CHAPTER 3

PRELIMINARY ROAD INSPECTION

CHAPTER 3 PRELIMINARY ROAD INSPECTION

3.1 General

3.1.1 Objectives of Inspection

The objectives of the road inspection are as follows:

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

3.1.2 Selection of Inspection Route

The study area includes approximately 60 000km of road throughout Turkey. The inspection routes, approximately 2 000km, were selected according to the following concepts;

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

Ankara - Hendek	277km
Ankara - Antalya	545km
Ankara - Hopa	930km
Sivrihisar - Bursa	245km
	1 997km

Fig. 3.1.1 shows the inspection routes.

3.1.3 Selection of Inspection Items

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

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

Table 3.1.1 shows the damage types for the inspection.

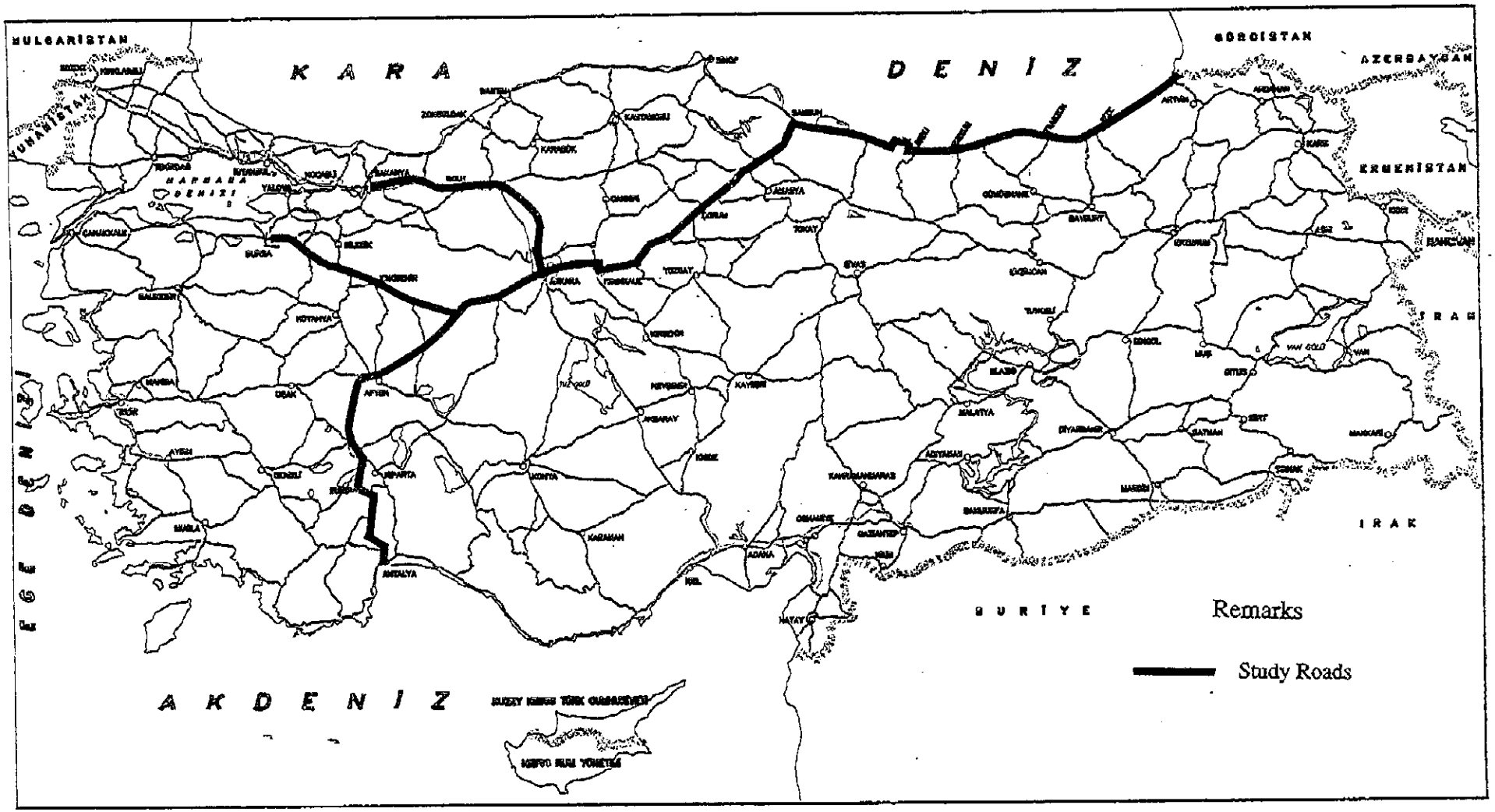


Fig. 3.1.1 Inspection Routes

Table 3.1.1 Damage Types

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

The study does not include the bridge, traffic safety facilities and tunnel maintenance systems.

3.2 Inspection Method

3.2.1 Inspection Tools

Tools for inspection for this Study are shown in Table 3.2.1.

Table 3.2.1 Tools for Inspection

Tool Name	Tool Name
Survey Sheet	Flash light
Camera	Slant Meter
Binoculars	Chalk
Tape measure	String line
Ribbon tape	Rain coat
Hand tape	Pens and pencils
Safety yellow jacket	Paint

3.2.2 Inspection Sheet

The inspections were carried out using the inspection sheet as shown in Table 3.2.2. The inspection sheet was prepared based on the following concepts;

(1) be easy,
(2) display each item to be inspected.
(3) display each type of damage,

Table 3.2.2 Inspection Sheet

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

			Box Culvert			Embankment			Slope					Snow & Ice Control Facilities	Retaining Wall			Side Ditch			Shoulder	Gulley			Pavement					km	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

(4) be designed so that I sheet is for 1 km of road, and
(5) provide basic data on road characteristics, site conditions, and traffic volumes.

Table 3.2.3 shows the number of Divisions and Sub-Divisions.

3.2.3 Evaluation of Damage

The nature of damage and the deterioration of the different road elements varies considerably, and personal judgment varies from inspector to inspector. Consequently, the definition of rating the observations is very important in our goals to manage and maintain the roads adequately.

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

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

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

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

3.2.4 Inspection Method

Basically, the inspection was carried out according to the following inspection methods:

(1) Before the inspection, the Study Team collected the road damage data, damage types and damage points, from KGM.
(2) The KGM counterparts and the Study Team considered and decided on the inspection points and damage types.
(3) For the first two days, the three inspection teams, KGM counterparts and Team members, carried out an inspection on the same section of road to standardize the inspection method e.g. inspection point and damage level.
(4) The inspection team allowed time for the discussion of the present problems of the road maintenance system and other road problems.

Table 3.2.3 Number of Division and Sub-Division

Bölge No *Division No*	Bölge Adı *Division Name*	Şube No *Sub Division No*	Şube Adı *Sub Division Name*
1	İstanbul (Güzelyalı)	11 12 13 14 15 17 18	Lüleburgaz Topkapı Gelibolu Merdivenköy Kırklareli Adapazarı Tekirdağ
2	İzmir	21 23 24 25 26 27 28 29	Ödemiş Manisa İzmir Uşak Muğla Denizli Aydın Ayvalık
3	Konya	31 32 33 34 35 36 37	Afyon Akşehir Karaman Konya Konya Beyşehir Ermenek 38 (Aksaray)
4	Ankara	41 42 43 44 45 46 47	Bolu Kızılcahamam Beypazarı Kırıkkale Polatlı Eskişehir Ankara
5	Mersin	51 52 53 54 55 56 57 58	Silifke Mersin Antakya Gaziantep K.Maraş Kozan Adana Elbistan
6	Kayseri	61 62 63 64 65 66 67 68	Kırşehir Pınarbaşı Kayseri Niğde Yozgat Develi Nevşehir Boğazlıyan
7	Samsun	71 72 73 74 75 76 77 78	Osmancık Amasya Çorum Tokat Samsun Niksar Ordu Sinop 79 (Boyabat)
8	Elazığ	81 82 84 85 86 87	Malatya Elazığ Bingöl Arapgir Tunceli Adıyaman

Bölge No *Division No*	Bölge Adı *Division Name*	Şube No *Sub Division No*	Şube Adı *Sub Division Name*
9	Diyarbakır	91 92 93 94 95 96 97	Şanlıurfa Diyarbakır Mardin Siirt Cizre Siverek Batman
10	Trabzon	101 102 103 104 105	Gümüşhane Artvin Rize Giresun Akçabat 106 (Bayburt)
11	Van	111 112 113 114 115 116 117	Van Tatvan Muş Hakkari Erciş Malazgirt Yüksekova
12	Erzurum	121 122 123 124 125 126 127 128	Aşkale Erzurum Ağrı Kars Kağızman Ardahan Oltu Hınıs 129 (Iğdır)
13	Antalya	131 132 133 134 135 136	Fethiye Antalya Alanya Burdur Isparta Finike
14	Bursa	141 142 143 144 145 146 147 148	Balıkesir Çanakkale Bursa Bilecik Kütahya Bandırma İznik Emet
15	Kastomonu	151 152 153 154 155 156 157	Kastamonu İnebolu Safranbolu Cide Devrek Bartın Ilgaz
16	Sivas	161 162 163 164 165	Sivas Zara Suşehri Erzincan Kangal
17	Istanbubul	Boğaz köprüleri ve bunlara bağlı otoyollarından sorumludur. (*It has specific responsibility for the Bosphorous Bridges and associated motorways.*)	
18	Kars	Henüz kuruluş aşamasında, şu anda 12. Bölgenin içerisindedir. (*It was only recently set up and it is now within the12th Division).*	

3.3 Survey Team

Three inspection teams carried out the road inspection and were as shown in Table 3.3.1.

The Teams comprised the Study Team Member, KGM counterpart, Division Chief Maintenance Engineer and Sub-Division Chief. The Team member and the arrangements for inspection vehicles for the inspection teams are shown in Table 3.3.1.

Table 3.3.1 Inspection Team Arrangement

A Team	B Team	C TEAM
(1) Mr. Takao INAMI (Study Team) (2) Mr. Olcay Ari (KGM Counterpart) (3) Division Maintenance Chief (4) Sub-Division Chief (5) Assistant	(1) Mr. Hiromichi ENOKIDA (Study Team) (2) Mr. Masataka FUJIKUMA (Study Team) (3) Ms. Tijen OKTEN (KGM Counterpart) (4) Division Maintenance Chief (5) Sub-Division Chief (6) Assistant	(1) Mr. Chai Seng CHIEW (Study Team) (2) Mr.Mustafa KARLIER (KGM Counterpart) (3) Division Maintenance Chief (4) Sub-Division Chief (5) Assistant
KGM Vehicles	KGM Vehicles	KGM Vehicles

In general, inspection was carried out for 7 hours each day (08:30 - 17:00 including 1.5 hours for lunch). On some occasions, the working day was extended by starting earlier or finishing later.

3.4 Inspection Schedule

Table 3.4.1 shown the inspection schedule for three inspection teams.

The inspections were carried out throughout the week ends and holiday periods with the cooperation of KGM.

Table 3.4.1 Inspection Schedule

Month	Date		Mr.INAMI (A)			Mr.ENOKIDA & Mr.FUJIKUMA(B)			Mr.CHIEW (C)		
			Sub-Division	Length	Stay	Sub-Division	Length	Stay	Sub-Division	Length	Stay
May	11	Sun									
	12	Mon	Kirikkale	45km	Kirikkale	Kirikkale	45	Kirikkale	Kirikkale	45	Kirikkale
	13	Tue	Kirikkale	45	Kirikkale	Kirikkale	45	Kirikkale	Kirikkale	45	Kirikkale
	14	Wed			(Ankara)	Corum	55	Corum			Antalya
	15	Thu	Kizilcahamam	63	Kizilcahaman	Corum	64	Corum	Antalya	45	Antalya
	16	Fri	Kizilcahamam	75	Bolu	Corum	40	Merzifon	Antalya	40	Isparta
	17	Sat	Bolu	37	Bolu	Amasya	44	Merzifon	Burdur	44	Isparta
	18	Sun	Bolu	68	Bolu	Samsun	55	Samsun	Burdur	44	Isparta
	19	Mon	Adpazari	16	(Ankara)	Samsun	55	Samsun	Burdur	44	Afyon
	20	Tue			Bursa	Samsun	59	Samsun	Afyon	51	Afyon
	21	Wed	Bursa	65	Bursa	Ordu	50	Ordu	Afyon	45	Afyon
	22	Thu	Bilecik	48	Eskisehir	Ordu	58	Giresun	Afyon	44	Polatli
	23	Fri	Eskisehir	78	(Ankara)	Giresun	55	Giresun	Polatli	70	Polatli
	24	Sat				Giresun	61	Trabzon	Polatli	71	(Ankara)
	25	Sun				Akcaabat	55	Trabzon			
	26	Mon				Akcaabat	56	Rize			
	27	Tue	Polatli	32	(Ankara)	Rize	60	Rize			
	28	Wed				Rize	63	Trabzon			
	29	Thu									
	30	Fri									
	31	Sat									

CHAPTER 4

RESULTS OF PRELIMINARY ROAD INSPECTION

4 Results of Preliminary Road Inspection

4.1 General

The visual inspection was carried out on the 2000 km route as agreed with the KGM counterparts. The main aim of the inspection was to locate the defects on the road, to enable a record to be placed in the database system and to identify and understand the types of problem faced to enable the manuals (evaluation and repair) to be prepared. It was neither meant as a criticism of the individual sub divisions nor to compare their performances. It is hoped that when the database is ready with the preliminary information gathered, it will be made available to the KGM divisions to continue with the registration of defects.

As part of the transfer of technology, KGM counterparts have been requested to participate with the input of the data and to understand how the programme works. The counterparts can in turn transfer their working knowledge to other KGM colleagues. The programme is tailor made for this project and ultimately the ownership is with the KGM.

During the Inspection, carried out by the three Study Teams (including counterpart engineers from the maintenance department), we have noted that similar problems occured on different sections of road even though they were at geographically and climatically different locations. This led us to conclude that there are primary factors that have to be looked at to resolve the problems associated with maintenance. We are working towards this end to assist KGM and hope that the recommendations proposed will be implemented. A list of special recommendations will be given at the end of our study, in the final report, following the detailed study.

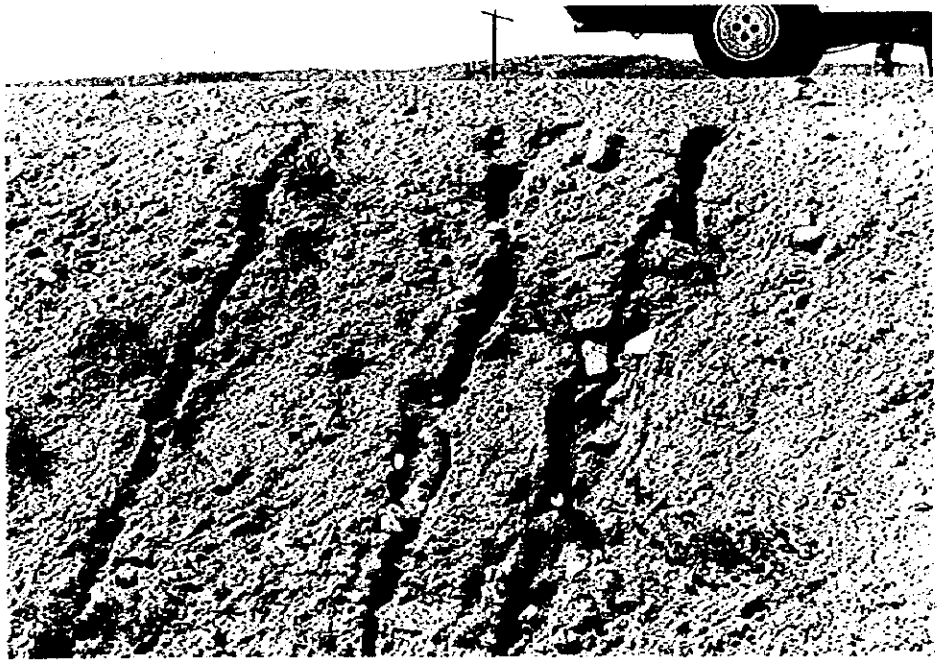
4.2 Damage Type and Damage Level

When the Inception Report was drafted, we included a large number of items to be studied. Following the discussions with KGM counterparts, it was jointly decided that other items such as traffic signals, road markings, road lighting - just to name a few - could be omitted as they could be dealt with easily by KGM's staff. Hence the scope of the visual inspection has been limited to the following main items

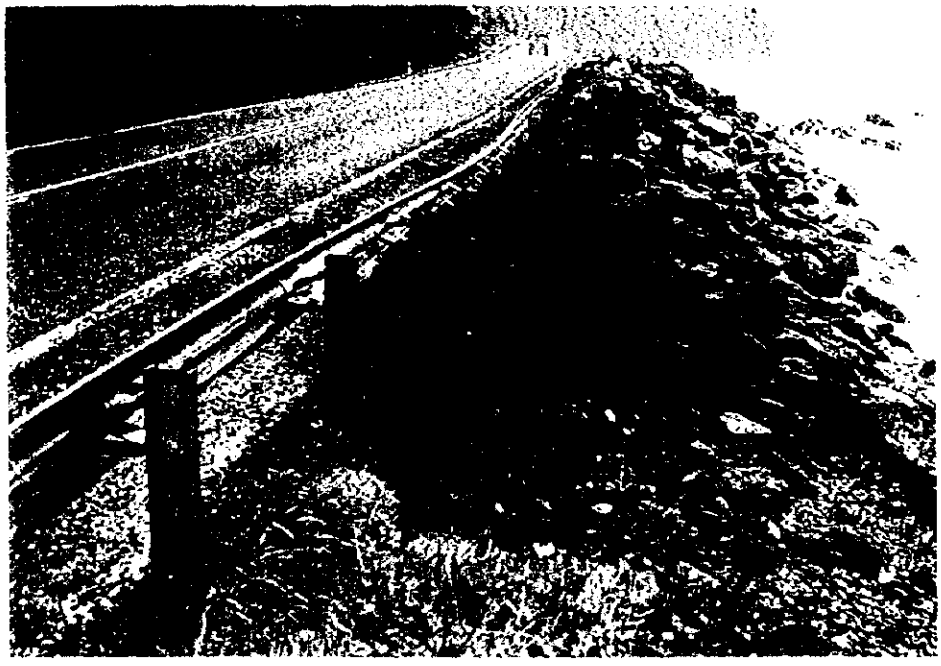
- Slopes
- Snow and Ice control facilities
- Retaining walls
- Side ditches
- Shoulders
- Gulleys
- Pavement
- Embankments
- Culverts

a Slopes

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



Erosion by rain and surface run-off



Erosion by wave action

Landslide

Cracks in slope

Rock
Avalanche

b Snow and Ice control facilities

- refers to the conditions of the snow fences, snow walls etc

Wooden snow fence

c Retaining wall

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

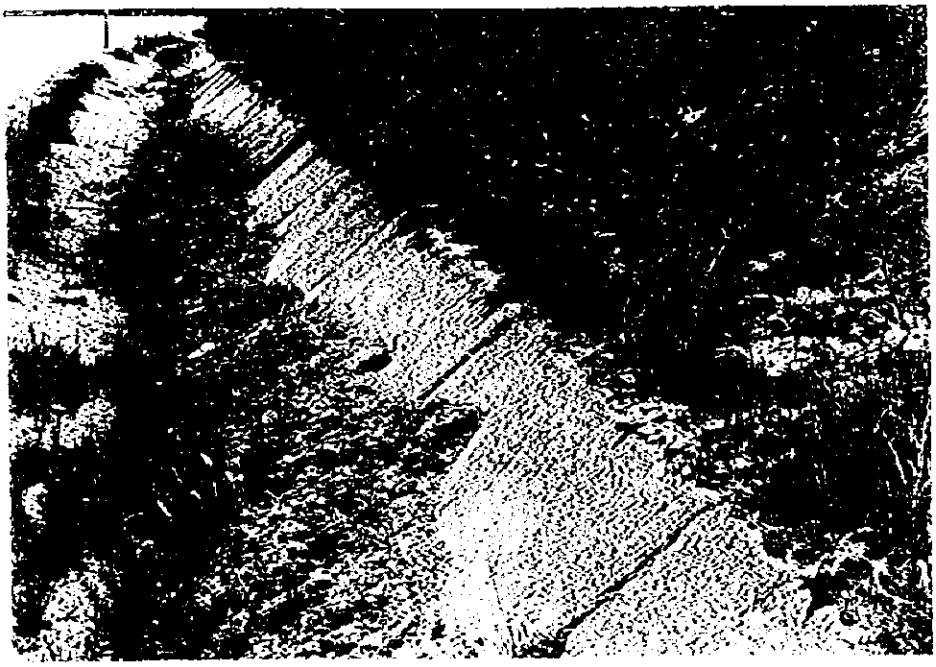
Cracking

Settlement & Collapse

Collapse

d Side ditches/ verge drains

- Accumulation of debris - whether natural or man-made
- settlement - obstructing flow
- Collapse - structural defects

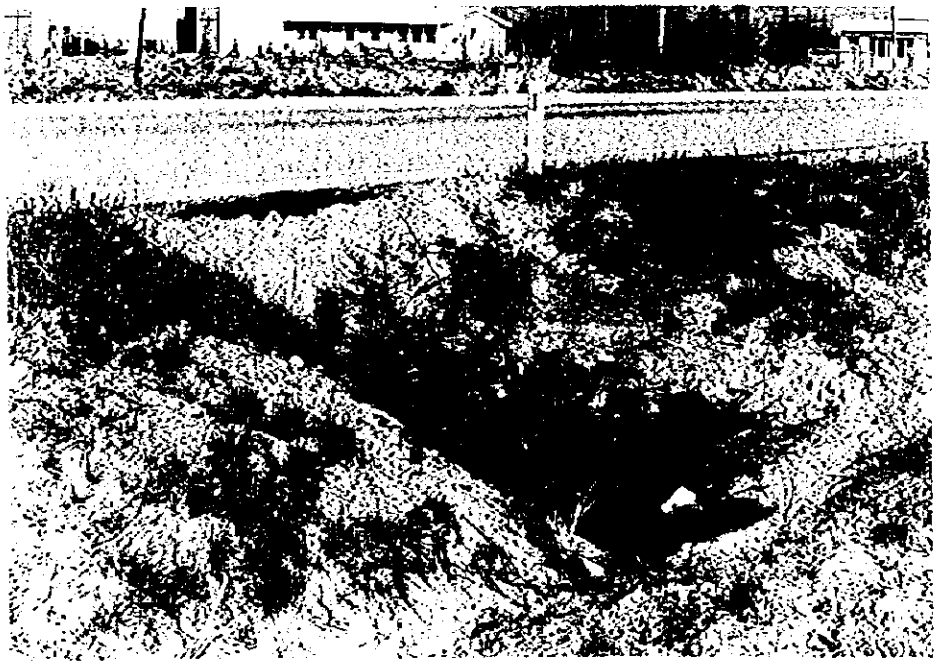


Accumulation of debris

Collapse

e Shoulders

- wash out only - as it is considered as the most serious problem



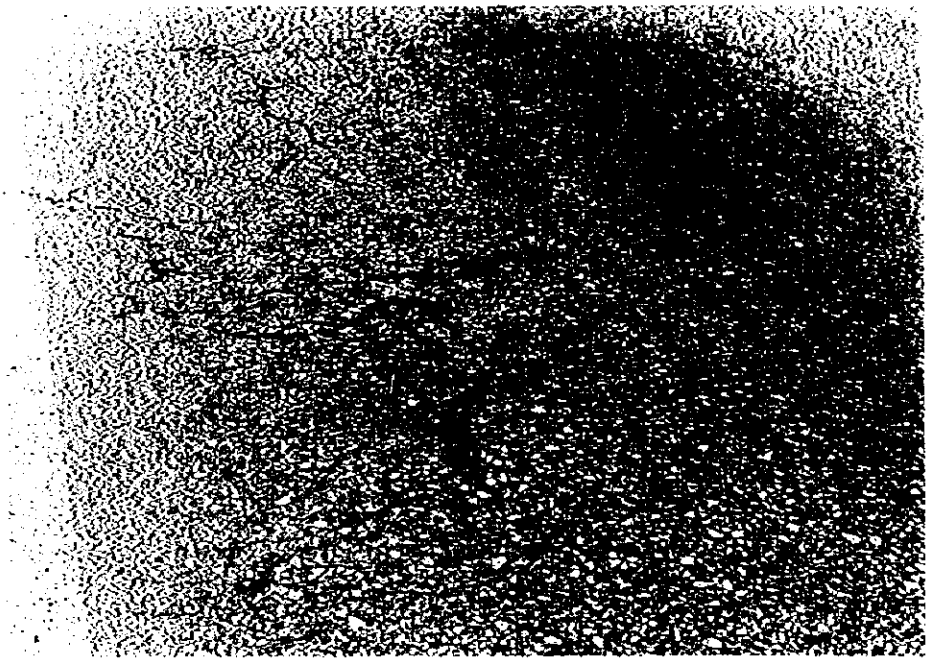
f Gulleys

- Accumulàtiòn of debris - whether natural or man-made
- settlement - obstructing flow
- Collapse - structural defects

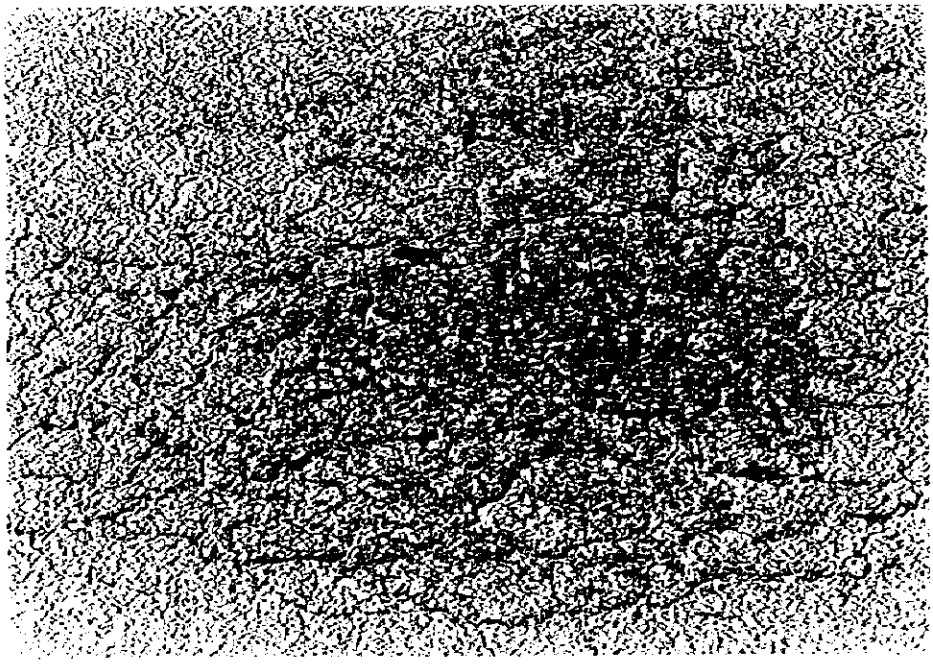
Accumulation of debris

g Pavement

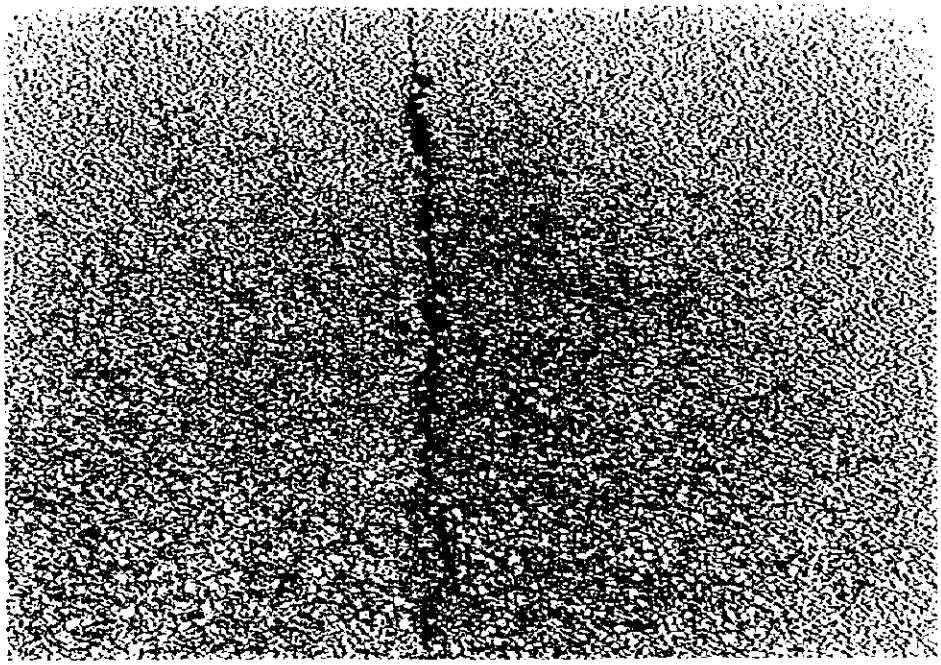
- Cracking - all types of surface cracks
- Settlement - resulting from visible and localised settlement of the earthworks
- Rutting - migration of asphalt in wheel tracks
- Undulation - surface imperfection affecting riding quality
- Potholes - localised loss or peeling of asphalt surfaces



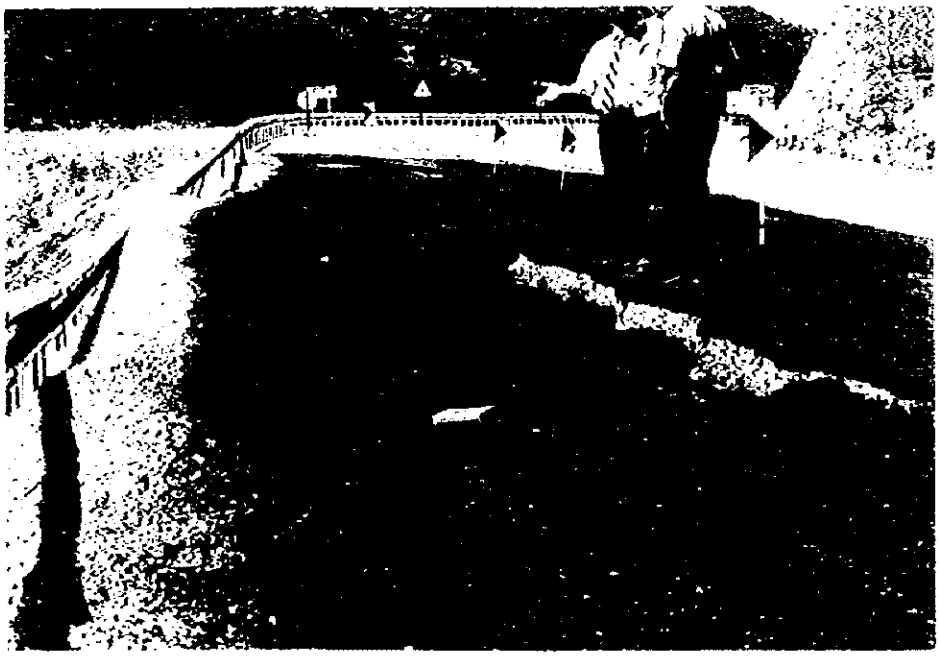
Random cracks



Alligator Cracks

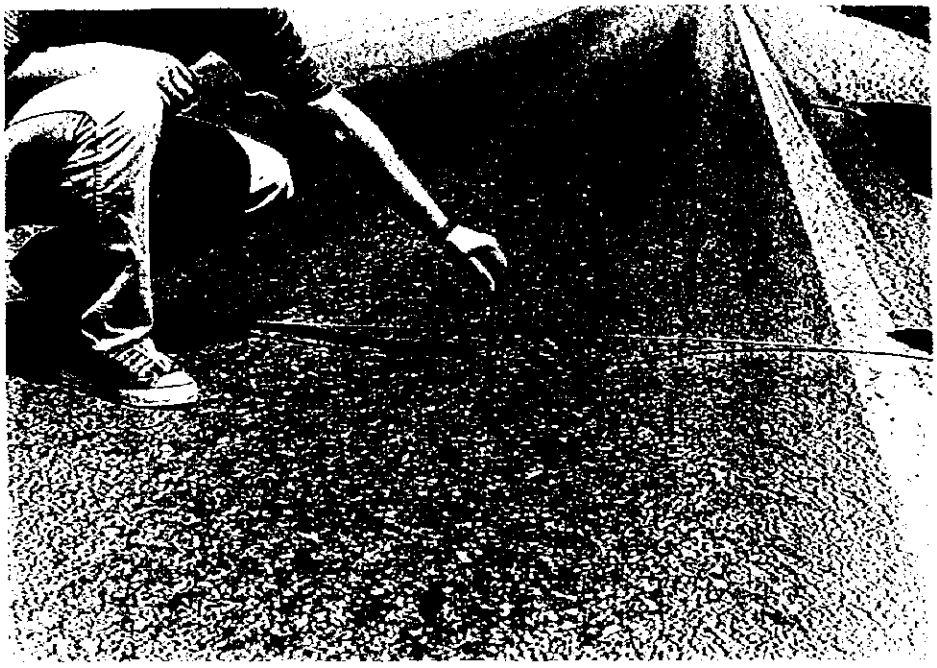


Longitudinal Cracks

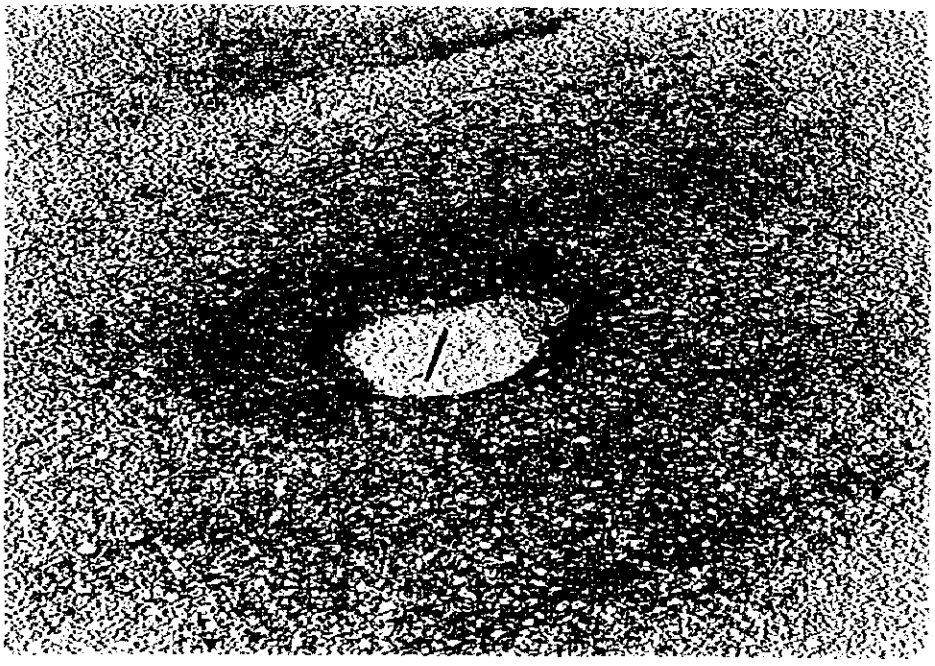


Settlement of carriageway

Undulation/ settlement



Rutting



Pothole

h Embankments

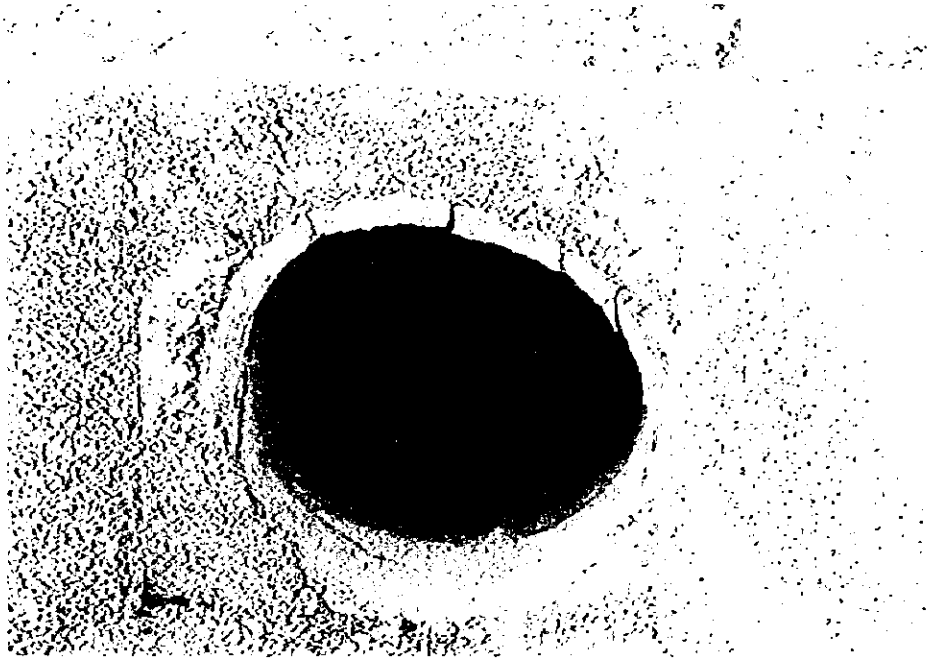
- submerged - waterlogged due to non-existence of drainage facilities or blocked drainage system

i Culverts

- Accumulation of debris - whether natural or man-made
- Settlement - localised depression resulting in flow being obstructed
- Collapse - structural failure

Accumulation of debris

Failure of concrete



Collapse

The damage level for all the aforementioned items is categorised into three levels namely A, B and C. Their definitions are as follows:

A Damage is serious and problem is obvious. Remedial action must be taken as soon as possible

B Damage noted and requires further investigation into the cause of the problem before any remedial work is proposed.

C Damage noted but not serious and does not warrant remedial actions. Continue with monitoring

4.3 Formulation of Database

4.3.1 Concept

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

4.3.2 Objective

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

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

With this concept in mind, the database has been designed to be as simple and as user friendly as possible, yet a source of invaluable information. It has been specifically designed with the contributions from the experiences of members of the study team to the requirements of this project. To further assist and encourage its use by KGM engineers, the program is interactive and has the available options of use in either the Turkish or English language.

The program has been tested to ensure that no major errors can occur and further improvements have also been made to the way inspection data can be input. All inspection information can be easily stored in the database by answering the relevant questions on the computer screen. Incorrect input Data can easily be amended.

As part of our duty in technology transfer, counterpart engineers have been actively participating in the data collection and in the input of the inspection data collected from the 2000 km of pilot study roads. In this way the relevance of data collected for the program can be easily understood.

4.3.2 Database Items

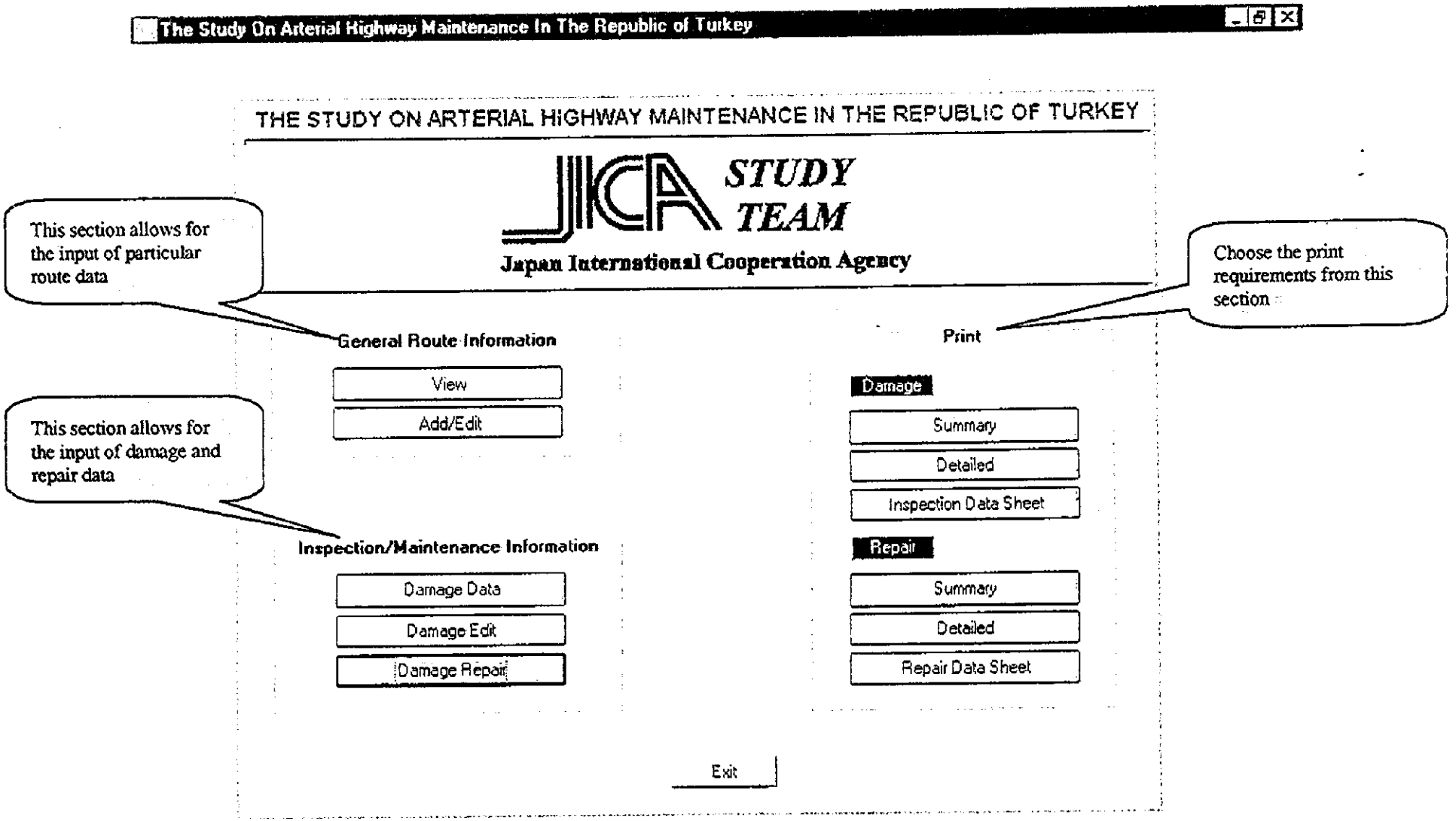
The program has been designed using the items agreed with counterpart engineers, which are as follows:

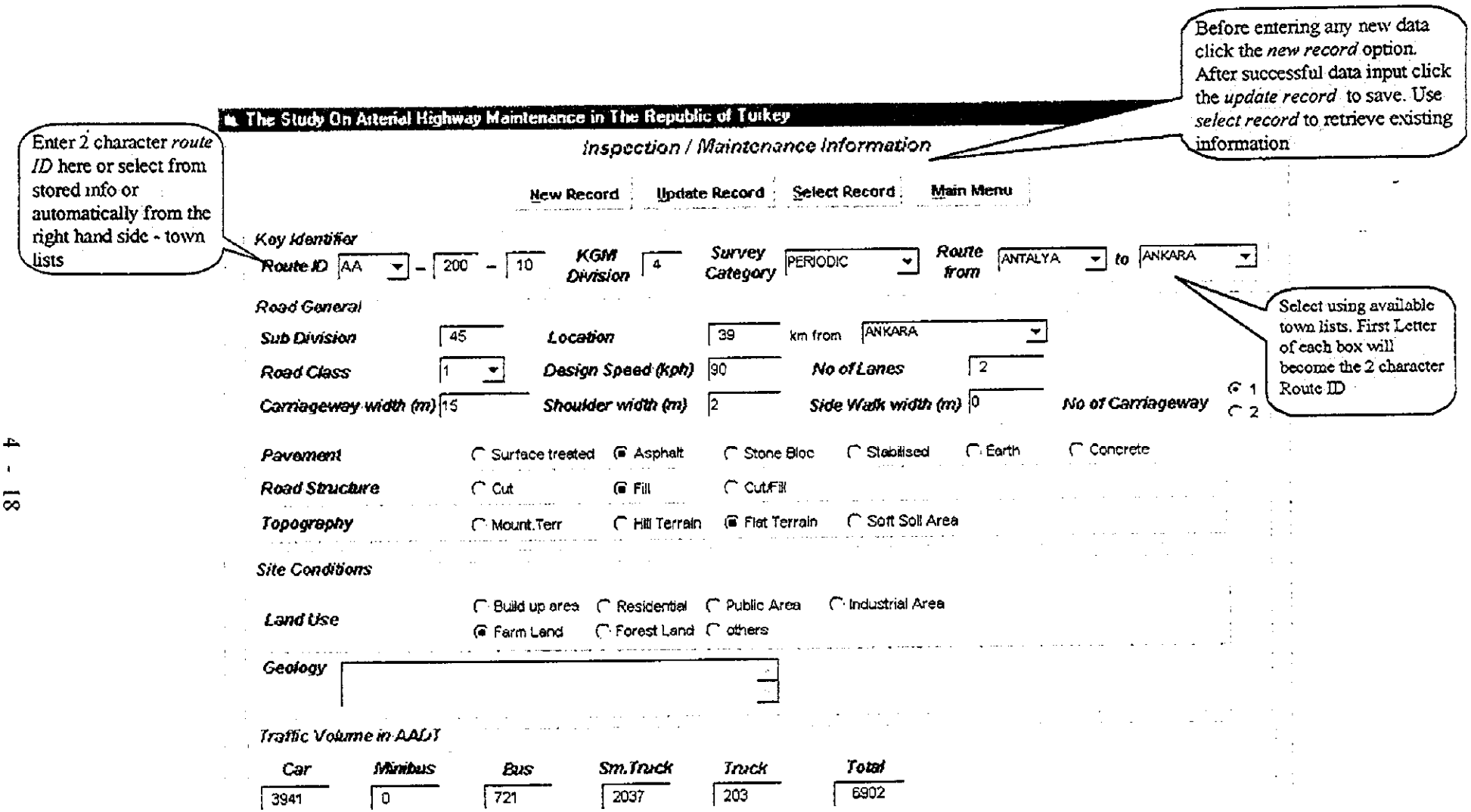
- Slopes
- Snow and Ice control facilities
- Retaining walls
- Side ditches
- Shoulders
- Gulleys
- Pavement
- Embankments
- Culverts

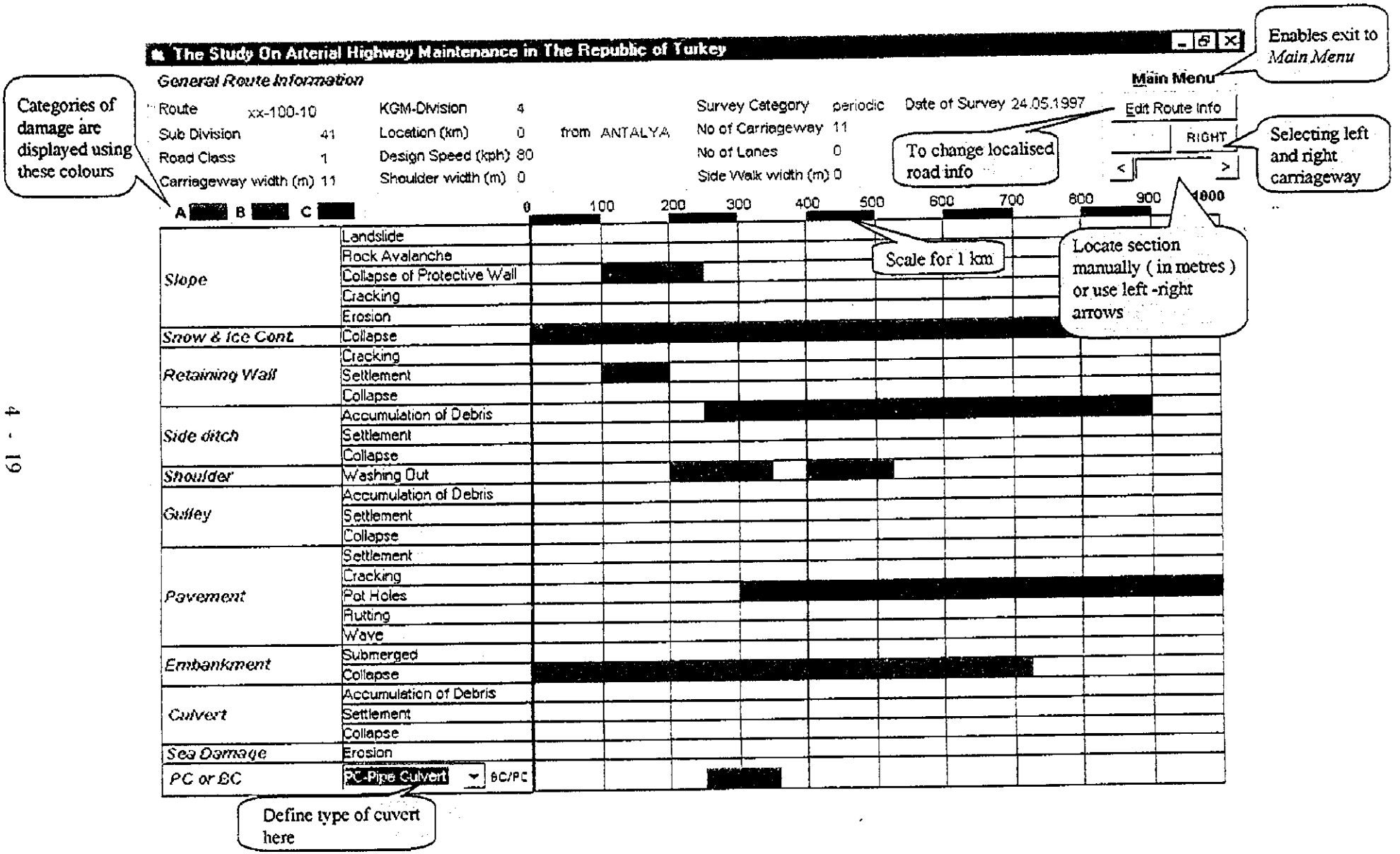
If there is a need in the future for additional items to be included, they may be inserted by special arrangement between KGM and the programmers.

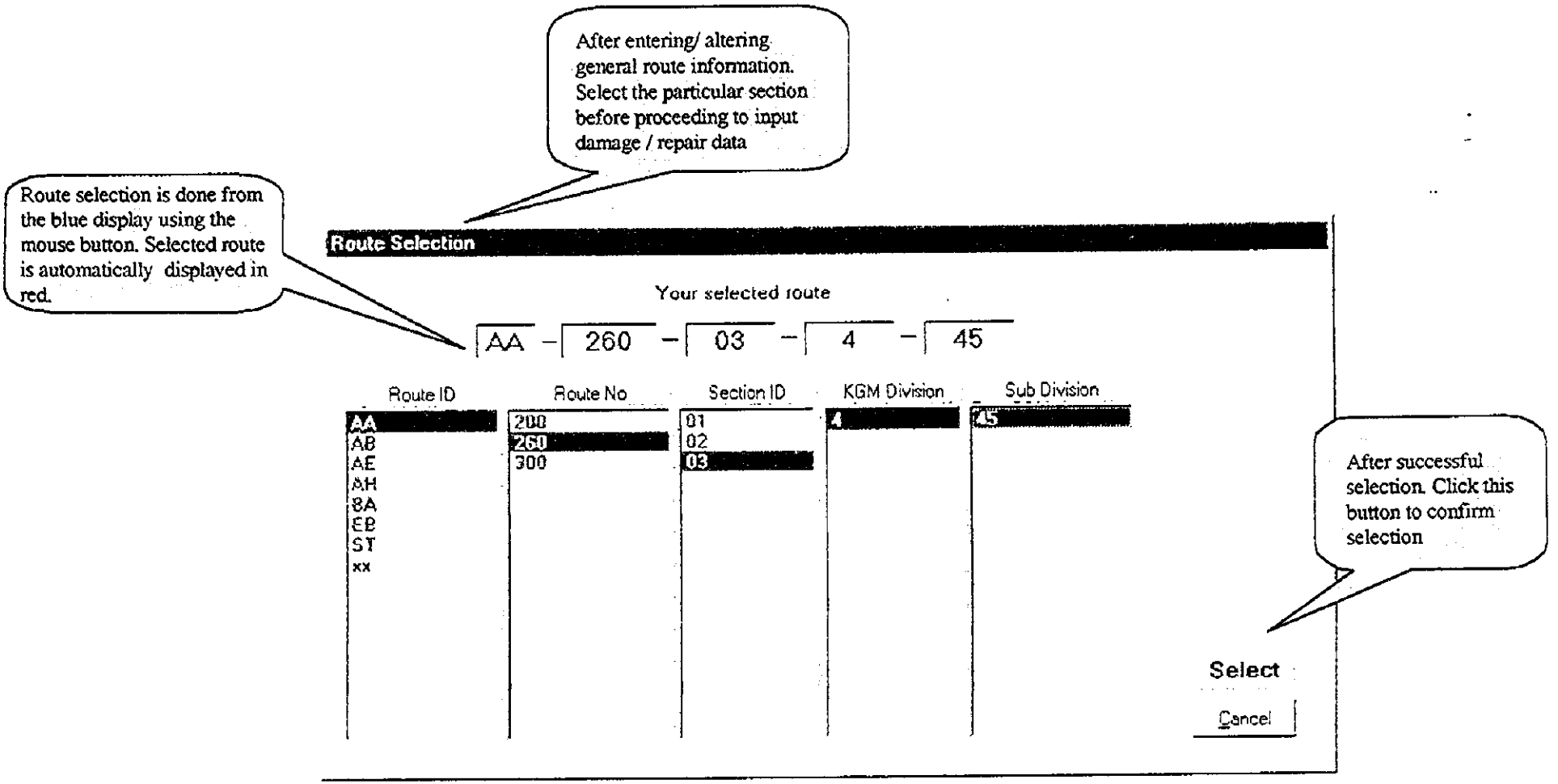
4.3.4 Input Screen

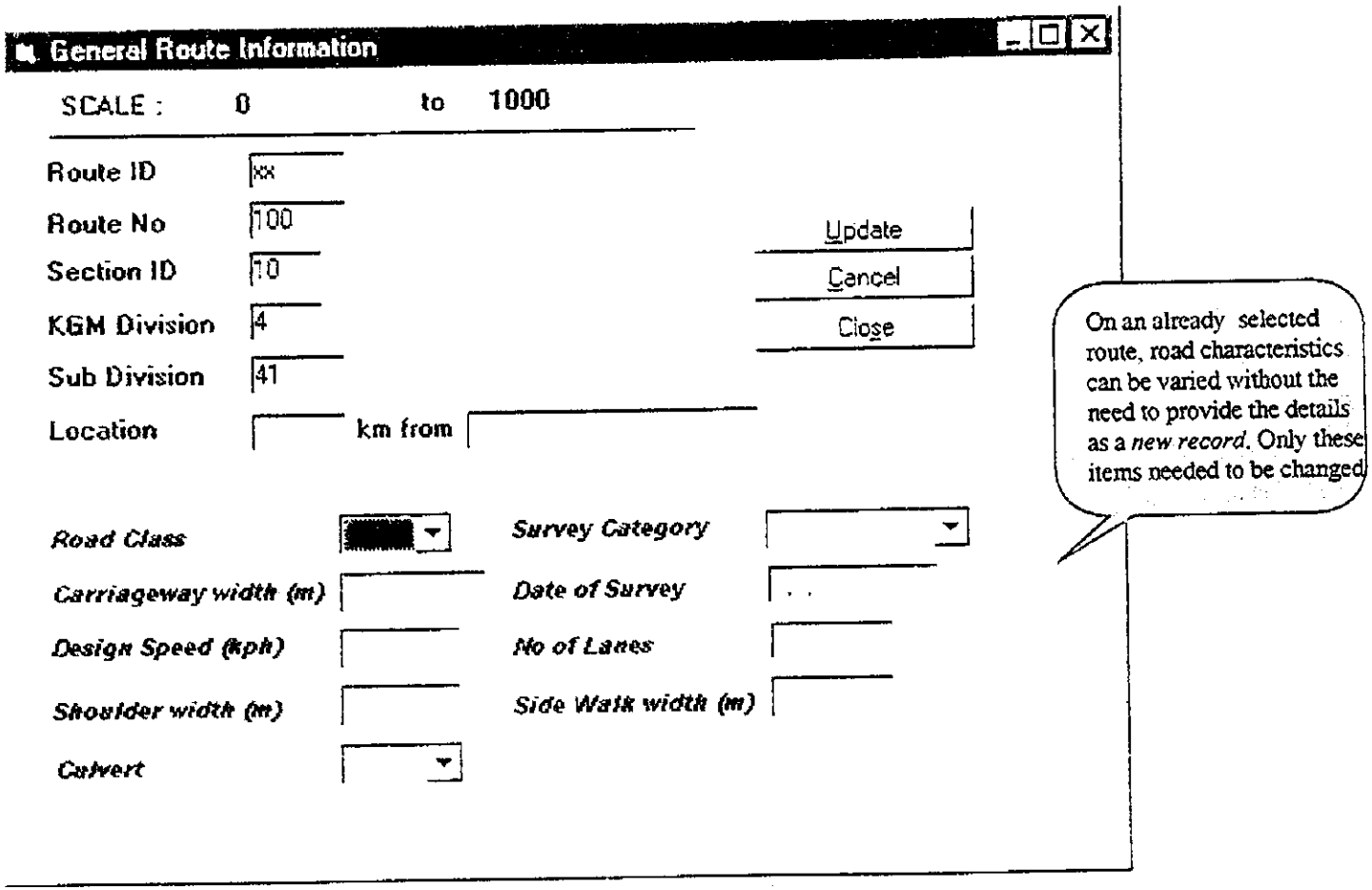
The program was deliberately designed to be as simple and user friendly as possible. In this section various excerpts are presented to illustrate the program

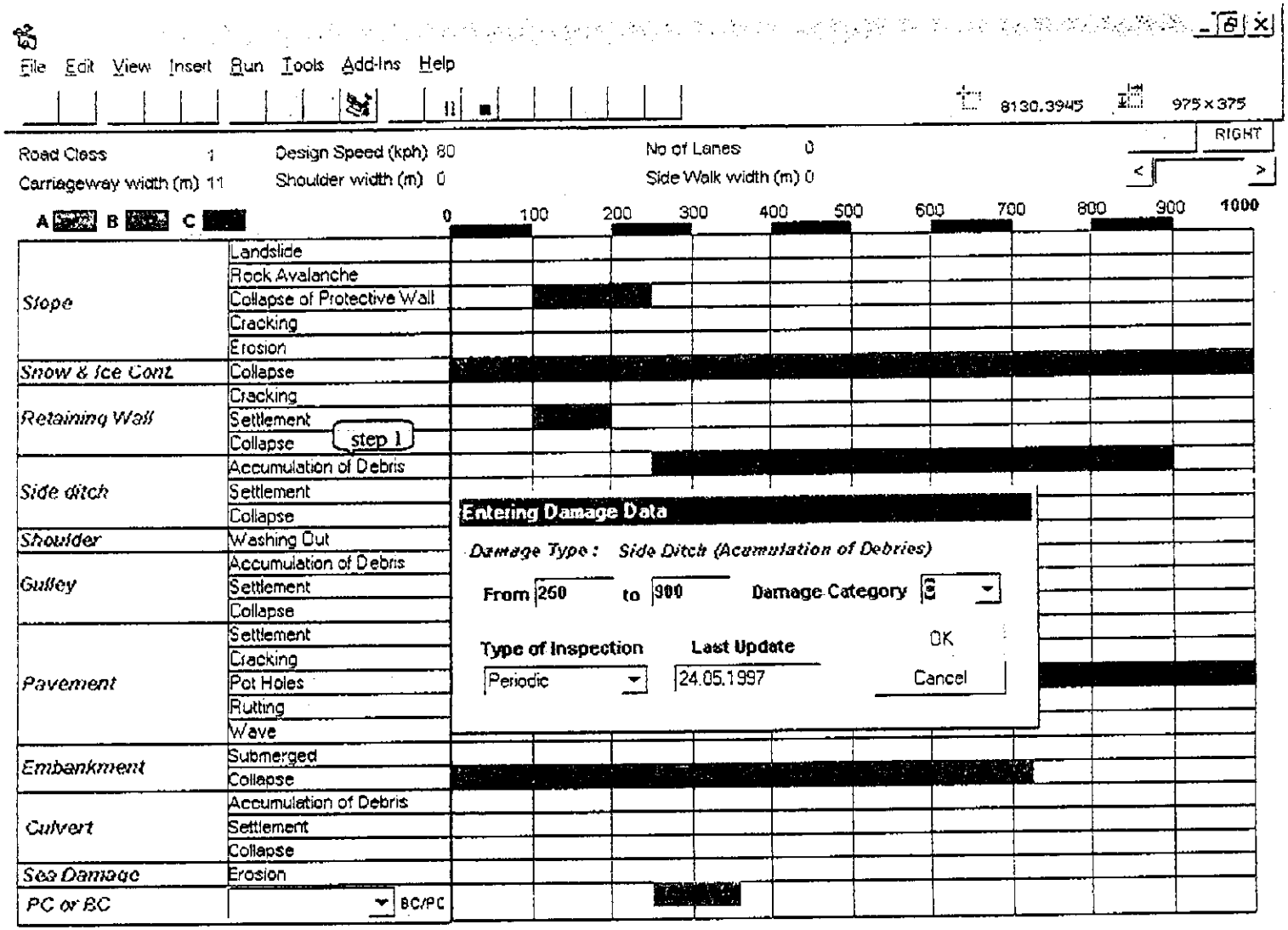

The Study On Arterial Highway Maintenance In The Republic of Turkey
THE STUDY ON ARTERIAL HIGHWAY MAINTENANCE IN THE REPUBLIC OF TURKEY
JICA STUDY TEAM
Japan International Cooperation Agency
This section allows for the input of particular route data
Choose the print requirements from this section
General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


The Study On Arterial Highway Maintenance in The Republic of Turkey
General Route Information
Main Menu
Enables exit to Main Menu
Route xx-100-10
Sub Division 41
Road Class 1
Carriageway width (m) 11
KGM-Division 4
Location (km) 0
from ANTALYA
Design Speed (kph) 80
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
Edit Route Info
To change localised road info
RIGHT
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
Sea Damage
Erosion
PC or BC
PC-Pipe Culvert
BC/PC
Define type of cuvert here


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


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



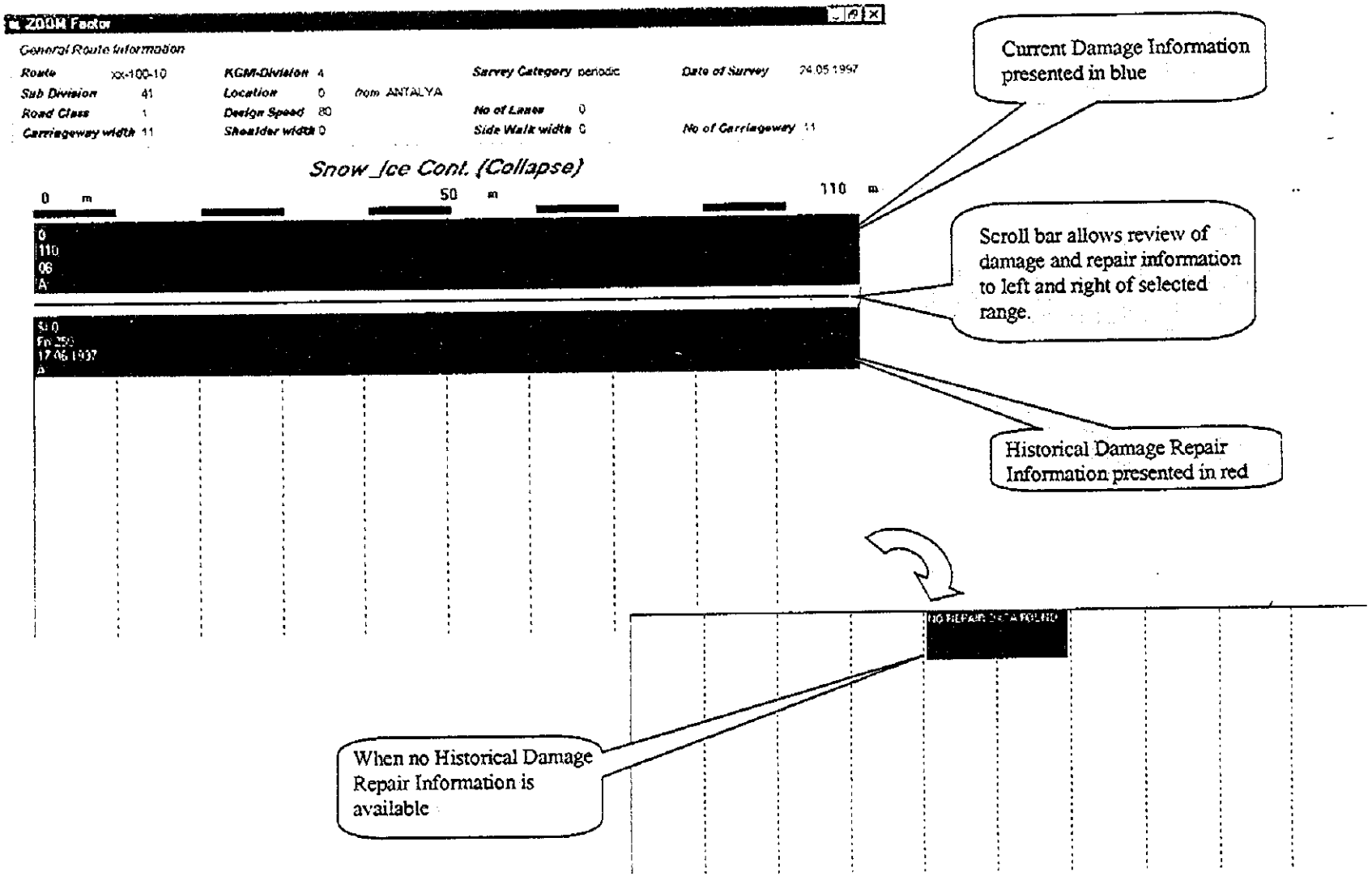
This is the screen when *Damage Data* option is selected.

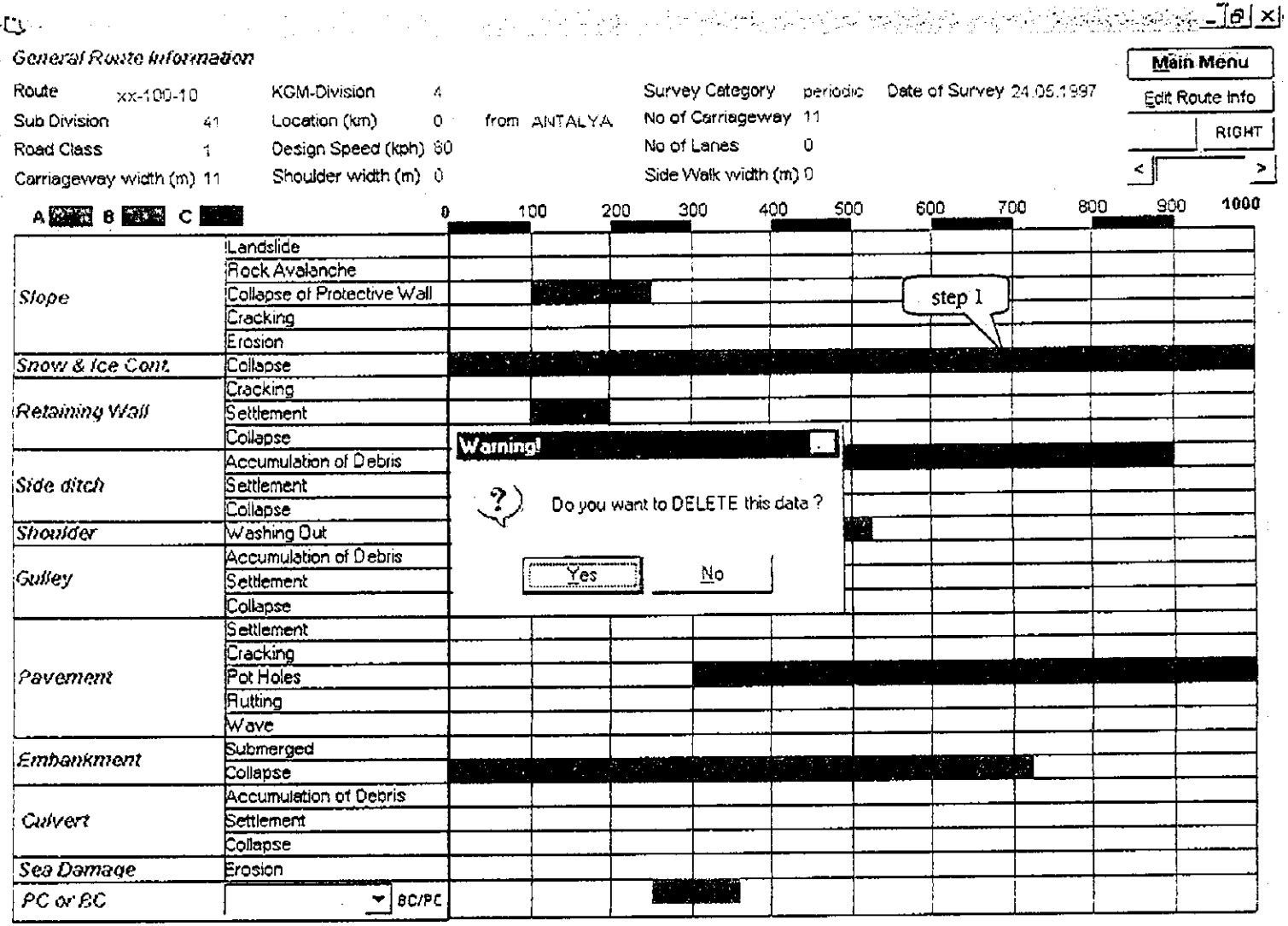
1 Point the cursor on the particular subject area where damaged data is to be stored. Click the mouse

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 11
Snow_Ice Cont. (Collapse)
0 m
50 m
110 m
0
110
06
A
17.06.1997
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



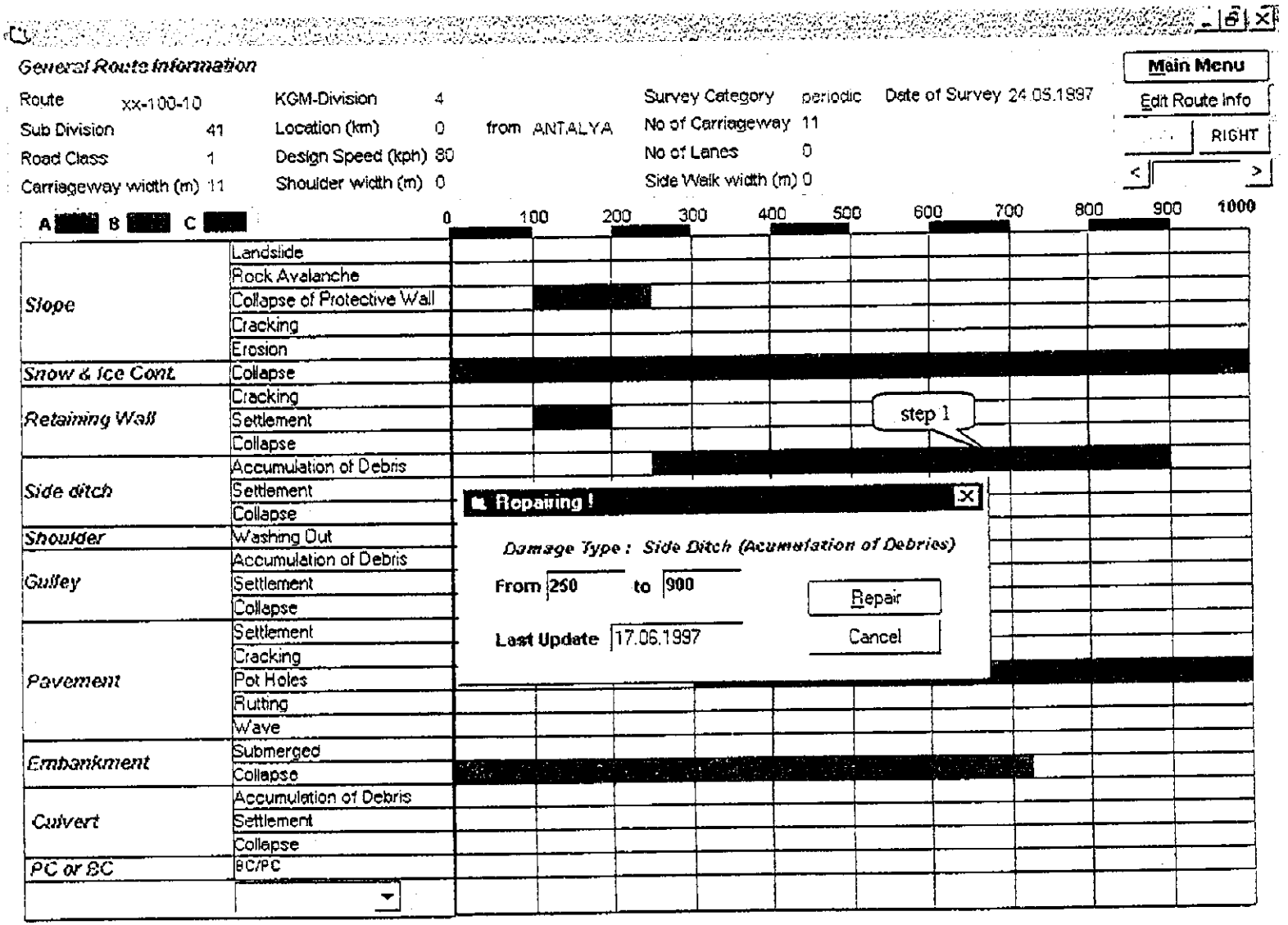
This is the screen when *Damage Edit* option is selected.

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.

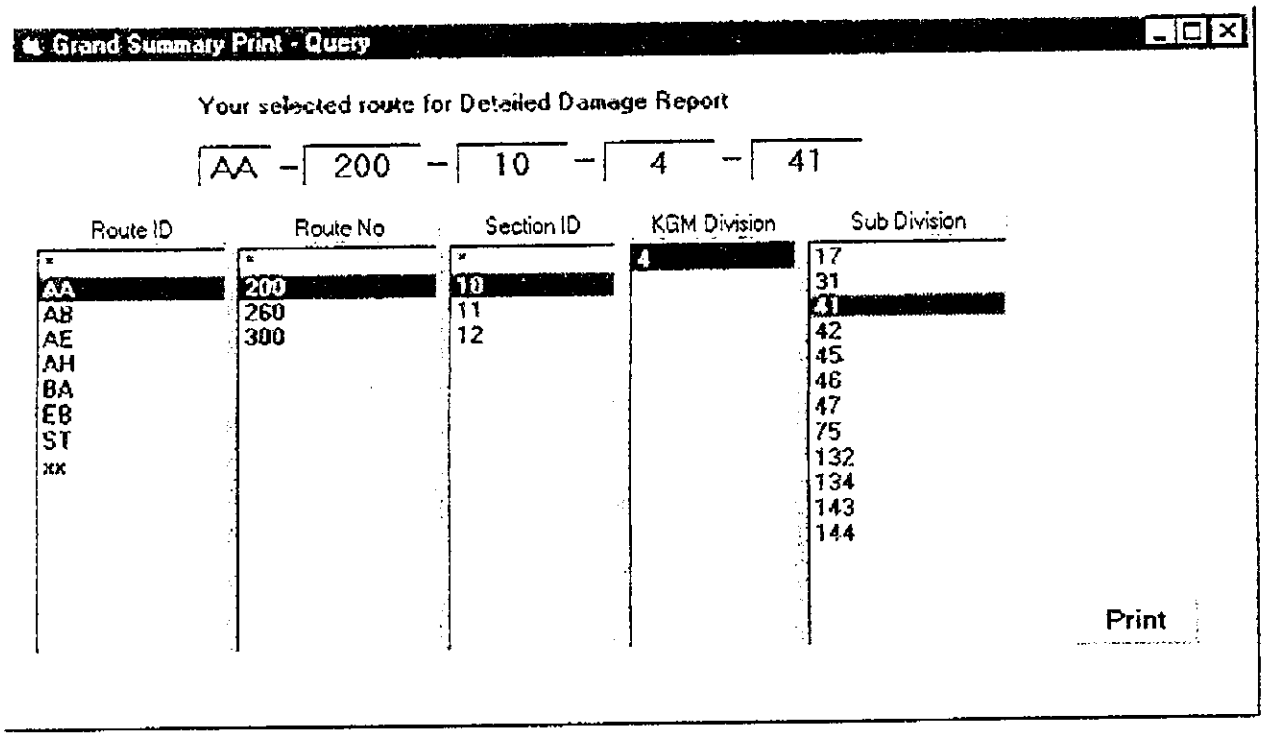
1 Point the cursor on the particular damage area which is to be repaired. Click the mouse

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*

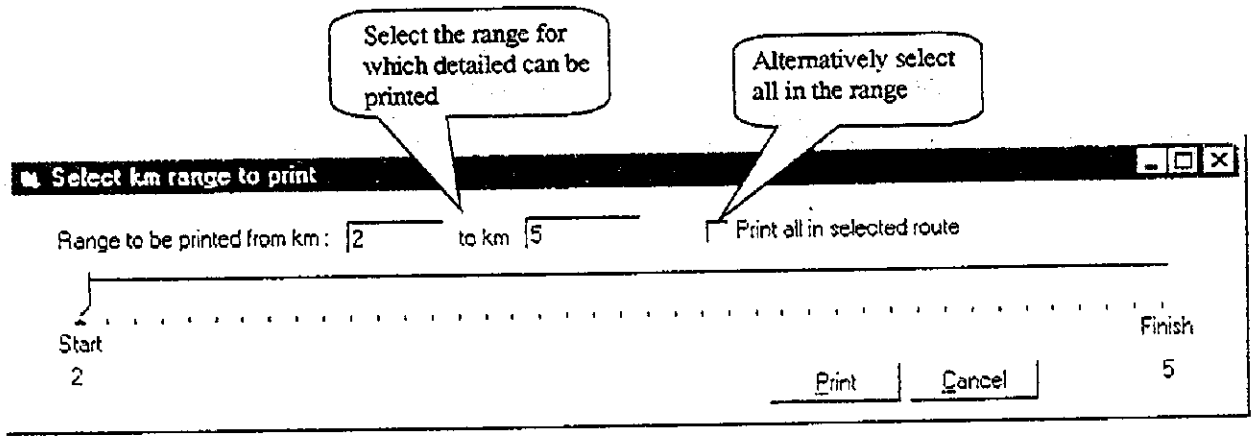
2 Print only a selected route ID, select a route ID from *Route ID* and select * from *Route No* and *Section ID*

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

4.3.5 Output Screen

The PRINT option on the MAIN MENU of the programme allows for a number of output possibilities. The following pages contain some sample output format.

CHAPTER 5

PRESENT PROBLEMS OF ROAD MAINTENANCE SYSTEM

CHAPTER 5 PRESENT PROBLEMS OF ROAD MAINTENANCE SYSTEM

5.1 General

This Chapter is summarises the problems of the present road maintenance system based on the inspection results and analysis of the data and information collected. These problems will be considered and a new road maintenance system will be recommended in the next stage.

5.2 Summary of Problems

The major problems of the present maintenance system are listed below:

(1) As mentioned in Chapter 2, the budget for road maintenance is not enough. Therefore, there is insufficiency work carried out to repair the damage.

(2) Since the maintenance of the pavement has a high priority for road maintenance, the repair works for other damage types (slope, drainage etc.) is sometimes neglected.

(3) The inspection and repair methods lack consistency in each division or sub-division.

(4) The cause of the damage is not always analysed, and standard repair works are carried out. Therefore, the damage is sometimes found at same the point again.

(5) There are not enough maintenance Engineers in the Sub - Division Offices to carry out the repair work.

(6) There is insufficient training for the maintenance engineers.

5.3 Discussion of Problem Items

5.3.1 Insufficient Budget

From Table 5.3.1, it can be seen that the allocation of budget falls a long way short of that requested, being 10% and 16% for 1996 and 1997 respectively. This means that major repair works are not carried out when needed and further deterioration of these defects will make the repair much more expensive to carry out when it is eventually allocated some funds.

Table 5.3.1 "113 Budget" for Maintenance and Traffic Divisions for 1988 to 1997

(x10^6)

Year	Budget Requested (TL)	Budget Requested Current Value (TL)	Budget Allocated (TL)	Budget Allocated Current Value (TL)	Allocated/ Requested %
1988	129 422	18 005 185	36 600	5 091 792	28
1989	232 663	19 636 764	45 000	3 798 000	19
1990	289 475	14 818 245	54 000	2 764 260	19
1991	949 970	31 206 514	77 000	2 529 450	8
1992	1 424 365	27 905 418	130 650	2 577 245	9
1993	1 052 637	12 526 381	196 200	2 334 780	19
1994	1 512 000	11 007 360	286 729	2 087 387	19
1995	3 474 861	11 258 550	377 225	1 222 209	11
1996	5 533 200	9 959 759	555 950	1 007 710	10
1997	8 535 841	8 535 841	1 282 500	1 282 500	16

Other points to note are that following a steady increase in the requested budget from 1988 to 1991, there followed a rapid reduction in the requested budget over the next few years and the 1997 figure is about 45% of that in 1988. It is also interesting to note that the budget allocated in 1997 is only 25% of the budget allocated in 1988.

The budget allocation and use will be further examined in the next stage of the study.

5.3.2 Pavement Priority

As in most countries, pavement works are given a very high priority in terms of budget allocation when compared to other items such as slope and drainage works. The objective being to keep the road open and in a sound and safe condition for the road user.

However, it is very important to strike a balance between the allocation to the various elements to be repaired as a lack of attention may create a rapid deterioration which might have more serious consequences. For example, a major slope failure may block the road to traffic and be very expensive both to clear and to stabilise; inefficient drainage might cause a very expensive pavement failure which could be avoided with more regular attention.

5.3.3 Consistency of Inspection and Repair Methods

From the information received from the Divisions, it is clear that frequency of inspection of the various elements on the road is not only variable between Divisions but also between the Sub - Divisions in the same Division.

We will investigate further the reasons for this variation which may be down to misunderstanding the information required or perhaps the element is not common in the particular Division.

Nevertheless, in order to make the best use of the inspection data collected and to be able to make decisions on suitable courses of action, it is important to create a consistent inspection programme throughout the country so that data on a particular element is collected at the same frequency in all Sub - Divisions. In this way, patterns of behaviour for each element can be monitored and data can be collected to enable deterioration patterns and repair and maintenance patterns to be better understood both for each element and for variations due to climate or topographical reasons in different parts of Turkey.

5.3.4 Standard Repair Works

From the Preliminary Site Survey on the 2000km Study Route, it appeared that in a number of cases, the cause of the damage was not always investigated and a standard repair was carried out. However, the same problem reappears later on and the standard repair may be carried out again and so the cycle continues.

Although this may be the cheapest short term option, it is not necessarily the best use of the maintenance budget. Where a problem reoccurs at the same location, a full investigation of the cause of the problem should be made so that a more long lasting repair can be carried out and so reduce the requirement for repeat repair works. This highlights the importance of logging dates, locations and types of defects so that this sort of problem can be identified.

5.3.5 Sub - Division Engineers

From the data collected so far and from the visits to the various Sub -Divisions by the study team before and during the inspection programme, it is evident that each Sub - Division, which on average is responsible for 500km of the road network, has only a limited number of engineers to carry out the maintenance duties. These duties include the inspection, evaluation and consideration of the repair method, the supervision of the maintenance and repair works and the quality control of the materials and work.

It appears that some of these duties are carried out by technician staff and unless these members of staff are very experienced or have had adequate training, this may lead to a deterioration of the quality of the maintenance service being provided at Sub - Division level.

More engineers provided at Sub - Division Offices would help to strengthen the capability of these teams and provide the level of skill to deal with the duties and responsibilities allocated to them.

5.3.6 Training for Engineers

Managers working with limited budgets in most cases see training as an area for cuts as they look upon it as a cost rather than looking at the benefits that training can produce. This

happens across the world and in some of the most well known companies. If training is focused on the issues being dealt with on a day to day basis by the member of staff, not only will they become more efficient in what they are doing but in the case of maintenance work they may well be able to identify problems at an early stage. This could save considerable sums of money by being able to carry out preventative maintenance early rather than have an expensive major repair to carry out later on. Training properly identified and carried out boosts the staff morale and in doing so benefits the employer in the ways indicated above. However, both the staff to be trained and the subject matter need to be carefully selected.

Training in the materials in use, understanding how the road pavement works, issues that reduce the pavement life, inspection and evaluation techniques and repair methods are all topics that could be used as training material and dealt with to a lesser or greater degree of detail depending on the different levels of staff undergoing training.

Whilst experience counts for a great deal when dealing with pavement and maintenance issues generally, a formal training programme for new staff or to increase the knowledge of the established staff will keep a high level of performance in the maintenance team. KGM has a programme of training and this should be strengthened with specific maintenance topics focused on the key issues effecting the work undertaken by the Maintenance Division.

CHAPTER 6

DETAILED INSPECTION

CHAPTER 6 DETAILED INSPECTION

6.1 General

6.1.1 Objectives of the Detailed Inspection

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

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

6.1.2 Selection of Inspection Section

40 sections (40km) have been selected for detailed inspection based on the results of the preliminary inspection. The selection conditions are as follows:

(1) All types and levels of road damage are covered.
(2) The sections cover all the sub-divisions on the study route.
(3) The detailed survey is carried out on main routes.
(4) The special damage types in Turkey are covered.

Table 6.1.1 shows the detailed inspection sections, damage items and damage levels. Fig.6.1.1 shows the detailed inspection sections.

6.2 Selection of Detailed Inspection Items

The detailed inspection items are selected based on the following conditions:

(1) To include the damage that was found during the visual inspection.
(2) To cover the overall characteristics of the type of damage.
(3) To cover the items selected by the study team and KGM counterparts.
(4) To collect data and information to be included in the manuals.

Table 6.2.1 shows the detailed inspection items for each damage type, and Table 6.2.2 shows the supplemental survey points and items.

Table 6.1.1 Selection of Detailed Inspection Section

	Section No.	Sub-Div	Km.	Pavement Type	Detailed Inspection Items																								Remarks
					Pavement					Slope										Side Ditch and Culvert						Retaining Wall			Snow&Ice Control Facilities	
										Cutting					Embankment					Side Ditch			Culvert							
					Settlement	Crack	Pothole	Rutting	Wave	Landslide	Rock Avalanche	Collapse of Protective Wall	Crack	Erosion	Landslide	Rock Avalanche	Collapse of Protective Wall	Crack	Erosion	Accumulation of Debris	Settlement	Collapse	Accumulation of Debris	Settlement	Collapse	Crack	Settlement	Collapse		
1	100-10	17	40-41	As.Con.		A	A													A									
2	300-07	31	35-36	As.Con.															A										
3	650-09	31	16-17	Sur. Tr.	B	B	A	A	A	B																			
4	100-11	41	41-42	As.Con.		A		A	A	A									A	A			A						
5	100-12	41	9-10	As.Con.				A	A					A						A									
6	100-12	41	26-27	As.Con.						A	A			A						A			A						
7	750-05	42	26-27	Sur. Tr.		A													A	A					A				
8	750-05	42	31-32	Sur. Tr.		A								A											A				
9	750-06	42	4-5	As.Con.		A	A	A	A	A	A			A						A							A		
10	750-06	42	15-16	Sur. Tr.						A			A							A				A			A		
11	200-13	44	17-18	As.Con.				B							A														
12	200-14	44	27-28	As.Con.	A	A																						A	
13	200-09	45	50-51	As.Con.	A	A		A																					
14	200-11	45	21-22	As.Con.		B	B	B	B													A							
15	200-08	46	19-20	As.Con.	A	A		A	A										A										
16	200-09	46	23-24	As.Con.	A	A																							
17	200-13	47	34-35	As.Con.		A																							
18	100-17	72	55-56	Sur. Tr.						A		A							A										
19	795-03	72	20-21	Sur. Tr.			A		A																				
20	190-01	73	11-12	Sur. Tr.	A	A		A																					
21	190-02	73	18-19	Sur. Tr.	A																								
22	785-05	73	15-16	Sur. Tr.		B					A																		
23	795-01	75	61-62	As.Con.	A	A	A	A																					
24	795-02	75	25-26	As.Con.	A	B																							
25	10-08	77	19-20	Sur. Tr.	A	B	B	B	A										A										
26	10-08	77	26-27	Sur. Tr.		B	B		A	A										A									
27	10-23	103	6-7	Sur. Tr.		B	B	A											A										
28	10-23	103	31-32	Sur. Tr.		B	B	B											A										
29	10-23	103	57-58	Sur. Tr.		A	A	A		A																			
30	10-19	104	16-17	Sur. Tr.		B	B	B		A																		A	
31	10-19	104	25-26	Sur. Tr.		B	B	B																			A		
32	10-20	104	26-27	Sur. Tr.		B	B	B											A	A									
33	10-21	105	5-62	Sur. Tr.		B	B	B											A	A							A		
34	10-21	105	28-29	Sur. Tr.		B	B	B		A										A	A		A				A		
35	650-14	132	13-14	Sur. Tr.	B	B	B	B	B																B	B			
36	650-12	134	36-37	Sur. Tr.						B															A	A	A		
37	650-10	134	49-50	Sur. Tr.			A			A																			
38	200-06	143	12-13	As.Con.		A																							
39	200-07	144	41-42	As.Con.		A																							
40	200-06	147	38-39	As.Con.		A																							

As.Con.:Asphaltic Concrete, Sur.Tr.:Surface Treated

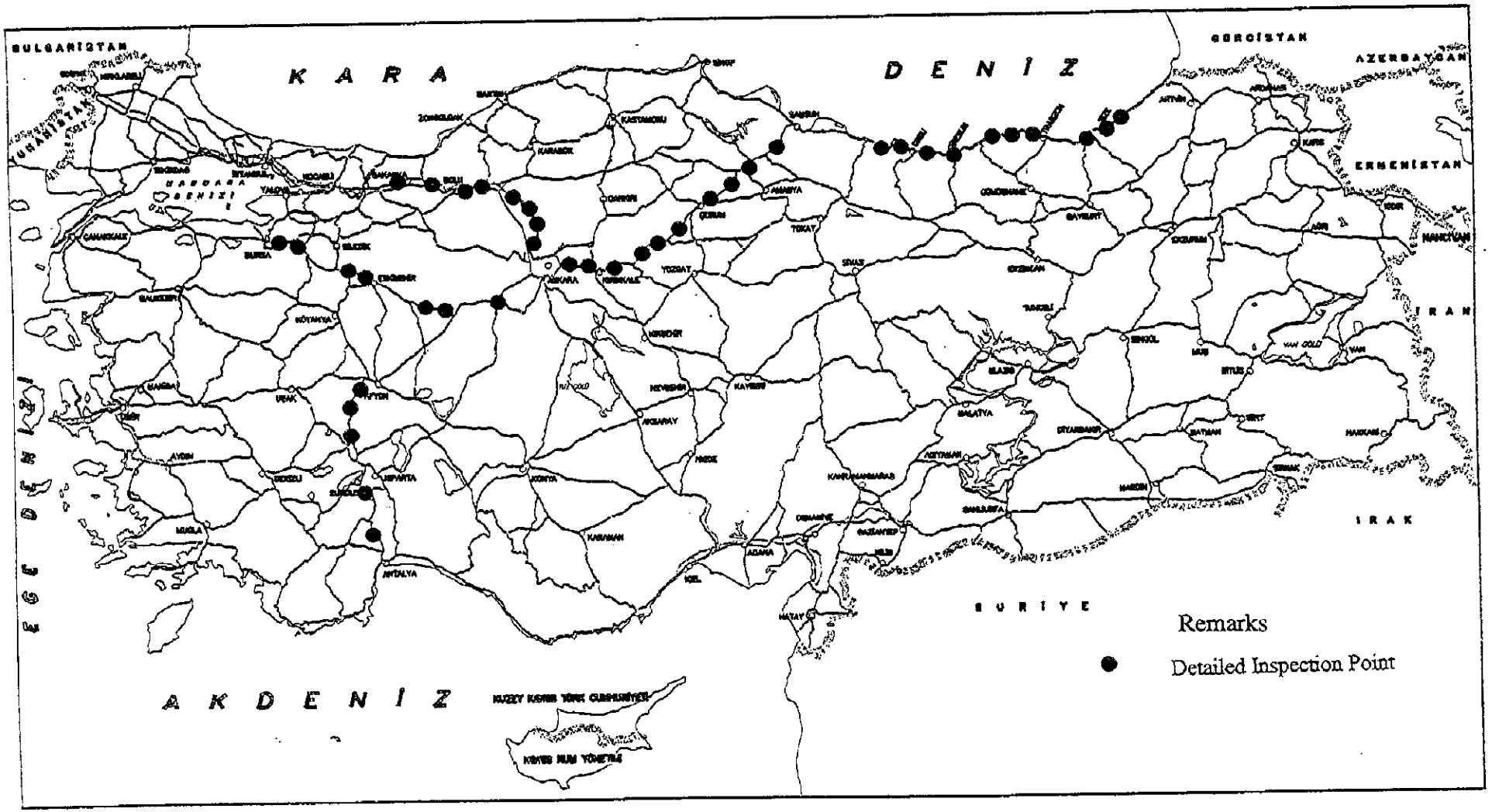


Fig. 6.1.1 Selection of Detailed Inspection Section

Table 6.2.1 Detailed Inspection Items

Inspection Items	Damage Type	Inspection Items														Application
		Site Inspection		Survey				Soil Tests						Correction of Data		
				Measurement		Topographical Sr.		Site Study		In-Situ Test			Labaratory Tests			
		Present Condition	Slope Measurement	Dimension/gradient	Surface Condition	Cross Section	Height	Top Soil	Gradient	Bore Hole	Core Test	CBR		Geological Map	Inventory	
Embankment	Submerge	O		O						O		O		O		
	Collapse	O	O	O										O		
Pavement	Settlement	O								O		O	O			
	Crack	O			O						O		O			
	Pothole	O			O						O					
	Rutting	O			O						O					
	Wave	O			O						O					
Gulley	Accumulation of Debris	O														
	Settlement	O														
	Collapse	O		O												
Shoulder	Washing Out	O				O								O	O	
Side Ditch	Collection of Debris	O														
	Settlement	O														
	Collapse	O		O												
Retaining Wall	Crack	O		O		O				O		O		O		
	Settlement	O		O			O			O		O		O		
	Collapse	O				O				O		O		O		
Snow&Ice Control Facilities	Collapse	O		O		O								O		
	Chain Signboard	O													O	
	Abrasion due to chain	O			O						O					
	Snowploughing														O	
Slope	Landslide	O	O			O		O		O				O		
	Rock Avalanche	O				O		O	O					O		
	Collapse of Protective Wall	O		O										O		
	Crack	O	O	O				O						O		
	Erosion	O				O		O						O		
Culvert	Collection of Debris	O					O							O		
	Settlement	O					O							O		
	Collapse	O				O								O		

Table 6.2.2 Supplementary Survey Points and Items

	Section No.	Sub Div.	Km.	Pavement Type	Detailed Inspection Items																								Remarks
					Pavement					Slope										Side Ditch and Culvert						Retaining Wall			Snow&Ice Control Facilities	
										Cutting					Embankment					Side Ditch			Culvert							
					Settlement	Crack	Pothole	Rutting	Wave	Landslide	Rock Avalanche	Collapse of Protective Wall	Crack	Erosion	Landslide	Rock Avalanche	Collapse of Protective Wall	Crack	Erosion	Accumulation of Debris	Settlement	Collapse	Accumulation of Debris	Settlement	Collapse	Crack	Settlement	Collapse		
1	100-10	17	40-41	As.Con.		CB,CR	CB,CR																						
2	300-07	31	35-36	As.Con.															CS										
3	650-09	31	16-17	Sur. Tr.																									
4	100-11	41	41-42	As.Con.																									
5	100-12	41	9-10	As.Con.																									
6	100-12	41	26-27	As.Con.						BH,CS	CS			CS															
7	750-05	42	26-27	Sur. Tr.																									
8	750-05	42	31-32	Sur. Tr.										CS											CS				
9	750-06	42	4-5	As.Con.																									
10	750-06	42	15-16	Sur. Tr.																									
11	200-13	44	17-18	As.Con.											BH,CS														
12	200-14	44	27-28	As.Con.																									
13	200-09	45	50-51	As.Con.		CB,CR		CB,CR																					
14	200-11	45	21-22	As.Con.																									
15	200-08	46	19-20	As.Con.															CS										
16	200-09	46	23-24	As.Con.																									
17	200-13	47	34-35	As.Con.		CB,CR																							
18	100-17	72	55-56	Sur. Tr.											BH,CS														
19	795-03	72	20-21	Sur. Tr.																									
20	190-01	73	11-12	Sur. Tr.	BH,CS	CB,CR		CB,CR																					
21	190-02	73	18-19	Sur. Tr.																									
22	785-05	73	15-16	Sur. Tr.																									
23	795-01	75	61-62	As.Con.	BH,CS	CB,CR	CB,CR	CB,CR																					
24	795-02	75	25-26	As.Con.																									
25	10-08	77	19-20	Sur. Tr.																									
26	10-08	77	26-27	Sur. Tr.						BH,CS																			
27	10-23	103	6-7	Sur. Tr.																									
28	10-23	103	31-32	Sur. Tr.																									
29	10-23	103	57-58	Sur. Tr.		CB,CR	CB,CR	CB,CR																					
30	10-19	104	16-17	Sur. Tr.																									
31	10-19	104	25-26	Sur. Tr.																								CS	
32	10-20	104	26-27	Sur. Tr.																									
33	10-21	105	5-62	Sur. Tr.															CS										
34	10-21	105	28-29	Sur. Tr.																									
35	650-14	132	13-14	Sur. Tr.		CB,CR	CB,CR	CB,CR	CB,CR																	CS	CS	CS	
36	650-12	134	36-37	Sur. Tr.																									
37	650-10	134	49-50	Sur. Tr.																									
38	200-06	143	12-13	As.Con.		CB,CR																							
39	200-07	144	41-42	As.Con.		CB,CR																							
40	200-06	147	38-39	As.Con.		CB,CR																							

CB:CBR Test, CS:Cross Section, BH:Bore Hole, CR:Core Sampling, As.Con.:Asphaltic Concrete, Sur.Tr.:Surface Treated

6.3 Inspection Method

6.3.1 Inspection Method

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

The Inspection Items are:-

- Pavement
- slope (cuttings and embankments)
- drainage (side ditches, gullies and culverts)
- retaining walls
- snow and ice facilities

(1) Pavement

The Detailed Inspection programme has been devised to demonstrate all the types of survey and methods for the collection and recording of data. This will include:-

- cracking
- potholes
- rutting
- longitudinal roughness (wave)
- settlement

in addition core sampling and CBR tests will be carried out.

(a) Cracking Survey

The survey is carried out by sketching the road surface condition onto a grid and this may be supplemented by site photographs.

The road surface is divided into 0.5 meter squares and the surface condition is sketched onto a standard 10m x 3.5m grid sheet which is provided with the inspection sheet. In order to make the measurements, a grid must be marked on the road surface or alternatively a rope grid can be used which is spread onto the road surface in 5m or 10m sections.

Individual cracks are marked on the grid with a line as observed and areas of alligator cracking (crazing) and potholing are marked on as a hatched area to represent patching.

From the sketch showing the surface condition, a cracking ratio can be calculated to indicate the crack condition of the section of road.

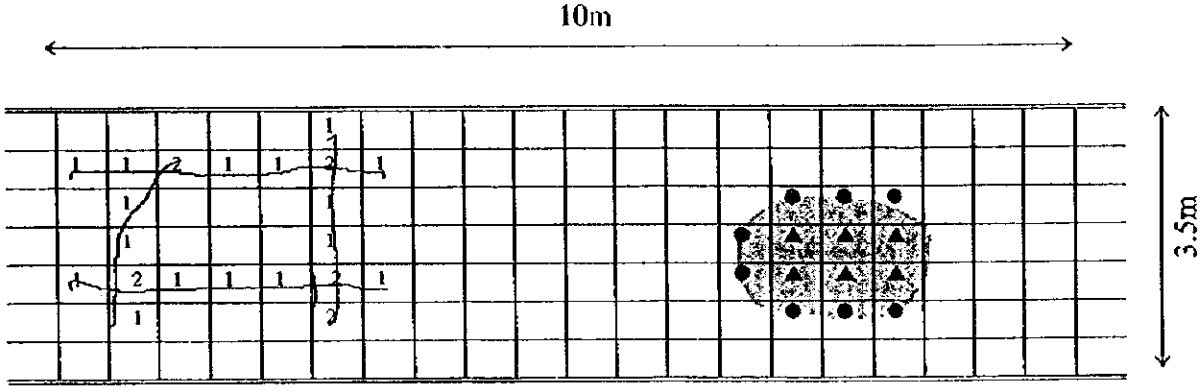
Fig. 6.3.1 shows an example of a sketch and calculation of the Cracking Ratio.

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 of Grids		Area		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

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

Fig. 6.3.1 Calculation of Cracking Ratio

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 by a visual inspection of the road section which will save a lot of time and resources.

(b) Pothole Survey

At the same time as the cracking survey, a pothole survey should be carried out. The maximum plan dimension and the maximum depth of each pothole in the survey section should be measured and recorded in the space provided on the inspection sheet. These measurements are in mm.

(c) Rutting Survey

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

To determine the average rut depth, a 3.5m straight edge is used and measurements are taken in each wheel track at 20m intervals (see Fig. 6.3.2). The maximum rut depth for each wheel track is recorded as D_1 and D_2 (see Fig. 6.3.3) and the rutting depth (D), is defined as the greater of D_1 and D_2 at each 20m interval. The average rut depth is calculated from the 5 recorded values of D.

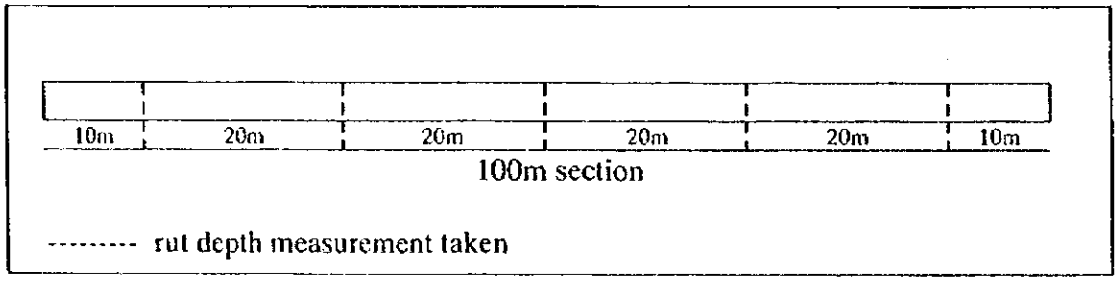


Fig. 6.3.2 Rut depth sections

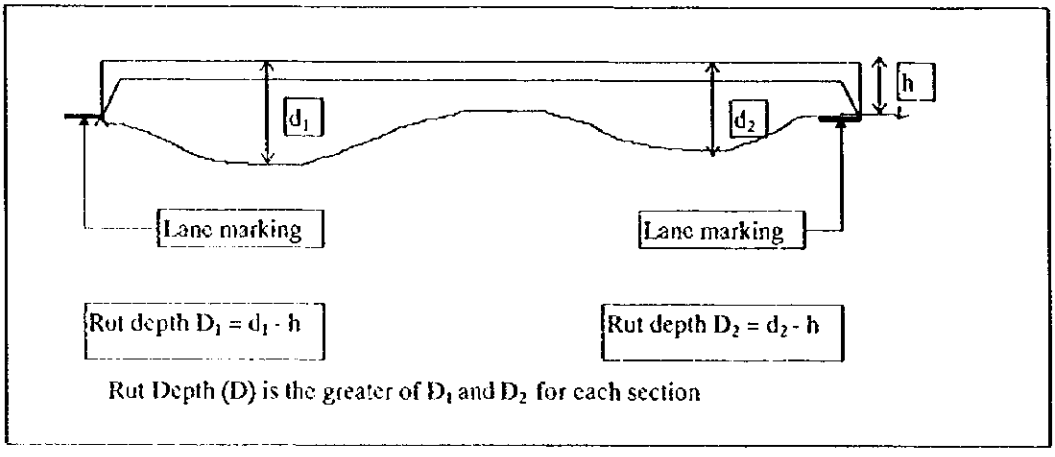


Fig. 6.3.3 Measurement of Rut Depth

(d) Longitudinal Roughness (wave)

The easiest and quickest way to measure longitudinal roughness is with a laser profilometer, either manually operated or vehicle mounted. However, as this equipment is expensive or may not be available, we are proposing that this survey is 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 0.8m to 1.0m away from the edge of the lane. Measurements are taken for each 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.

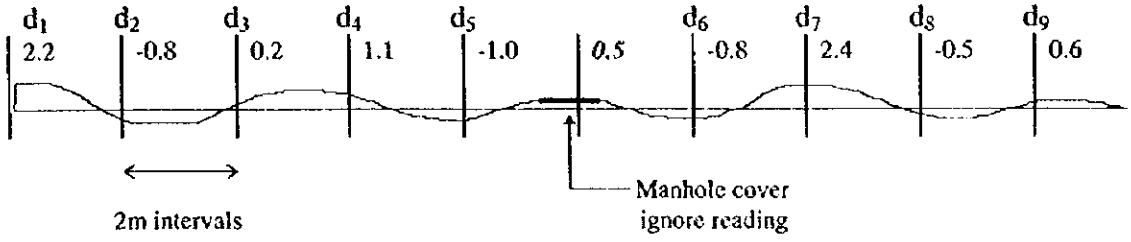


Fig. 6.3.4 Longitudinal Roughness Measurements

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

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

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

(e) Settlement

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.

Measurements should be taken in the wheel tracks in each lane over a 15m length on the approach to the structure. The maximum depth over the 15m is recorded as the settlement depth in mm.

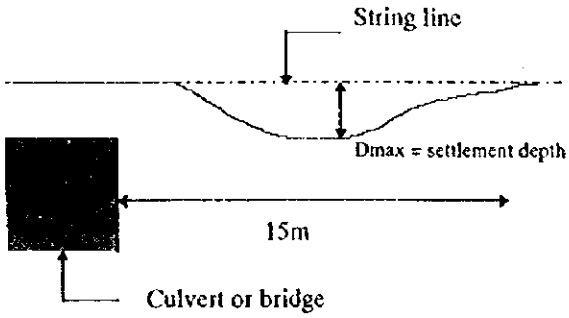


Fig. 6.3.5 Settlement Measurement

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.

CBR Values

CBR values will be obtained using in situ tests.

Core Sampling

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. Core sample locations should be selected to suit the defects being investigated.

Pavement Condition Rating

Many countries now use a pavement condition rating to assist in managing the pavement works. Using data collected from some of the above surveys, a pavement condition rating can be calculated and this process is described below.

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. This enabled the maintenance managers to focus their attention on those sections of road showing poor characteristics. It also helped them to prioritise these sections and to use their limited budget to try to maintain a consistent ride quality for the road user.

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 as follows:-

- cracking
- patching and potholes
- rutting
- longitudinal roughness

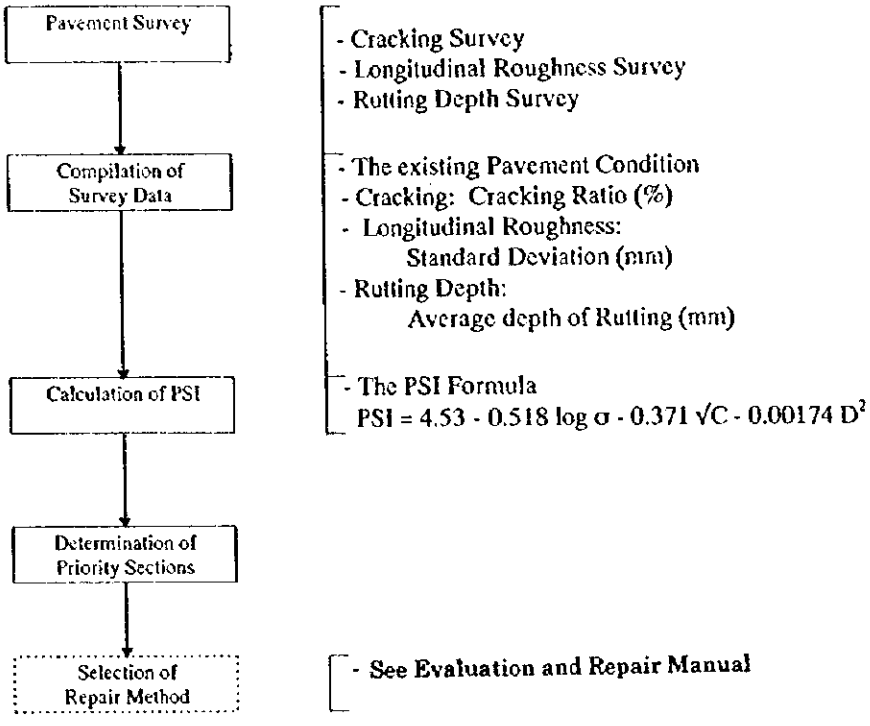


Fig. 6.3.6 Flow Chart for Pavement Condition Rating

A flow chart for the pavement condition rating is shown in Fig. 6.3.6.

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.

Calculation of PSI

Following the pavement condition survey, the Present Serviceability Index can be calculated from the following formula:-

$$PSI = 4.53 - 0.518 \log \sigma - 0.371 \sqrt{C} - 0.00174 D^2$$

where,
PSI = Present Serviceability Index
σ = Standard Deviation of longitudinal roughness (mm)
C = Cracking Ratio (%)
D = Average Depth of Rutting (mm)

The PSI value will provide a common index by which the pavement condition on each section of road can be judged. It will enable the worst sections of road to be prioritised in the planning of works programmes and may also be used as a guide to the most appropriate method of maintenance or repair.
Table 6.3.1 shows an approximate relationship between PSI and various Treatment Methods.

Table 6.3.1 PSI Values and the Related Treatment Methods

PSI Value	Treatment Method
PSI < 1.0	Reconstruction
1.1 < PSI < 2.0	Overlay
2.1 < PSI < 3.0	Surface Treatment
PSI > 3.0	No work required

The figures in Table 6.3.1 are a guide only and may require adjustment depending on the experience of the particular pavement and materials in use and their rate of deterioration. Similar methods have been used in Turkey and this experience should prove useful in deciding on the threshold levels for the various treatment methods.

In deciding when to repair sections of road, consideration should be given to repairing damage early before it becomes more serious.

(2) Slope (cuttings and embankments)

Cuttings and embankment slopes 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 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 stabilized provided that the maintenance engineer is aware of the causes of the failure and recognizes 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.

The Detailed Inspection requires the slope to be inspected on foot and sketches provided on the Inspection sheet.

A plan and section of the slope being inspected should be sketched into the spaces provided on the Inspection Sheet. The slope condition and any slope protection works should be indicated. Other inspection items to be recorded are:-

- slope type
- damage type
- soil type
- plantation (vegetation)
- drainage
- ground water

(3) Drainage

Maintaining effective drainage is one of the key factors in achieving long pavement life. The Detailed Inspection is designed to identify problems at an early stage in order to prevent more serious defects developing.

A plan and section should be sketched on the Inspection sheet at the site to identify the location and problem. The direction of flow of the drainage system and the fall on the culvert should be shown. For the drainage system and culverts, the following items should be identified:-

- drainage system or culvert type
- damage type
- land use

Where no drawings or design details of the culvert are available, measurements should be taken and recorded on the inspection sheet for future use.

(4) Retaining Walls

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.

Sketches and a cross section of the retaining wall should be drawn at the site showing all the key dimensions.

Items to be recorded are:-

- wall type
- damage type
- presence of weep holes
- soil type

(5) Snow and Ice Control Facilities

Ineffective snow and ice control facilities can have a serious impact on traffic movements through blocked or icy roads in the winter periods. The inspection of these facilities is therefore very important in order to keep the roads open to traffic.

The Inspection will include identifying the type of facility, and for fences, the recording of dimensional information on the inspection sheet for future use.

In addition, general information on the condition and effectiveness of the facility will be collected from the area. This information should be collected from local KGM staff and where it may be helpful, from local residents. The information to be collected includes:-

- effectiveness of the facility
- defects
- general conditions in the area
- maintenance information

The information is recorded on the inspection sheet and will be used to assess whether further investigation is required at the site or in terms of a review of the design of the facility.

6.3.2 Inspection Sheet

The detailed inspection was executed out using an inspection sheet for each inspection item. The inspection sheets (Table 6.3.2 to Table 6.3.9) were prepared to have the following characteristics:

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

6.3.3 Inspection Tools

Tools for the detailed inspection are shown in Table 6.3.10

Table 6.3.10 Tools for Inspection

Tool Name	Tool Name
Survey Sheet	Flash light
Camera	Slant Meter
Binoculars	Chalk
Tape measure	String line
Ribbon tape	Rain coat
Hand tape	Pens and pencils
Gauge	Survey Pole
Safety yellow jacket	Paint

6.4 Inspection Team

The detailed inspection will involve three teams each comprising of the study team member, KGM counterpart, division chief maintenance engineer and sub-division chief.

6.5 Inspection Schedule

The detailed inspection will be carried out throughout the week ends and holidays periods with the cooperation of the KGM and the police. The period of the inspection is for about 3 to 4 weeks from the end October.

In November, the supplementary surveys for cores, boring, topographical survey etc, will be carried out by local consultants contracted by the JICA study team. This period is for about 1 month.

Table 6.3.2 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	$PSI = 4.53 - 0.518\log\sigma - 0.371\sqrt{C} - 0.00174D^2 =$

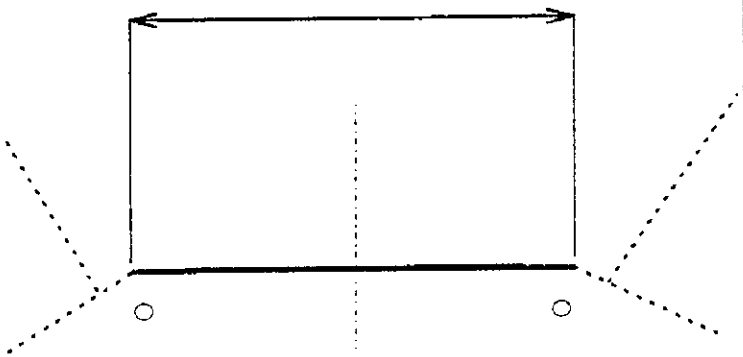
Index of PSI

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

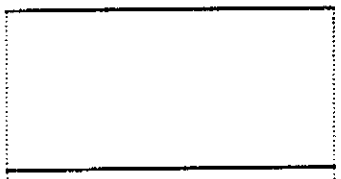
Survey Point: km+ m to m



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

Cracking ratio C = %

Calculation of rutting depth

No.1	Depth:	No.6	Depth:
No.2		No.7	
No.3		No.8	
No.4		No.9	
No.5		No.10	

Average Depth (mm)

Database for pothole

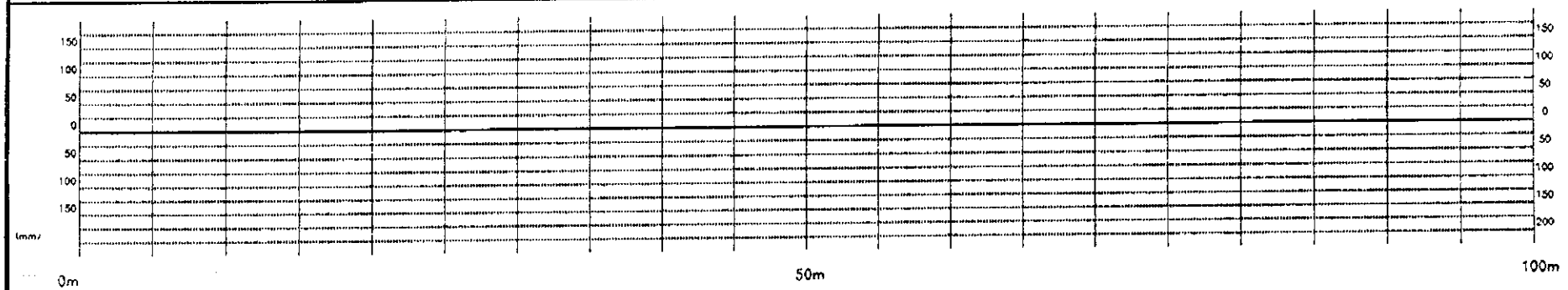
No.1	Depth:	Diameter	No.6	Depth:	Diameter
No.2			No.7		
No.3			No.8		
No.4			No.9		
No.5			No.10		

Average depth = mm

Average diameter mm

Longitudinal Roughness Survey point: km+ m to m

Standard Deviation of Roughness σ = mm



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

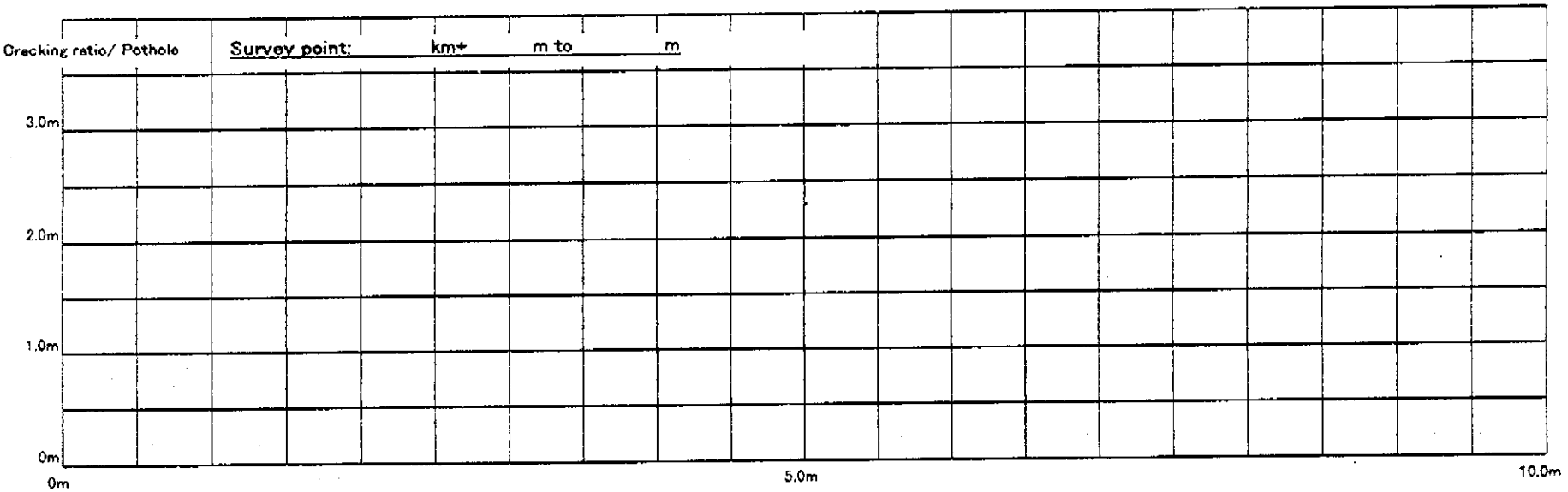


Table 6.3.3 Detailed Inspection Sheet

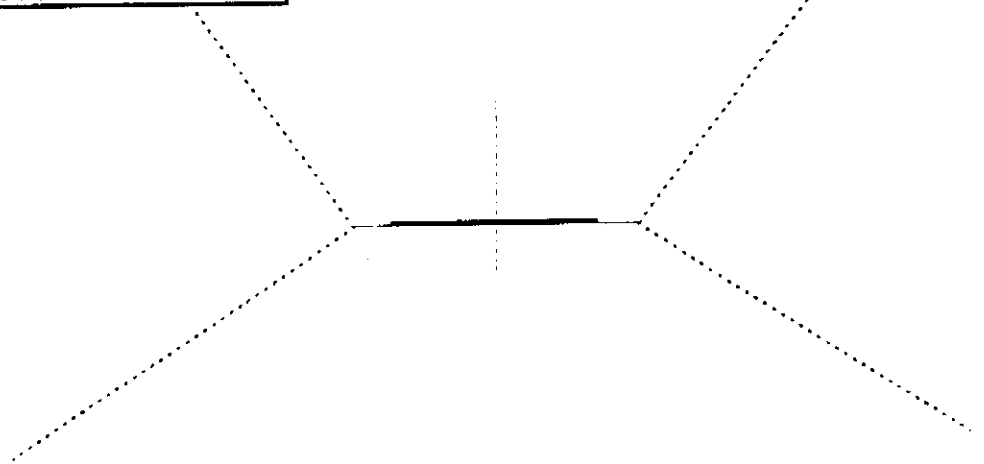
Detailed Inspection Sheet for : SLOPE & SHOULDER — Inspection Date: / / — No.

				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 avalanche (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) Shotorete (3) Gabion (4) Plantation (5) Other
	Sketch	
Slope Condition	Sketch	Road

Sketch for Plan

Sketch for Section



Version 1 8/97

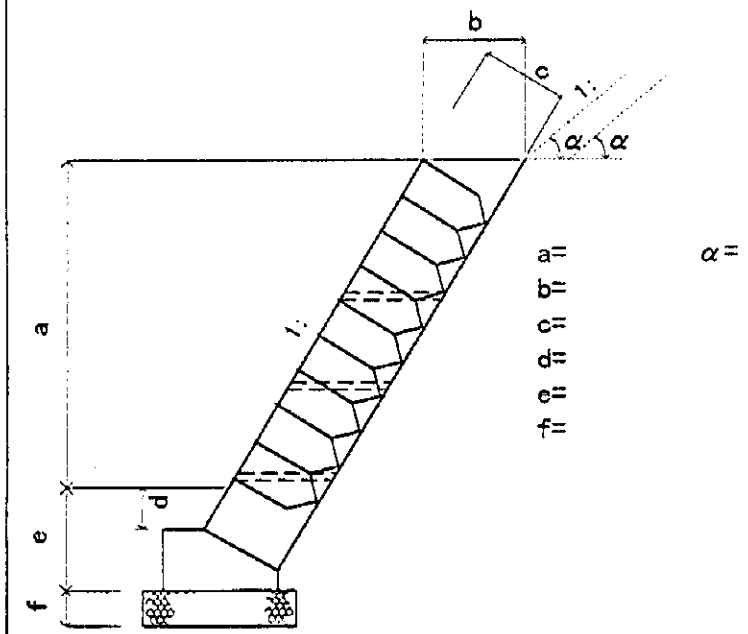
Table 6.3.4 Detailed Inspection Sheet

Detailed Inspection Sheet for : RETAINING WALL				Inspection Date: / /		No.
				Directorate	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	Structure type	(1) Stone masonry (2) Retaining wall (Gravity, L-shaped, Couterfort, Other)	Sketch for Section
	Damage type	(1)Cracking (2)Settlement (3) Collapse	
	Soil type	(1) Rock (Hard or Soft) (2) Gravel (3) Sand (4) Silt (5) Clay (6) Other ( )	
	Weep hole	(1) Yes (diameter: mm) (2) None (Interval: m × m)	

Sketch

Sketch for Stone Masonry



a=
b=
c=
d=
e=
f=

α =

Sketch for Retaining Wall

Version 1 8/97

Table 6.3.5 Detailed Inspection Sheet

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

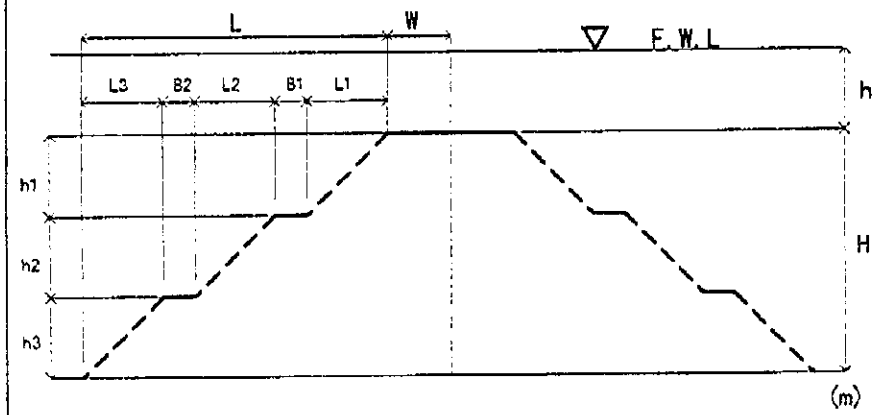
				Director	Chief Eng.	Inspector
General Information	Route:	Location: km to km				
	KGM-Division:	Subdivision:				
	Road Class:	No. of Carriageways:	No. of Lanes:			
	Direction: to					
	Year of construction:					

Inspection Items	Damage type	(1) 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

Version 1 8/97

Table 6.3.6 Detailed Inspection Sheet

Detailed Inspection Sheet for: SNOW/ICE CONTROL FACILITIES 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:					

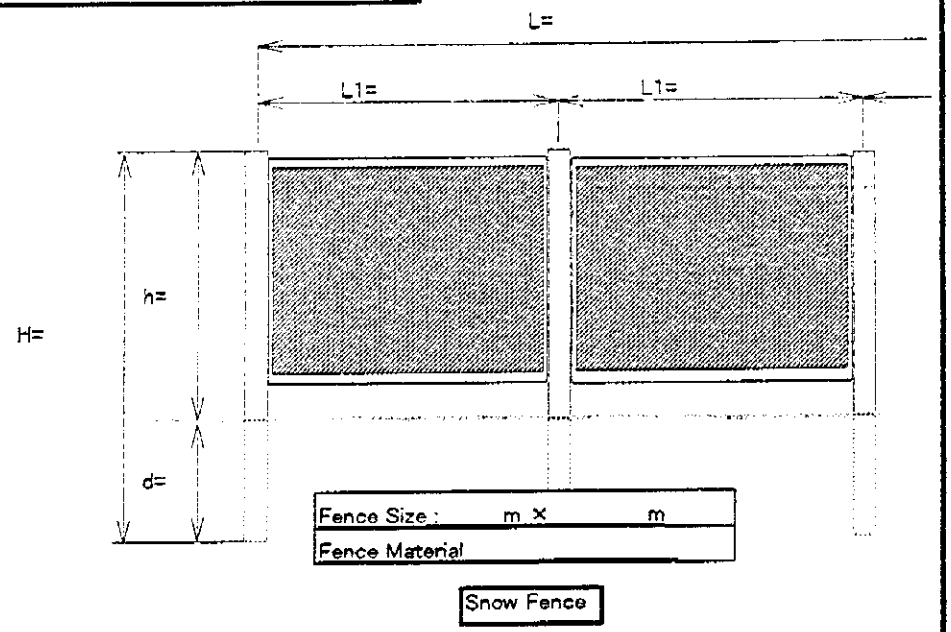
Inspection Items	Survey Items	(1)Snow fence (2) Tree fence (3)Tunnel (4) Forest plantation (5)Terrain modification
	Damage type	(1) Collapse
	Comment	

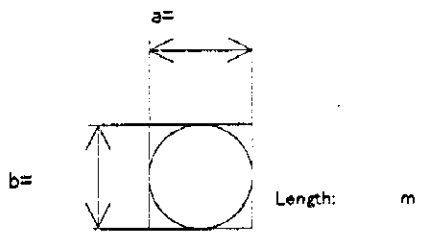
Sketch

Sketch for Plan

Sketch for Section

Sketch for Fence dimensions





Post material: (1) Wooden (2) RC (3) PC

Fence post dimension

Sketch for Foundation

Version 1 8/97

Detailed Inspection Sheet for: SNOW/ICE CONTROL FACILITIES		Inspection Date: / / No.
Items	**Evaluation/Condition**	**Comment**
1.Effect of facility	(1)Good	
	(2)Not good enough, should be replaced/improved	
2.Defect of facility	(1)No defect, almost perfect	
	(2)Facility height is not enough	
	(3)Facility width is not enough	
	(4)Facility length is not enough	
	(5)Facility location is not suitable	
	(6)Facility material is not suitable	
	(7)Facility design is poor	
	(8)Facility is not strong enough	
	(9)Other	
3.Snow/Ice condition	(1)Heavy snowfall	
	(2)Strong wind	
	(3)Low temperature	
	(4)Poor visibility due to blizzard	
	(5)Snow drift on road	
	(6)Snow Avalanche	
	(7) Snow falling down from cutting slope	
	(8)Road surface freezing	
	(9)Other	
4.Maintenance of facility	(1)No maintenance work is needed	
	(2).Repair is needed sometimes	
	(3)Repair is needed almost every year	
	(4)Maintenance work is done by KGM	
	(5)Maintenance work is assigned to contractors	
	(6)Repair cost	

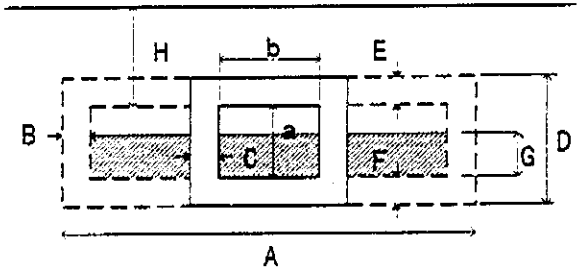
Table 6.3.7 Detailed Inspection Sheet

Detailed Inspection Sheet FOR : Drainage and Culvert			Inspection Date: / /		No:
			Director	Chief Eng.	Inspector
General Information	Route:	Location: km to km			
	KGM-Division:	Sub-Division:			
	Road Class:	Number of Carriageways:			
	Number of Lanes:	Direction: to			
	Year of Construction:				

Drainage & Culvert	Culvert Type	(1) Box (2) Pipe (3) Other
	Damage Type	(1) Accumulation of Debris (2) Collapse (3) Settlement
	Land Use	(1) Residential (2) Urban (3) Industrial (4) Farm (5) Forest (6) Others

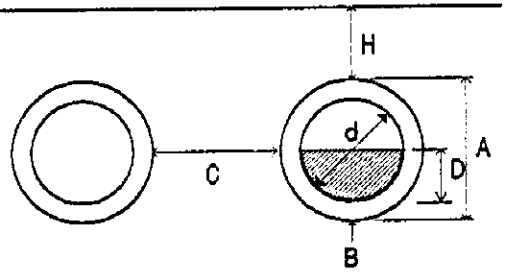
Defects Observed

Road



A= B= C=
D= E= F=
G= H=
a= b=

Road



A= B= C=
D= H=
d=

Table 6.3.8 Detailed Inspection Sheet

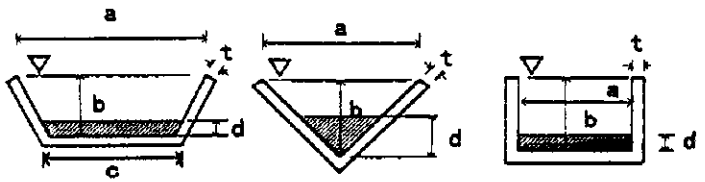
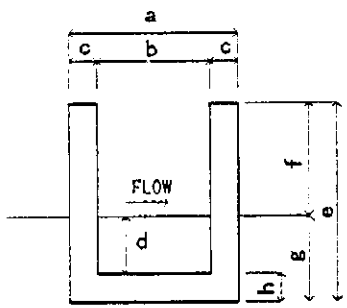
Detailed Inspection Sheet FOR : Side Ditch and Gully			Inspection Date: / /		No:
			Director	Chief Eng.	Inspector
General Information	Route:	Location: km to km			
	KGM-Division:	Sub-Division:			
	Road Class:	Number of Carriageways:			
	Number of Lanes:	Direction: to			
	Year of Construction:				
Side Ditch	Damage Type	(1) Accumulation of Debris (2) Collapse (3) Settlement	Defects Observed:		
	Dimension	 a= b= c= d= t= a= b= d= t= a= b= d= t=			
Gully	Damage Type	(1) Accumulation of Debris (2) Collapse (3) Settlement	Defects Observed:		
	Dimension	 a= b= c= d= e= f= g= h=			

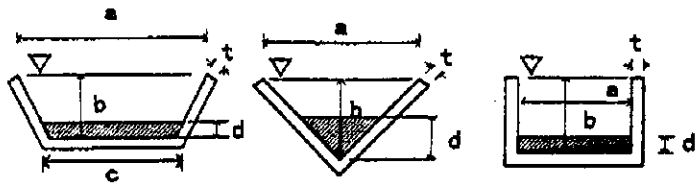
Table 6.3.9 Detailed Inspection Sheet

Detailed Inspection Sheet FOR : Drainage for Slope Inspection Date: / / No:

Drainage System	(1) Berm Ditch (2) Crest Ditch (3) Toe Ditch
Damage Type	(1) Accumulation of Debris (2) Collapse (3) Settlement
Land Use	(1) Residential (2) Urban (3) Industrial (4) Farm (5) Forest (6) Others

Defects Observed:

Drainage for Slope



a=
b=
c=
d=
t=

a=
b=
d=
t=

a=
b=
d=
t=