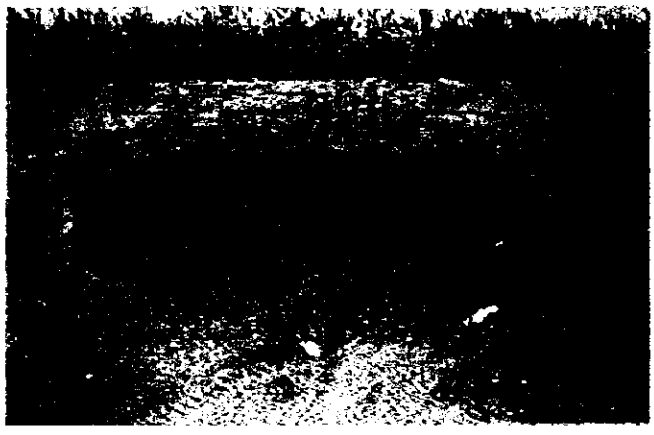


Accumulation of Debris, Damage Rank A



Accumulation of Debris, Damage Rank A

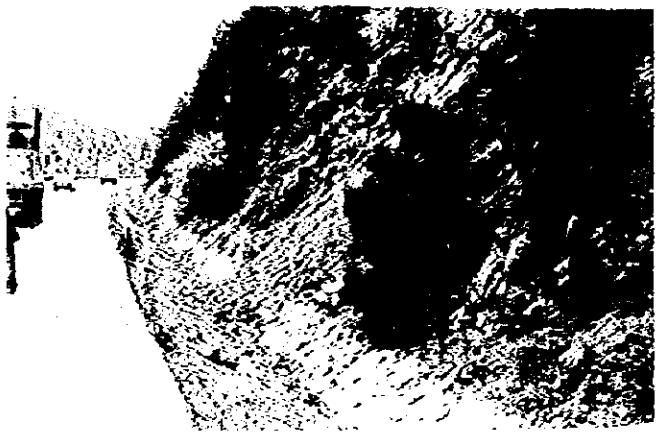
Accumulation of Debris, Damage Rank A



Accumulation of Debris, Damage Rank A

(2) Side Ditch, Accumulation of Debris

Accumulation of Debris, Damage Rank A

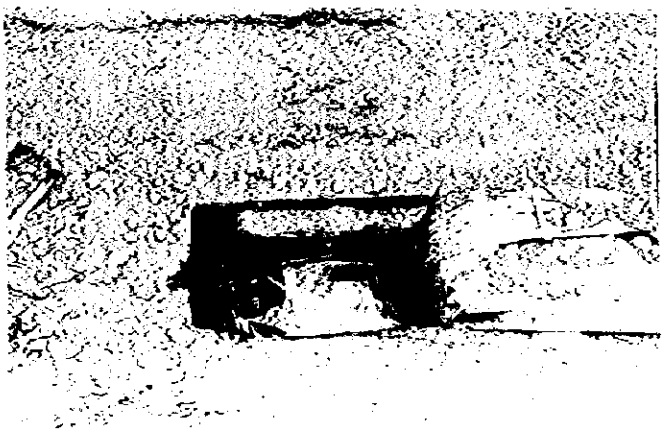


Accumulation of Debris, Damage Rank B

Accumulation of Debris, Damage Rank C

(3) Gully, Accumulation of Debris

Accumulation of Debris, Damage Rank A



Accumulation of Debris, Damage Rank A

(4) Side Ditch, Collapse

Collapse, Damage Rank A

3.8 Retaining Wall

Retaining wall failures can be very expensive to repair as often the retained soil will need removing in order to repair or strengthen the wall. It is thus important to inspect the retaining walls regularly and to catch any defects early so that repairs or strengthening can be carried out without major reconstruction, heavy plant requirements and possible road narrowing or closures.

The following photographs show examples retaining wall defects.

(1) Retaining Wall,

Collapse, Damage Rank B

Collapse, Damage Rank C

CHAPTER 4 SPECIAL INSPECTION

4.1 General

Special Inspections are carried out following natural disasters such as floods, avalanches or earthquakes, or following heavy rainfall or an accident.

The priority is to ensure the safety of the road users and to keep the road open to traffic and in a safe condition.

The inspection items, defects, method of inspection, reporting procedure and actions to be taken are all as for the Routine Inspection described in Chapter 3.

4.2 The Inspection Process

4.2.1 General

The Special Inspection is a visual inspection carried out on foot. The aim is to identify a range of defects that may have been caused by the disaster or accident for each of the inspection items.

4.2.2 The Inspection Flow Chart

The flow chart for Special Inspections is shown in Fig. 4.2.1.

It is identical to that for Routine Inspections except for Emergency Measures that may be required as a result of some natural disasters and provision is made for this.

Emergency Measures Needed

When the inspector finds obstructions or defects that endanger road users, he should decide whether emergency measures are necessary to clear the obstacle or repair the defect to maintain the road in a safe condition and to prevent accidents. Assistance should be requested from the Sub-Division to carry out the necessary emergency actions.

4.2.3 Reporting Procedure

This is as for Routine Inspections except where an obstruction on the road was located, this should be indicated on the Visual Inspection Data Sheet in the bottom empty box. Similarly, if any emergency actions are needed, they should be noted in the empty box at the bottom of the inspection sheet.

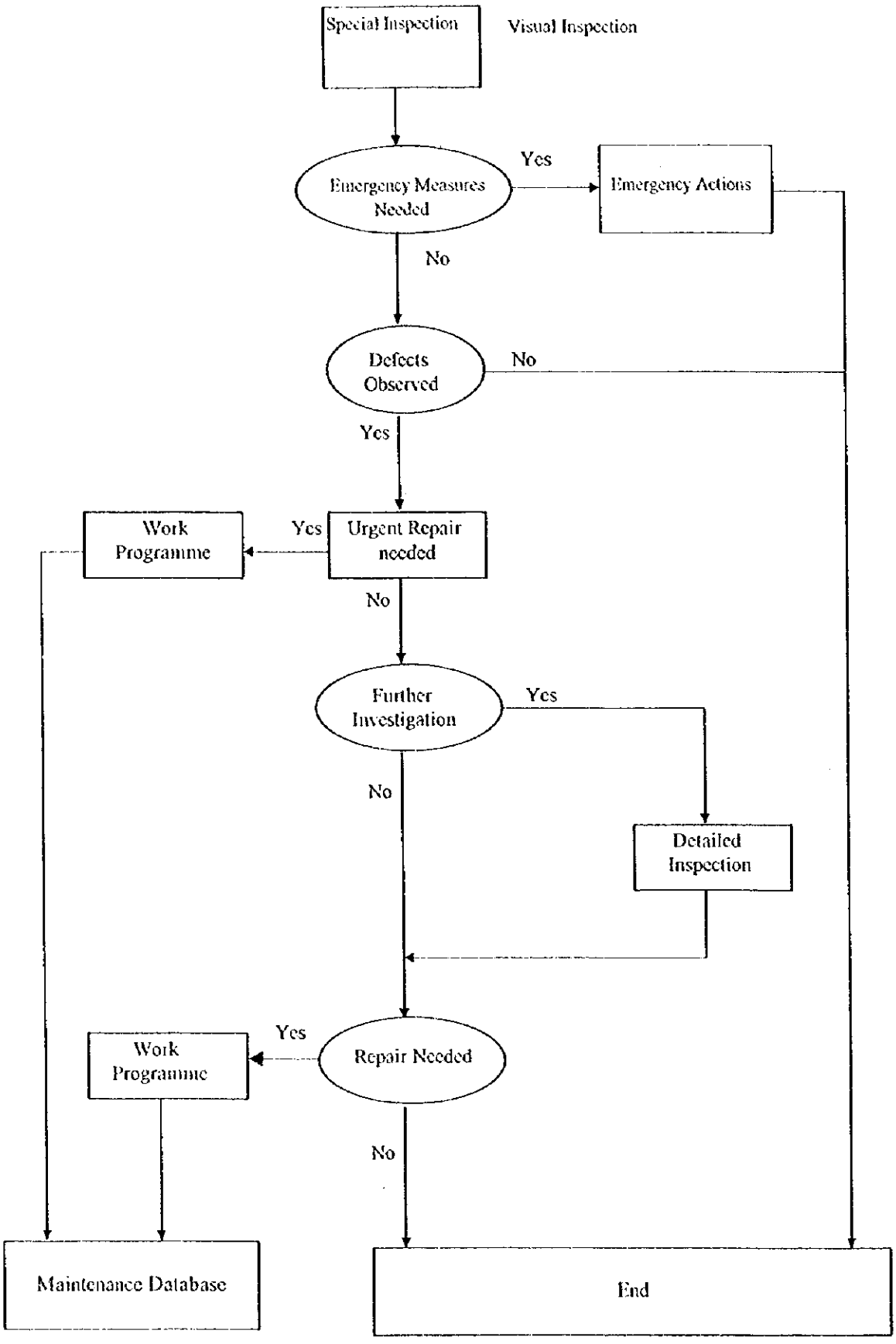


Fig. 4.2.1 Flow Chart for Special Inspections

4.2.4 Actions to be Taken

If Emergency Measures are required, the Sub-Division should be informed immediately in order to arrange for personnel, equipment and materials to be at the site as soon as possible.

In other cases, proceed as for a Routine Inspection.

4.3 Pavement

The pavement should be inspected first to see whether any damage, defect or obstacle presents a risk to the safety of the road user. These may include large cracks, depressions or debris from landslides or slope failures, vehicle debris following an accident or flooding which could make road impassable or create an accident risk.

Where traffic is still using the road, the inspection should be done from the edge of the road without encroaching onto the carriageway. Any major defects likely to cause a safety problem should be clearly visible from the edge of the road.

4.4 Slope

Following a natural disaster, cracking may well occur and if left undetected can allow the ingress of water which could lead to more serious landslide or avalanche problems. The slopes should therefore be checked very carefully for the signs of new cracking.

Landslides, avalanches and collapse of protective walls are all likely defects following natural disasters.

4.5 Embankment

Flooding and heavy rain can cause serious problems for embankments. The flooding in itself can saturate the embankment materials giving a potential risk of collapse. As flood water subsides, the flow of the water against the toe of the embankment can cause serious scouring again leading to a potential collapse.

Inspectors should be particularly vigilant as flood waters subside to monitor the embankment and be prepared to close the road if the stability is threatened.

4.6 Shoulder

Heavy rain, flooding and earthquakes can all cause damage to the shoulder. As the shoulder provides support to the edge of the pavement, it is particularly important to check for shoulder washing out. This leaves the pavement unsupported with potential for further rapid breaking up of the pavement edge under traffic loading and the ingress of water into the pavement material.

4.7 Side Ditch, Gully and Culvert

Following natural disasters, accumulation of debris, settlement and collapse in relation to the drainage items are all likely defects to be investigated. Flood water often carries a considerable amount of sediment and other debris such as tree branches. As the flood water reduces, this debris is deposited or is caught up in a blockage. In some situations, if this blockage is not cleared, it can lead to further flooding of the road and risk of scour and softening of the embankment materials.

Inspectors shold check for blockages and where these could lead to further flooding and possible accidents or damage to road facilities, he should report it to the Sub-Division to enable a clearance team to remove the blockage as quickly as possible.

4.8 Retaining Wall

Vehicle impact often causes the collapse of sections of wall, with natural disasters likely to create cracks settlement and possible collapse in earthquake or flood situations.

Inspectors should examine the wall carefully to determine whether there is a threat to the wall stability or to the stability of the retained material. Where this is the case, he should report it to the Sub-Division for immediate action to get the wall into a safe condition through a temporary or permanent repair.

CHAPTER 5 DETAILED INSPECTION

5.1 General

The Detailed Inspection methods described in this section have been developed to suit the existing situation within the Maintenance Department. They are basic methods which can be used any where in Turkey using equipment that is either already available or is easy and inexpensive to purchase.

The basic methods can be adapted or changed as new equipment and technology becomes available in the future and as the data collected identifies the major maintenance issues.

5.2 Objectives

A detailed inspection is carried out to obtain sufficient information to establish the cause of a defect and to enable an appropriate repair method to be determined.

Sufficient data needs to be collected for the inspection item to:-

(a) determine the need for repair work
and
(b) to assist in the selection and design of the appropriate repair method.

5.3 Work Sequence

The initial work sequence for all items is as follows:-

The Work Sequence is as follows:-

(i) The Team Leader should identify the survey item or section. For pavement this should be marked with spray paint at the edge of the road avoiding getting paint on the white line edge of carriageway markings.

(ii) Where necessary install the traffic management in accordance with the appropriate traffic management drawing. No personnel should start the survey until the traffic management is fully installed.

(iii) To minimise the amount of time that the traffic management is in place, the Team Leader should complete the 'General Information' at the top of the Inspection Sheet before arriving at the site or whilst the traffic management is being installed.

Chapters 5.7 to 5.11 describe the Detailed Inspection process for each of the Inspection Items listed in Chapter 2.2.

5.4 Personnel and Equipment

To carry out Detailed Inspections, which involve taking measurements, the inspection team should have a minimum of 3 personnel and preferably 4, with 2 people needed to hold string lines, 1 measuring and 1 recording data.

A team will also be required to install and remove the traffic management required in accordance with Chapter 5.5.

The equipment required for a Detailed Inspection will vary depending on the items to be inspected. Table 5.4.1 indicates the likely range of equipment that will be needed.

Table 5.4.1 Schedule of Equipment for Detailed Inspections

Item	Check Box (✓)
1. Net grid - 10m x 3.5m in 0.5m squares	
2. Hammer	
3. Nails	
4. 30m tape	
5. 3m tape	
6. Ranging rods	
7. String line	
8. Chalk	
9. Inclinometer	
10. Spray paint	
11. Inspection sheets	
12. Pencils	
13. Calculator	
14. Camera	
15. Clip board	
16. Level and staff	
17. Signs and cones (see Chapter 5.5)	
18. Safety jackets	
19. Torch	

5.5 Safety and Traffic Management

Safety must be the primary consideration at all roadworks and arrangements for detailed inspections shall seek to minimise the disruption to traffic whilst ensuring adequate access for proper inspection and maintaining a safe working environment for the inspection personnel, the road user and the general public.

The pavement surveys involve physical measurements on the road surface. This requires one lane to be closed to traffic whilst the measurements are taken.
Other inspections are generally carried out from the roadside or on the earthworks slopes. Traffic management should be installed whenever the maintenance engineer decides that the inspection staff need additional protection from moving traffic.

We have identified 5 different road layouts where inspections may be required and have prepared traffic management drawings for each of these situations. If other situations arise, additional traffic management drawings should be prepared based on the following basic principles:-

- It is essential that the warning signs are clearly visible and are placed sufficiently in advance of the works to allow safe stopping distances for the prevailing traffic conditions.

- The signs should be simple to understand to avoid driver confusion and wherever possible should follow standard patterns so that the road user becomes familiar with the traffic sign layout and spacing. Standardisation also makes the task of planning and setting out the traffic management much simpler.

Where possible, the Detailed Inspections should be carried out when closures are in operation for other maintenance work. Where a separate closure is necessary, inspections should be undertaken in off peak periods to keep traffic delays to a minimum.

The inspection work should be planned to minimise the length of time that the traffic management is in place.

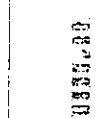
No inspection work should commence until all of the traffic management is in place.

All staff involved in the Detailed Inspection should be wearing a high visibility reflective jacket. These jackets enable staff to be clearly seen by motorists and reduce the potential accident risk for the inspection personnel.

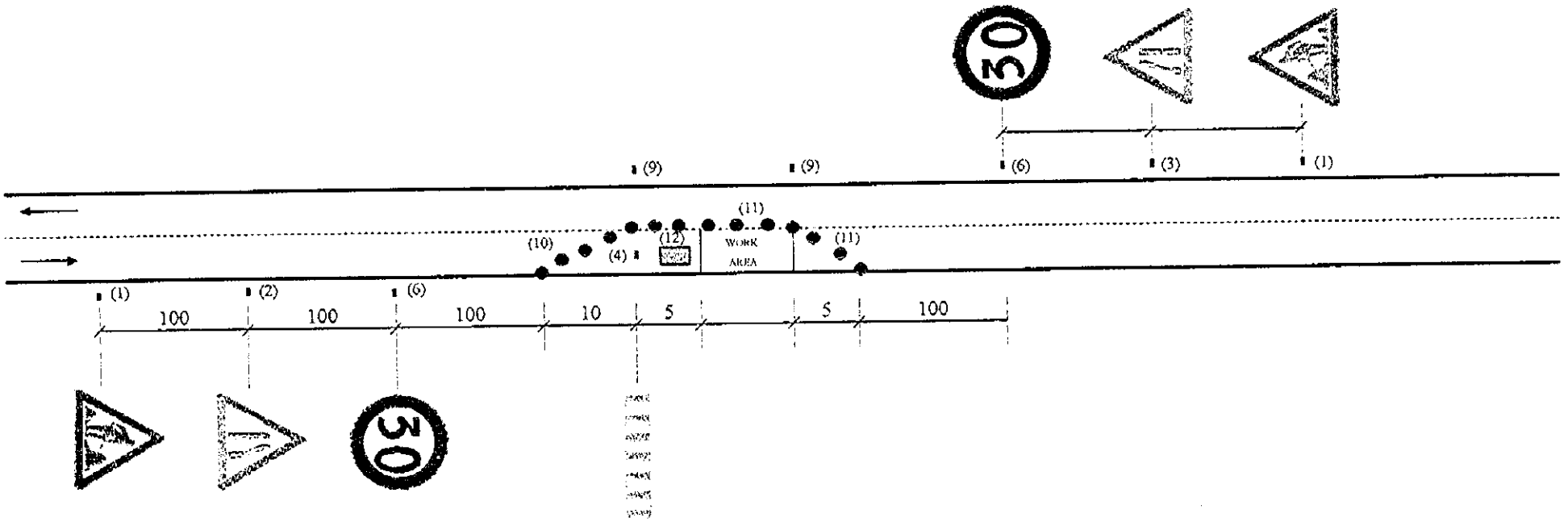
The standard traffic management drawings are shown on the following pages.

Traffic Management Drawings

Traffic Signs Schedule

Traffic Sign No	1	2	3	4	5	6	7	8	9	10	11	12
Traffic Sign Type									flagman	cones at 1.5m centres	cones at 3 m centres	KGM vehicle
Layout No	Number of Signs											
1	2	1	1	1	-	2	-	-	2	8	4+(W.A)/3	1
2	2	-	2	4	3	2	-	2	-	32	37+2(W.A)/3	1
3	2	-	2	2	2	-	2	2	-	16	18+2(W.A)/3	1
4	2	-	1	4	4	2	-	1	-	32	37+(W.A)/3	1
5	2	1	-	4	4	-	2	2	-	40	45+2(W.A)/3	1
6	2	-	2	2	2	-	2	2	-	16	15+2(W.A)/3	1
7	2	2	-	1	1	-	2	-	-	8	4+(W.A)/3	1
8	2	-	2	1	1	-	1	2	-	8	4+(W.A)/3	1
9	4	2	2	3	3	-	2	4	-	24	35+(W.A)/3	-

Detailed Inspection – Traffic Management
2-lane road - 1 lane closed

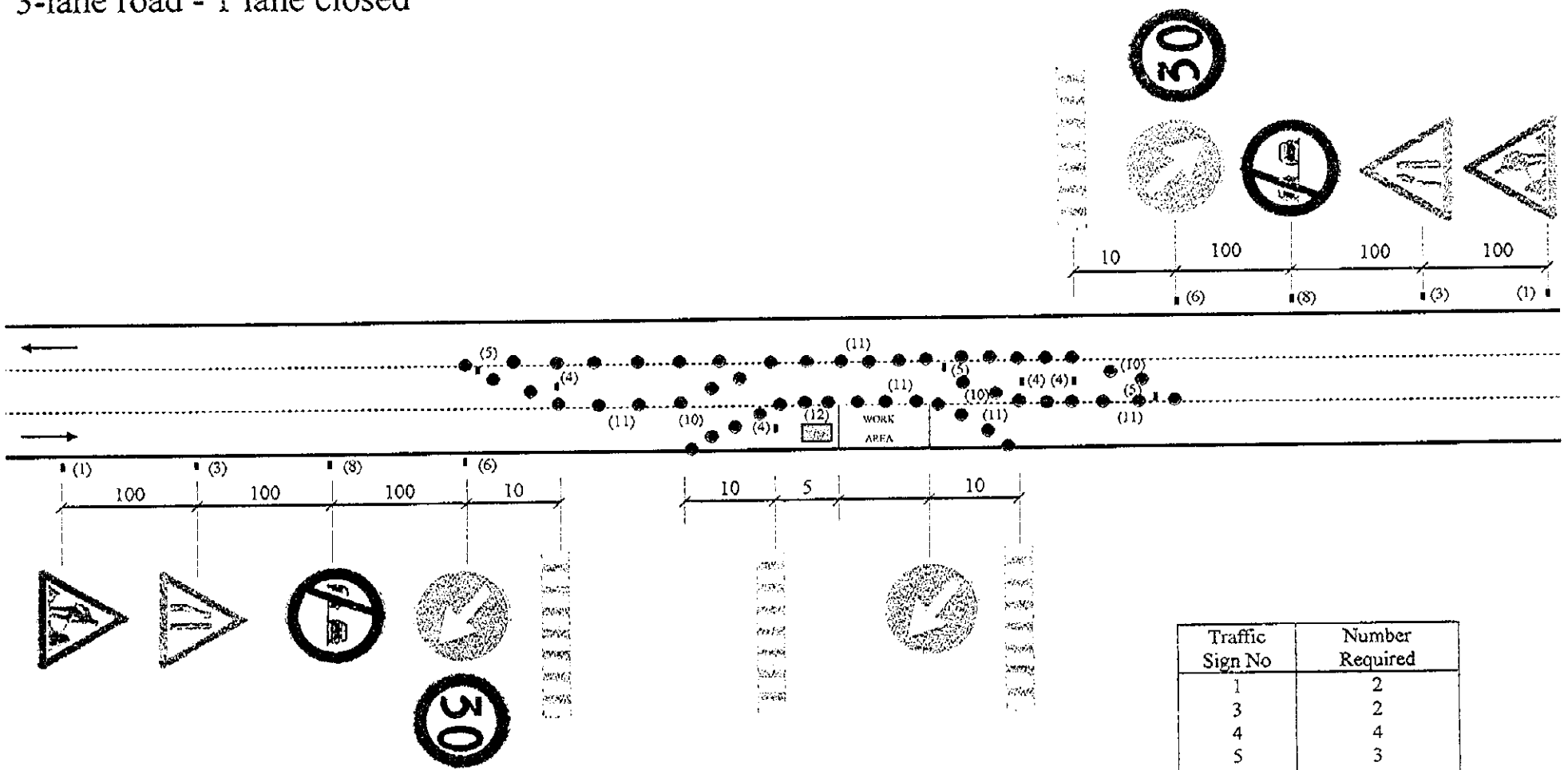


(9) flagman
(10) cones at 1.5 m centres
(11) cones at 3 m centres
(12) KGM vehicle

Traffic Sign No	Number Required
1	2
2	1
3	1
4	1
6	2
9	2
Cone	
10	8
11	4+(W.Area)/3

LAYOUT NO.1

Detailed Inspection – Traffic Management
3-lane road - 1 lane closed

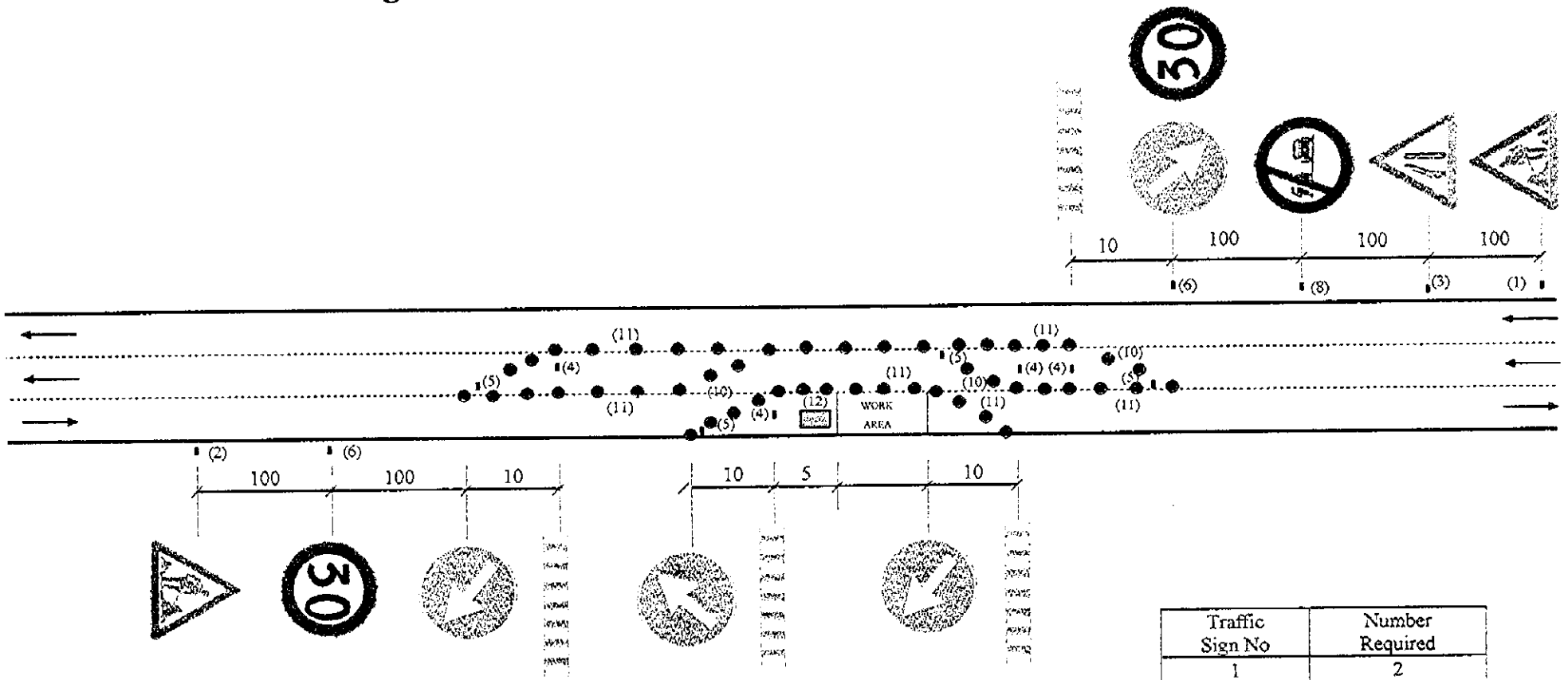


(10) cones at1.5 m centres
(11) cones at 3 m centres
(12) KGM vehicle

Traffic Sign No	Number Required
1	2
3	2
4	4
5	3
6	2
8	2
Cone	
10	32
11	37+2(W.Area)/3

LAYOUT NO.2

Detailed Inspection – Traffic Management
2-lane road with climbing lane – 1 lane closed

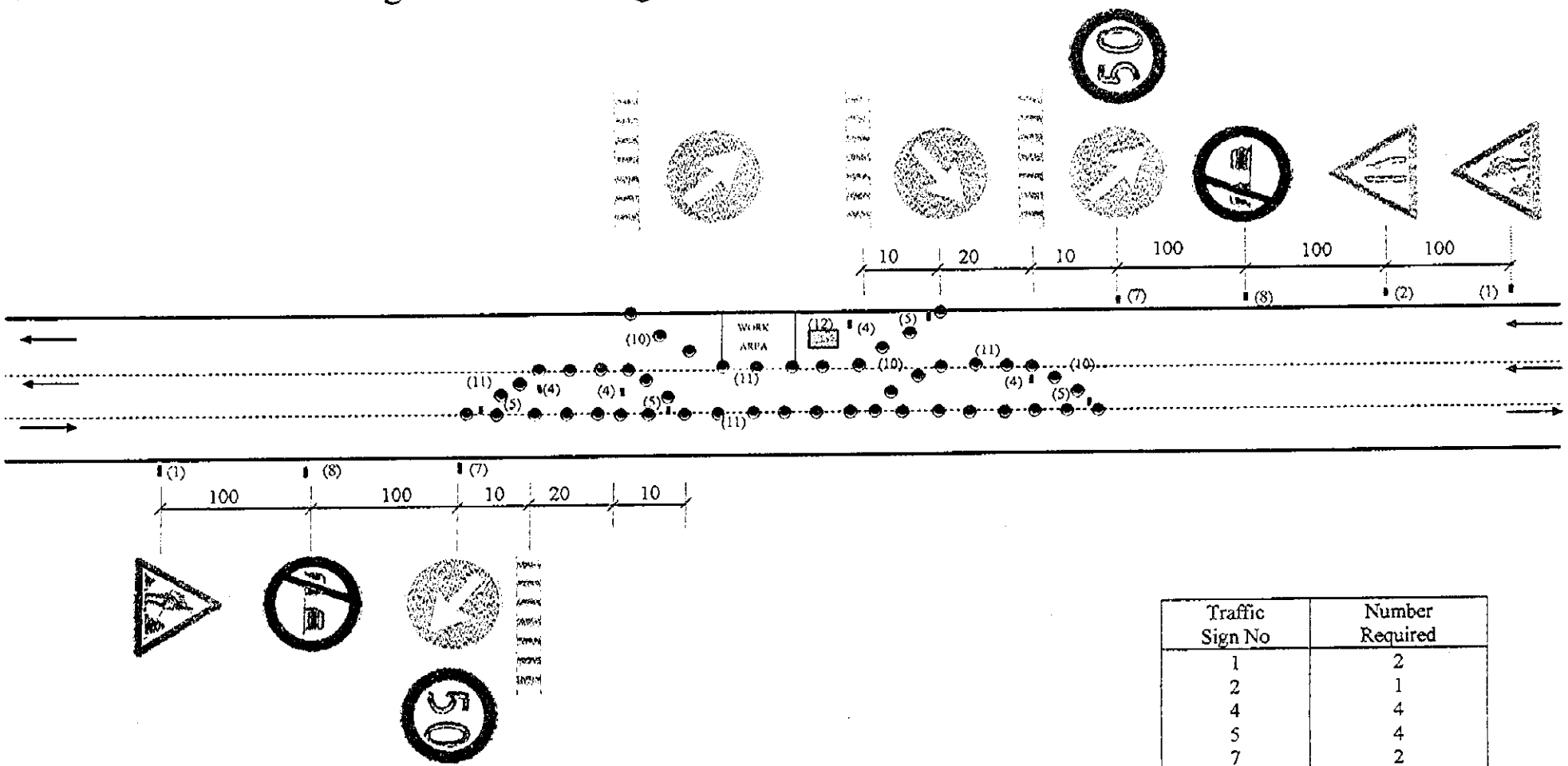


(10) cones at 1.5 m centres
(11) cones at 3 m centres
(12) KGM vehicle

Traffic Sign No	Number Required
1	2
3	1
4	4
5	4
6	2
8	1
Cone	
10	32
11	37+(W.Area)/3

LAYOUT NO.4

Detailed Inspection – Traffic Management
2-lane road with climbing lane – climbing lane closed

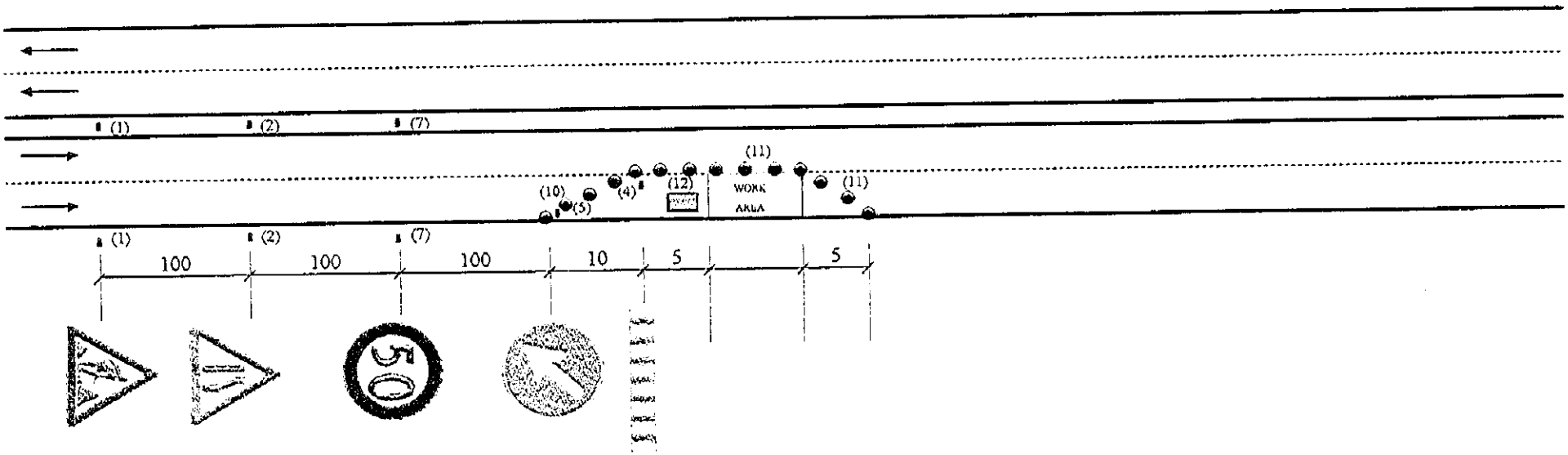


Traffic Sign No	Number Required
1	2
2	1
4	4
5	4
7	2
8	2
Cone	
10	40
11	45+2(W.Area)/3

(10) cones at 1.5 m centres
(11) cones at 3 m centres
(12) KGM vehicle

LAYOUT NO.5

Detailed Inspection – Traffic Management
Dual 2-lane road - 1 lane closed



Traffic Sign No	Number Required
1	2
2	2
4	1
5	1
7	2
Cone	
10	8
11	4+(W. Area) / 3

(10) cones at 1.5 m centres
(11) cones at 3 m centres
(12) KGM vehicle

LAYOUT NO.7

5.6 Supplementary Surveys

During the Detailed Inspection, the survey team may decide that additional information may be needed at particular damage locations both to help to confirm the cause of the damage and to collect data to assist with the design of the repair works. Supplementary surveys may be carried out as shown in Table 5.6.1.

Table 5.6.1 Supplementary Surveys

Item	Damage Type	Supplementary Survey			
		Core Sampling	Boreholes	CBR	Cross Section
Pavement	Settlement		□	□	
	Cracking	■		■	
	Potholes	□			
	Rutting	■		□	
	Wave	□		□	
Slope (cutting)	Landslide		■		■
	Rock Avalanche		□		■
	Collapse of Protection Wall				□
	Cracking		□		■
	Erosion		□		■
Slope (embankment)	Landslide		■		■
	Collapse of Protection Wall				□
	Erosion		□		■
Shoulder	Washing Out			□	
Embankment	Submerge				■
	Collapse				■
Culvert					□
Retaining Wall					□

Notes: ■ essential survey □ optional survey

(a) Core Sampling

(i) General

Core sampling is used to establish the thickness of the existing pavement layers and to establish the extent of the cracking and the effect of rutting in the pavement structure.

(ii) Location
Core sample locations should be selected to suit the defects being investigated. They should be clearly marked on the road surface with spray paint to make the location easy to find by the coring team.

(iii) Traffic Management
Traffic management should be put in place before the start of the coring work in accordance with the standard traffic management drawings in Chapter 5.5.

Further details for core sampling are given in Appendix D.

(b) Boreholes

Boreholes are used to establish the geological characteristics, soil type and ground water levels; to carry out insitu Standard Penetration Tests and to get soil samples for laboratory testing to determine design parameters or to check strength characteristics.

(c) CBR Tests

(i) General
CBR tests are used to get information on the strength of the sub grade.

(ii) CBR Tests
CBR tests may be carried out in-situ or in the laboratory. The in-situ tests are done with a cone penetrometer or dynamic cone penetrometer depending on the equipment available. Where laboratory tests are to be done, the samples collected at the site should be clearly marked with the date and location.

(d) Cross Section

Cross sections should be taken to assist with the evaluation of the problem and the design of remedial works.

A cross section survey may be required at culverts where a design check is required. This should include the invert and soffet levels at both the inlet and outlet; road levels over the top of the culvert on the line of the culvert; ground levels in the inlet and outlet areas.

For retaining walls the cross section should show the road adjacent to the wall, should include any side ditches and drainage, the wall itself and the retained material. The section should extend for at least 25 metres beyond the edge of the retained material in case flattening of the slope is required.

5.7 Pavement

5.7.1 General

Many countries now use a pavement condition rating to assist in managing the pavement works. Using data collected from the Detailed Inspections, a pavement condition index can be calculated. This index will enable the maintenance managers to focus their attention on those sections of road showing poor characteristics. It will also help them to prioritise these sections and to use their limited budget to try to maintain a consistent ride quality for the road user.

The performance of a road pavement can be judged from a combination of achieving the design life in terms of structural condition, and providing a safe surface with good ride characteristics for the road user. In order to quantify the ride comfort, serviceability-performance criteria were developed by AASHTO to provide a common index by which pavement performance could be judged.

There are many systems in use and a selection are described below.

Pavement Condition Rating (PCR) involves a visual inspection of 13 pavement items; ravelling, bleeding, patching, potholes, crack sealing deficiency, rutting, settlement, corrugations, wheel track cracking, block and transverse cracking, longitudinal joint cracking, edge cracking and random cracking.

Each item has a distress weighting allocated to it and the inspector decides from his visual inspection the severity and extent of the damage. This is simply on the basis of low, medium and high severity and occasional, frequent or extensive in the extent of the damage.

By applying the factors for severity and extent to the distress weighting a Pavement Condition Rating can be calculated.

This method covers a wide range of pavement defects to give an overall pavement condition rating.

The International Roughness Index (IRI) is another approach that has been adopted as the standard measure of pavement condition in the World Bank's Highway Design Model (HDM). IRI is based on a simulation of the roughness response in a car travelling at 80 km/hr.

Ride Number (R_N) Visual Condition Index (VCI) and Pavement Quality Index (PQI) are all similar methods using a combination of pavement items to arrive at an overall rating for the pavement condition.

For the purposes of this study, we have adopted another index, The Present Serviceability Index (PSI). The reason for adopting this method is the relatively few items requiring inspection to arrive at a condition rating and the fact that these could be done relatively simply. We have adopted the view that after having carried out measurements for a period of time, the inspectors should have gained sufficient experience to make the pavement condition judgement on a purely visual basis in the longer term.

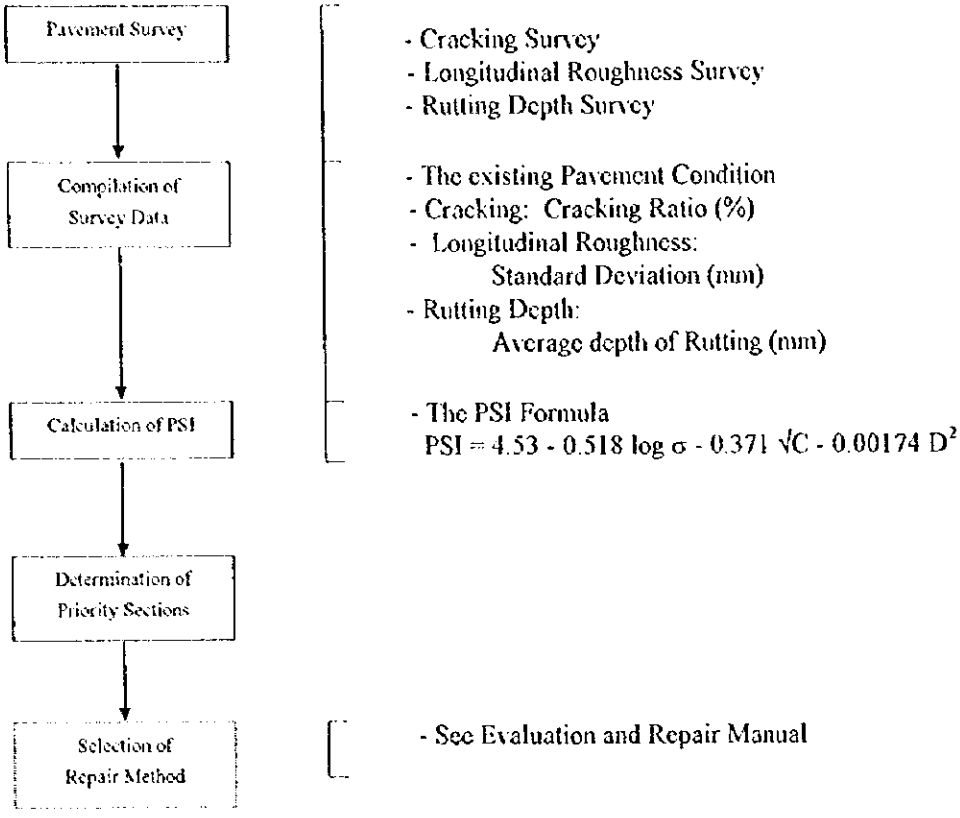


Fig. 5.7.1 Flow Chart for Pavement Condition Rating

The serviceability of a pavement is expressed in terms of it's Present Serviceability Index (PSI). The PSI value is obtained from measurements of the surface characteristics.

5.7.2 Method of Inspection

Each survey section should be 100 metres long by one lane width in order to get an average section condition rather than a localised one. Within the section the following surveys will be carried out:-

- cracking survey
- pothole survey
- rutting survey
- longitudinal roughness (wave) survey

(a) General

Using the 30 metre tape, the 10 metre points can be measured out over the length of the section and marked with chalk at the edge of the road.

(b) Cracking Survey

The road surface is divided into 0.5 metre squares and the surface condition is sketched onto a standard 10m x 3.5m grid which is provided on the inspection sheet. From the sketch showing the surface condition, a cracking ratio can be calculated to indicate the crack condition of the section of road.

(i) The Team Leader should select the start point for the 10m x 3.5m rope grid which should be laid out on the road surface. The corners should be attached to nails in the road surface so that the grid is evenly spread over the full 10 metre length and the width of the lane to give a grid of 0.5 metre squares.

(ii) The team members should then mark with chalk all cracks that are visible.

(iii) The outline of any patched area, any area with alligator cracking or extensive potholing should also be marked with chalk.

(iv) For the patched areas, the Team Leader should check each grid square. Where the marked area covers between 25% and 75% of the grid square, he should mark that square with a circle. Where the marked area covers more than 75% of the grid square, he should mark the square with a triangle.

(v) When the grid is fully marked, the data needs to be recorded onto the grid on the inspection sheet. One person should be allocated to record the data whilst the Team Leader is responsible for calling out the crack and patching condition marked on the road.

For cracks, the Team Leader should start at the bottom left hand corner of the grid and call information out for each grid square. Where there are no cracks marked in the square, he should call out 'zero'; where there is 1 crack marked in the square, he should call out '1'; where there are 2 or more cracks marked in the square, he should call out '2'.

For patching areas, the team Leader should call out 'triangle' or 'circle'.

The person recording should mark up the inspection sheet grid with '1s, '2s', '●s' and '▲s' exactly as it is called out by the Team Leader.

The numbers of '1s', '2s', '●s' and '▲s' can then be added up and entered into the formula on the inspection sheet to arrive at a Cracking Ratio for the 10m section.

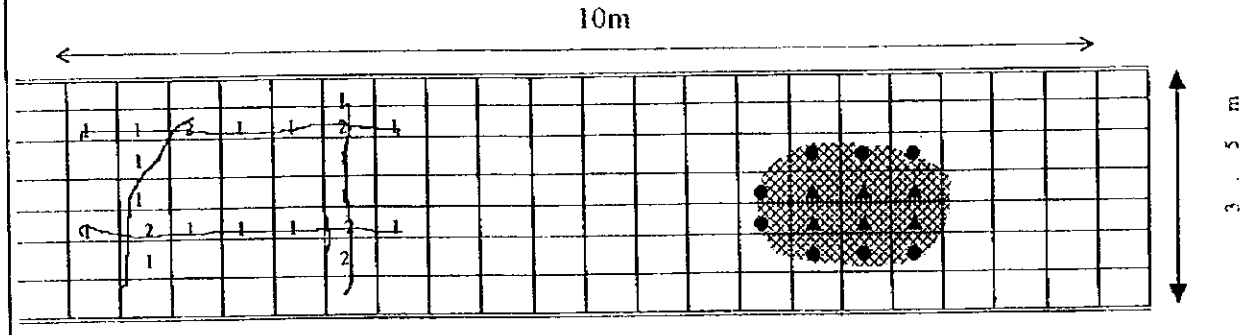
An example of the calculation of Cracking Ratio is shown on Fig.5.7.2.

The Cracking Ratio is calculated as follows:-

Cracking Ratio (C) = {(c+P)/A} x 100 %

c = the cracked surface area
if the grid contains 1 crack, the equivalent surface area assumed is 0.15m^2
if the grid contains 2 or more cracks, the equivalent surface area assumed is 0.25 m^2

P = patched surface area
if the patching covers between 25% and 75% of the grid, the equivalent surface area is 0.125 m^2
if the patching covers more than 75% of the grid, the equivalent surface area is 0.25m^2



	Symbol	Number		Area of Grids		Total m^2
Cracks (c):-						
1 crack	1	16	x	0.15	=	2.40
2 or more cracks	2	5	x	0.25	=	1.25
Patch Area (P):-						
25% - 75%	●	8	x	0.125	=	1.00
>75%	▲	6	x	0.25	=	1.50
				Total (c+P)	=	6.15 m^2

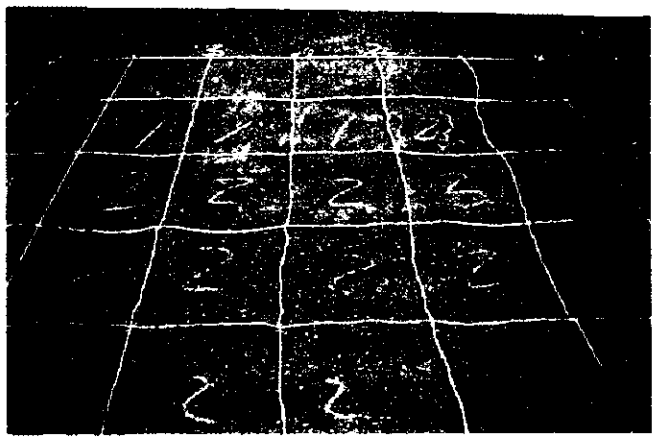
A = 10m x 3.5m = 35 m^2

<u>Cracking Ratio (C) = (6.15/35) x 100 = 18 %</u>

Fig. 5.7.2 Example of the Calculation of Cracking Ratio

(vi) Having established the Cracking Ratio for the selected 10m section, the other nine 10m sections should be assessed by visual inspection. First examine the extent of cracking and patching in the selected 10m section and then compare it with each section in turn, allocating a Cracking Ratio by visual inspection only. The nine values should be recorded on the bottom of the inspection sheet and an average of all 10 values should be calculated to give the average Cracking Ratio for the 100m section.

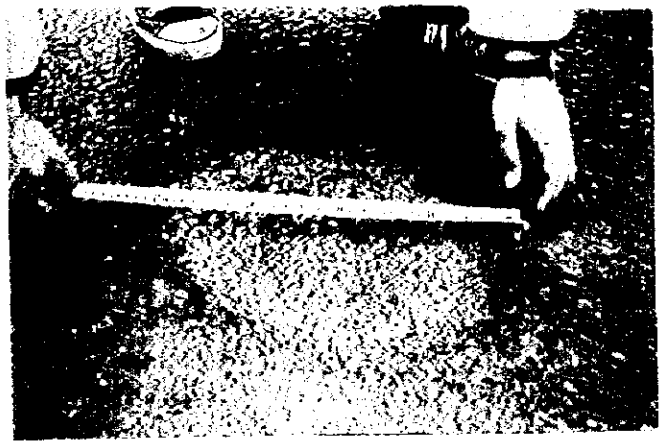
Experience has shown that after a period of carrying out cracking surveys by the measurement method and calculating the Cracking Ratio, staff will become familiar with a surface condition relating to a particular Cracking Ratio. They should then be able to allocate a Cracking Ratio simply by a visual inspection of the road section which will save a lot of time and resources.



Grid for Cracking Survey.

(c) Pothole Survey

At the same time as the cracking survey, a pothole survey should be carried out. The maximum plan dimensions (length and width) and the maximum depth of the worst 10 potholes in the survey section should be measured and recorded in the space provided on the inspection sheet. These measurements are in mm. The measurement should be done with a 3m tape as shown in the photograph below.

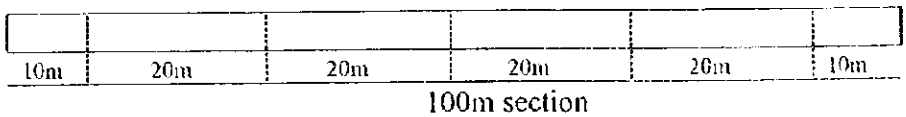


Pothole Measurement with 3m Tape

(d) Rutting Survey

The rutting condition is calculated as the average rut depth, measured in mm, over the section being inspected.

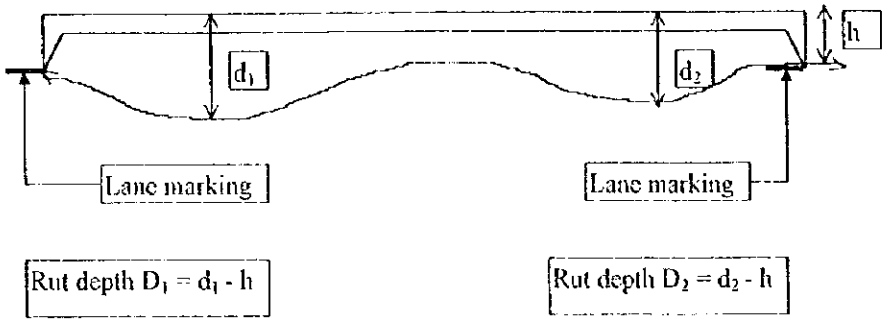
To determine the average rut depth, measurements are taken in each wheel track at 20m intervals, at the 10m, 30m, 50m, 70m and 90m points (see Fig. 5.7.3). Measurements are taken and the maximum rut depth (D) at each 20m section is recorded on the inspection sheet. The average rut depth is calculated from the 5 recorded values of D.



--------- rut depth measurement taken

Fig. 5.7.3 Sections for Rut Depth Measurements

Various methods are available for measuring the rut depth. Where a purpose made straight edge is available this should be used. Fig. 5.7.4 shows this method.

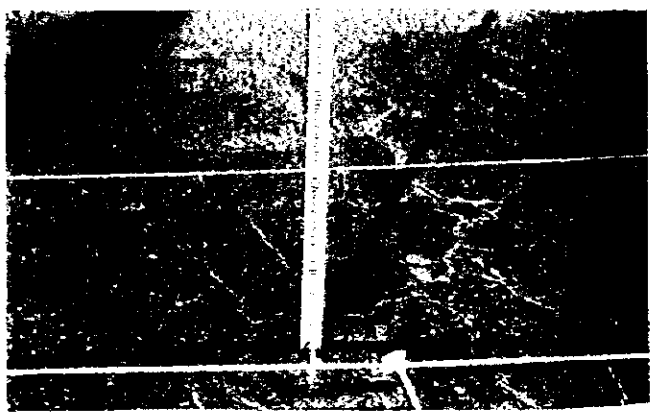


Rut Depth (D) is the greater of D_1 and D_2 for each section

Fig. 5.7.4 Measurement of Rut Depth using a Straight Edge

Where no straight edge is available, 2 ranging rods and a string line should be used. The string is attached at the 200mm point on each ranging rod. The rods are held at each edge of the lane being surveyed so that the string line is tight. Measurements are taken with a 3m tape from the road surface to the string line. Several readings should be taken across each wheel track to find the maximum reading for the section. 200mm is deducted from the reading and this is recorded as D, the maximum rut depth on the inspection sheet.

This process is repeated for each of the 5 sections and the average of the 5 measurements is calculated.



Rut Depth Measurements using Ranging Rods and String line.

(e) Longitudinal Roughness (wave)

The easiest and quickest way to measure longitudinal roughness is with a laser profilometer (see Chapter 6.2), either manually operated or vehicle mounted. However, as this

equipment is expensive or may not be available, this survey shall be carried out by traditional topographical survey methods.

Measurements are taken at 2 metre intervals along the 100m survey section. The survey line should be parallel to the edge of the lane and 1.0m away from the edge of the lane. Where a measurement would coincide with a manhole cover or similar non pavement material, this measurement should not be made as it may be unrepresentative of the adjacent pavement level. Measurements are in millimetres.

Work Procedure

(i) The survey points should be marked out in chalk on the road surface so that the levelling can be done as soon as the grid for the cracking survey is removed.

(ii) Where possible, the points should be levelled from a single instrument station to avoid the need for corrections. On steep gradients this will not be possible.

(iii) The level at each survey point is recorded.

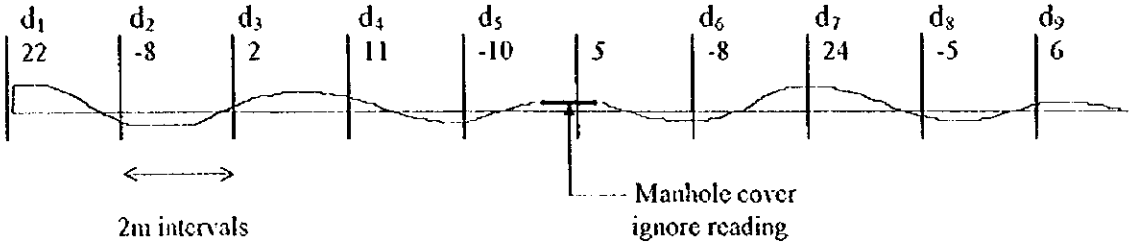


Fig. 5.7.5 Longitudinal Roughness Measurements

The value of longitudinal roughness used is the standard deviation of the measurements taken which is calculated using the following formula:-

$$\sigma = \sqrt{\{\Sigma(d^2) - ((\Sigma d)^2/n)\}/(n-1)}$$

Where
σ = the standard deviation
d = the measurement taken in mm
n = the number of measurements taken

The method of calculating the standard deviation is shown in Appendix C.

(f) Settlement

Settlement measurements are not a part of the general pavement condition survey but may be requested from time to time following a Routine Inspection. The purpose is to monitor the settlement over time to determine when the settlement has stopped so that repairs can be planned accordingly.

Settlement often occurs adjacent to bridges and culverts when insufficient compaction was achieved at the construction stage or excessive ground water has softened the material allowing traffic loading to create settlement.

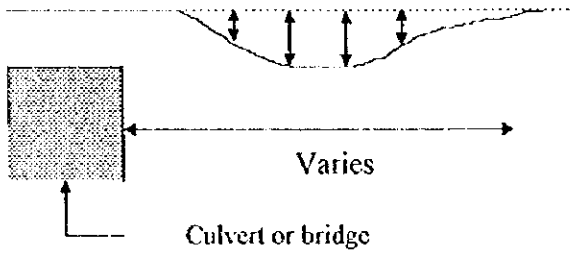


Fig. 5.7.6 Settlement Measurements

Levels should be taken in the wheel tracks in each lane on the approach to the structure. Levels should be taken using a permanent benchmark where available or alternatively a temporary benchmark should be established locally to the structure. It should be in a position that will not be effected by any movement, traffic or other damage, as repeat levels will be required from the same benchmark over a period of time. Repeat surveys will be required to determine when the settlement has stopped so that the appropriate timing for repair works can be determined.

For localised settlement away from bridges or culverts, a straight edge or string line should be used to record the maximum depth of settlement in mm.

5.7.3 Data Recording

A sample Pavement Inspection Sheet is shown overleaf.

For the Cracking, Rutting and Pothole Surveys, the data is entered onto the Inspection Sheet as the survey proceeds.

(1) Cracking Survey

The data is marked onto the grid as described in Chapter 5.7.3 (b). The kilometre reference should also be entered onto the sheet at the top of the grid.

(2) Rutting Survey

The maximum rut depth in millimetres at each 20m section should be entered into the boxes at the top of the sheet and the average rut depth calculated and entered in the bottom box.

(3) Pothole Survey

The depth, length and width of the worst 10 potholes in the section being inspected should be entered into the boxes on the right hand side of the sheet. The average depth should be calculated and entered into the bottom box.

(4) General Information

The information on the front of the Inspection Sheet, should be inserted before starting the inspection.

(5) Inspection Items

In general, a cross is marked over the number representing the appropriate answer.

Damage Types
Mark all damage types found during the inspection.

Pavement
Mark the pavement type.

Topography
Mark the topography representing the area surrounding the inspection section.

Soil Type
The soil type should be marked. Where it is a mixed soil type, more than one type may be marked e.g. sand and clay.

Drainage pipe
If a piped drainage system is present, mark (1) and the diameter of the pipe if it can be measured. Otherwise mark (2).

Ground Water
If there is evidence of groundwater, mark (1), (2) or (3) as appropriate. Otherwise mark (4).

Snow fall
Where the local area has snow fall, mark (1) and insert the typical snowfall depth in millimetres based on local knowledge. If there is no snowfall, mark (2).

Chain abrasion
Where snow chains are known to cause abrasion of the road surface, mark (1) and insert the typical wear on the road surface in 1 year (in millimetres) based on local knowledge.

(6) Sketch

A standard sketch format is given on the Inspection Sheet and the inspector should mark up the sketch to show the section at the defect location.

- the location should be inserted above the sketch.
- the basic cross section dimensions at the defect location should be measured and inserted onto the sketch.
- make the appropriate dotted line into a solid line to show whether there is a slope or embankment at the location.
- cross out the drainage pipes where these are not present at the defect location.

Detailed Inspection Sheet

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
	Pavement	(1) Asphalt concrete (2) Surface treated
	Topography	(1) Mount (2) Hill (3) Flat (4) Soft soil area (5) Other
	Soil type	(1) Rock (H or S) (2) Gravel (3) Sand (4) Silt (5) Clay (6) Other (
	Drainage pipe	(1) Yes (diameter = mm) (2) None
	Ground water	(1) Flow (2) Seepage (3) Wet (4) None
	Snow fall	(1) Yes (ave h= mm) (2) No
	Chain abrasion	(1) Yes (ave d= mm) (2) No

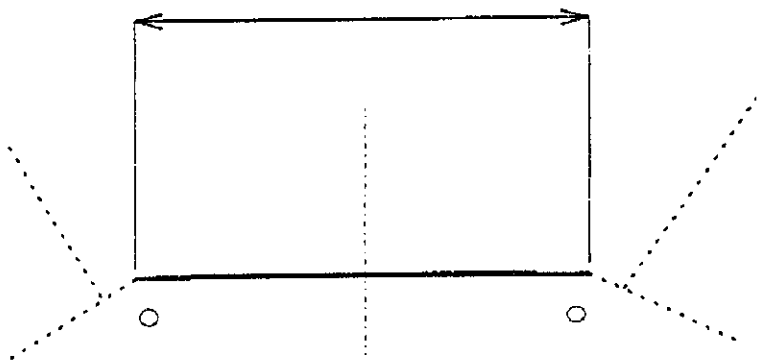
Cracking Ratio	C = %
Rutting Depth	D = mm
Long. Rough.	σ = mm
Pothole	Diameter = mm Depth = mm
PSI	$PSI = 4.53 - 0.518 \log \sigma - 0.371C - 0.00174D^2$ =

Index of PSI	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	Unnecessary 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
(○): 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						

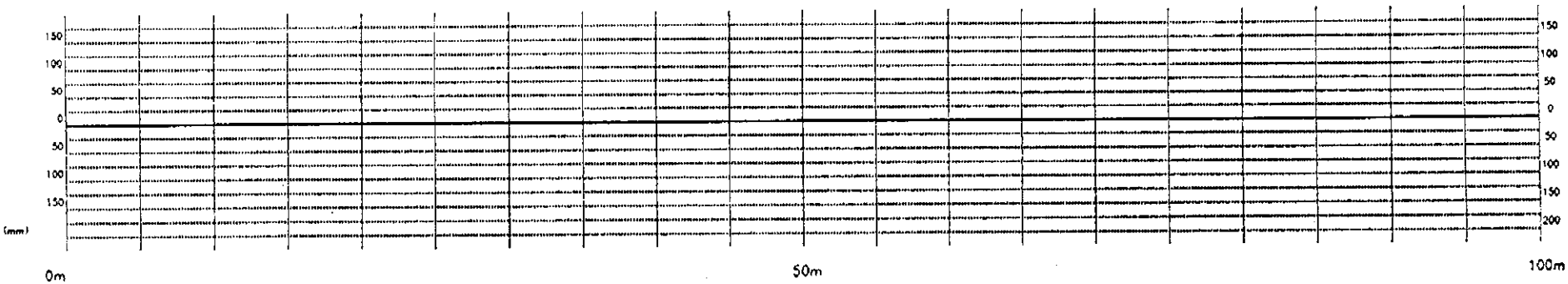
Detailed Inspection Sheet for : PAVEMENT

Inspection Date: / /

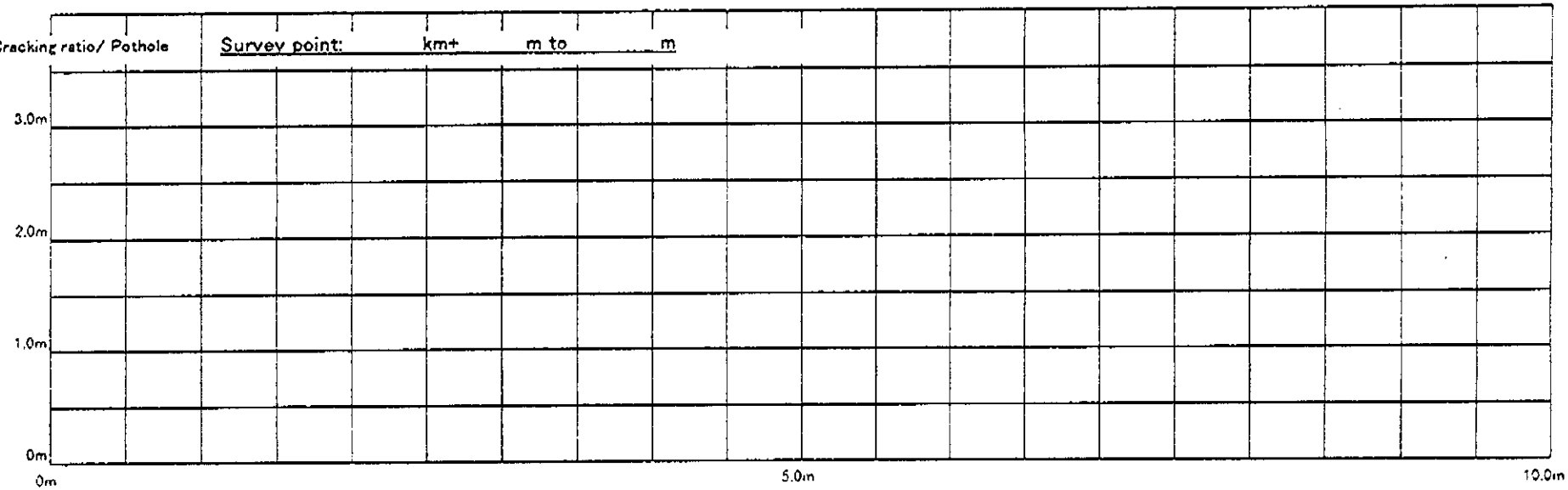
Calculating of cracking ratio/patching area	Caluculating of rutting depth				Database for pothole					
	No.1	Depth:	No.6	Depth:	No.1	Depth:	Diameter	No.6	Depth:	Diameter
	No.2		No.7		No.2			No.7		
	No.3		No.8		No.3			No.8		
	No.4		No.9		No.4			No.9		
	No.5		No.10		No.5			No.10		
Cracking ratio C = %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

Logitudenal Roughness Survey point: km+ m to m

Standard Deviation of Roughness σ = mm



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



Version 1 8/97

5.8 Slope, Shoulder and Embankment

5.8.1 General

Slopes, shoulders and embankments are susceptible to failure as a result of reduction in strength due to weathering and water ingress. The failed material may then move down onto the carriageway in the case of cuttings, or undermine or remove the road structure in the case of shoulders and embankments. Structures at the top of cutting slopes may also be threatened. Slope failures in the early stages of development can often be identified and stabilised provided that the maintenance engineer is aware of the causes of the failure and recognises those slopes most at risk. Appropriate inspections are therefore required as a matter of routine. In order to maintain the stability of slopes, the drainage systems must be inspected and maintained regularly. In order to prevent failures, additional slope drainage may also be required on slopes not showing signs of failure but which are in areas of known instability.

5.8.2 Method of Inspection

The Detailed Inspection shall be carried out on foot. Sketches shall be made and measurements taken and recorded on the Detailed Inspection Sheet.

(a) Slope Survey

(i) The Team Leader should identify the section to be surveyed.

(ii) Slope measurements should be taken using a ranging rod and inclinometer and a 30m tape to give the cross section information which should be recorded on the inspection sheet.

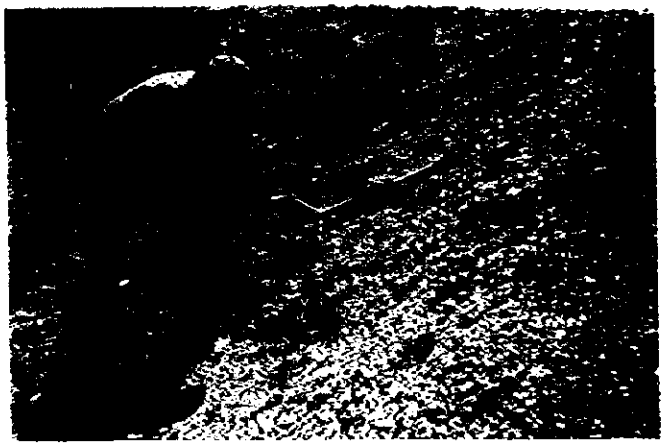
(iii) To establish the slope condition, the inspector shall, where practical, walk on the slope and record the observed condition on the inspection sheet. Observations on the presence of water, type of vegetation, soil type, slips, cracks or movement should be marked on the inspection sheet.

(iv) Observations on slope drainage and side ditch drainage should be recorded.

(v) Major defects should be photographed for record purposes.

(b) Embankment Survey

This is carried out in the same way as a slope survey.



Slope Angle Measurement with the Inclinometer

(c) Shoulder Survey

(i) The Team Leader should identify the section to be surveyed.

(ii) Measurements should be taken with a 30 metre tape to plot a section from the white line marking at the edge of the road, across the shoulder. The sketch should show the full shoulder cross section and the damaged section so that it clearly shows how much of the shoulder is left. This measurements should be put on the cross section on the inspection sheet and a photograph of the damaged area should be taken.

The cause of the wash out should be identified.

5.8.3 Data Recording

Sample Inspection sheets for slope, embankment and shoulder are shown overleaf.

(1) General information

The information should be inserted before starting the inspection.

(2) Inspection Items

A cross is marked over the number representing the appropriate information. In some cases more than one number may be used for a particular item e.g. the soil type may be sandy clay in which case both (3) and (5) should be crossed.

(i) Slope and Shoulder Inspection Sheet
Slope Protection
Where slope protection is provided, a sketch with dimensions should be included in the box and the type of protection indicated with a cross through the appropriate number.

(3) Slope Condition

The data from the survey should be put on the sketch.

(4) Plan

The plan should show the presence of any side ditch and the direction of flow.

(5) Sketch for Section

The section should show the approximate shape of the section at the point of the defect. Any additional comments on soil type, presence of water or similar matters should be added to the sketch.

(ii) Embankment Inspection Sheet
Sketch for Embankment Section

The dimensions should be entered where they can be measured during the survey. If required, a cross section supplementary survey should be requested to complete this data.

(6) Sketch for Plan

This should show the location of the defect plus the location of any other significant features.

(7) Comments

This box should contain any additional comments from the inspection team regarding the slope stability, traffic control needs or safety issues to draw them to the attention of the maintenance engineer considering the next course of action.

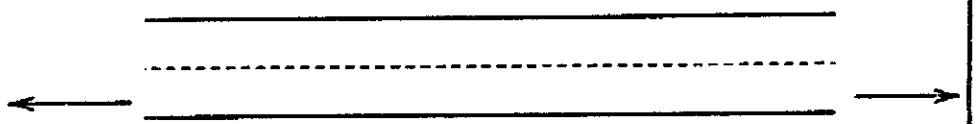
Detailed Inspection Sheet

Detailed Inspection Sheet for : SLOPE & SHOULDER | Inspection Date: / / | No.

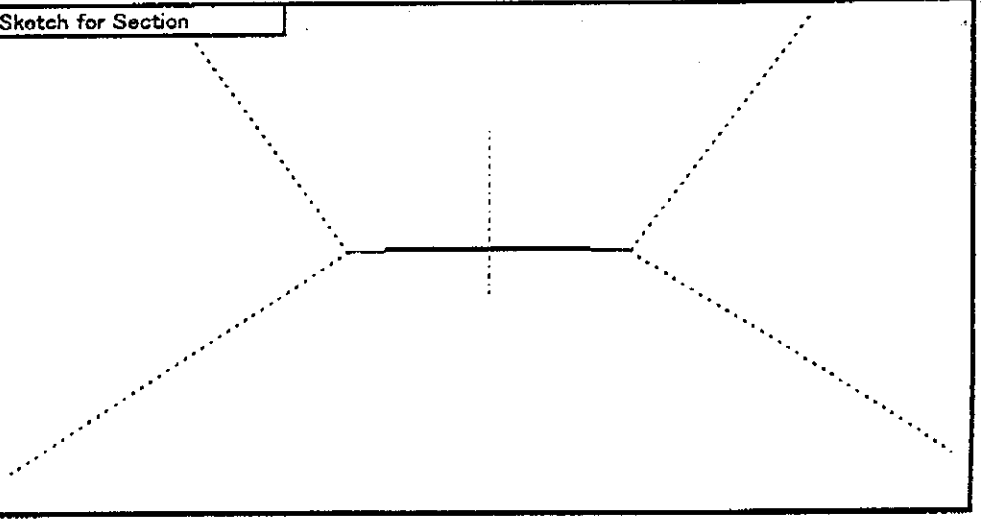
				Director	Chief Eng.	Inspector
General Information	Route:	Location: km to km				
	KGM-Division:	Subdivision:				
	Road Class:	No. of Carriageways:	No. of Lanes:			
	Direction: to					
	Year of construction:					

Inspection Items	Slope type	(1) Cut (2) Embankment
	Damage type	(1)Land slide (2)Rock avarsnche (3)Collapse of prot. wall(4)Cracking (5) Erosion
	Soil type	(1) Rock (H or S) (2) Gravel (3) Sand (4) Silt (5) Clay (6) Other ( )
	Plantation	(1) Tree (2) Bush (3) Grass (4) None (5) Other
	Drainage	(1) Crest (2) Berm (3) Toe (4) None
	Ground water	(1) Flow (2) Seepage (3) Wet (4) None
	Drain hole	(1) Yes (diameter = mm) (2) None
Slope Protection	Protection type	(1) Crib (2) Shotcrete (3) Gabion (4) Plantation (5) Other
	Sketch	
Slope Condition	Sketch	Road

Sketch for Plan



Sketch for Section



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

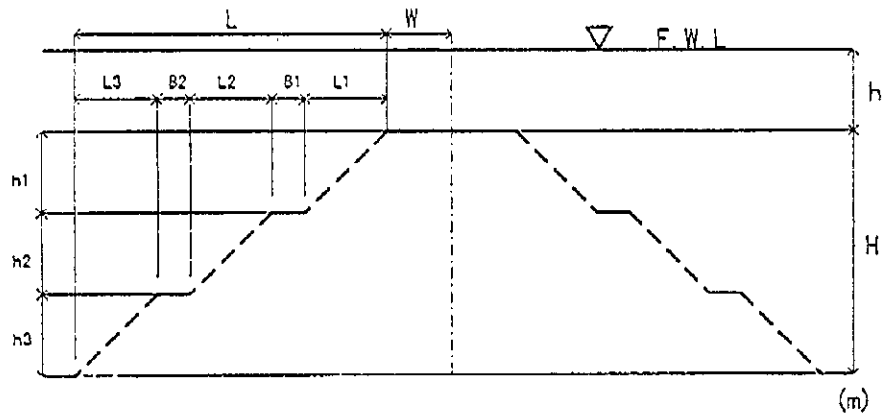
General Information			
Route:	Location: km to km	Director	Chief Eng. / Inspector
KGM-Division:	Subdivision:		
Road Class:	No. of Carriageways: / No. of Lanes:		
Direction: to			
Year of construction:			

Inspection Items		
Damage type	(1) Flooded (2) Collapse	
Topography	(1) Mount (2) Hill (3) Flat (4) Soft soil area (5) Sea side (6) River side	
Soil type	(1) Rock (2) Gravel (3) Sand (4) Silt (5) Clay (6) Other ( )	
Flooding	(1) Yes (times a year) (2) None	

Sketch for Plan

Sketch

Sketch for Embankment section



W= L= H= h=

L1= L2= L3= h1= h2= h3=

B1= B2=

Comment

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