DIRECTORATE FOR ROADS OF VIETNAM (DRVN)
MINISTRY OF TRANSPORT (MOT)
THE SOCIALIST REPUBLIC OF VIETNAM

JAPAN INTERNATIONAL COOPERATION AGENCY

# THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE II

## FINAL REPORT

## (*Volume 2.1: Pavement Condition Survey Manual*)

**March 2018**

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**KATAHIRA & ENGINEERS INTERNATIONAL**
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**ORIENTAL CONSULTANTS**
**PASCO CORPORATION**

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# VOLUME 2.1

1. **Overview of Pavement Condition Survey *[PCS-Vol. 1]***
2. **Management Manual *[PCS-Vol. 2]***
3. **Operation (Field survey & Data analysis) *[PCS-Vol. 3]***
4. **Instruction Book of REAL Mini *[PCS-Vol. 4]***
5. **Data Preparation *[PCS-Vol. 5]***
6. **Data Validation *[PCS-Vol. 6]***
7. **Appendix 1**

JAPAN INTERNATIONAL COOPERATION AGENCY

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# THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE II

## PAVEMENT CONDITION SURVEY MANUAL

## Volume 2.1.1: Overview

MARCH 2018

JICA PROJECT TEAM

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# Glossary

| | |
|---|---|
| Administration Database | Database of PMS data storing administrative information. |
| Analyzed section Table (Table-3) | The final section table prepared by PC data. |
| Calibration | Adjustment of devices for true value |
| Camera for front image | The device for measuring the front image |
| Camera for road image | The device for measuring the road image |
| Crack | Damage index based on the pavement surface crack. |
| End point | The end position of the target route. |
| Excluded section | The out of scope section for survey. For example, the section that is under construction or being transferred to the management of another agency. |
| IRI (International Roughness Index) | Damage index based on the longitudinal shape on the pavement surface. |
| KP (Kilometer post) | Positon of route. It is consist of Kilo-post station number and distance from the Kilo-post station. |
| Kilo-post station | A road sign on the side of the road to indicate distances from major cities. |
| Kilo-post station number | The number indicated on the kilo-post stations in the side of the road. |
| Laser displacement sensor | The device for measuring of longitudinal profile |
| Laser scanner | The device for measuring of transverse profile |
| Main control unit | The unit to control the measurement device |
| Marking | Marking of the start point and end point for easier recognition. |
| Overlapping section | A section in which two routes overlap in terms of management. |
| Patching | The repaired part of partially damage area (Pothole, crack, and so on). |
| Pavement condition | The condition of pavement surface. The pavement condition is evaluated for cracks, ruts and IRI. |
| Pavement condition survey vehicle | Vehicle assembled with measurement devices. |

| | |
|---|---|
| PDCA cycle | Management cycle acronym for PLAN, DO, CHECK and ACT. |
| PMS | Pavement Management System. |
| PMS Database | Database stored for PMS dataset. |
| Power control unit | The Unit for supply and control the electric power to the measurement device |
| REAL Mini | Name of the pavement condition survey vehicle made by PASCO CORPORATION. |
| Rut | Damage index based on the transverse shape on the pavement surface. |
| Start point | The start position of the target route. |
| Survey plan section Table (Table-1) | Table of planned survey length |
| Surveyed section Table (Table-2) | Table-1 with extensions added |

# Acronyms

| | |
|---|---|
| AC | Asphalt Concrete |
| BOT | Build-Operate-Transfer |
| BST | Bituminous surface treatment |
| CC | Cement Concrete |
| DPI | Department of Planning and Investment |
| DRVN | Directorate for Roads of Vietnam |
| HDD | Hard Disk Drive |
| IWP | In wheel path |
| KP | Kilometer post |
| MMD | Management and Maintenance Department |
| OWP | Out wheel path |
| PC data | Pavement condition data |
| PCS | Pavement Condition Survey |
| PCSV | Pavement Condition Survey Vehicle |
| PDOT | Provincial Department of Transport |
| PPC | Provincial People's Committee |
| QC | Quarter-Car |
| RMBs | Road Management Bureaus |
| SB | Sub Bureaus |
| STEICD | Science, Technology, Environment, International Cooperation Department |
| TOR | Terms of Reference |

# 1. Introduction

## 1.1. About This Manual

Overview (PCS-Vol.1) is one of six manuals comprising the suite of the documentation for pavement condition survey. Figure 1.1 shows the component of pavement condition survey manual. Pavement condition survey manual is divided into three parts, Overview, Operation manual and Technical manual. Documents to be referenced depend on the responsibility and work steps of stakeholders involved in pavement condition survey. Overview describes the basic items of survey that all stakeholders should refer to. Operation manual shows important matters to be referred to mainly when survey work managing. Technical manual indicates technical matters such as system and device operation methods, data definition and data preparation. Figure 1.2 shows the description of contents of each document.

This document explains the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey. If there is any lack of information, addition and updates by DRVN staff would be recommended.

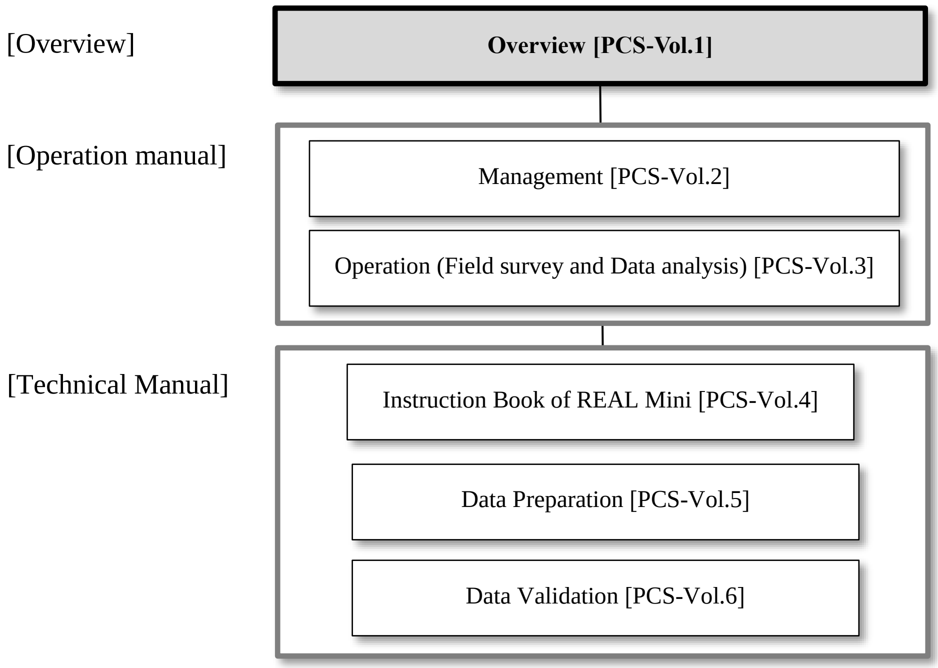



Figure 1.1 Pavement condition survey manual

[Overview]

| Overview (PCS-Vol.1] |
|---|

➔ Describe the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey.

[Operation manual]

| Management [PCS-Vol.2] |
|---|

➔ Describe the management work of road administrator on pavement condition survey. It contains all management works such as the planning, supervising, and data checking on pavement condition survey describing. It is to be used by administrator who to carry out the management of pavement condition survey.

| Operation (Field survey and Data analysis) [PCS-Vol.3] |
|---|

➔ Describe the survey and analysis work of survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey.

[Technical manual]

| Instruction Book of REAL Mini [PCS-Vol.4] |
|---|

➔ Describe the operation procedure of REAL Mini system. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

| Data Preparation [PCS-Vol.5] |
|---|

➔ Describe the contents of pavement condition data (PC data). It contains the code definition, explanation of each item of PC data and so on.

| Data Validation [PCS-Vol.6] |
|---|

➔ Describe the data check procedure when creating the PC data. It is to be used by person whose task is to carry out the data check in pavement condition survey.

Figure 1.2 Contents of Pavement condition survey manual

# 2. Summary of Pavement Condition Survey

## 2.1. Pavement Condition Survey

1) Pavement Condition Survey

Pavement condition survey measures pavement damages such as cracks, ruts and IRI using the pavement condition survey vehicle (hereafter PCSV) on moving and make the pavement condition data files. The pavement damage expresses surface (crack), transverse (rut) and longitude (IRI) (Figure2.1).

Pavement condition survey measures not only pavement condition but also road inventory information, forward view image and position information at the same time.

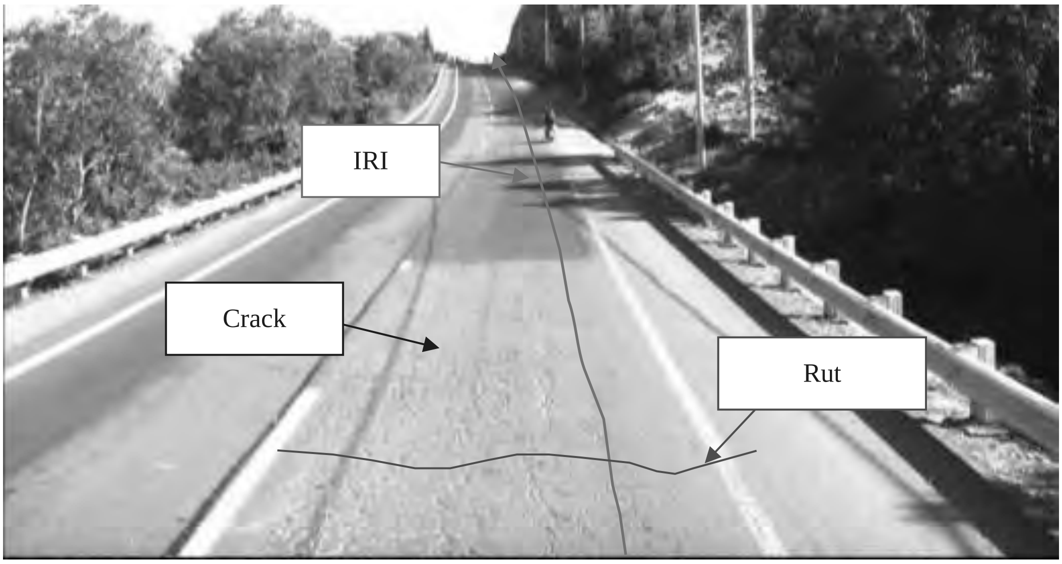



Figure 2.1 Pavement damage to be evaluated by PCS

a) Pavement Condition Survey Vehicle (PCSV)

PCSV is a measuring system for the continuous collection of the pavement condition data (Crack, Rut and IRI) and forward view image of the vehicle synchronized with distance and positional information. These data are measured by the equipment installed to the vehicle. PSCV has the following sensors (Figure2.2): CCD camera for front image, GPS, Laser Scanner, CCD Cameras for road image, Inertial Measurement Unit (IMU) and Laser Displacement Sensor. The front camera records front images of the road; GPS records locations; the laser profiler records cross section profiles to identify rut depths; The CCD camera for front image in black and white to identify cracks; IMU and laser displacement sensor identify longitudinal profile for IRI.

In the field survey, operator uses two kinds of application modules. One is the measurement module. Other is Starting and ending point setting module. The measurement module is to control a start and end point of survey and display status of the system. Starting and ending point setting module is set the start/end position to collect data for analysis.

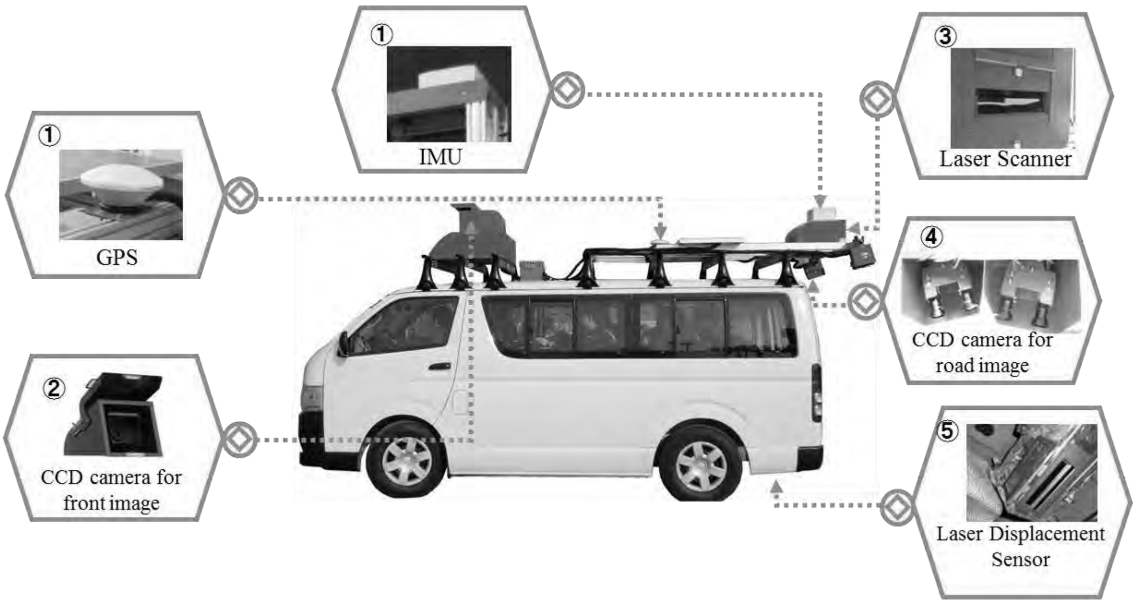



Figure 2.2 PCSV (REAL Mini)

Table 2.1 Applications of REAL Mini

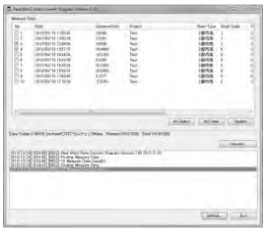
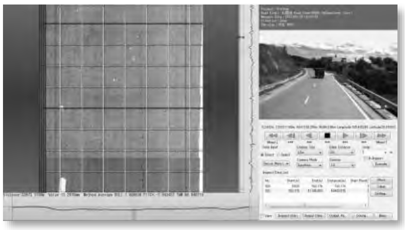
| Module | Module window | Description |
|---|---|---|
| Measurement module |  | To control and monitor the measurement |
| Starting and ending point setting module |  | To set the starting point and ending point in the measurement data. |

b) Applications for PC Data preparation

PCSV also has the dedicated applications for preparing the pavement condition data (hereafter PC data) file. There are four applications, data convert, data analysis, location setting and data processing. Table 2.2 shows the component of applications for preparing the PC data. Figure 2.3 shows the work flow of preparing the PC data using applications.

Operator converts the measurement data of PCSV to analysis data using Data convert module. And then, Operator analyzes the analysis data using Data analysis module. Data analysis module output the each result file (Rut depth, Cracking ratio/index, IRI) and list of front image and coordinates. Next, Operator set the location information to analysis data using Location setting module. Location setting module outputs the location data of road facility, intersection, changing lane, and so on. Finally, Operator processes the analysis data. Data processing module outputs the PC data for PMS using the output data of analysis and location module.

Table 2.2 Applications for PC data preparation

| No. | Module | Module window | Description |
|---|---|---|---|
| 1 | Data convert module |  | Convert the measurement data to analysis data. |
| 2 | Data Analysis module |  | Analysis the crack, rut, IRI. and Output the each result file and FV image list. |
| 3 | Location Setting module |  | Set the position of KP, structure, intersection, peculiar condition and so on. And output the position file based on setting result. |
| 4 | Data Processing module |  | Prepare the PC data file from the data of analysis and location setting application. |

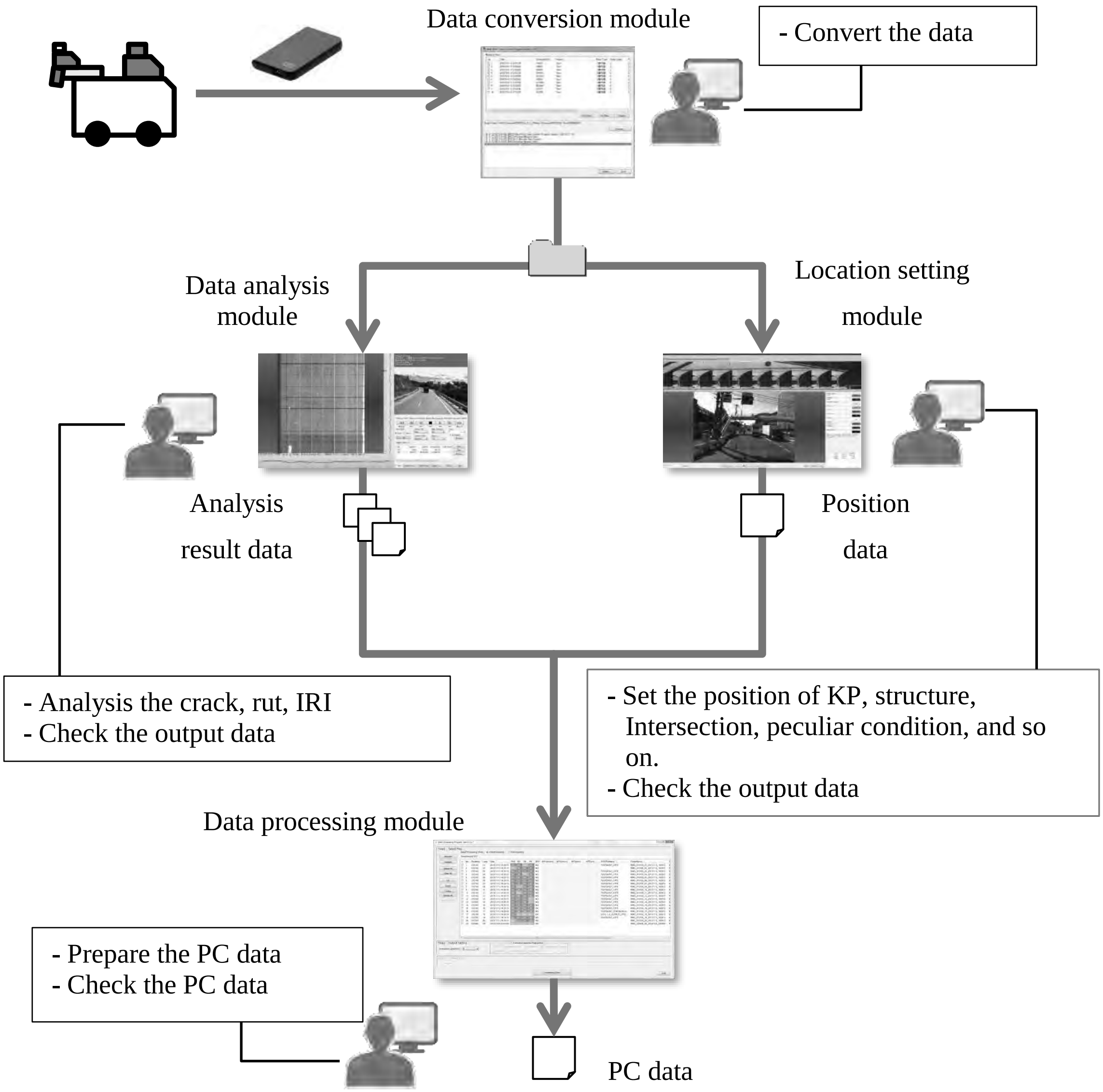



Figure 2.3 Work flow for PC preparation

2) Pavement Condition Data (PC data)

PC Data file is result of road surface damage status by pavement condition survey. Damage of road surface is evaluated by crack rate, rut depth, IRI and MCI. These evaluated data are prepared for every 100 m unit section. Description of evaluation item of road surface damage is shown in Table 2.3. If you would like to know detail information, refer to chapter 4 for details.

Table 2.3 Evaluation item of road surface damage

| Item | Content | Description | Note |
|---|---|---|---|
| Crack | Crack ratio [%]<br>Patching [%]<br>Pothole [%] | Crack ratio is calculated by damaged area per total area grids. | In case of AC, BST |
| | Crack index [cm/m2] | Crack index is calculated by crack length of damaged per total area | In case of CC |
| Rut | Rut depth (Average,)[mm] | Average rutting depth within unit section (100m) | |
| | Rut depth (Max) [mm] | Maximum rutting depth within unit section (100m) | |
| IRI | IRI [mm/m] | Total Axial displacement of QC model in unit section (100m) | |
| MCI | Integrated condition index using above 3 damage items | automatic calculated by 3 damaged values | |

## 2.2. The Importance to Conduct the Constantly Pavement Condition Survey

Since pavement condition survey should is not completed at once, it should be carried out continuously. Time-series database will be established by continuously conduction of pavement condition survey. Time-series database is utilized for management and evaluation for pavement maintenance work.

- Survey Plan

Long-term survey plan shall be prepared. In survey plan, the following points shall be considered.

・ <u>Capacity of PCSV</u>

Survey length that can be carried out in a year is decided according to the number of PCSV.

・ <u>Secure human resource</u>

Engineers for field survey work and data analysis work

・ <u>Budget for survey</u>

Secure enough budgets for PCS

・ <u>Compatibility with progress of previous 5-year pavement maintenance plan</u>

Decide next timing of survey based on the progress of 5-year pavement maintenance plan with previous PC data

- Survey scheme

・ <u>One time survey scheme</u>

All road networks is surveyed in one time

・ <u>Equalization of survey length</u>

Survey length is equalized for each fiscal year

Figure 2.4 shows a survey scheme of equalization of survey length. In case that road network of 1500km is surveyed in 3 years, road network is divided into 3 groups (A, B, and C). In that case, survey length in one year is 500km. Road network in Group A is measured in the first year. Next survey in Group A is conducted in the 4th year after completion of all network survey.

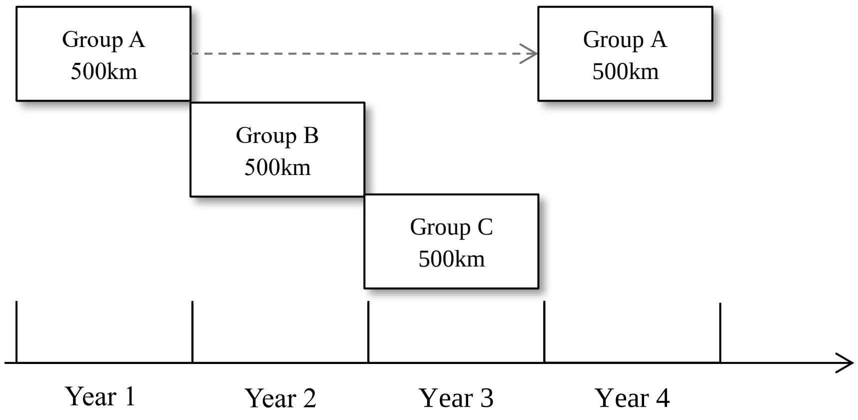



Figure 2.4 Sample of survey scheme (equalization of survey length)

## 2.3. Work Allocation on Pavement Condition Survey

Pavement condition survey work is divided into four steps, 1) Survey Plan, 2) Measurement, 3) Data Analysis and Data Processing, and 4) Data Check and Data Install. List of work item and assignment on Pavement Condition Survey is shown in table 2.4. Responsible division of DRVN in pavement condition survey is shown in Figure 2.5.

- DRVN (DPI, MMD, STECID and IT Center)

**DRVN is Top manager of pavement condition survey** (hereinafter, this is called "Top manager”). In the future, RMBs or PDOT can become top manager of the pavement condition survey. Role of top manager are as follows;

・ Approve the survey plan
・ Check the progress of the pavement condition survey based on RMBs report
・ Manage the PCSV
・ Approve the completion of the pavement condition survey
・ Install the PC data to PMS server (IT Center)

- RMB (DPI, MM, SB)

**RMBs are manager of each work in pavement condition survey** (hereinafter, this is called "Work manager”). Role of work manager are as follows;

・ Prepare the survey plan
・ Supervise the work of the survey consultant
・ Submit the plan, progress report and complete PC data to top manager

- Survey consultant

Survey consultant conducts the below contents.

・ Preparation of implementation plan
・ Measurement
・ Data analysis
・ Data processing

Table 2.4 Work item and Assignment on Pavement Condition Survey

| No. | Work Item | DRVN (Top manager) | RMMBs (Work manager) | Survey Consultant |
|---|---|---|---|---|
| 1 | Survey plan | ・Approve the survey plan | ・Preparation of survey plan<br>・Submit the survey plan to DRVN<br>・Assign Survey consultant | ・Preparation of Implementation plan |
| 2 | Field survey | ・Management of PCSV<br>・Check the progress report form RMBs | ・Supervise field work (Progress, Problem)<br>・Report the progress to DRVN | ・Field survey |
| 3 | Data analysis<br>Data Processing | ・Check the progress report form RMBs | ・Supervise data work (Progress, Problem) | ・Data analysis<br>・Data processing |
| 4 | Data check<br>Data install | ・Approve the completion of the pavement condition survey<br>・Install PC data (IT center) | ・Data check<br>・Submit PC data to DRVN | ・Correct data |

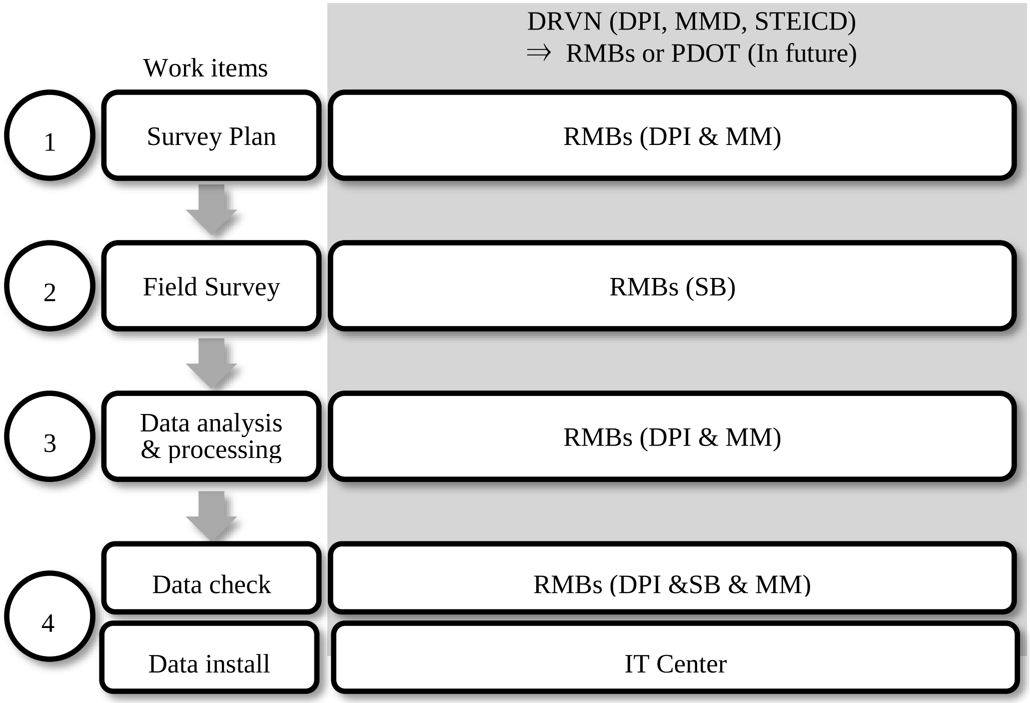



Figure 2.5 Responsible division of Pavement Condition Survey

## 3. Understanding of pavement condition data

In this chapter, some definitions of pavement condition data are described here for better understanding.

## 3.1. Definition of section length

The unit section length of PC data is evaluated in 100m section basically. However, there are five special cases that the section length is shorter than 100 m.

Case -1 Start and end point of structure

When the position of start and end point of the structure, such as bridge and tunnel, is different from the position of the breakpoint of the 100m section, PC data is divided at the position of the start and end point of its structure.

Case-2 Distance between kilometer-posts

The distance between kilometer-posts installed in the field is defined as 1000m on the inventory data generally 1000m. However when actual distance between kilometer-posts is measured by PCSV, the actual distance is used for section length on PC data. If the actual distance is not exactly 1000m, the fractions number is considered in the last section. In that case, the length of last section is sometimes less than 100m.

Case-3 Route length

The section of PC data is prepared for each route. Certainly route length is not often an aliquot number by 100. In that case, the fractions number is considered in the last section and the length of last section is less than 100m.

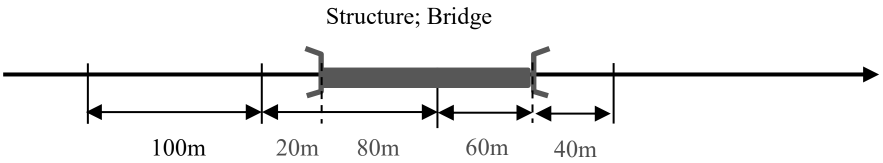
Case-4 Change point of pavement type

During survey on site, pavement type, such as AC, BST, CC and others, is identified. Change point of pavement type is different from the position of the breakpoint of the 100m section, PC data is divided at the position of change point of pavement type.

Case-5 Chainage of jurisdiction

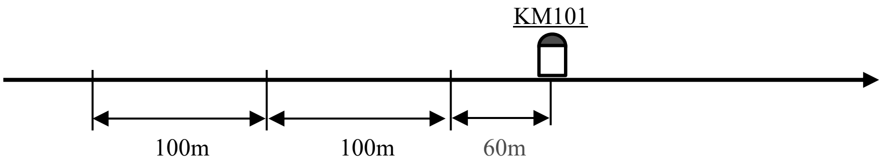
The section of PC data is divided at the chainage of jurisdiction border. In that case the section length with jurisdiction border is sometimes less than 100m.

Case -1 Start and end point of structure



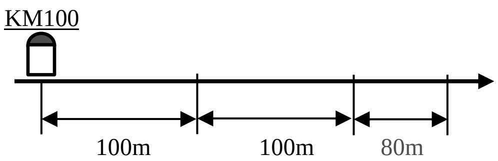

Section is divided at the position of the start and end point of structure.

Case-2 Distance between



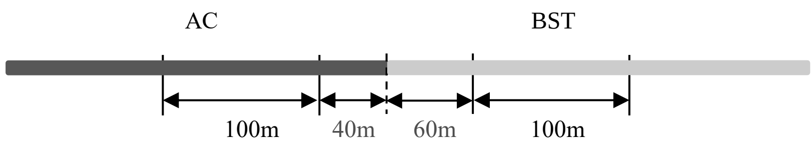

The actual distance is used for section length on PC data

Case-3 Route length



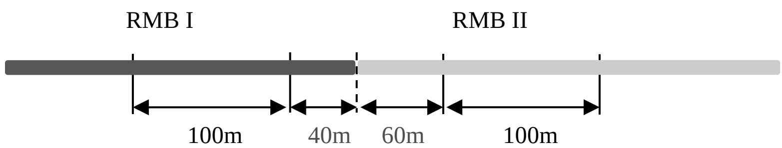

The fractions number is considered in the last section and the length of last section is less than 100m

Case-4 Change point of pavement type




PC data is divided at the position of change point of pavement type

Case-5 Chainage of jurisdiction




This section is divided at the chainage of jurisdiction border.

Figure 3.1 Cases of length definition in PC data

## 3.2. Kilometer Post Information (From-To)

Kilometer Post Information (From-To) is indicating the information of kilo-post station installed on site and distance from the nearest kilo-post station on the starting point side in units of 5m. Kilometer Post Information is defined by combination between kilo-post station number as “Km” and distance from kilo-post station as “m”.

Explanation of figure 3.2

Starting point of section A is located on 500m distance from kilo-post station number 3, and end point of section A is located on 600m distance from kilo-post station number 3. In this case, Kilometer Post Information of section A is described as follows;

From_Km : 3
From_M : 500
To_Km : 3
To_M : 600

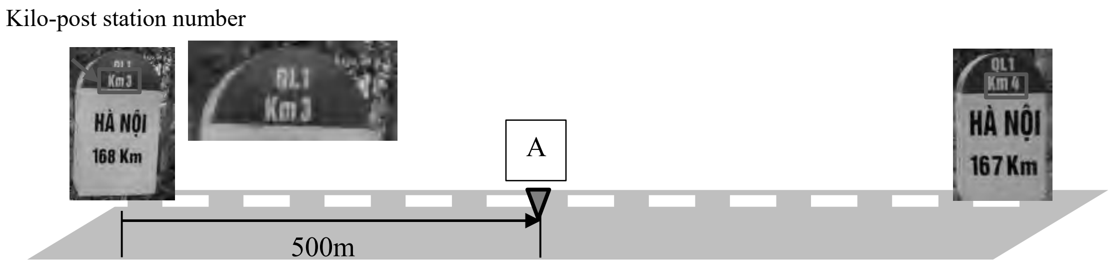



Figure 3.2 Conceptual Diagram of Kilometer Post

If there is a missing kilo-post station on site, a position is defined as from nearest kilo-post station on the starting point side, not from missing station. In that case, number of station number in m is over that 1,000m. If a kilo-post station number has an alphabet such as "14B", it can be assumed that it is missing kilo-post station.

Explanation of figure 3.3

Starting point of section A is located on 1400m distance from kilo-post station number 5, and end point of section A is located on 1500m distance from kilo-post station number 5. In this case, Kilometer Post Information of section A is described as follows;

From_Km : 5
From_M : 1400
To_Km : 5
To_M : 1500

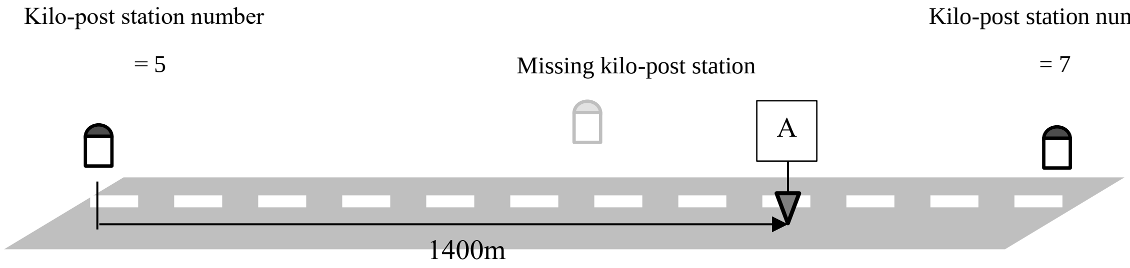



Figure 3.3 Conceptual Diagram of Kilometer Post (Missing kilometer)

## 3.3. Multi lane data

When lane number is multiple, each lane shall be surveyed separately. Data analysis and processing work is also done lane by lane. Therefore, PC data is prepared separately lane by lane. Lane position can be identified by the number of “Lane_Position_Number” on the PC data.

To keep compatibility of the position between adjacent lanes, first PC data of 1st lane is prepared. After that, the data of 2nd lane and 3rd lane is prepared with same attributes of location information as 1st lane.

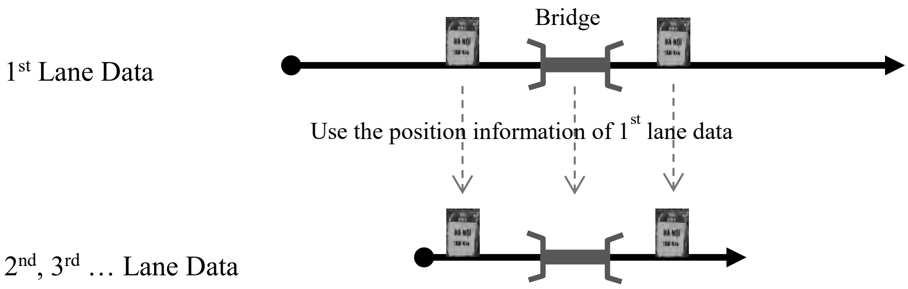
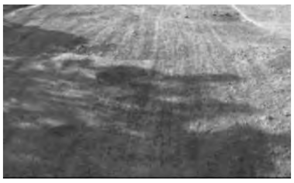
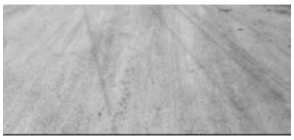



Figure 3.4 Reflect 1st lane information to multiple lane

### 3.4. Peculiar Condition

Peculiar condition is identified as a peculiar damage which cannot be evaluated by determined definition of pavement damage with crack interpretation way. Peculiar condition code is entered in case that a peculiar condition is found within an evaluation unit range. In cases that there are more than two kinds of peculiar condition are found within one evaluation unit range, the highest priority code number shall be entered.

Table 3.1 Definition of peculiar condition

| Item | Description | Image | Priority |
|---|---|---|---|
| 1.Broken | Once paved sections, but there is serious damage which cannot be evaluated. |  | High |
| 2.Unpaved or unidentified Pav. Type | Unpaved: never paved.<br>Unidentified Pavement type: besides, AC, CC and BST. |  | |
| 3.Wet Condition | The lane is covered with water or wet. |  | |
| 4.Other damage | Other type damages that cannot be judged as cracking. (Ex. Raveling, Scratch, etc.) |  | |
| 5.Invisible | Surface cannot be seen due to coverage of pavement surface by other objects, such as sand, soil, construction material, etc. |  | |
| 6.Under construction | Ongoing construction work on the survey lane. |  | Low |

# 4. Method of measuring and analysis of pavement condition

This chapter describes the method of measuring and analysis of each evaluation item in pavement condition.

## 4.1. Crack

1) Introduction

The objective of this chapter is to show evaluation and calculation method of cracks on pavement surface. The results of these measurements are evaluated as the crack ratio for asphalt pavements and the crack index for concrete pavements.

2) Measurement Tools

PSCV uses the Area Photo Method which captures images for every fixed area while consecutively overlapping these images of the pavement surface by using CCD cameras.

PCSV operates to synchronize the crack detection devices with the vehicle speed. Therefore, continuous series of images of the pavement surface can be captured. The cracks are deducted from these images and are summarized as the crack ratio or the crack index.

3) Summary of the results

Apply the 0.5m square grids onto the images of the pavement surface which are obtained from the field survey. Calculate the crack ratio by following method.

a) Summary of the asphalt pavement. (refer Note 1 and 2)

i) The grids with one linear crack and with more than two linear cracks will be counted separately.

ii) For the patch, visually estimate the area of each grid occupied by the patch and count them separately according to the following three classes.

a. 0% or more and less than 25%

b. 25% or more and less than 75%

c. 75 % or more

iii) For the pothole, visually estimate the area of each grid occupied by the pothole and count them separately according to the following three classes.

a. 0% or more and less than 25%

b. 25% or more and less than 75%

c. 75 % or more

iv) Calculate the crack area of each grid as follows.

- If a grid contains one crack, assume that 0.15 $m^2$ of the crack is produced.
- If a grid contains more than two cracks, assume that 0.25 $m^2$ of the cracks is produced.
- If the area of the patch is 0% or more and less than 25%, assume that the crack area is 0 $m^2$.
- If the area of the patch is 25% or more and less than 75%, assume that the crack area is 0.125 $m^2$.
- If the area of the patch is 75 % or more, assume that the crack area is 0.25 $m^2$.
- If the area of the pothole is 0% or more and less than 25%, assume that the crack area is 0.03 $m^2$.
- If the area of the pothole is 25% or more and less than 75%, assume that the crack area is 0.125 $m^2$.
- If the area of the pothole is 75 % or more, assume that the crack area is 0.25 $m^2$.

v) Calculate the crack ratio of each unit (100m) by using the formula shown in 4 .1. as one places of decimal.

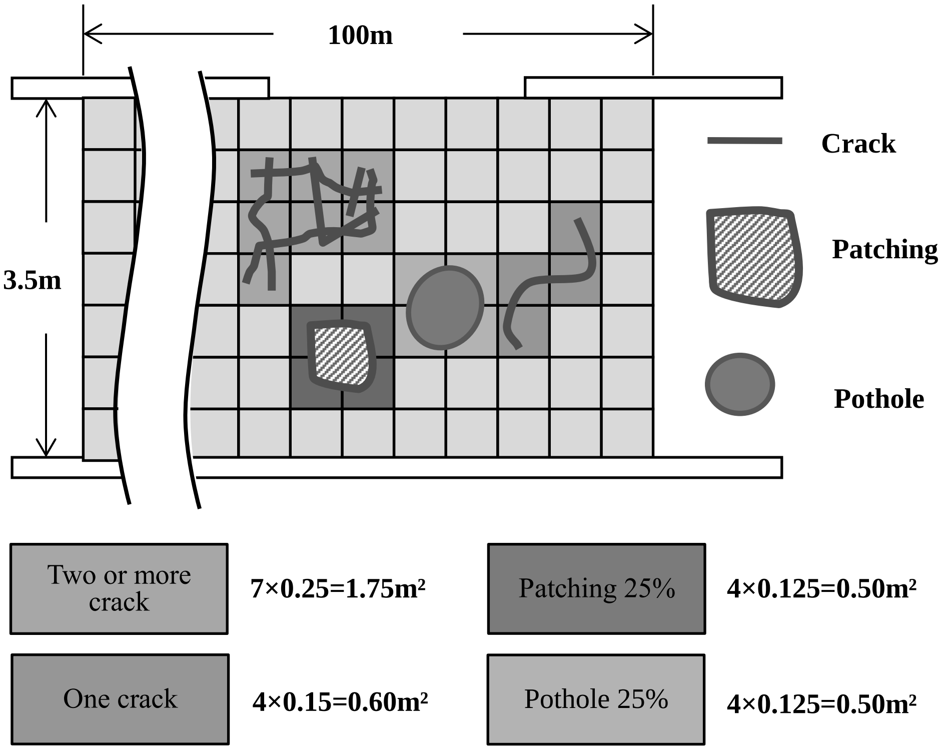
$$The\ crack\ ratio(\%) = \frac{the\ crack\ area(m^2)}{Survey\ Section\ area(m^2)} \times 100 \quad \text{--------------- (4.1)}$$

Note 1:

As the lane width is not always multiples of 0.5m, the length of the end of the grid may sometimes be less than 0.5m. For example, assume that the grid area is A$m^2$. The grid area at the end is calculated as follows. If the grid has one linear crack, the crack area is calculated as 0.6xA $m^2$. If the grid has more than two linear cracks, the crack area is calculated as A$m^2$. For the patch, the grid area occupied by the patch is classified as 0% or more and less than 25%, 25% or more and less than 75% and 75 % or more. The patch area is calculated as 0 $m^2$, 0.5xA $m^2$ and A$m^2$ respectively.

Note 2:

In the case of containing both cracks and patches in a grid, the grid is considered as a crack grid.




**Crack ratio = ((1.75+0.60+0.50+0.50)/(3.5×100))×100 = 1.0%**

Figure 4.1 Example of Calculations of the Crack Ratio

b) Summary of the concrete pavement (refer Note 3 and 4)

i) Visually measure the length of cracks in each grid and count the number of the grids separately according to the following six classes.

a. Total crack length is 25cm - 50cm in the grid
b. Total crack length is 50cm - 75cm in the grid
c. Total crack length is 75cm - 100cm in the grid
d. Total crack length is 100cm - 125cm in the grid
e. Total crack length is 125 - 150cm in the grid
f. Total crack length is over 150cm in the grid

.

ii) Calculate the length of cracks separately according to the following three classes.

- If total crack length is 0cm - 25cm in the grid, assume that 0cm of the crack length is produced.
- If total crack length is 25cm - 50cm in the grid, assume that 25cm of the crack length is produced.

- If total crack length is 50cm - 75cm in the grid, assume that 50cm of the crack length is produced.
- If total crack length is 75cm - 100cm in the grid, assume that 75cm of the crack length is produced.
- If total crack length is 100cm - 125cm in the grid, assume that 100cm of the crack length is produced.
- If total crack length is 125cm - 150cm in the grid, assume that 125cm of the crack length is produced.
- If total crack length is over150cm in the grid, assume that 150cm of the crack length is produced.

.

iii) Visually measure the area of each patch in the grid, count the number of the grids separately according to the following three classes. They are 0% or more and less than 25%, 25% or more and less than 75%, and 75 % or more of the area of the grid.

iv) Calculate the area of the patch separately according to the following three classes. If the area of the patch is 0% or more and less than 25%, its area is 0 $m^2$. If the area of the patch is 25% or more and less than 75%, its area is 0.125 $m^2$. If the area of the patch is 75 % or more, its area is 0.25 $m^2$.

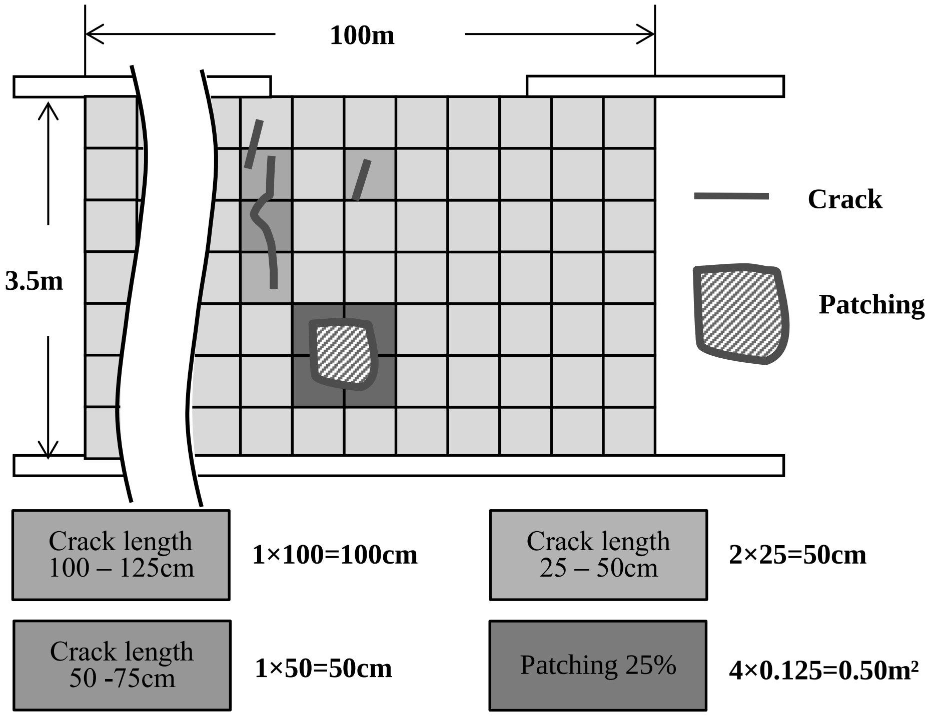
v) Calculate the crack index of each unit (100m) by using the formula shown in 4.2 as one places of decimal. Crack index is calculated from crack length and patching. The crack area is calculated by crack length multiply damage width of the pavement due to crack. The damage width is 0.3 m. In order that the unit of patching is converted from "$m^2$" to "cm", Patching value is divided by 0.3 and multiplied 100.

$$The\ crack\ Index(cm/m^2) = \frac{Accumulate\ crack\ length(cm) + \left(\frac{Patch\ Area(m^2)\times 100}{0.3(m)}\right)}{Survey\ Section\ area(m^2)} \quad \text{---- (4.2)}$$

Note 3:
As the lane width is not always multiples of 0.5 m, the length of the end of grid may be sometime less than 0.5 m. If the crack develops in the transverse direction and extends to the end of the grid, assume that the transverse direction of the grid length is defined as A cm. The crack length is calculated as follows. If the crack length is 25cm in the grid, its length is 0.5 x A cm. The patch area is calculated as 0 $m^2$, 0.5xB $m^2$ and B $m^2$ respectively assuming that a grid area is B $m^2$.

Note 4:

In the case of containing both cracks and patches in a grid, the length of cracks and the area of patches are calculated separately and summarized.




**Crack index = ((100+50+50)+(0.5/0.3)×100)/(3.5×100) = 1.1cm/m²**

Figure 4.2 Example of Calculations of the Crack Index

## 4.2. Rut

1) Introduction

The objective of this section is to show how to measure the rut depth which develops on the wheel path by friction, deformation of the pavement, or the flow of the asphalt composite materials.

2) Measurement Tools

PCSV uses the laser scanner for measurement of transverse profile. Transverse profile is measured in each 1meter.

3) Summary of the results

Rut depth is calculated by following method.

i) When the convex in the middle of the lane is higher than the convex of both the shoulder and the center side lines, the values of the rut depth will be measured as D1 and D2 in mm by using the method shown on Figure 4.4 a).

ii) When the convex in the middle of the lane is lower than the convex of both the shoulder and the center side lines, the values of the rut depth will be measured as D1 and D2 in mm by using the method shown on Figure 4.4 b).

iii) The larger of the values of D1 or D2 is selected as the rut depth of the transverse profile.

iv) Finally, calculate the average of rut depth and maximum of rut depth in each unit (100m).

- Average of rut depth

Average value of rut depth for all value within unit section (100m)

$$Average\ of\ Rut\ depth\ (mm)\ =\frac{the\ sum\ total\ of\ Rut\ depth\ of\ all\ transverse\ profile\ in\ 100m}{Number\ of\ transverse\ profile\ in\ 100m}$$

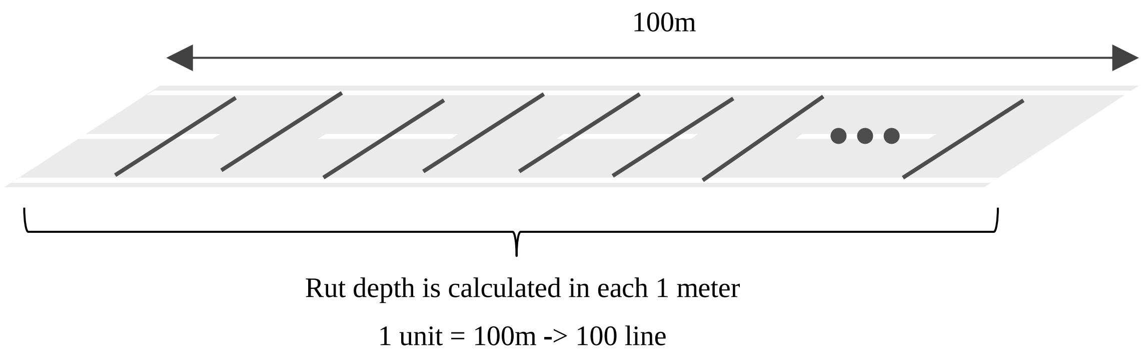
---- (4.3)

- Maximum of rut depth

Maximum value of rut depth within unit section (100m)

$$Maximum\ of\ Rut\ depth\ (mm) =\ the\ Maximum\ rut\ depth\ of\ all\ transverseprofile\ in\ 100m$$

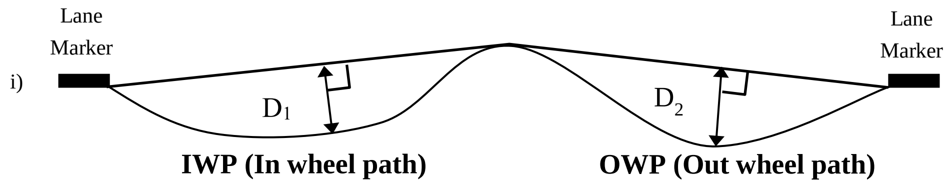
---- (4.4)




Average of Rut depth = Sum of total rut depth within 100 line / 100

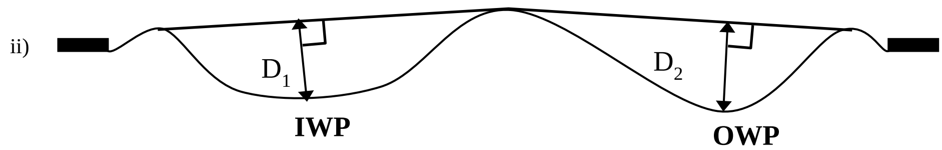
Maximum of Rut depth = Maximum value of rutting depth within100 line

Figure 4.3 Calculation method of average and maximum of rut depth



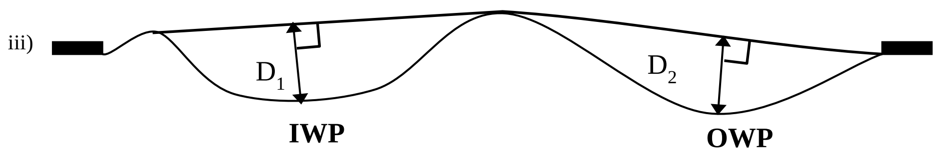

Normal

Line: Lane marker –> The convex in the middle of the lane –> Lane marker




The rut shape of near the lane mark is higher than the lane mark in both sides.

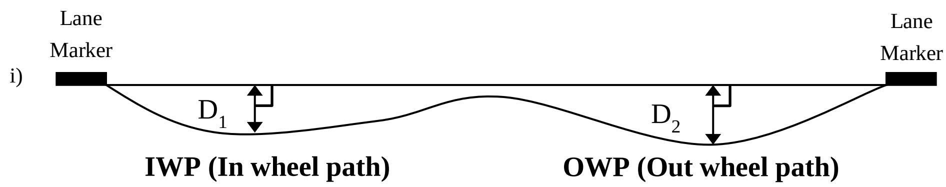
Line: The top of rut shape –> The convex in the middle of the lane –> The top of rut shape




The rut shape of near the lane mark is higher than the lane mark in one side.

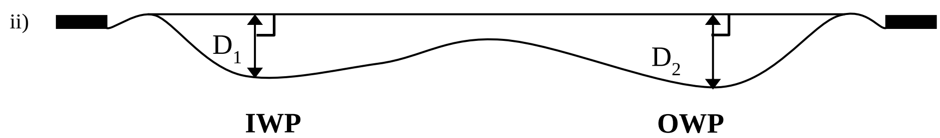
Line: The top of rut shape –> The convex in the middle of the lane –> Lane marker

a) Rut Depth mainly due to the movement of the surface of pavement



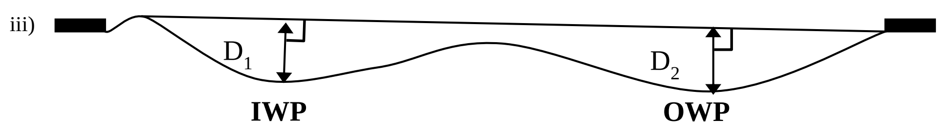

Normal

Line: Lane marker –> Lane marker




The rut shape of near the lane mark is higher than the lane mark in both sides.

Line: The top of rut shape –> The top of rut shape




The rut shape of near the lane mark is higher than the lane mark in one side

Line: The top of rut shape –> Lane maker

b) Rut Depth mainly due to the friction of the surface of pavement

Figure 4.4 The Definition of Rut Depth

## 4.3. IRI

1) Introduction

International Roughness Index (IRI) is the roughness index measured by longitudinal road profiles. It is calculated using a quarter-car vehicle math model, whose response is accumulated to yield a roughness index with units of slope (mm/m).This chapter explains how to obtain the IRI which evaluates the roughness of the pavement surface.

The survey method of IRI is classified 1 to 4 depending on the method of the surface profilers. The PCSV introduced in DRVN has roughness measurement method of Class 2.

The PCSV measures longitudinal profile of out wheel path by the laser displacement sensor and IMU, and IRI value is calculated based on the Quarter-Car simulation (QC simulation).

Table 4.1 Measuring methods for road roughness and IRI calculation methods

| Class | Road roughness measurement method | IRI calculation method |
|---|---|---|
| 1 | Leveling | Measure the longitudinal profile with the leveling method at an interval of 250mm or less and calculate the IRI from QC simulation. |
| 2 | Any device for longitudinal profiler (any) | Measure the longitudinal profile using any longitudinal profiler and calculate the IRI from QC simulation. |
| 3 | RTRRMS (response type road roughness measurement system) | Measure the roughness index of any scale by using a RTRRMS (response type road roughness measurement system), and convert to IRI by correlation equation. |
| 4 | Physical and visual experience of the inspector riding the patrol car. | IRI is judged based on the physical and visual experience of the inspector riding the patrol car. |

2) Measurement Tools

The longitudinal profile is measured by using a laser displacement meter and accelerometer equipped in the survey vehicle.

3) IRI Calculation Procedures

Calculate IRI by using QC simulation with longitudinal profile data measured by PCSV. QC simulation is a quarter model which extracts one wheel from a regular car with two axes and four wheels. It is expressed as a dynamics system shown on Figure 4.5. IRI is a ratio of the accumulated values of movement displacements (mm) of the vertical direction and the survey distance (m) at a consistent vehicle speed. IRI is calculated in each unit (100m). IRI is calculated in the following series of equations of motion which are equation (4.5) through equation (4.7).

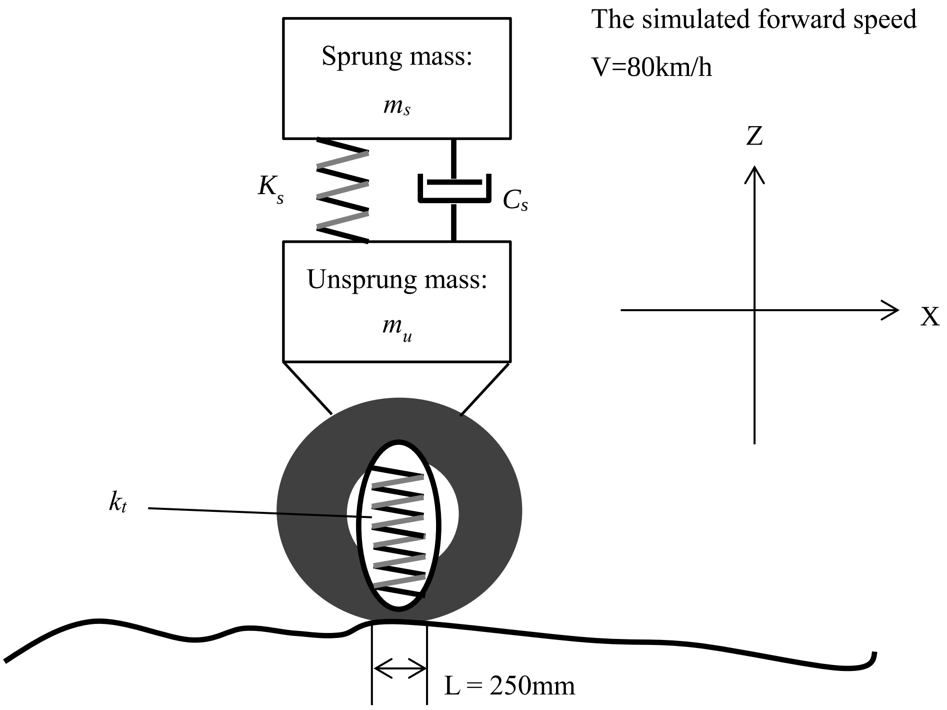



Figure 4.5 Quarter-Car (QC) Model

$\dot{x} = Ax + Bh_{ps}$ ---------------------------------------------------------------------------- (4.5)

$$x = [z_s, \dot{z}_s, z_u, \dot{z}_u]^T$$

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 \\ -k_2 & -c & k_2 & c \\ 0 & 0 & 0 & 1 \\ k_2/c & c/3 & -(k_1 + k_2)/3 & -c/\mu \end{pmatrix}$$

$B = [0, 0, 0, k_1/,]^T$ ---------------------------------------------------------------------- (4.6)

$h_{ps} =$ Smoothed profile elevation

$z_s =$ Height (vertical coordinate) of the sprung mass

$\dot{z}_s =$ Derivative of Height (vertical coordinate) of the sprung mass

$z_u =$ Height (vertical coordinate) of the unsprung mass

$\dot{z}_u =$ Derivative of Height (vertical coordinate) of the unsprung mass

The following values are the normalized parameters.

$c = c_s/m_s = 6.0$

$k_1 = k_t/m_s = 653$

$k_2 = k_s/m_s = 63.3$

$\mu$ $6\mathrm{m_u}/\mathrm{m_s} = 0.15$

Where

$\mathrm{c_s}$ : Suspension damping rate

$\mathrm{k_s}$ : Suspension spring rate

$\mathrm{k_t}$ : Tire spring rate

$\mathrm{m_s}$ : Sprung mass (portion of vehicle body mass supported by one wheel)

$\mathrm{m_u}$ : Unsprung mass (mass of the wheel, tire, and half of the axle/suspension)

L : Length of the profile

Equation 4.5 is solved by inputting the $h_{ps}$ value. Then IRI is calculated by using equation (4.6). The simulated forward speed is defined as 80km/h.

$IRI = \{\int_0^{L/V} |\dot{z}_s - \dot{z}_u| dt\}/L$ ---------------------------------------------------------------- (4.7)

## 4.4. MCI

In order to evaluate pavement condition, an evaluation method using comprehensive index, MCI (Maintenance Condition Index) is considered. MCI had been used by MLIT (Ministry of Land, Infrastructure, Transport and Tourism) in Japan as an index for the pavement evaluation until 2005.

MCI is given by following equations;

$$MCI = 10 - 1.48C^{0.3} - 0.29D^{0.7} - 0.48\sigma^{0.2} \text{ -------------------------- } (4.8)$$

$$MCI_0 = 10 - 1.51C^{0.3} - 0.3D^{0.7} \text{ ------------------------------------- } (4.9)$$

$$MCI_1 = 10 - 2.23C^{0.3} \text{ -------------------------------------------------- } (4.10)$$

$$MCI_2 = 10 - 0.54D^{0.7} \text{ -------------------------------------------------- } (4.11)$$

Here, $MCI_i$ : Maintenance Control Index
$C$ : Crack ratio (%)
$D$ : Rut depth (mm)
$\sigma$ : Evenness (mm)

where C is cracking rate (%), R is mean value of rutting depth (mm) and σ is longitudinal evenness (mm). MCI is given by minimum value among the results getting from equation (4.8), (4.9), (4.10) and (4.11), and full mark (no damage) is 10points.

Longitudinal evenness is defined by following method;
- Measure the height from the road surface to vehicle by 3 sensors located in 1.5m interval (Figure 4.6)
- Measure the height in every 1.5m
- Calculate the height of longitudinal profile from height of each sensor by equation (4.12)
- Calculate the Evenness from the height of longitudinal profile by equation (4.13)

$$H = (h_1 + h_3) / 2 - h_2 \text{ ---------------------------------------------------- } (4.12)$$

$$\sigma = \sqrt{(\sum H^2 - (\sum H)^2/n)/(n-1)} \text{ --------------------------------- } (4.13)$$

$H$ : Height of longitudinal profile (mm)
$h_i$ : Height from the road surface measured by each sensor (mm)
$n$ : number of height
$\sigma$ : Evenness (mm)

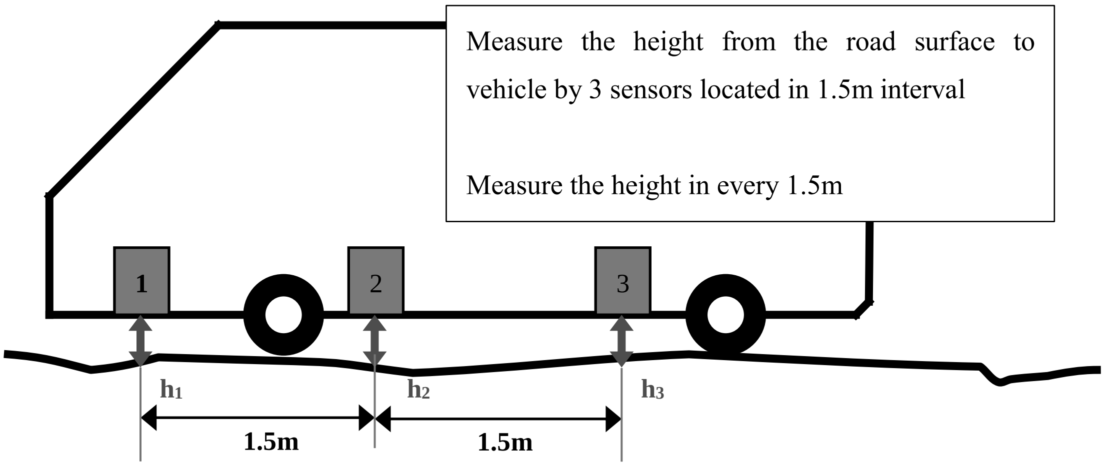



Figure 4.6 Measurement method for evenness

Longitudinal evenness can be conversed from IRI using following equation.

$$\sigma = (IRI - 0.75) / 1.47 \text{ -------------------------------------------------------- } (4.14)$$

Crack index for shall be converted into cracking ratio for MCI calculation using equation (4.16).

Figure 4.7 shows the case that there is one crack in one square meter. In this case, crack ratio for AC is 30%. On the other hand, crack index for CC is 100 cm/m$^2$. The conversion factor between Crack ratio and Crack index can be defined by the following equation;

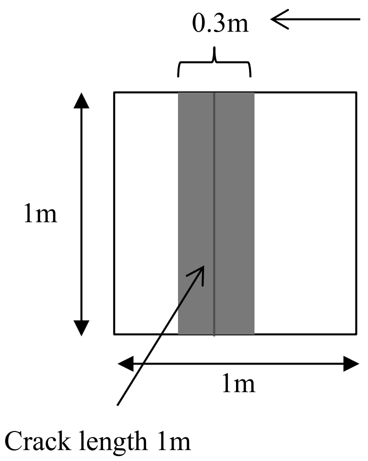
$$\text{Crack index: Crack ratio} = 100(\text{cm/m}^2)\text{: } 30\ (\%) \text{ ------------------------ } (4.15)$$

Then the equation for conversion from crack index to crack ratio by equation (4.15) is as follows;

$$\text{Crack ratio} = \min\left(\frac{30 \times \text{Crack index}}{100}, 100\right) = \min\left(\frac{30/30 \times \text{crack index}}{\frac{100}{30}}, 100\right)$$

$$= \min\ (\text{Crack index} / 3.33) \text{ --------------------------- } (4.16)$$

Crack index shall be divided by 3.33 to convert to Crack ration and maximum Crack ratio is not exceed 100%.




One line crack

(Average crack width of line crack is assumed as 0.3 m)

One crack in one square meter,

Crack ratio
= (Crack length x damage width) / grid area
= (1m x 0.3 m / 1m$^2$) x 100 = 30%

Crack index
= Crack length / grid area
= 100cm / 1m$^2$ = 100cm/m$^2$

Figure 4.7 Example of one crack in one square meter

From the above definition of MCI, MCI depends much on cracking rate and rutting depth, so it expresses mainly the quantity of cracking and rutting on pavement surface. This concept is based upon that cracking ratio and rutting depth are as the important Indices for judgment of repair pavement. This concept is very close to PSI (Present Serviceability Index) developed in USA.

JAPAN INTERNATIONAL COOPERATION AGENCY

DIRECTORATE FOR ROADS OF VIETNAM

MINISTRY OF TRANSPORT (MOT)

THE SOCIALIST REPUBLIC OF VIETNAM

# THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHAE II

## PAVEMENT CONDITION SURVEY MANUAL

## Volume 2.1.2: Management

MARCH 2018

JICA PROJECT TEAM

**Record of updates**

| Rev. | Date | Contents change |
|---|---|---|
| 1.00 | 2017.12.19 | First edition |
| | | |

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# Glossary

| | |
|---|---|
| Administration Database | Database of PMS data storing administrative information. |
| Analyzed section Table (Table-3) | The final section table prepared from PC data. |
| Calibration | Adjustment of devices for true value |
| Camera for front image | The device for measuring the front image |
| Camera for road image | The device for measuring the road image |
| Crack | Damage index based on the pavement surface crack. |
| End point | The end position of the target route. |
| Excluded section | The out of scope section. For example, the section that is under construction or being transferred to the management of another agency are in this excluded section. |
| IRI (International Roughness Index) | Damage index based on the longitudinal shape on the pavement surface. |
| KP (Kilometer post) | Positon of route. It is consist of Kilo-post station number and distance from the Kilo-post station number. |
| Kilo-post station | A road sign on the side of the road to indicate distances from major cities. |
| Kilo-post station number | The number indicated on the kilo-post stations in the side of the road. |
| Laser displacement sensor | The device for measuring the longitudinal profile |
| Laser scanner | The device for measuring the transverse profile |
| Main control unit | The Unit for control the measurement device |
| Marking | Marking of the start point and end point for easier recognition. |
| Overlapping section | A section in which two routes overlap in terms of management. |
| Patching | The repaired part of partially damage area (Pothole, crack, and so on). |

| | |
|---|---|
| Pavement condition | The condition of pavement surface. The pavement condition is evaluated for cracks, ruts and IRI. |
| Pavement condition survey vehicle | Vehicle assembled with measurement devices. |
| PDCA cycle | Management cycle acronym for PLAN, DO, CHECK and ACT. |
| PMS | Pavement Management System. |
| PMS Database | Database stored for PMS dataset. |
| Power control unit | The Unit for supply and control the electric power to the measurement device |
| REAL Mini | Name of the pavement condition survey vehicle made by PASCO Corporation. |
| Rut | Damage index based on the transverse shape on the pavement surface. |
| Start point | The start position of the target route. |
| Survey plan section Table (Table-1) | Table of planned survey length |
| Surveyed section Table (Table-2) | Table-1 with extensions added |

# Acronyms

| | |
|---|---|
| AC | Asphalt Concrete |
| BOT | Build-Operate-Transfer |
| BST | Bituminous surface treatment |
| CC | Cement Concrete |
| DPI | Department of Planning and Investment |
| DRVN | Directorate for Roads of Vietnam |
| HDD | Hard Disk Drive |
| IWP | In wheel path |
| KP | Kilometer post |
| MMD | Management and Maintenance Department |
| OWP | Out wheel path |
| PC data | Pavement condition data |
| PCS | Pavement Condition Survey |
| PCSV | Pavement Condition Survey Vehicle |
| PDOT | Provincial Department of Transport |
| PPC | Provincial People's Committee |
| QC | Quarter-Car |
| RMBs | Road Management Bureaus |
| SB | Sub Bureaus |
| STEICD | Science, Technology, Environment, International Cooperation Department |
| TOR | Terms of Reference |

# 1. Introduction

## 1.1. About This Manual

Management (PCS-Vol.2) is one of six manuals comprising the suite of the documentation for pavement condition survey. Figure 1.1 shows the component of pavement condition survey manual. Pavement condition survey manual is divided into three parts, Overview, Operation manual and Technical manual. Documents to be referenced depend on the responsibility and work steps of stakeholders involved in pavement condition survey. Overview describes the basic items of survey that all stakeholders should refer to. Operation manual shows important matters to be referred to mainly when survey work managing. Technical manual indicates technical matters such as system and device operation methods, data definition and data preparation. Figure 1.2 shows the description of contents of each document.

This manual explains the contents, procedure and explanation of management work on pavement condition survey conducted by administrator. It is to be used by administrator who to carry out the management of pavement condition survey. If there is any lack of information, addition and updates would be recommended.

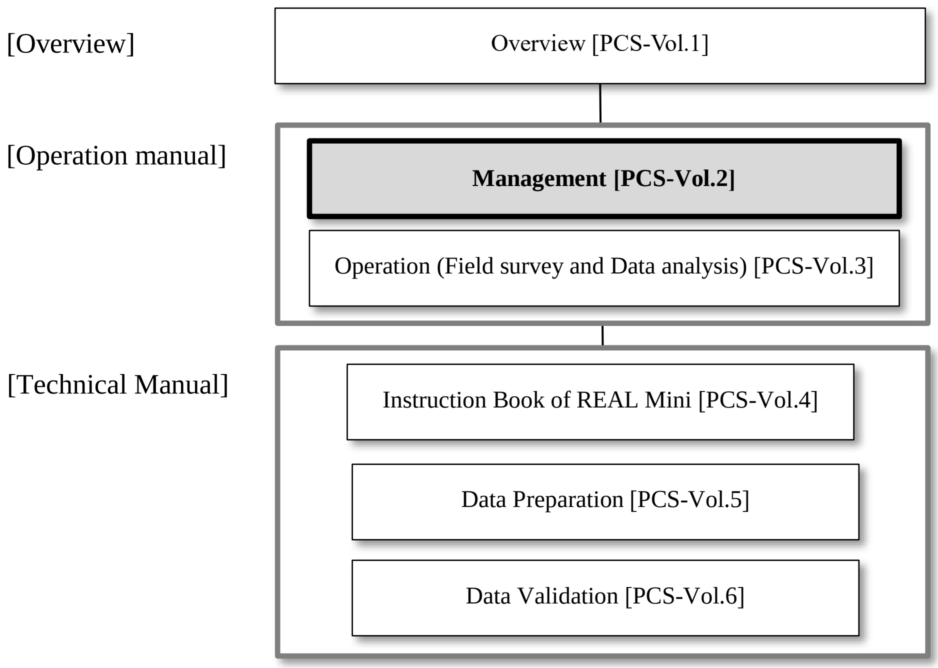



Figure 1.1 Pavement condition survey manual

[Overview]

| |
|---|
| Overview (PCS-Vol.1] |

➔ Describe the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey.

[Operation manual]

| |
|---|
| Management [PCS-Vol.2] |

➔ Describe the management work of road administrator on pavement condition survey. It contains all management works such as the planning, supervising, and data checking on pavement condition survey describing. It is to be used by administrator who to carry out the management of pavement condition survey.

| |
|---|
| Operation (Field survey and Data analysis) [PCS-Vol.3] |

➔ Describe the survey and analysis work of survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey.

[Technical manual]

| |
|---|
| Instruction Book of REAL Mini [PCS-Vol.4] |

➔ Describe the operation procedure of REAL Mini system. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

| |
|---|
| Data Preparation [PCS-Vol.5] |

➔ Describe the contents of pavement condition data (PC data). It contains the code definition, explanation of each item of PC data and so on.

| |
|---|
| Data Validation [PCS-Vol.6] |

➔ Describe the data check procedure when creating the PC data. It is to be used by person whose task is to carry out the data check in pavement condition survey.

Figure 1.2 Contents of Pavement condition survey manual

## 1.2. Summary of Pavement Condition Survey and Work Allocation

1) Pavement Condition Survey

Pavement condition survey (PCS) measures pavement damages such as cracks, ruts and IRI using the pavement condition survey vehicle (hereafter PCSV) on moving and make the pavement condition data files. The pavement damage expresses surface (crack), transverse (rut) and longitude (IRI) (Figure 1.3). The PCSV assembled some devices such as laser scanner and cameras for the pavement damages measurement (Figure 1.4).

Pavement condition survey measures not only pavement condition but also road inventory information, forward view image and position information at the same time.

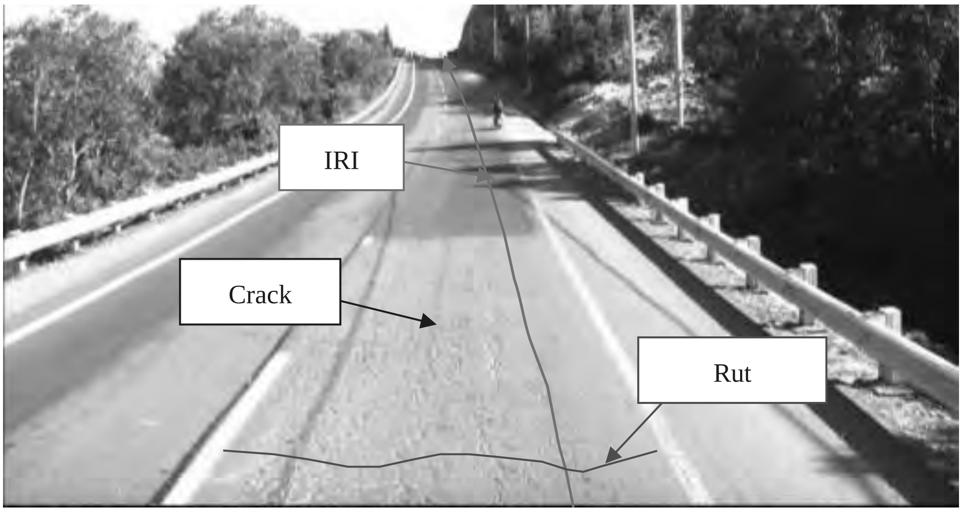



Figure 1.3 Pavement damage to be evaluated by PCS

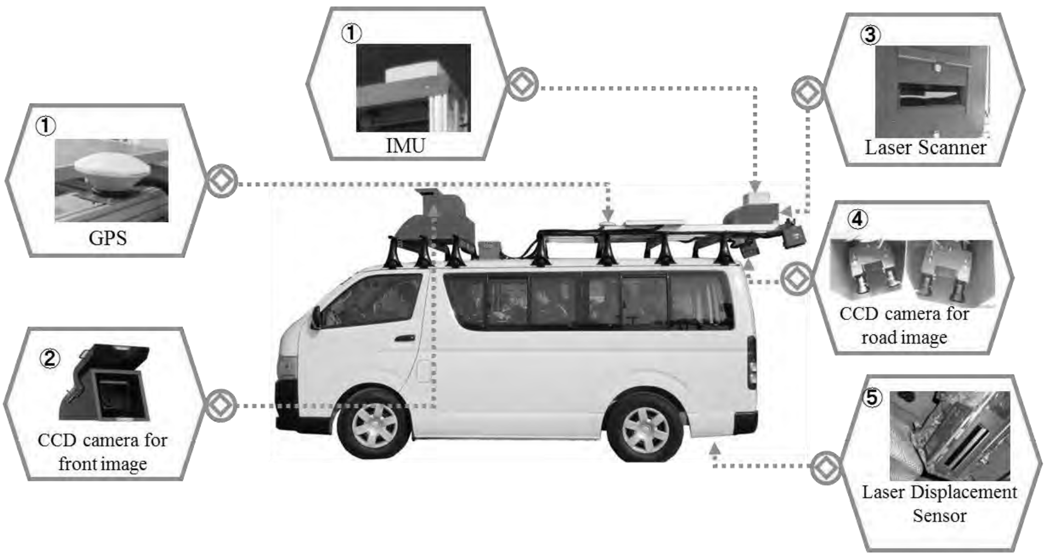



Figure 1.4 PCSV (REAL Mini)

2) Pavement Condition Data

PC Data file is result of road surface damage status by pavement condition survey. Damage of road surface is evaluated by crack rate, rut depth, IRI and MCI. These evaluated data are prepared for every

100 m unit section. Description of evaluation item of road surface damage is shown in Table 1.1. For more detail information, refer to the manual of ”Overview [PCS-vol.1]”.

Table 1.1 Evaluation item of road surface damage

| Item | Content | Description | Note |
|---|---|---|---|
| Crack | Crack ratio [%]<br>Patching [%]<br>Pothole [%] | Crack ratio is calculated by damaged area per total area grids. | For AC, BST |
| | Crack index [cm/m$^2$] | Crack index is calculated by crack length of damaged per total area | For CC |
| Rut | Rut depth (Average,)[mm] | Average rutting depth within unit section (100m) | |
| | Rut depth (Max) [mm] | Maximum rutting depth within unit section (100m) | |
| IRI | IRI [mm/m] | Total Axial displacement of QC model in unit section (100m) | |
| MCI | Integrated condition index using above 3 damage items | automatic calculated by 3 damaged values | |

3) Work Allocation of Manager on Pavement Condition Survey

Pavement condition survey can be divided into four steps, 1) Survey Plan, 2) Measurement, 3) Data Analysis and Data Processing, and 4) Data Check and Data Install. List of work item and assignment on Pavement Condition Survey is shown in Table 1.2. Responsible division of DRVN in pavement condition survey is shown in Figure 1.5**.**

- DRVN (DPI, MMD, STECID and IT Center)

**DRVN has a responsibility of Top manager of pavement condition survey** (hereinafter, this is called "Top manager”). In the future, RMBs or PDOT can become top manager of the pavement condition survey. Role of top manager are as follows;

- Approve the survey plan
- Check the progress of the pavement condition survey based on RMBs report
- Manage the PCSV
- Approve the completion of the pavement condition survey
- Install the PC data to PMS server (IT Center)

- RMB (DPI, MM, SB)

**RMBs manages all works in pavement condition survey** (hereinafter, this is called "Work manager"). Role of work manager are as follows;

- Prepare the survey plan
- Supervise the work of the survey consultant
- Submit the plan, progress report and complete PC data to top manager

- Survey consultant

Survey consultant conducts the below contents.

- Preparation of implementation plan
- Measurement
- Data analysis
- Data processing

In case the pavement condition survey would be conducted in the road managed by Expressway Company or PDOT, the below responsibility assignment of all work on pavement condition survey should be determined.

Table 1.2 Work item and Assignment on Pavement Condition Survey

| No. | Work Item | DRVN (Top manager) | RMMBs (Work manager) | Survey Consultant |
|---|---|---|---|---|
| 1 | Survey plan | ・Approve the survey plan | ・Preparation of survey plan<br>・Submit the survey plan to DRVN<br>・Assign Survey consultant | ・Preparation of Implementation plan |
| 2 | Field survey | ・Management of PCSV<br>・Check the progress report form RMBs | ・Supervise field work (Progress, Problem)<br>・Report the progress to DRVN | ・Field survey |
| 3 | Data analysis<br>Data Processing | ・Check the progress report form RMBs | ・Supervise data work (Progress, Problem) | ・Data analysis<br>・Data processing |
| 4 | Data check<br>Data install | ・Approve the completion of the pavement condition survey<br>・Install PC data (IT center) | ・Data check<br>・Submit PC data to DRVN | ・Correct data |

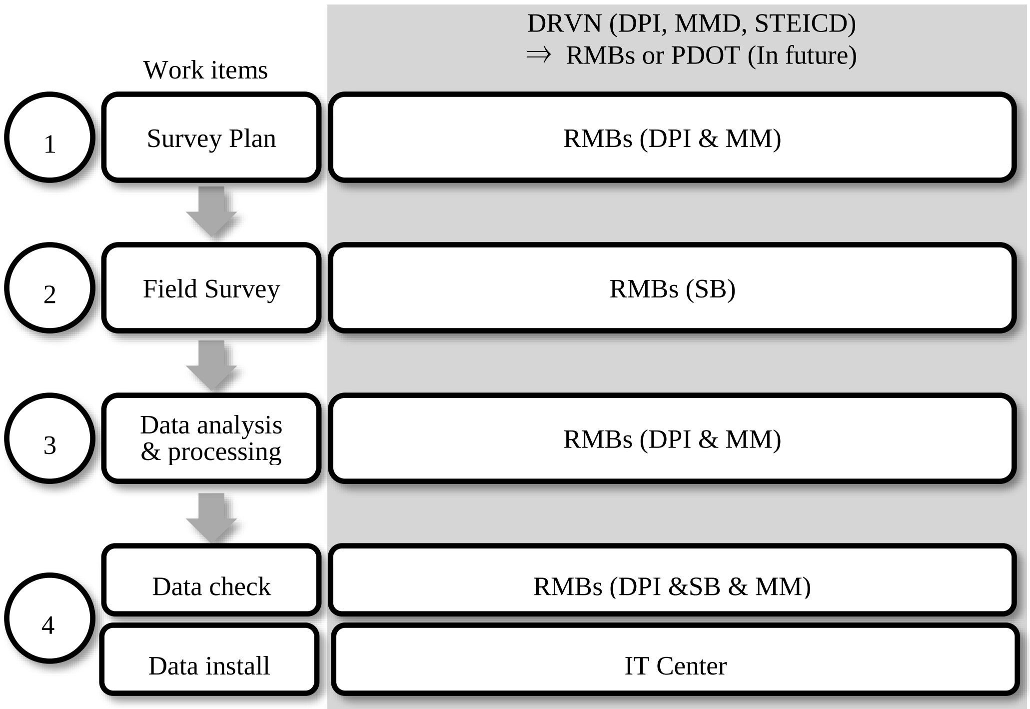



Figure 1.5 Responsible division of Pavement Condition Survey

## 1.3. Referential Document of This Operation Manual

This operation manual refers to the below manual and standard document as detail specification or procedure. Refer to the below manuals or documents in detail.

1) Survey plan

- Format of TOR (Appendix 1)
- Format of implementation Plan (Appendix 2）
- Format of Survey Plan Section Table(Appendix 3)
- Data Preparation [PCS-Vol.5]

2) Field survey

- Format of Calibration Report (Appendix 4)
- Format of Surveyed Section Table(Appendix 5)
- Format of Measurement Report (Appendix 6)
- Operation (Field survey and Data analysis) [PCS-Vol.3]
- Instruction book of REAL Mini [PCS-Vol.4]

3) Data analysis and Data processing

- Format of Data Analysis Report (Appendix 7）
- Format of Analyzed Section Table(Appendix 8)
- Operation (Field survey and Data analysis) [PCS-Vol.3]
- Instruction book of REAL Mini [PCS-Vol.4]

4) Data check and data install

- Data Preparation [PCS-Vol.5]
- Data Validation [PCS-Vol.6]

# 2. Survey Plan

Work flow of survey plan is shown in Figure 2.1.

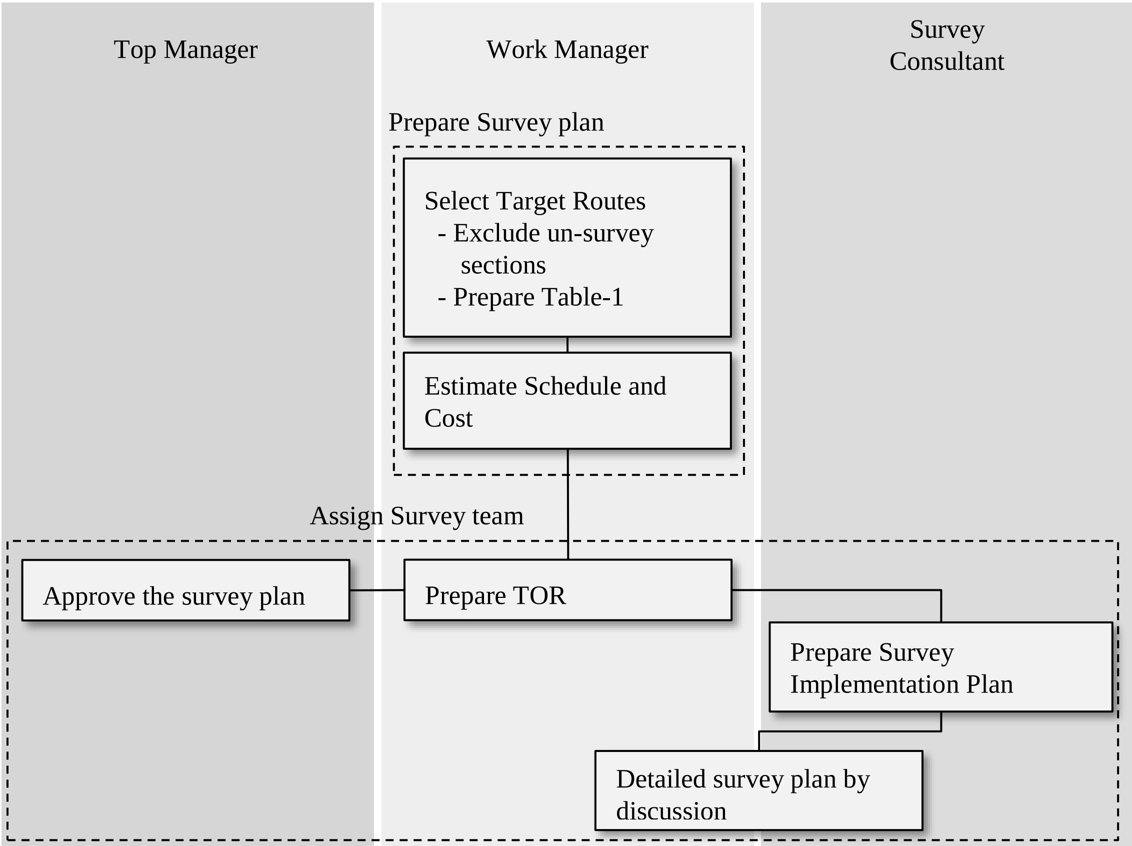



Figure 2.1 Work flow of survey plan

## 2.1. Prepare Survey Plan

Work manager prepares the survey plan for conducting of the pavement condition survey work. Work manager prepares the “Survey Plan Section Table (Table-1)” after selection of target routes and sections. Work manager estimates the schedule and cost for work based on the planed survey length.

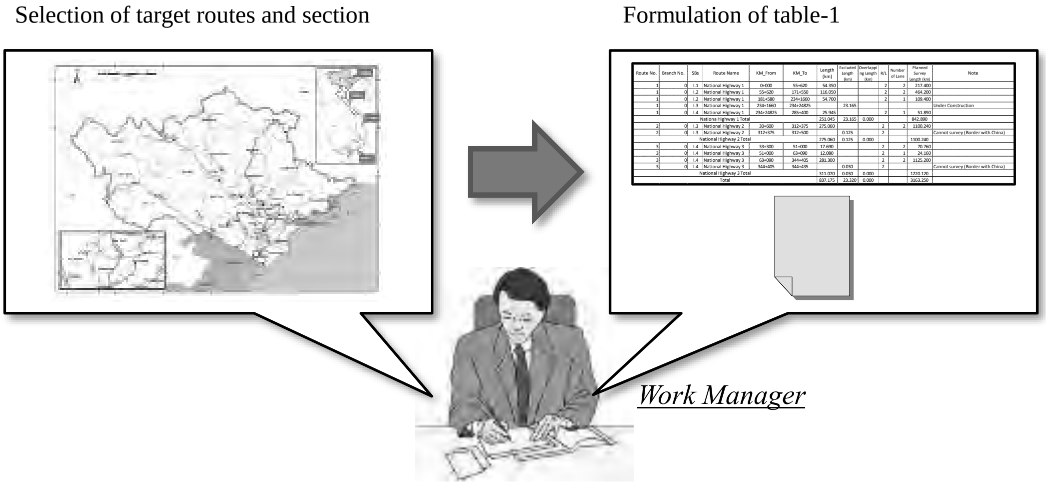



Figure 2.2 Preparation of Survey plan

[Section Table]

Three kinds of Section Table are prepared in the Pavement condition survey work. The Section Table is the information of section length in the target routes of PCS. Section Table is used for checking the section length in each work (Plan, Survey, and Analysis). Contents of section table are shown in Table 2.1.

Table 2.1 Contents of section table

| Section Table | Information | Prepared by | Timing | Note |
|---|---|---|---|---|
| Survey plan section table (Table-1) | Survey Planned Section | Work manager | When preparing of Survey Plan | Information of Target section for PCS |
| Surveyed section table (Table-2) | Surveyed Section | Survey consultant | After field survey | Section information of after field work |
| Analyzed section table (Table-3) | Analyzed Section | Survey consultant | After Data Analysis | Section information of after analysis work (Section of PC data) |

1) Select Target Route

Work manager selects the pavement condition survey routes. Selected survey routes are aggregated in the below information using Road inventory (RI) data of PMS

・ <u>Route number, Route name</u>

- Survey length (Lane, Direction (Right/Left))
- The KP number of overlapping starting and ending point

- Excluding sections from survey

Excluding sections from survey are selected by Work Manager. Planned construction or repair sections and sections where management was transferred shall be considered as excluding sections in Table **2.2**.

Table 2.2 Excluding sections from survey

| Excluding sections | Description |
|---|---|
| Planned construction or repair sections | Out of management due to transferred to BOT company |
| Sections where management was transferred | Out of management due to transferred to other road administration agency |

- The section with planned large scale rehabilitation during the pavement condition survey.

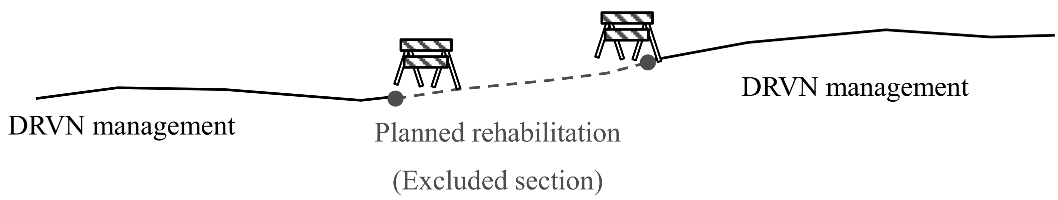



Figure 2.3 Planned rehabilitation section

- The section with planned transfer of management for PPC, BOT or other agency.

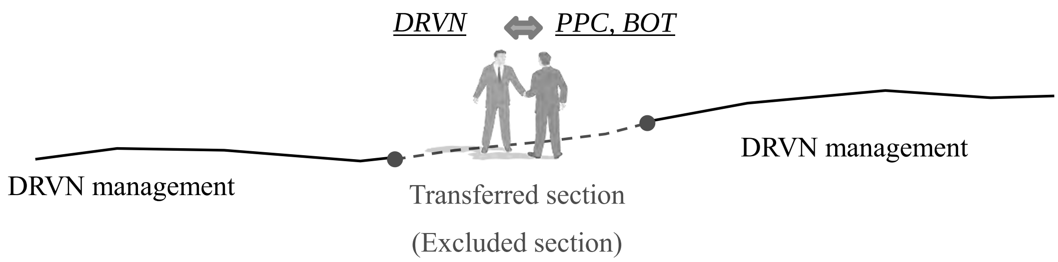



Figure 2.4 Transferred section

- Preparation of Survey Plan Section Table (Table-1)

Work Manager shall prepare the Survey Plan Section Table (Table-1) as the following steps;

・Road Inventory Data
(Road Category, Road No., Road No., Supplement, RMBs, SBs, Direction, Lane Position, KP)
・Section length
(Section length, Exclude length, Overlapping length and Planed survey length)
・Note

Road Inventory data shall be downloaded from PMS Database through the Web-System.
Section length is calculated as the following equation;

Section length = (”To KP” - “From KP”) x 1000 + (“To M” – “From M”)

Calculated section length values (Section length, Exclude length, Overlapping length and Planed survey length) are inputted into each column. For excluding sections as showing in Figure 2.3 and Figure 2.4, the reason of excluding is written in Note column. For Overlapping sections, the target route name of overlapping is written in Note column.
Finally, total survey length is calculated.

Total survey length =
(Total section length) – (Total excluding section length and overlapping sections)

Work Manager shall check all information of targeted survey sections, and prepare the final table as “Survey Plan Section Table (Table-1)”.

Survey Plan Section Table (Table-1) will be referred when TOR preparation and survey on site. In case that road inventory information in the database is not sufficient to prepare survey plan, e.g. new constructed roads, Expressway or roads managed by other road administration agencies), Work Manager shall collect necessary information for Table-1 preparation. The methodology to prepare New Road Code is descried in the manual of “Data Preparation [PSC-Vol.5]”

Table 2.3 Sample of Table-1

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping | Planned Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 285 | 400 | 321 | 800 | 83000 | 36400 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 321 | 800 | 330 | 0 | | | | 8200 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 330 | 0 | 368 | 400 | | 38400 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 383 | 0 | 423 | 600 | 84000 | 40600 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 423 | 600 | 425 | 875 | | | | 2275 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 425 | 875 | 449 | 300 | | 23425 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 449 | 300 | 451 | 0 | | | | 1700 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 451 | 0 | 458 | 0 | | 7000 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 458 | 0 | 467 | 0 | | | | 9000 | |
| 1 | 1 | [illegible] | [illegible] | [illegible] | RMB II | SB II.3 | Right | 1 | 467 | 0 | 468 | 0 | 128000 | 1000 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Left | 2 | 481 | 0 | [illegible] | [illegible] | | | | [illegible] | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Left | 2 | 484 | 0 | 504 | 400 | | 20400 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Left | 2 | 509 | 0 | 509 | 880 | 5800 | 880 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Left | 2 | 509 | 880 | 514 | 800 | | | | 4920 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Left | 2 | 517 | 900 | 561 | 0 | 43100 | 43100 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Left | 2 | 657 | 25 | 663 | 810 | 6785 | | | 6785 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.5 | Left | 2 | 717 | 0 | 729 | 910 | 12910 | 12910 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.5 | Left | 2 | 740 | 640 | 791 | 500 | 50860 | 50860 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Left | 2 | 791 | 500 | 819 | 850 | 76243 | 28350 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Left | 2 | 819 | 850 | 840 | 500 | | | | 20650 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Left | 2 | 840 | 500 | 867 | 743 | | 27243 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Left | 2 | 873 | 54 | 883 | 280 | 10226 | 10226 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Left | 2 | 886 | 890 | 893 | 180 | 6290 | 6290 | | | Under Condtruction |
| | | | | | | | | | | | | | 1904048 | 1564743 | | 339305 | |

[Road Code]

Road Code is defined as 10 digit codes. Road code consists of road category, road number, road number supplement and branch number. Each road code is corresponding with route name.

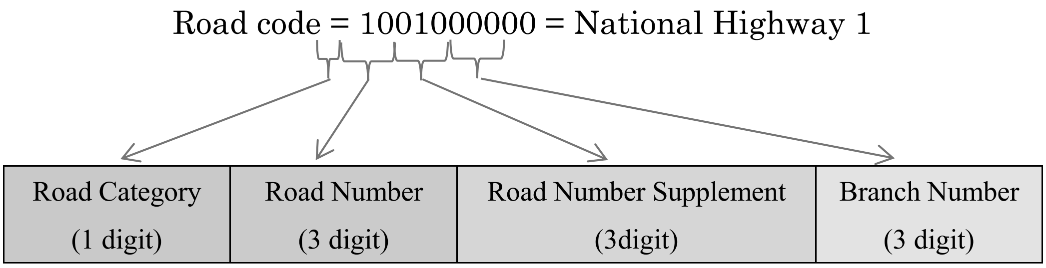



Figure 2.5 Road code

Road Category is the information used to identify the road category; whether the road national highway, expressway, provincial road, or others road.

Table 2.4 Road Category

| Classification | Code_Name | Code_ID |
|---|---|---|
| National Highway | NH | 1 |
| Expressway | Exp | 2 |
| Provincial Road | PR | 3 |
| Others Road | OR | 4 |

Road Number is the number assigned to each road. It consists of 3 digit numbers.

Road Number Supplement identifies the alphabet code on road name as a maximum 3 digit unique number. Road number supplement is defined beginning with 10 in alphabetical order from A. The code interval is basically set to 10 in order to correspond to the index number, such as NH4H1.
The alphabet which is not used in Vietnam has no code definition, such as F, J W and Z.

Table 2.5 Road Number Supplement

| Classification | Code_Name | Code_ID | Classification | Code_Name | Code_ID |
|---|---|---|---|---|---|
| A | A | 010 | M | M | 110 |
| B | B | 020 | N | N | 120 |
| C | C | 030 | O | O | 130 |
| D | D | 040 | P | P | 140 |
| E | E | 050 | Q | Q | 150 |
| G | G | 060 | R | R | 160 |
| H | H | 070 | S | S | 170 |
| H1 | H1 | 071 | T | T | 180 |
| H2 | H2 | 072 | U | U | 190 |
| I | I | 080 | V | V | 200 |
| K | K | 090 | X | X | 210 |
| L | L | 100 | Y | Y | 220 |

Branch Number is a number given in order to manage road section when same chainage is used for multiple sections such as in the case of bypass or road split into branches/subsidiary road from the main route. It consists of 3 digits numbers.

[Calculation Method of Survey Length]

Survey route length is calculated by total of the planed survey length. Planed survey length defined by length of each section.

- Planed Survey length = Length
- Route survey length = Sum of “Planed survey length”

| RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping | Planned Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RMB II | SB II.1 | Right | 1 | 285 | 400 | 321 | 800 | 36400 | 36400 | | | Under Condtruction |
| RMB II | SB II.1 | Right | 1 | 321 | 800 | 330 | 0 | 8200 | | | 8200 | |
| RMB II | SB II.1 | Right | 1 | 330 | 0 | 368 | 400 | 38400 | 38400 | | | Under Condtruction |
| RMB II | SB II.2 | Right | 1 | 383 | 0 | 423 | 600 | 40600 | 40600 | | | Under Condtruction |
| RMB II | SB II.2 | Right | 1 | 423 | 600 | 425 | 875 | 2275 | | | 2275 | |
| RMB II | SB II.2 | Right | 1 | 425 | 875 | 449 | 300 | 23425 | 23425 | | | Under Condtruction |
| RMB II | SB II.2 | Right | 1 | 449 | 300 | 451 | 0 | 1700 | | | 1700 | |
| RMB II | SB II.2 | Right | 1 | 451 | 0 | 458 | 0 | 7000 | 7000 | | | Under Condtruction |
| RMB II | SB II.2 | Right | 1 | 458 | 0 | 467 | 0 | 9000 | | | 9000 | |
| RMB II | SB II.1 | Right | 2 | 285 | 400 | 321 | 800 | 36400 | 36400 | | | Under Condtruction |
| RMB II | SB II.1 | Right | 2 | 321 | 800 | 330 | 0 | 8200 | | | 8200 | |
| RMB II | SB II.1 | Right | 2 | 330 | 0 | 368 | 400 | 38400 | 38400 | | | Under Condtruction |
| RMB II | SB II.2 | Right | 2 | 383 | 0 | 467 | 0 | 84000 | 84000 | | | Under Condtruction |
| RMB II | SB II.1 | Left | 1 | 285 | 400 | 321 | 800 | 36400 | 36400 | | | Under Condtruction |
| RMB II | SB II.1 | Left | 1 | 321 | 800 | 330 | 0 | 8200 | | | 8200 | |
| RMB II | SB II.1 | Left | 1 | 330 | 0 | 368 | 400 | 38400 | 38400 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 1 | 383 | 0 | 423 | 600 | 40600 | 40600 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 1 | 423 | 600 | 425 | 900 | 2300 | | | 2300 | |
| RMB II | SB II.2 | Left | 1 | 425 | 900 | 449 | 300 | 23400 | 23400 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 1 | 449 | 300 | 451 | 0 | 1700 | | | 1700 | |
| RMB II | SB II.2 | Left | 1 | 451 | 0 | 458 | 0 | 7000 | 7000 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 1 | 458 | 0 | 467 | 0 | 9000 | | | 9000 | |
| RMB II | SB II.1 | Left | 2 | 285 | 400 | 321 | 800 | 36400 | 36400 | | | Under Condtruction |
| RMB II | SB II.1 | Left | 2 | 321 | 800 | 330 | 0 | 8200 | | | 8200 | |
| RMB II | SB II.1 | Left | 2 | 330 | 0 | 368 | 400 | 38400 | 38400 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 2 | 383 | 0 | 423 | 600 | 40600 | 40600 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 2 | 423 | 600 | 425 | 900 | 2300 | | | 2300 | |
| RMB II | SB II.2 | Left | 2 | 425 | 900 | 449 | 300 | 23400 | 23400 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 2 | 449 | 300 | 451 | 0 | 1700 | | | 1700 | |
| RMB II | SB II.2 | Left | 2 | 451 | 0 | 458 | 0 | 7000 | 7000 | | | Under Condtruction |
| RMB II | SB II.2 | Left | 2 | 458 | 0 | 467 | 0 | 9000 | | | 9000 | |
| | | | | | | | | 668000 | 596225 | | 71775 | |

Route Survey Length

Sum the planed survey length, calculate the route survey length.

Figure 2.6 Calculation method of Route Survey Length

2) Estimation of schedule and cost

Work manager estimates the work period according to target survey length and work amount per day of work items. Work manager also estimates the cost of survey work based on total work amount.

The progress speed should be noted in the terms below:

- Survey Planning: 15 days (If the survey will be held in 4 RMBs)
- Calibration: 3 days/time
- Measurement: 70km/day
- Data Analysis: 10km/day (1 operator)
- Data Processing: 70km/day (1 operator)
- Final Report: 5 days

## 2.2. Assign Survey Consultant

Work manager makes the Terms of Reference (hereafter TOR) based on survey plan. And Work manager submits the TOR to top manager and gets the approval of top manager. As the result of bidding, Work manager contracts with the Survey consultant and Work manager order to the Survey consultant to make the “Implementation Plan”. “Implementation Plan” shall be discussed detail between Work manager and Survey consultant before starting the survey.

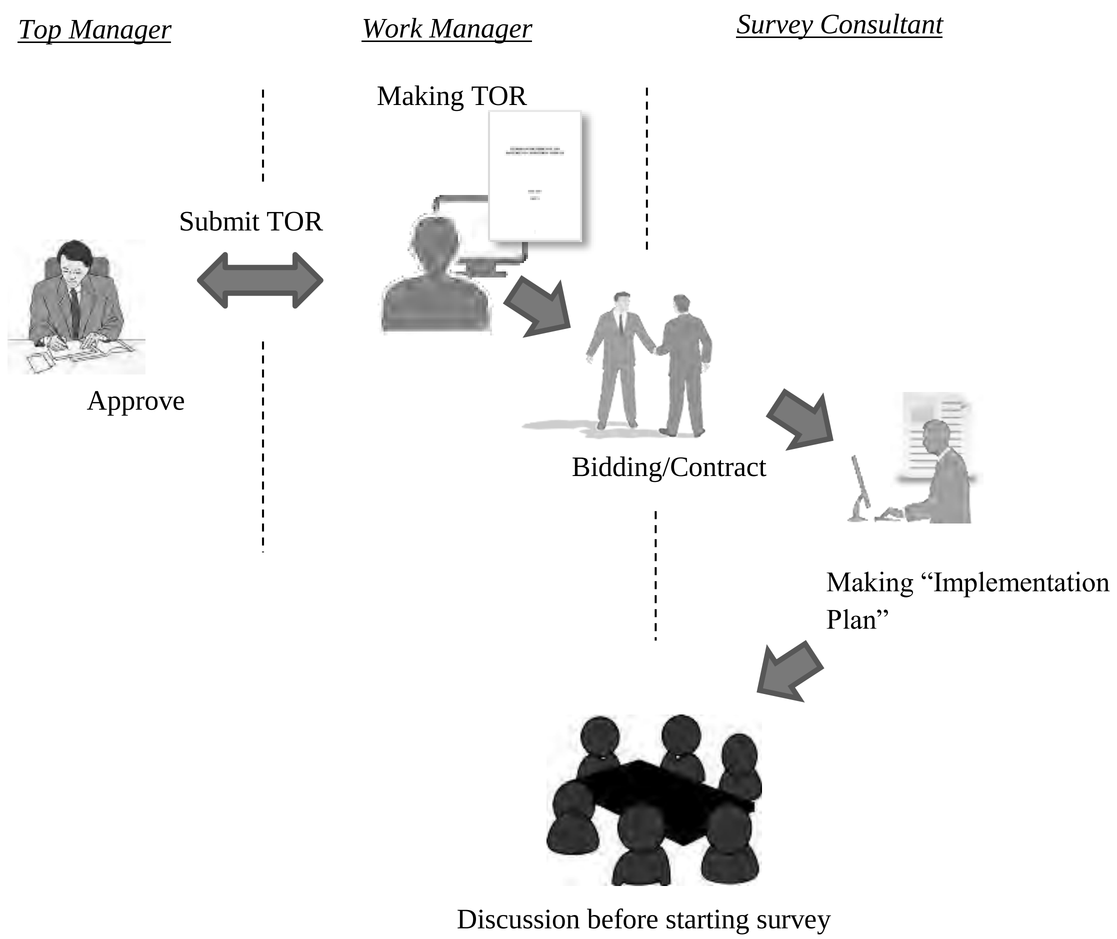



Figure 2.7 Work flow of entrustment of PCS

1) Making the TOR

Work manager makes the TOR based on the Table-1 and schedule in the survey plan. Content list is shown in Table 2.6. When the TOR is updated using the format in Appendix 1, the items in Table 2.6 shall be updated.

After making the TOR, Work manager submits the TOR to Top manager and gets the approval of Top manager.

Table 2.6 Content list of TOR

| Contents | Description |
|---|---|
| Target area | Managed RMBs |
| Target route and length | Survey Section Table 1 |
| Specification of Pavement condition survey work | Regulation of Pavement condition Survey |
| Implementation method | Detail of survey work item |
| Output Item | Item of delivered |
| Payment terms | Terms for payment to be made |
| Implementation Schedule | Describe the project implementation period |
| Survey vehicle and equipment | Describe the equipment specifications to use project |

2) Entrustment of PCS

Work manager shall make an entrustment of Pavement Condition Survey Work with Survey Consultant according to the specified procedure.

3) Instruction to prepare Implementation Plan

Work Manager shall instruct Survey Consultant to prepare Implementation Plan. Survey Consultant shall update the following information in the TOR by using the format of Implementation Plan (Appendix-2). Survey Consultant shall submit the Implementation Plan to Work Manager promptly.

- Date of submission of Implementation Plan
- Signature of Survey Consultant
- Period of Calibration
- Period of Measurement
- Target RMB and Sub-Bureau
- Survey Length Table
- Period of Data Analysis
- Period of Data Processing
- The name, mobile number and email address of Team Leader
- The name, mobile number and email address of Survey team member

- The name, mobile number and email address of Data Analysis team member
- Implementation schedule table

Implementation structure in Survey Consultant is described in Figure 2.8. Survey Consultant has two partied, Survey team and Data Analysis team.

Survey Team has five (5) members, including one (1) driver three (3) operators and one (1) navigator. Work Manager shall dispatch a navigator who takes a responsibility of confirmation of road information, such as start/end point of road, direction, etc.

Data Analysis team has ten (10) members, who take responsibilities of data analysis and data processing work using collected data on site by Survey Team.

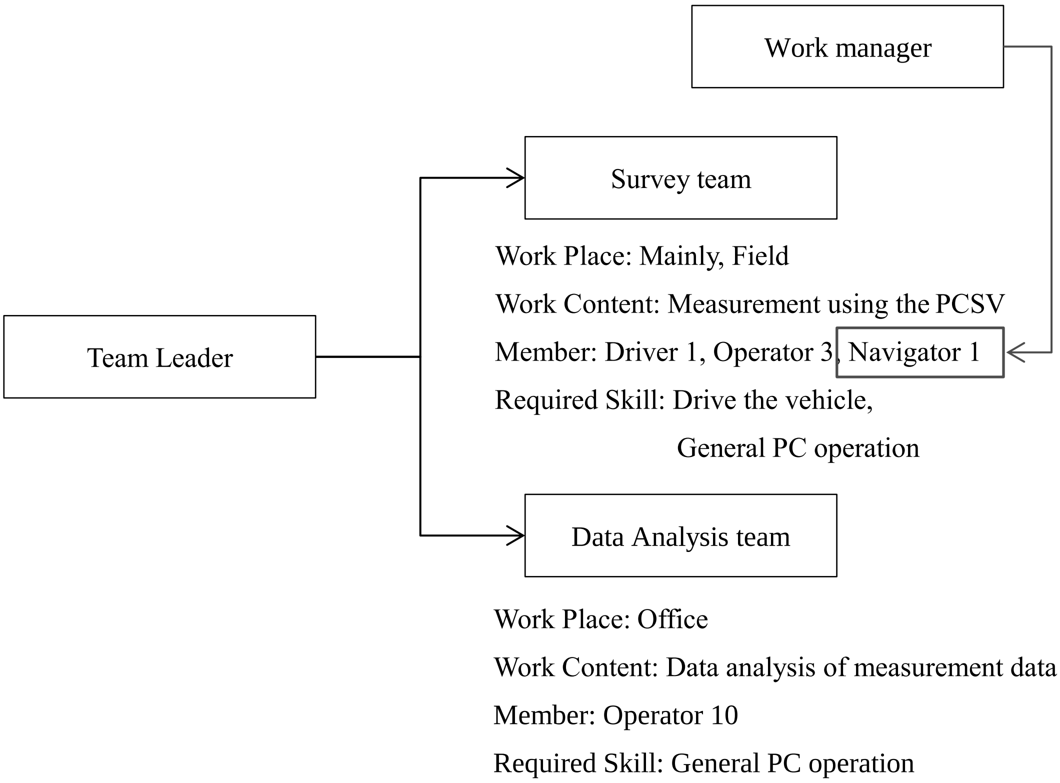



Figure 2.8 Formation of Survey Consultant

4) Discussion before survey

Discussion between Work Manager and Survey Consultant shall be held based on the Implementation Plan prepared by Survey Consultant. Work manager shall check all information in the Implementation Plan and confirm it.

- Survey length (Route length, Planned survey length)
- Excluded section, length
- Implementation schedule
- Report contents (particularly how to treat the traffic accident)
- The place of calibration

## 2.3. The Importance to Conduct the Constantly Pavement Condition Survey

Since pavement condition survey should is not completed at once, it should be carried out continuously. Time-series database will be established by continuously conduction of pavement condition survey. Time-series database is utilized for management and evaluation for pavement maintenance work.

- Survey Plan

Long-term survey plan shall be prepared. In survey plan, the following points shall be considered.

・ <u>Capacity of PCSV</u>

Survey length that can be carried out in a year is decided according to the number of PCSV.

・ <u>Secure human resource</u>

Engineers for field survey work and data analysis work

・ <u>Budget for survey</u>

Secure enough budgets for PCS

・ <u>Compatibility with progress of previous 5-year pavement maintenance plan</u>

Decide next timing of survey based on the progress of 5-year pavement maintenance plan with previous PC data

- Survey scheme

・ <u>One time survey scheme</u>

All road networks is surveyed in one time

・ <u>Equalization of survey length</u>

Survey length is equalized for each fiscal year

Figure 2.9 shows a survey scheme of equalization of survey length. In case that road network of 1500km is surveyed in 3 years, road network is divided into 3 groups (A, B, and C). In that case, survey length in one year is 500km. Road network in Group A is measured in the first year. Next survey in Group A is conducted in the 4th year after completion of all network survey.

In case that Length of road network: 1500km is surveyed in 3 years

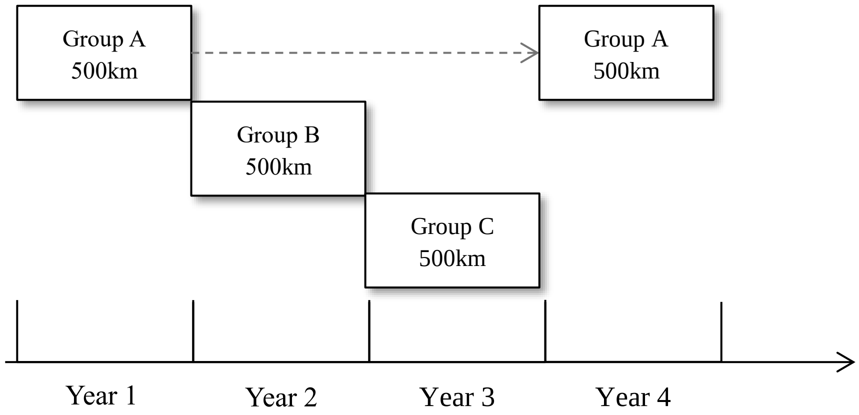



Figure 2.9 Sample of survey scheme (equalization of survey length)

# 3. Field Work Supervision

Work flow of field work is shown in Figure 3.1.

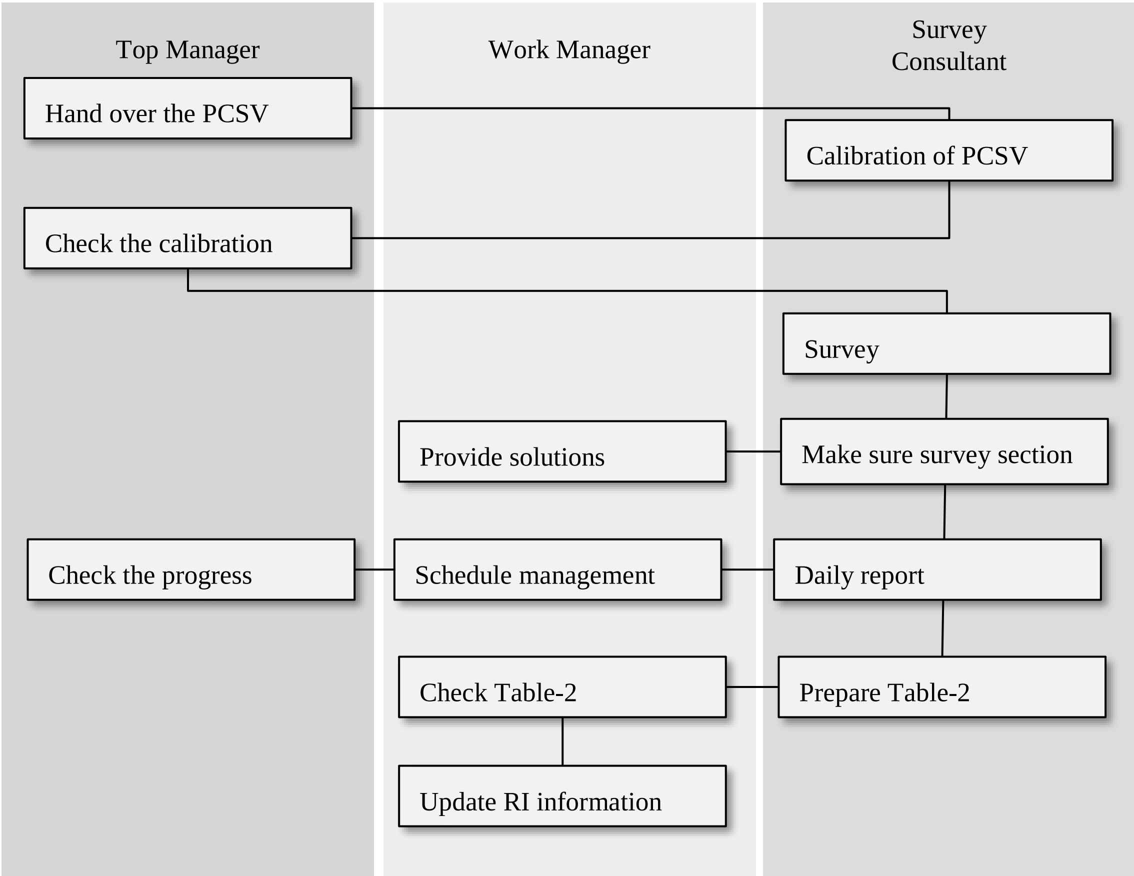



Figure 3.1 Work flow of field work

1) Field Work of Survey team

After complete the implementation contents at the first discussion, Survey team will start the measurement following the implementation schedule. Work manager supervises their activity in the office. Survey team will conduct the survey work as below items.

- Calibration of the measurement devices (Before the measurement)
- Survey
- Report the problem (Traffic Accident/Broken)
- Confirmation of unclear point on survey
- Daily report
- Prepare "Surveyed Section Table (Table-2)"

Table 3.1 is showing the items to be measured on site. Road damage data (Crack, Rut and IRI) are evaluated by using measured three items (Road image, cross-section profile and longitudinal profile). And front view image data with coordinates, which is one of the output data on PCS, is used to identify pavement type or road surround information when data analysis.

Table 3.1 Measurement item in field survey

| Measurement item | Equipment | Analysis item |
|---|---|---|
| Road image | CCD camera for road image | Crack |
| Transverse profile | Laser scanner | Rut |
| Longitudinal profile | Laser Displacement sensor & IMU | IRI |
| Front image with coordinate | CCD camera for front image & GPS | (Finally the front image is registered to PMS server) |

Calibration

Marking

Measurement

Operation

Figure 3.2 Steps of field work

2) Matters to be Handled by Top manager

Top manager will respond to the following matters at the office.

- Before measurement (hand over the PCSV. Check the calibration result)
- Progress check

3) Matters to be Handled by Work manager

Work manager will respond to the following matters at the office as field work supervision.

- Provide solutions to the report or question from the Survey team
- Schedule management
- Check the Table-2

Furthermore, Work manager shall pay attention to the safety and data quality as a field supervisor. For example, Work manager instructs to Survey team the below contents.

- To Arrange the safety keeper when the marking at the starting and ending point

- <u>To check the starting and ending point of the target survey route</u>
- <u>To check the brightness of the image (visible the crack in the image)</u>
- <u>To check the position of measurement stop (possible to stop the measurement on the just KP position)</u>

## 3.1. Preparation the PCSV before Measurement

Survey team prepares the PCSV as shown in Figure 3.3.

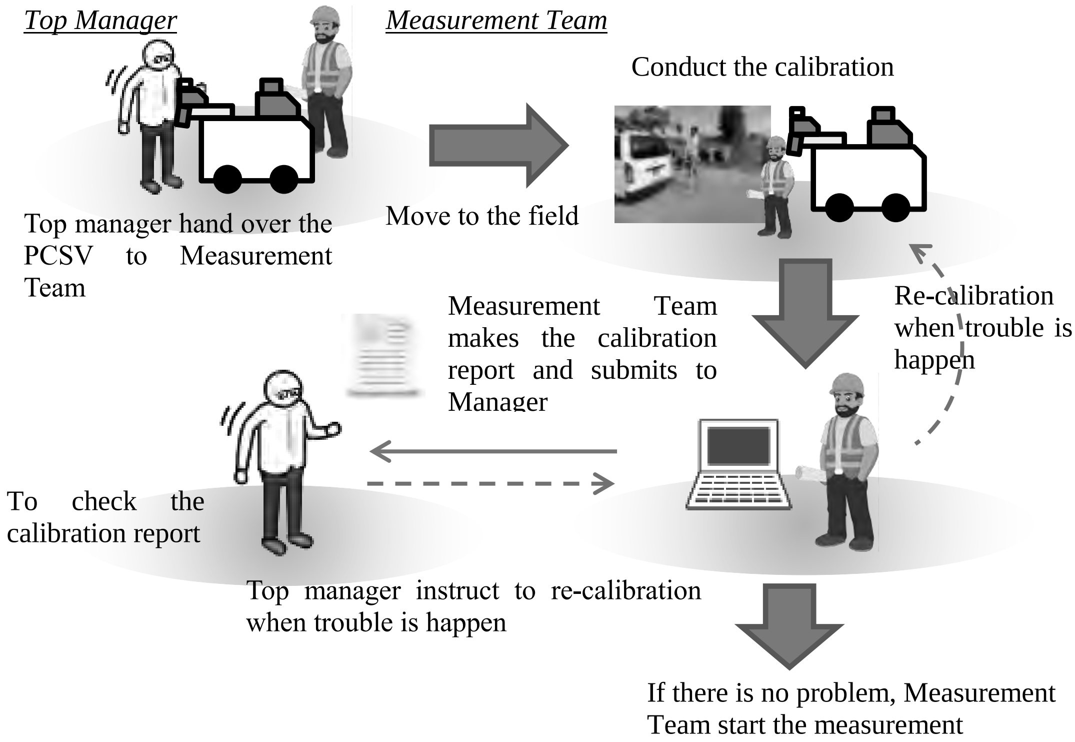



Figure 3.3 Work flow of survey preparation

1) Handover of PCSV

Top Manager shall handover the PCSV to Survey Consultant. Top Manager and Survey Consultant make sure survey method and operation procedure of the PCSV based on the manual of "Instruction Book of REAL Mini [PCS-Vol.4]" and "Management [PCS-Vol.2]". And Top Manager and Survey Consultant check basic operation of the PCSV and apparent condition of the vehicle, and make sure that there are no damages or failures in the PCSV. The results of above checks shall be recorded on a document with both signature between Top Manager and Survey Consultant.

2) Calibration of PCSV

Measurement device of the PCSV will have some change on setting location or device conditions by long-team use, and it might cause error of measurement data. To avoid measurement error, calibration of the PCSV shall be done to verify accuracy of measurement data and adjust device parameters.

Calibration work shall be done when the following timing;

Timing of calibration
- Before survey in case of survey over 350km in total during one survey term
- When measured length is over 5000km from the last calibration
- When over 6 months pass from the last calibration
- In case of changing tires or changing air pressure of tires

Table 3.2 is showing the items for calibration. For more detail about calibration work, refer to "Instruction Book of REAL Mini [PCS-Vol.4]" and "Calibration Report (Appendx-4)".

Table 3.2 Calibration item

| No. | Work Item | Check item | Tolerance |
|---|---|---|---|
| 1 | Inspection vehicle check | Condition of system | No Error |
| 2 | Camera check | Detection accuracy of crack width in image | 2mm or more |
| 3 | Camera calibration | Measurement span | 3.8m or more |
| 4 | Laser displacement sensor check | Accuracy of measurement | 0.4mm |
| 5 | Laser scanner check | Accuracy of Rut depth measurement | 6mm |
| 6 | Distance calibration | Accuracy of mileage measurement | Within range of -0.5% to 0.5% |
| 7 | Long test | Operating condition of inspection vehicle | No Error |

3) Calibration Report

   Survey Team of Survey Consultant shall prepare the Calibration Report using the format of the report and submit it to Top Manage. In case that there are some problems in the Calibration Report, Top manager shall instruct Survey Team to do calibration again.

## 3.2. Field survey

Survey team conducts the survey every day excluding rainy days. Survey team reports about progress to Work manager via email with an attached "Format of Measurement Report" (Appendix 6) every day.
Work manager checks the progress from the report. If there is a big delay from the plan, Work manager confirms the reason for the delay. Work manager and Survey team discuss the countermeasure for the reason.

Work manager submits the progress of field survey to Top manager. Top manager checks the progress based on the report from Work manager.

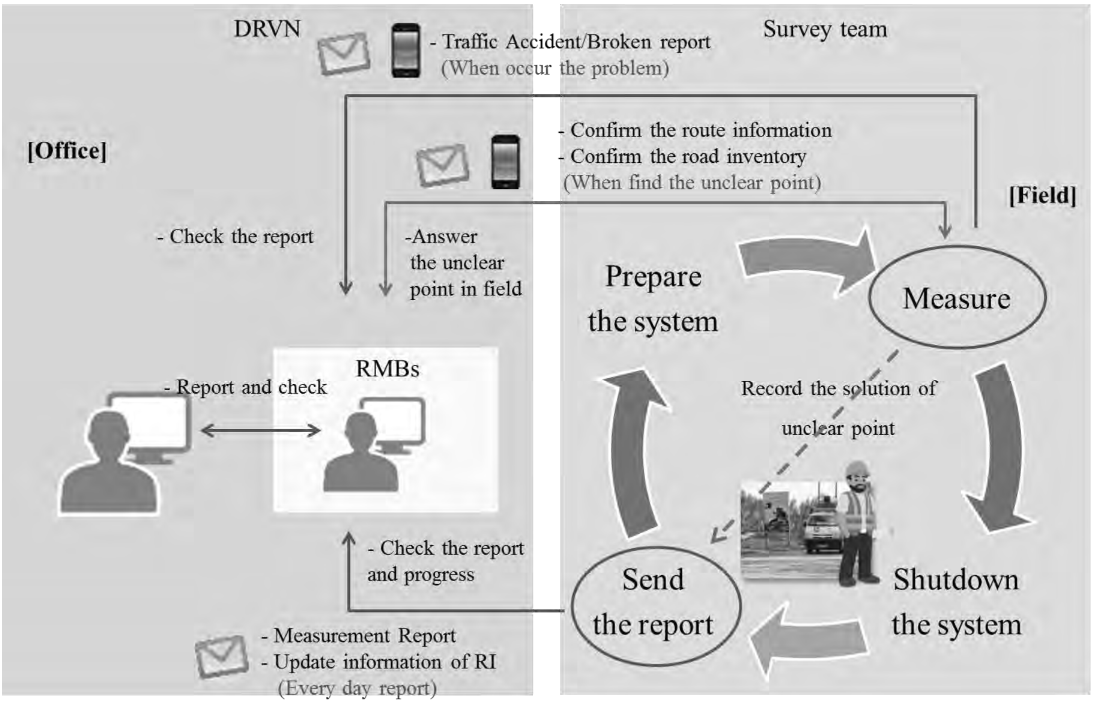



Figure 3.4 Work flow of field survey

In case the conducting the pavement condition survey in new route (new construction, expressway, PDOT management roads, etc.), the below contents should be confirmed carefully about each route situation in order to clear the problem point of survey in advance.

・Kilo post station is exist or not
・Pavement is exist or not
・Possibility of the starting and ending point (particularly expressway)
・Road code setting is appropriate or not

1) Schedule management

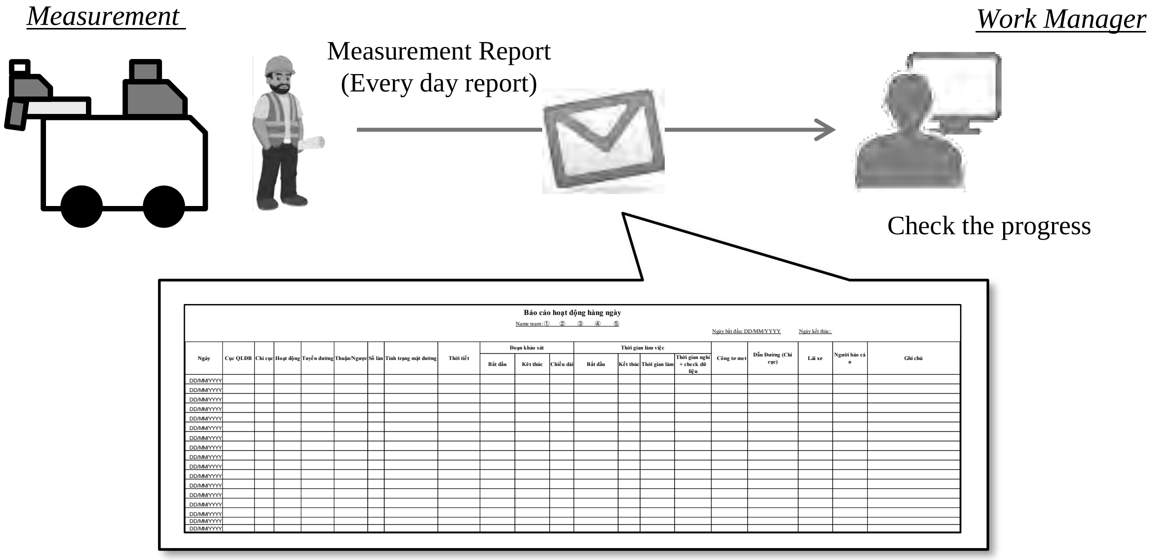
Survey team reports to Work manager via email with an attached "Format of Measurement Report" (Appendix 6) every day.

・ Survey team:

Survey team reports to Manager via email about which route and how many km had been surveyed every day.

・ Work Manager:

Work manager checks and manages the progress based on the report from the Survey team. If the progress is delayed from the plan, Manager finds out the reason and takes countermeasure for the reason.




**Báo cáo hoạt động hàng ngày**

Name team: ① ② ③ ④ ⑤

Ngày bắt đầu: DD/MM/YYYY Ngày kết thúc:

| Ngày | Cục QLĐB | Chi cục | Hoạt động | Tuyến đường | Thuận/Ngược | Số làn | Tình trạng mặt đường | Thời tiết | Đoạn khảo sát | | | Thời gian làm việc | | | | Công tơ met | Dẫn Đường (Chi cục) | Lái xe | Người báo cáo | Ghi chú |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Bắt đầu | Kết thúc | Chiều dài | Bắt đầu | Kết thúc | Thời gian làm | Thời gian nghỉ + check dữ liệu | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |

Figure 3.5 Format of measurement report

Dear XXXX,

I send today's daily report.
Please kindly refer the attachment for the detail.

Date: DD/MM/YYYY
Reporter: Name
Report at: Place
Survey length: Length
Survey route: Route name

BR,
XXXX

Figure 3.6 Sample of mail format

2) Provide Solutions

Survey team reports any problem and question to Work manager if needed. Work manager instructs the solution to the Survey team.

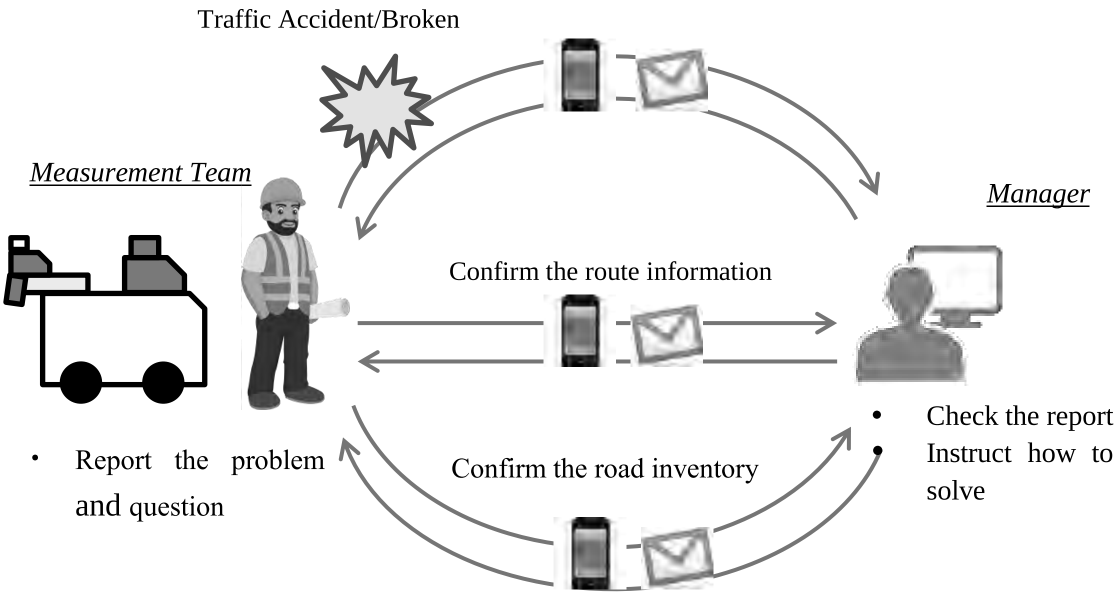



Figure 3.7 Flow of report and responding for the report

a) Safety Management

In case of traffic accident, Survey Team shall report to Work manager about situation of accident, including (1) Accident situation, (2) with or without injured persons and (3) Possibility to continue the survey, etc. In case of with injured persons, Survey Team requests an ambulance and reports to the police for highest priority of life rescue. If measurement device or vehicle has problems due to accident, Survey Team shall report to Top manager and Work manager about condition of the PCSV promptly.

If it is impossible to move the vehicle to a safe place, the PCSV is repaired there in case of minor damage. Or the PCSV is moved by tow-away and repaired.

In case that the vehicle has no damage but measurement device has failures, Survey Team shall go back to the garage of the PCSV and repair the device.

Finally, Survey Team shall make sure that the PCSV is operated properly by operation test.

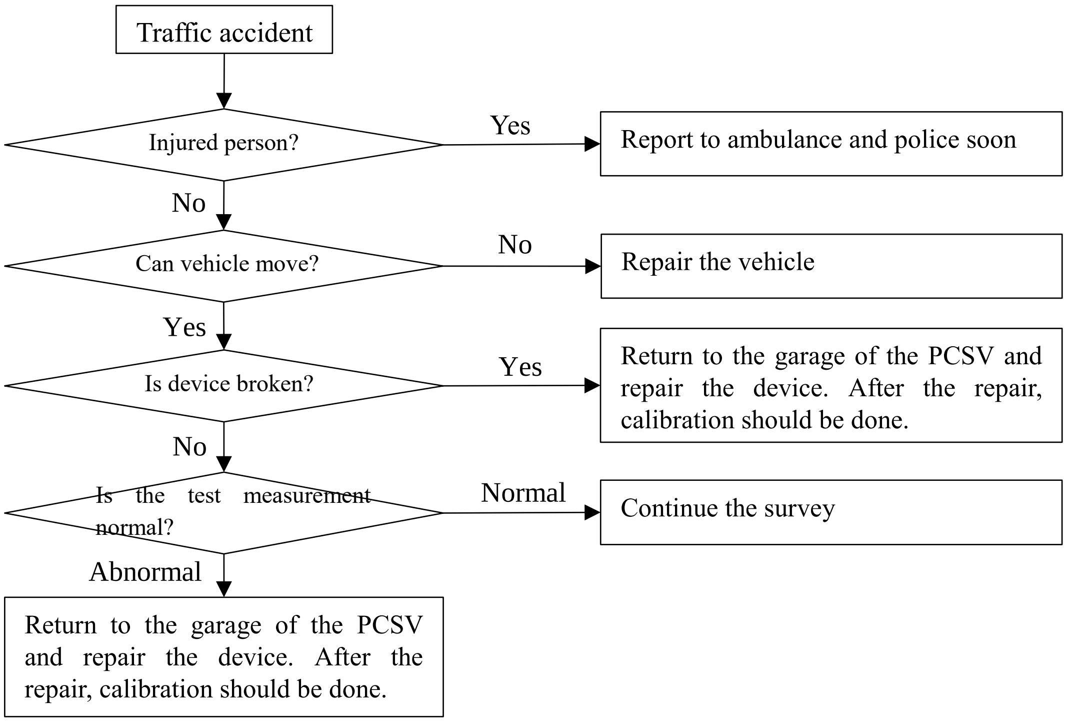



Figure 3.8 Flow in case of traffic accident

b) Confirmation of the Route Information

Survey team checks the differences between information on the Table-1 and information on site. Check item is below.

- Starting/ending point of the target route
  Check the starting/ending point in the route
- Excluded section
  Confirm the additional section of rehabilitation section and transferred section.
- Overlapping section
  Check the starting/ending point of overlapping section in the route.

When hard to continue survey due to above issues, Survey Team shall ask navigator or Work Manager to provide solutions to correct information between planned information and on site situation. Navigator or Work Manager shall confirm the situation and direct solutions to Survey Team.

[Example of the difference]

➢ Route Change

When new opened route is found on site within the targeted route, Survey Team shall make sure the jurisdiction and road inventory (road code, branch code, etc.) of both routes (new route and old route) by asking to Work Manager. Work Manager shall provide necessary information to Survey Team.

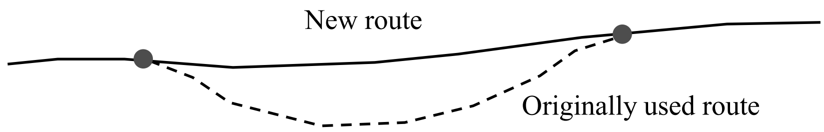



Figure 3.9 Route change

- Jurisdiction change

  When targeted sections are transferred to other road administration agencies, including BOT construction sections, these sections shall be excluded from survey. The start and end point of excluding sections shall be marked up on pavement, and these sections shall be measured at that time. The excluding section will be confirmed when data analysis.

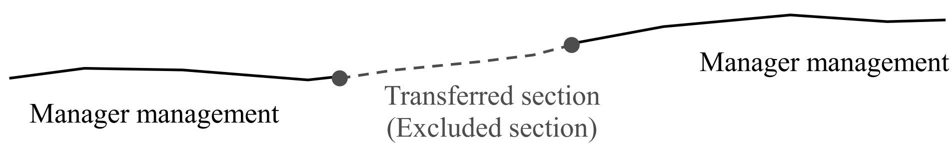



Figure 3.10 Transferred section

c) Confirm the Road Inventory Information

Survey team reports to navigator or Work Manager if there is different inventory information (ex: road width, change position of number of lane, etc.) between Table-1 and information on site. The navigator or Work Manager checks the report and instruct proper solutions to Survey team.

### 3.3. After Field Survey Completed (Check Table-2)

Survey Team shall prepare the "Surveyed Section Table (Table-2)" using measured information (route name, KP and surveyed length) after field survey completion as the following steps;

- Insert a row in the 8 columns next to "Planned survey length (km)" in Table-1
  KP (From and To), Surveyed length (surveyed length, excluding sections length and overlapping length), Note
- KP information and surveyed length are inputted into the targeted columns based on measured information
- Information on additional excluding sections and additional survey sections are inputted into added column
  ("Added excluding section" or "Additional survey sections" are written in Note)
- "Surveyed Section Table (Table-2)" is completed after all information are inputted.

Survey Team shall submit the Table-2 to Work Manager. Work Manager shall check it and verify KP information and section length of additional excluding sections and additional survey sections.

- Select sections which has “Added excluding section” and “Additional survey sections” in Note in Table-2
- KP (From and To) information and section length of corresponding records shall be confirmed.

Work Manager shall instruct Survey Team to update the Table-2 if needed. In the case of misstatement of KP or survey length, Survey Team corrects the relevant part and resubmits it.
When a section different from the actual section is set as excluding section or additional survey section, Survey Consultant shall survey that section again and update the Table-2.
Table-2 and survey length is fixed by Work Manager.

When there is a big difference between "Planned survey length (km)” and "Survey length (km)", Work Manager shall discuss with Survey Consultant to change contract contents.
For example;
"Planned survey length (km)” > "Survey length (km)"
Add survey routes
"Planned survey length (km)” < "Survey length (km)"
Update the contract amount

Table 3.3 Sample of Table-2

| Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_ KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Planned Survey Length | Note | From_KP | From_M | To_KP | To_M | Excluded Length | Overlapping Length | Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 321 | 800 | 330 | 0 | | | | 8200 | | 321 | 800 | 330 | 0 | | | 8540 | |
| 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 423 | 600 | 425 | 875 | | | | 2275 | | 423 | 600 | 425 | 875 | | | 2095 | |
| 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 449 | 300 | 451 | 0 | | | | 1700 | | 449 | 300 | 451 | 0 | | | 1665 | |
| 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 458 | 0 | 467 | 0 | | | | 9000 | | 458 | 0 | 467 | 0 | | | 9600 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 468 | 0 | 484 | 0 | | | | 16000 | | 468 | 0 | 484 | 0 | | | 16000 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 504 | 400 | 518 | 0 | | | | 13600 | | 504 | 400 | 517 | 1080 | | | 13680 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 561 | 0 | 587 | 0 | | | | 26000 | | 561 | 0 | 587 | 0 | | | 26000 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 591 | 600 | 595 | 0 | | | | 3400 | | 591 | 600 | 595 | 5 | | | 3405 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 595 | 0 | 597 | 590 | 2590 | | | 2590 | | 595 | 5 | 597 | 590 | | | 2385 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 625 | 125 | 625 | 880 | 755 | | | 755 | | 625 | 125 | 625 | 880 | | | 755 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 657 | 25 | 663 | 815 | 6790 | | | 6790 | | 657 | 25 | 663 | 815 | | | 6645 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 671 | 230 | 672 | 305 | | | | 1075 | | 671 | 230 | 672 | 305 | | | 1075 | |
| 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 819 | 850 | 840 | 500 | | | | 20650 | | 819 | 850 | 840 | 500 | | | 20300 | |
| 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 868 | 100 | 872 | 600 | | | | 4500 | | 868 | 100 | 872 | 600 | | | 4330 | |
| 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 883 | 700 | 886 | 500 | | | | 2800 | | 883 | 700 | 886 | 500 | | | 2510 | |
| 0 | 0 | NH1 | RMB II | SB II.1 | Right | 2 | 321 | 800 | 330 | 0 | | | | 8200 | | 321 | 800 | 330 | 0 | | | 8530 | |

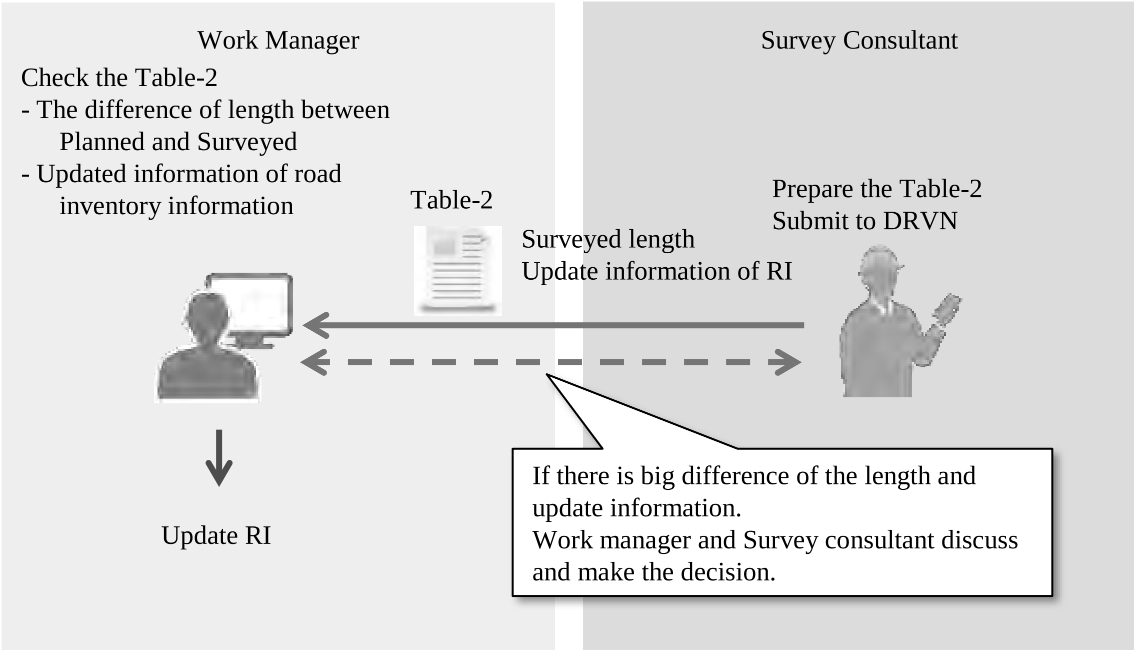



Figure 3.11 Work flow of preparing Table-2

## 4. Supervision of Data Analysis and Data Processing

Work flow of data analysis and data processing is shown in Figure 4.1.

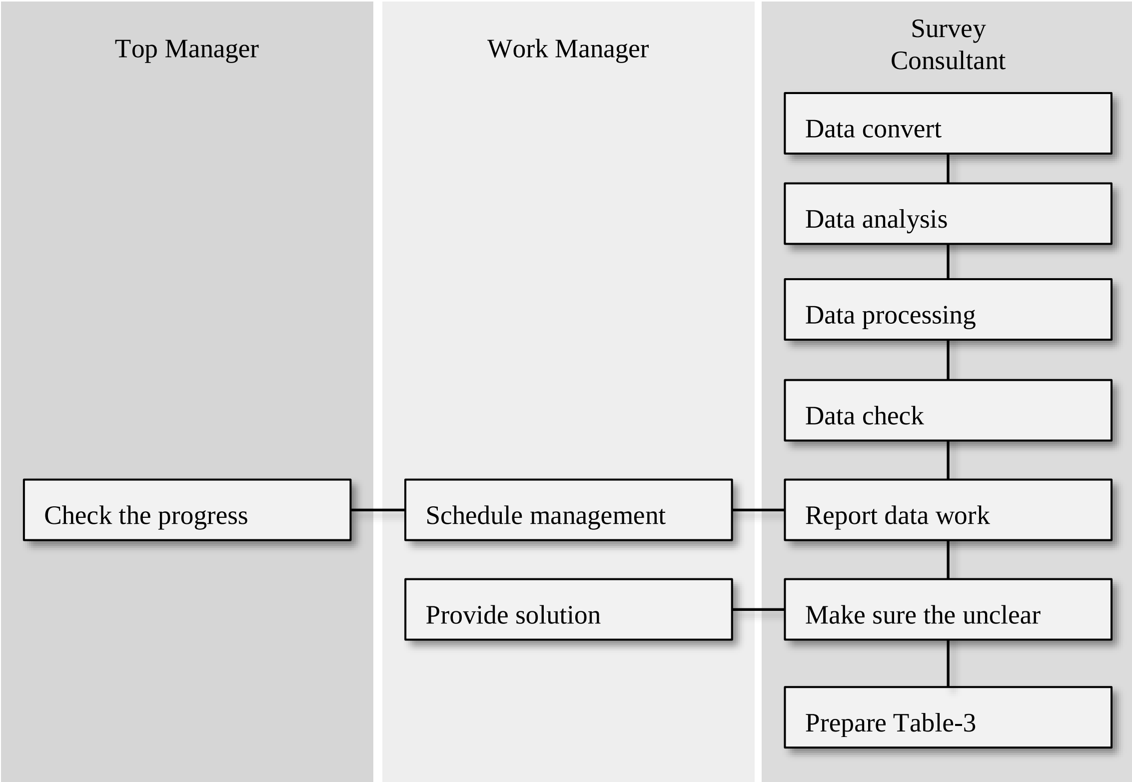



Figure 4.1 Work flow in data analysis and data processing

1) Data Analysis and Data Processing by Data Analysis team

The measurement data will be stored into the external HDD. Survey team hands over the external HDD to Data Analysis team. Data Analysis team conducts the data analysis and data processing to prepare the PC data. Data Analysis team uses the application of data analysis and data processing on PC. The work items are as below,

- <u>Data Conversion</u>
- <u>Data Analysis</u>
  - The starting and ending position setting
  - Road width setting
  - Interpretation of crack
  - Road surface type classification
  - KP and structure setting
- <u>Data processing</u>
  - Data processing for 100m
  - Data coupling
  - Output the data

- Data check
- Weekly report
- Confirmation of unclear point on analysis
- Prepare “Analyzed Section Table (Table-3)”

Top manager provides licenses of Data Analysis application and Data Processing Applications to Data Analysis team. After completion of survey project, Data Analysis team shall delete the installed applications from PCs.

In case of analysis work for new routes, such as new constructed routes, Expressway or routes managed by other road administration agencies, Analysis operators in Data Analysis team shall add new road code information and route name to the configuration file of Location Setting Application. For more detail procedure to update the configuration file, refer to the chapter 10 of manual of “Instruction Book of REAL Mini [PCS-Vol.4]”.


Figure 4.2 Data Analysis and Data Processing work in Office

2) The Matters should be treated by Top Manager

Top manager will respond to the following matter

- Progress check of analysis and processing work

3) The Matters should be treated by Work manager

Work manager supervises the below matters during the data analysis and data processing.

- Schedule management
- Responding for the Report and Question of data analysis and data processing
- Check the length of data analysis (Table-3)

## 4.1. Schedule Management

Data Analysis team conducts the data analysis and data processing work in the office every day. The leader of Data Analysis team records the progress every day for “Data Analysis Weekly Report”

(Appendix 7). The Data Analysis team leader sends the "Weekly Report" with attachment to Work manager via email like a Figure 4.3.

Furthermore the sample of "Weekly Report" would be indicated in Figure 4.4. It is possible to check the analysis length of section length of the data. Work manager checks the progress to confirm the sum of analysis length and "Table-2". If the progress is delayed significantly, Work manager finds out the reason and instructs to push up the progress.

Work manager submits the progress of analysis work and processing work to Top manager. Top manager checks the progress based on the report from Work manager.

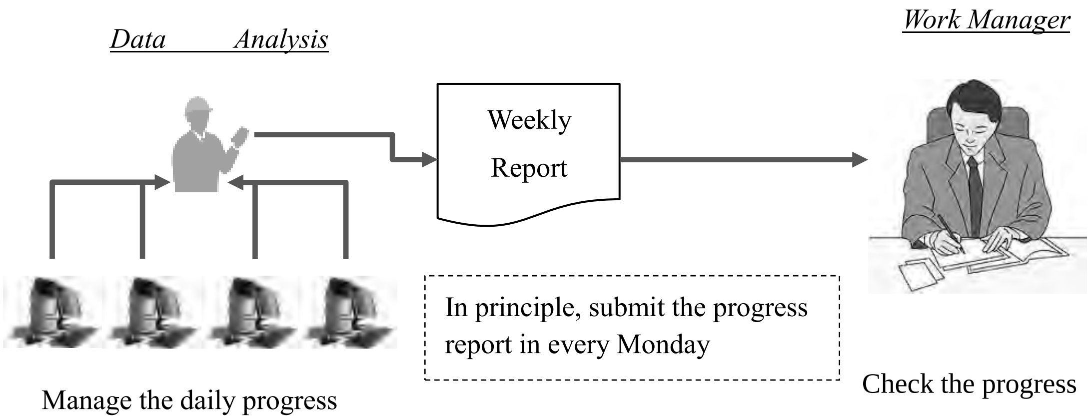



Figure 4.3 Flow of data analysis progress report

Dear XXXX,

I send weekly report.
Please kindly refer the attachment for the detail.

Date: DD/MM/YYYY
Reporter: Name
Analysis length in week: Length
Total analysis length: Length

BR,
XXXX

Figure 4.4 Sample of email of data analysis report

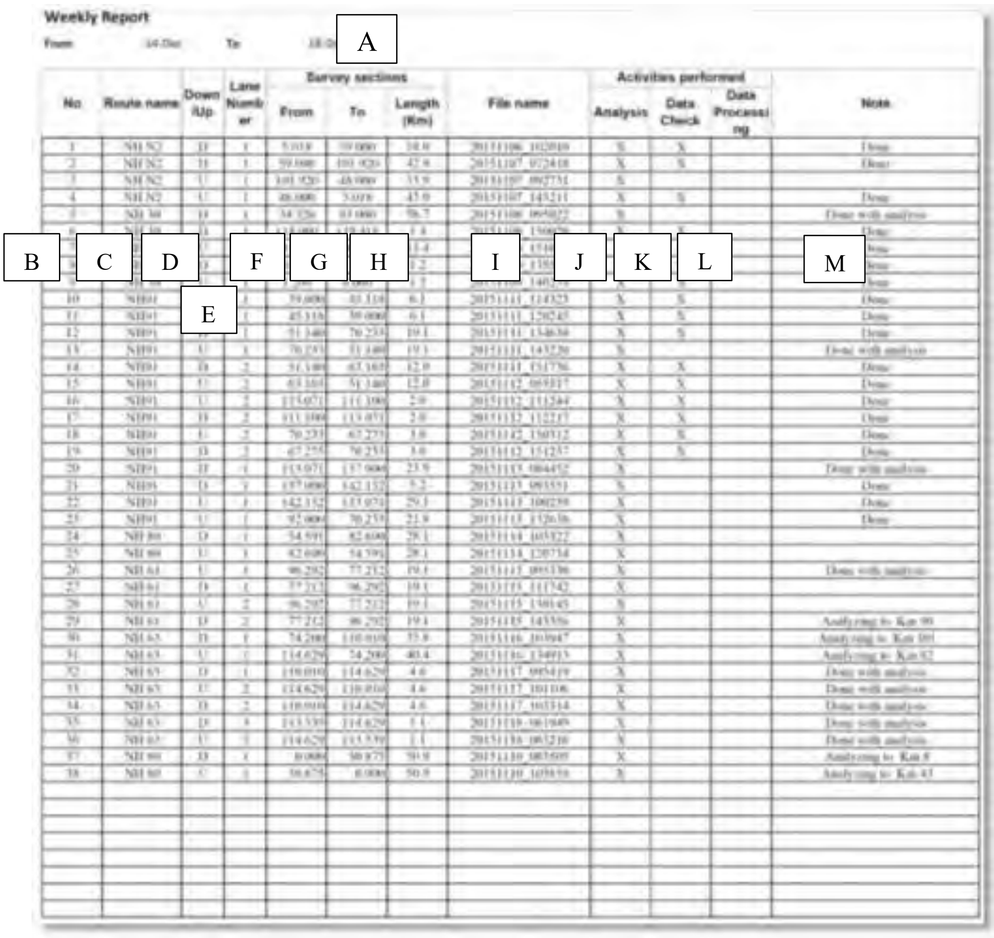



Figure 4.5 Format of data analysis Weekly Report

A. Analysis Period (From – To)
B. Analysis Number (sequential number)
C. Route Name
D. Right Left
E. Number of Lane
F. Survey Section (Starting position; KP number)
G. Survey Section (Ending position; KP number)
H. Survey Section (Length (km))
I. File Number (Folder number of Measurement)
J. Progress of Interpretation (X; Complete, Blank; Not complete)
K. Progress of Data Check (X; Complete, Blank; Not complete)
L. Progress of Data Processing (X; Complete, Blank; Not complete)
M. Note (Memo, Message)

## 4.2. Provide Solutions

Data Analysis team reports to Work manager about the unclear matter in the data analysis and data processing at every time. Work manager confirms the report or question and instructs to the matter.

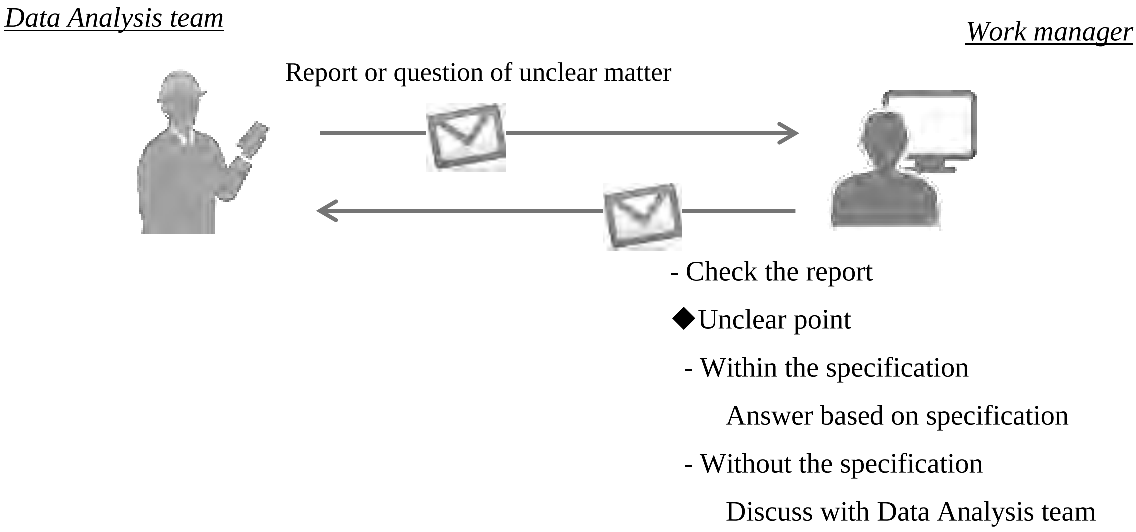



Figure 4.6 In case of report or question of unclear matter

[Example of Report and Instruction]

<Case 1: Setting of Pavement Surface Type>

How to set the pavement type where two pavement types exist in the same position?

(Ex. AC and BST exist in the same position)

➔ Set the wider pavement type at the place


Figure 4.7 Example of pavement type setting

<Case 2: Setting of road Width>

How to set the road width where there is no center line as narrow section?

➔ Set the all width of road image

Figure 4.8 Example of road width setting at narrow section

<Case 3: Setting of Patching>

Whether the repaired part is patching or not?

➔ The part is patching at the interpretation (in the red square)

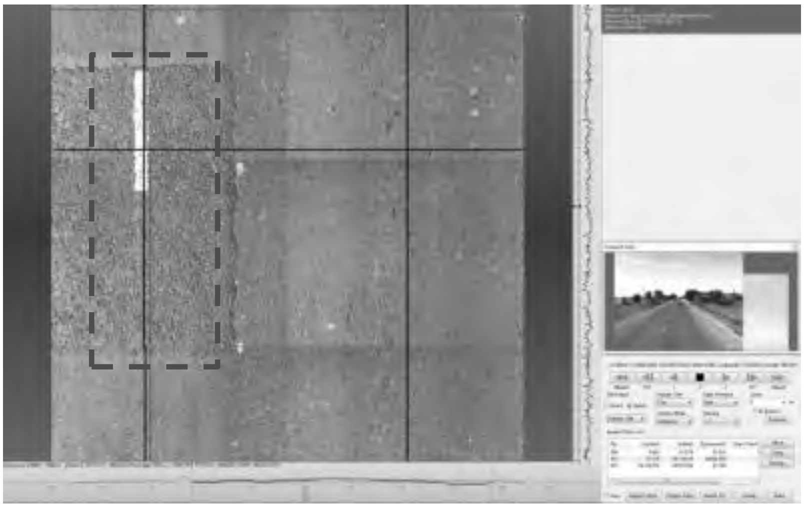


Figure 4.9 Example of patching setting

<Case 4: Visible only Forward View Image>

Visible the crack in the forward view image but invisible in the road image because the image is dark.

➔ Set the crack compare between forward view image and road image

Figure 4.10 Example of visible the crack only forward view image

<Case 5: Setting of peculiar condition>

Which peculiar condition is correct?

➔ Work manager check the road image and decide the category of peculiar condition

Table 4.1 Definition of peculiar condition

| Items | Description | Image |
|---|---|---|
| 1.Broken | Once paved sections, but there is serious damage which cannot be evaluated. |  |
| 2.Unpaved<br>or unidentified Pav. Type | Unpaved: never paved.<br>Unidentified Pavement type: besides, AC, CC and BST. |  |
| 3.Wet Condition | The lane is covered with water or wet. |  |
| 4.Other damage | Other type damages that cannot be judged as cracking. (Ex. Raveling, Scratch, etc.) |  |

| | | |
|---|---|---|
| 5.Invisible | Surface cannot be seen due to coverage of pavement surface by other objects, such as sand, soil, construction material, etc. |  |
| 6.Under construction | Ongoing construction work on the survey lane. |  |

## 4.3. Prepare Analyzed Section Table (Table-3)

Data Analysis team shall prepares the “Analyzed Section Table (Table-3)” after completed the data analysis and data processing. Contents of Table-3 are the following items.

・Road Inventory Data
(Road Category, Road No., Road No., Supplement, RMBs, SBs, Direction, Lane Position)
・KP
・Analysis length

Data Analysis team leader inputs the all information. After complete to input all of column, save as the file name “Analyzed Section Table”. Data Analysis team sends the Table-3 to Work manager. Work manager checks the Table-3 about the road inventory information and the difference between the “Analyzed Length” and “survey Length”. Work manager asks Data Analysis team when Work manager has any questions on the Table-3. The length of pavement condition survey in Table-3” shall become the fixed number.

Table 4.2 Sample of Table-3

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Analysis Length |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 1 | 321 | 800 | 330 | 0 | 8535 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 1 | 423 | 600 | 425 | 875 | 2095 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 1 | 449 | 300 | 451 | 0 | 1665 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 458 | 0 | 467 | 0 | 9590 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 468 | 0 | 484 | 0 | 15710 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 504 | 400 | 517 | 1075 | 13630 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 561 | 0 | 587 | 0 | 26095 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 591 | 600 | 595 | 5 | 3595 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 595 | 5 | 597 | 590 | 2330 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 625 | 125 | 625 | 880 | 755 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 657 | 25 | 663 | 815 | 6645 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 671 | 230 | 672 | 305 | 1075 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | R | 1 | 819 | 850 | 840 | 475 | 20290 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | R | 1 | 868 | 100 | 872 | 570 | 4330 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | R | 1 | 883 | 700 | 886 | 460 | 2510 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 2 | 321 | 800 | 330 | 0 | 8535 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 2 | 423 | 600 | 425 | 875 | 2095 |

# 5. Data Check and Data Install

Data Analysis team submits the PC data to Work manager after complete the data analysis and data processing. Work manager checks the quality of the data. If the quality of the data has no problem, Work manager can accept the data. If the quality of the data has some problems, Data Analysis team updates the problem points.

Finally, Work manager submits the PC data to Top manager. Top manager receives the PC data and approves the completion of the pavement condition survey. Top manager (IT center) installs the PC data to PMS database.

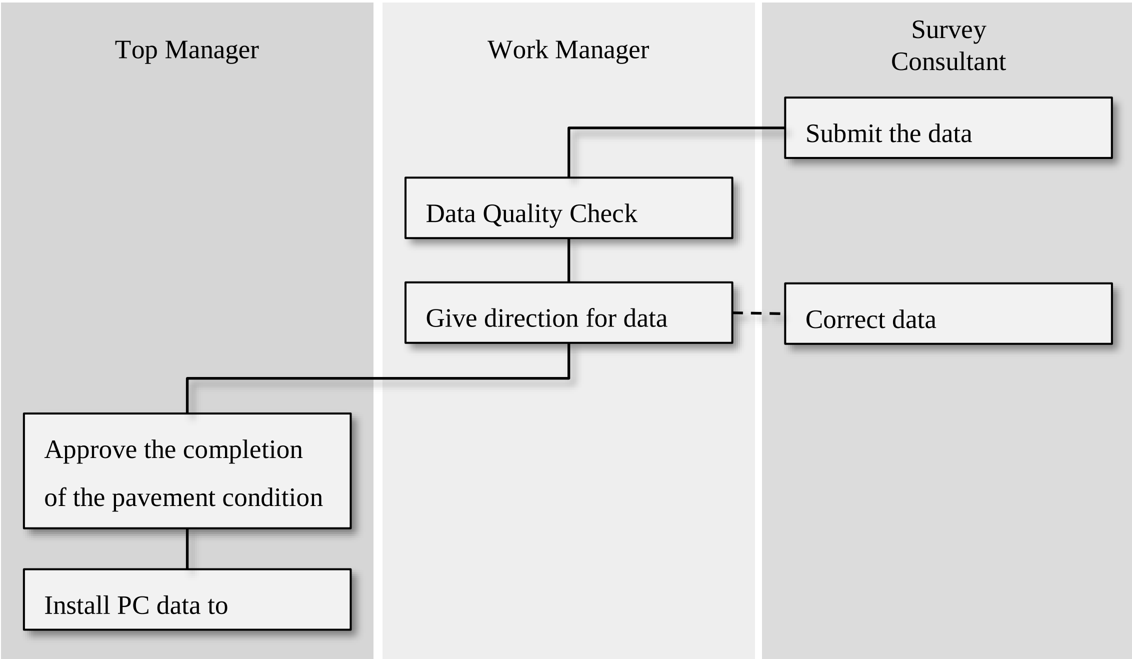



Figure 5.1 Work flow of Data Check and Data Install

## 5.1. Data Quality Check

Data Analysis team submits the Pavement Condition Data after complete the data analysis and data processing. Work manager check the quality of submitted data within 5 days. The quality check should be done as follow,

1) Quantity and Road inventory information

Work manager check the quantity and road inventory information by compare the Table-2 and Table-3. Items to be checked are as below;

- Surveyed and analyzed length
- Route code of surveyed routes

- Jurisdiction information
- The different of chainage

2) Check output of PC data and folder structure

Work manager check the number of output file and data structure.

- Output file

  Pavement Condition File (formatted as .csv)

  Image data with coordination File (formatted as .csv)

  Forward view image (formatted as . JPG)

- Folder structure

  Work manager check the folder structure. Folder structure is shown in Table 5.1.

Table 5.1 Data structure

| Folder Structure | | | | File |
|---|---|---|---|---|
| Root | | | | |
| ├ PCfile | ———— | | | PCfile_RMB I_2017.csv |
| ├ ImageFile | ———— | | | ImageFile_RMB I_2017.csv |
| └ 2017 | — RMB I | ┬ NH1 | ┬ Left_laen1 | 00000001.jpg |
| | | │ | │ | 00000002.jpg |
| | | │ | │ | : |
| | | │ | ├ Left_lane2 | 00000001.jpg |
| | | │ | │ | 00000002.jpg |
| | | │ | │ | : |
| | | │ | ├ Left_lane1 | |
| | | │ | └ Left_lane2 | |
| | | │ | | |
| | | ├ NH2 | ┬ Left_lane1 | |
| | | │ | └ Right_lane1 | |

3) Quantity of images

Work manager checks whether there is no difference in the number of forward image file with the number calculated from length of the Pavement Condition Data.

4) Abnormal value

Work manager checks the abnormal value based on definition value.

- Crack ratio: Over 70%

- Rutting Depth (max): Over 50mm
- Rutting Depth (average): Over 30mm
- IRI: Over 15mm/m
- MCI: Equal 0

When Work manager finds errors on data, Work Manager shall instruct Data Analysis team to update the output data.

### 5.2. Project Completion and Submission

After Work Manager confirms that there are no errors on the output data, Work Manager receives the final output data from Survey Consultant. Survey Consultant saves these data on external HDD and submits the HDD to Work Manager. Work Manager submits the PC data in the HDD to Top Manager. Finally Top Manager accepts the completion of the Pavement Condition Survey Project.

### 5.3. PC Data Registration

The data confirmed by Top manager is registered in the PMS server by IT center. The registration procedure is the following five steps.

1) Connect to HDD to PMS server
2) Copy the PC data file to PMS server
3) Copy the Image file to PMS server
4) Copy the FV image file to PMS server
5) Commit to import PC data to using web system

Copy each data to the following directory. Copy FV image file whole folder into the following directory.

- PC data file : [PMS] – [public] – [pcimport] – [pcfile]
- Image file : [PMS] – [public] – [pcimport] – [imagefile]
- FV image file : [PMS] – [public] – [Pavementconditionimage]

After copying the data to the server, use PMS to register the data.

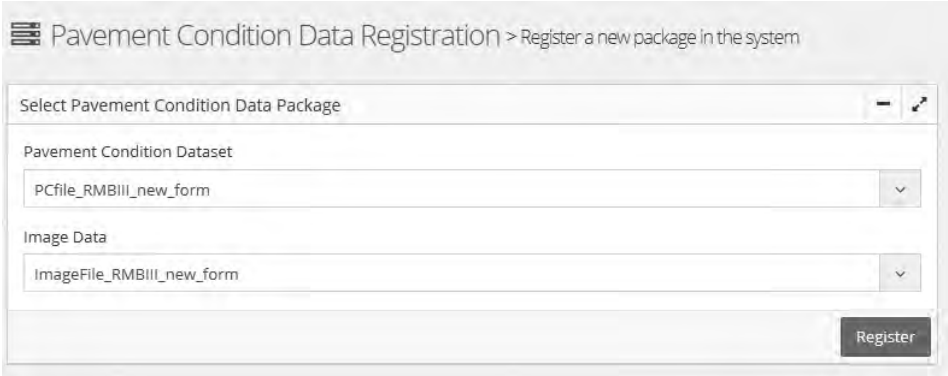



Figure 5.2 Pavement Condition Data Registration Function Display

The PC data registered in the PMS database can be displayed on the web-display system.

Figure 5.3 Image of Web-display system for Pavement Condition

# 6. Maintenance and inspection of Pavement Condition Survey System

It is quite important to maintain the pavement condition survey system (PCSS), including vehicle, device and PC systems, in order to utilize the PCSS continuously and keep accuracy of the output data from the system. Since the PCSS is composed of advanced technologies, the user (Top manager of Pavement Condition Survey) must receive support from a special manufacturer constantly. The Maintenance agreement shall be signed between Top manager and the manufacture for manufacturer's any support. Without the maintenance agreement, system user cannot receive any assistance from the manufacture.

The contents of general maintenance agreement are as follows. However Top Manager shall carefully discuss about the contents of agreement with the manufacture.

Coverage of the Maintenance Agreement
- Call center (consultation service)
- Simple work in emergency
- Periodical inspection of the PCSS by professional engineers (inspection and calibration)
- Service in case of failure on the PCSS (whether with or without consideration of payment)
- Preferential price of replacement parts or labor work

By signing of the agreement, the manufacture shall be responsible for the following items.

Manufacture’s scope of responsibility
- Keep information about the PCSS for timely support
- Manage history information on inspection and repair of the PCSS
- Secure professional engineers who can support the PCSS
- Grasp information about the possibility of inventory of system devices, replacement parts etc.
- Procurement of replacement parts or alternative way in case of system replacement (whether with or without consideration of payment)

# 7. Point to note of Pavement Condition Survey

This chapter describes points to be aware of when expanding of Pavement Condition Survey System.

a) Responsibility Assignment

In case that new target route, such as Expressway or routes managed by PDOTs, will be surveyed, the responsible agency shall determine the person in charge of all the tasks on PCS.

- Top Manager

Top Manager shall supervise and approve the project as the following tasks;

- ➢ Accept implementation plan
- ➢ Manage PCSS
- ➢ Check work progress report reported by Work Manager
- ➢ Accept completion of the project
- ➢ PC data install (by IT Center)

- Work Manager

Work Manager shall make a survey plan and supervise Survey Consultant as the following tasks;

- ➢ Prepare survey plan
- ➢ Submit survey plan to Top Manager
- ➢ Dispatch Survey Consultant
- ➢ Supervise field survey work (progress and problems)
- ➢ Report progress to Top Manager
- ➢ Supervise Data Analysis work(progress and problems)
- ➢ Data verification
- ➢ Submit the PC data to Top Manager

- Survey Consultant

Survey Consultant shall take responsibilities of whole survey work and preparation of PC data as the following tasks;

- ➢ Prepare the Implementation Plan
- ➢ Field survey
- ➢ Data analysis
- ➢ Data processing
- ➢ Data check

b) Survey plan

When the inventory information of the database for preparing the survey plan is insufficient (new construction routes, Expressway or route managed by other road administration agencies, etc.), it is necessary to securely obtain the information on the routes to be surveyed for preparing Table-1.

c) Survey for Expressway or routes managed by PDOTs

In case of expanding the PCSS to other routes, the following road conditions shall be checked in advance for each route.

・With or without Kilo-post station
・Paved or not
・Possibility to confirm star and end point on site (especially on Expressway for safety issue)
・Sufficiency of road code information

In case of hard to conduct survey due to above issues, Top Manager shall consult to manufacture of PCSS in advance.

d) Running speed on Expressway

The maximum speed of the PCSV is 70 km/h. When the speed of the vehicle exceeds 70 km/h, PCSS will stop. The driver shall keep the vehicle speed at 70 km/h or less.

e) Confirmation of lane structure in narrow section

When survey for narrow sections, Survey Team shall pay attention to the difference between inventory information and actual situation on site.

e.g.

Despite being a narrow width, the inventory has two directions (right and left).

Survey of narrow sections by both directions may cause duplication of survey data.

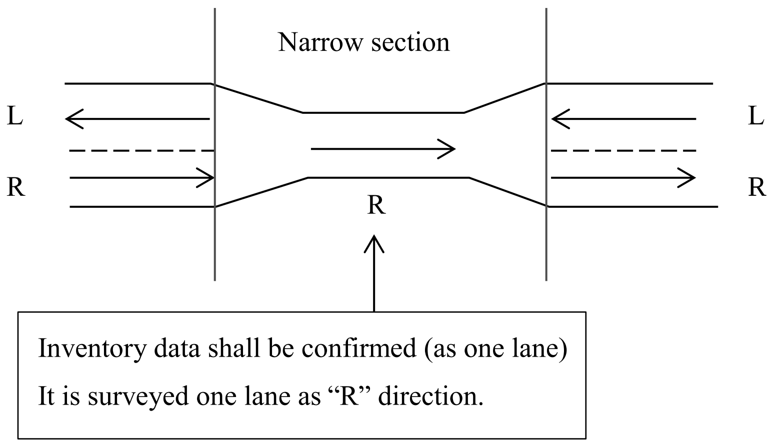



Figure 7.1 Survey for narrow sections

f) Safety Management

Especially when survey for Expressway, if confirmation work on the road is necessary, regulations on Expressway shall be applied for strict safety management.

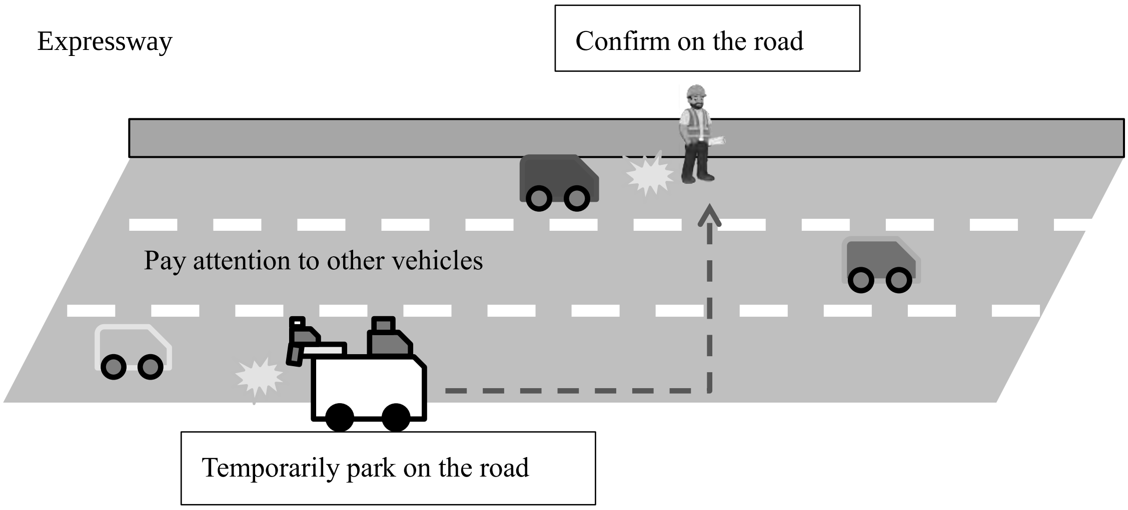



Figure 7.2 Safety management on Expressway

g) Data analysis application to apply new routes

When analysis work using analysis application as target (new constructed routes, Expressway and routes managed by other road administration agencies) without road code data, the configuration file shall be updated. For more detail procedure to update the configuration file, refer to the manual of "Instruction Book of REAL Mini [PCS-Vol.4]".

h) Referential document

The description in the reference manual shall be updated if needed.

i) Other

If unexpected events occur, consult to manufacture of PCSS.

Appendix 1: Format of TOR

# TERMS OF REFERENCE ON PAVEMENT CONDITION SURVEY

**MAY 2017**

**DRVN**

1. OBJECTIVE

- To provide pavement condition data to the development of PMS and the formulation of road pavement long-term budget plans and 3-Year repair work plans.
- To conduct pavement condition survey on national roads managed by RMB *.

2. MEASUREMENT

The Contractor shall conduct Pavement Condition Survey on each lane of the target road sections and analyze surveyed data accordingly. Total length of the target road sections of the survey is estimated at XXXX lane-km, upon road administration data provided by each RMBs. In case, actual survey length is different from estimated length (longer or shorter), the Contractor shall report to the Client for discussion.

Table.1 Target Survey Length of RMB *

| RMBs | Route Name | Lane Length (lane-km) |
|---|---|---|
| * | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| | NH * | XXX.X |
| Total | | X,XXX.X |

Note) detailed target sections are shown in Appendix 4

3. DATA ITEMS

Table 5 shows data items require to be collected. The data gathered in the survey are also recorded in the pavement condition database in every 100 meters.

Table.2 Data item and interval

| No. | Data Item | Unit | Recording Interval |
|---|---|---|---|
| 1 | Cracking Ratio (AC, BST) | % or | 100 m |
| 2 | Cracking Index (CC) | cm / $m^2$ | 100 m |
| 3 | Rutting depth (Max, Average) | mm | 100 m |
| 4 | IRI | mm / m | 100 m |
| 5 | GPS | M | 5 m |
| 6 | Front view image | M | 5 m |

## 4. IMPLEMENTATION METHOD

Pavement condition survey consists of two tasks; (1) field survey and (2) data analysis / processing.
Pavement condition survey shall be implemented based on the "Road Condition Survey System Basic Operation Manual, March 2014."

### 4.1 Implementation Plan

The Contractor shall make and update the implementation plan to conduct the pavement condition survey. The implementation plan shall include such as the purpose of the survey, scheduled work volume, methodology, accuracy management, schedule, formation and contact number of each person. The Contractor shall submit this implementation plan after contract immediately. When the content of the implementation plan would be changed, the Contractor shall modify and submit to Client each time.

### 4.2 Field Survey

The pavement condition survey vehicle will be provided by DRVN. The Contractor is requested to submit a survey plan to complete the survey by due date. The Contractor is also requested to assign a team leader, two (2) surveyors and a driver for field survey team. For smooth survey, DRVN will assign navigators to work at the field with survey team. Navigators will assist field survey to identify target sections.
The operation expenses for field survey, such as vehicle fuel cost, charges for toll roads, parking fee, insurance, storage device, all necessary and reasonable cost for field survey will be borne by the Client.

### 4.3 Calibration

As a preparation work for survey, the Contractor shall implement the calibration of the pavement condition survey vehicle in collaboration with DRVN engineer in the field by following the "Road Condition Survey System Basic Operation Manual, March 2014."

### 4.4 Data analysis / processing

The Contractor is requested to assign a team leader and eight (8) surveyors for data analysis / processing. They shall be trained for software of pavement condition data analysis. DRVN will allow to use ten (10) PCs installed the software during the analysis / processing. This task is assumed to be done in Hanoi.

### 4.5 Survey monitoring

The Client assigns an expert to monitor progress and quality of survey data both at the field and at the data processing periodically.

The composition of survey team shows in table.6.

Table. 3 Staff Assignment for Survey and Analysis (Person)

| Agency | DRVN | | Contractor | | |
|---|---|---|---|---|---|
| | | RMB / Sub Bureaus | | | |
| Category | Supervisor | Navigator | Survey leader | Surveyor | Driver |
| Assignment method | Periodic / Part time | Full Time | Full time | Full time | Full Time |
| (1) Field survey | 1 | 1 | 1 | 2 | 1 |
| (2) Data analysis / processing | — | — | 1 | 8 | — |

（NOTE）”” TE analysis / processing” includes the task of data registration into pavement condition database

（NOTE）”” TE analysis / processing” includes the

（NOTE）”” TE analysis / processing” includes the task of data registration into pavement condition database the daother reason of each target route.

5. FOR SUBMISSION

The output items for submission from the pavement condition survey are shown Table. 7. The sample of the output items are shown in Appendix 1 and Appendix 2.

Table. 4 Output Items for submission

| No. | Output Item | Quantity | Unit | Format Type |
|---|---|---|---|---|
| 1 | Survey Implementation Plan (English and Vietnamese) | 2 | Set | Hardcopy and Softcopy |
| 2 | Pavement Condition Data | 1 | Set | MS Excel, CSV |
| 3 | Geographic Coordinate Data Table | 1 | Set | MS Excel, CSV |
| 4 | Forward View Image | 1 | Set | JPG |
| 5 | Final Report of Pavement Condition Survey (EN and VN) | 2 | Set | Hardcopy and Softcopy |

After completion of data analysis and processing of each RMB, data and report shall be provided to the Client. The Client will check the data and report quality and request Contractor to correct is data are not as per the format/quality as specified in the operation manual.

6. PAYMENT TERMS

As far as the gap between the survey length and the estimated survey length, X,XXX km-lane, is within 5%, the payment shall be made upon contract amount.

7. IMPLEMENTATION SCHEDULE

The survey and data processing shall be completed by DD/MM/YYYY.

Final schedule will be set after the consultation with DRVN and contracted firm.

Table. 5 Implementation Schedule

| RMBx | Item | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RMBx | Preparation | | | | | | | | | | | |
| | Calibration | | | | | | | | | | | |
| | Field survey | | | | | | | | | | | |
| | Data processing | | | | | | | | | | | |
| | Data checking | | | | | | | | | | | |
| | Data preparation | | | | | | | | | | | |
| | Report | | | | | | | | | | | |

8. SURVEY VEHICLE AND EQUIPMENT

"Pavement condition survey vehicle" and "Data analysis and processing PC" which provided by JICA to DRVN in 2014 will be provided to the survey firm. Survey firm shall prepare the HDD for pavement condition survey.

Table.6 Equipment

| Content | Image |
|---|---|
| Pavement condition survey vehicle |  |
| Data analysis and processing PC |  |
| HDD |  |

# APPENDIX 1 Pavement Condition Data

## Table.7 Sample of Pavement Condition Data

| ID | Geographical Area | Jurisdiction | Maintenance Company | Route Number | Branch Number | Route Name | Kirometer Post | | | | Section Length (m) | Analysis Area (m2) | Structure | Intersection | Overlapping | Number of Lane | | Survey Lane | | Surface Type | Condition (Distress) | | | | | | | | | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | From (km,m) | | To (km,m) | | | | | | | | | | | | Date (yyyy/mm) | | CrackingRatio/ Cracking Index(%／㎝/m²) | | | | Rutting Depth(mm) | | IRI (mm/m) | |
| | | | | | | | | | | | | | | | | U | D | U/D | Path Lane | | | | Cracking | Patching | Pothole | Total | Max | Ave | | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 175 | 11 | 200 | 25 | 82.2 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 17 | 10 | 6.22 | *11k+175(11k+135) |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 200 | 11 | 300 | 100 | 332 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 13 | 8 | 4.05 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 300 | 11 | 400 | 100 | 331 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 15 | 8 | 3.17 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 400 | 11 | 500 | 100 | 334 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 15 | 8 | 2.21 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 500 | 11 | 600 | 100 | 331 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 17 | 9 | 2.47 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 600 | 11 | 700 | 100 | 334 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 15 | 10 | 2.75 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 700 | 11 | 800 | 100 | 332 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 17 | 10 | 2.43 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 800 | 11 | 900 | 100 | 330 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 17 | 9 | 2.24 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 11 | 900 | 12 | 0 | 100 | 332 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 16 | 9 | 2.11 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 12 | 0 | 12 | 100 | 100 | 332 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 26 | 10 | 2.76 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 12 | 100 | 12 | 200 | 100 | 331 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 19 | 12 | 3.24 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 12 | 200 | 12 | 300 | 100 | 330 | | | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 17 | 12 | 2.37 | |
| | NORTHERN AREA | RRMU2 | RRMC240 | 5 | 0 | NATIONAL HIGHWAY 5 | 12 | 300 | 12 | 400 | 100 | 333 | | I | | 3 | 3 | D | 1 | AC | 2012 | 10 | 0 | 0 | 0 | 0 | 18 | 11 | 3 | U/N |

## APPENDIX 2 Geographic Coordinate Data Table

Table.8 Sample of Geographic Coordinate Data Table

| ID | ID2 | Latitude | Longitude | Hight | Image Path |
|---|---|---|---|---|---|
| | | 106.71155 | 21.973593 | 293.704 | 00100\DOWN\0000k00010-0051k00000\PIC00000002.jpg |
| | | 106.71154 | 21.973549 | 293.445 | 00100\DOWN\0000k00010-0051k00000\PIC00000003.jpg |
| | | 106.71153 | 21.973506 | 293.31 | 00100\DOWN\0000k00010-0051k00000\PIC00000004.jpg |
| | | 106.71152 | 21.973463 | 293.184 | 00100\DOWN\0000k00010-0051k00000\PIC00000005.jpg |
| | | 106.71151 | 21.973418 | 293.013 | 00100\DOWN\0000k00010-0051k00000\PIC00000006.jpg |
| | | 106.7115 | 21.973373 | 292.784 | 00100\DOWN\0000k00010-0051k00000\PIC00000007.jpg |
| | | 106.71149 | 21.973329 | 292.59 | 00100\DOWN\0000k00010-0051k00000\PIC00000008.jpg |
| | | 106.71148 | 21.973285 | 292.308 | 00100\DOWN\0000k00010-0051k00000\PIC00000009.jpg |
| | | 106.71147 | 21.973242 | 292.125 | 00100\DOWN\0000k00010-0051k00000\PIC00000010.jpg |

# APPENDIX 3 Folder Structure

| Folder Structure | | | | | | | File |
|---|---|---|---|---|---|---|---|
| Root | | | | | | | |
| ├ PCfile | —— | | | | | | PCfile_RMB I_2017.csv |
| ├ ImageFile | —— | | | | | | ImageFile_RMB I_2017.csv |
| └ 2017 | — | RMB I | ┬ | NH1 | ┬ | Left_laen1 | 00000001.jpg |
| | | | │ | | │ | | 00000002.jpg |
| | | | │ | | │ | | : |
| | | | │ | | ├ | Left_lane2 | 00000001.jpg |
| | | | │ | | │ | | 00000002.jpg |
| | | | │ | | │ | | : |
| | | | │ | | ├ | Left_lane1 | |
| | | | │ | | └ | Left_lane2 | |
| | | | │ | | | | |
| | | | ├ | NH2 | ┬ | Left_lane1 | |
| | | | │ | | └ | Right_lane1 | |

# APPENDIX 4 Target Road Sections (Survey Plan Section Table)

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping | Planned Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 285 | 400 | 321 | 800 | 83000 | 36400 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 321 | 800 | 330 | 0 | | | | 8200 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 330 | 0 | 368 | 400 | | 38400 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 383 | 0 | 423 | 600 | 84000 | 40600 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 423 | 600 | 425 | 875 | | | | 2275 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 425 | 875 | 449 | 300 | | 23425 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 449 | 300 | 451 | 0 | | | | 1700 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 451 | 0 | 458 | 0 | | 7000 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 458 | 0 | 467 | 0 | | | | 9000 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 467 | 0 | 468 | 0 | 128000 | 1000 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 468 | 0 | 484 | 0 | | | | 16000 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 484 | 0 | 504 | 400 | | 20400 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 504 | 400 | 518 | 0 | | | | 13600 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 518 | 0 | 561 | 0 | | 43000 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 561 | 0 | 587 | 0 | | | | 26000 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 587 | 0 | 591 | 600 | | 4600 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 591 | 600 | 595 | 0 | | | | 3400 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 595 | 0 | 597 | 590 | 2590 | | | 2590 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 625 | 125 | 625 | 880 | 755 | | | 755 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 657 | 25 | 663 | 815 | 6790 | | | 6790 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 663 | 900 | 671 | 230 | 53100 | 7330 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 671 | 230 | 672 | 305 | | | | 1075 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 672 | 305 | 717 | 0 | | 44695 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.5 | Right | 1 | 717 | 0 | 791 | 500 | 74500 | 74500 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 791 | 500 | 819 | 850 | 113300 | 28350 | | | Under Condtruction |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 819 | 850 | 840 | 500 | | | | 20650 | |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 840 | 500 | 868 | 100 | | 27600 | | | Under Condtruction |

Appendix 2: Format of implementation Plan

# IMPLEMENTATION PLAN ON PAVEMENT CONDITION SURVEY

**May 2017**

**Survey Consultant Name**

# I. Calibration and Survey Plan

1. Calibration Plan:

Survey Consultant plans to calibrate the equipment of REAL-Mini in Hanoi together with DRVN before surveying.

Implementation duration: From **DD/MM/YYYY** to **DD/MM/YYYY**

2. Survey Plan:

The pavement condition survey will be done based on the TOR of pavement condition survey. Survey Consultant plan the below contents before conduct the survey,

- Responsibility assignment on pavement condition survey (filed survey, data analysis and data preparation)
- External HDD to store the measurement data and analysis data.
- Route confirmation such as the start point, end point, eliminated start point, eliminated end point, overlap start point and overlap end point.
- Operation check of survey vehicle, data analysis program and data processing program.

Implementation duration: on **DD/MM/YYYY**

# II. Survey Implementation Plan

1. Target Routes (RMB X):

| National Highway | From | To | Number of Lanes | Total Length (km) |
|---|---|---|---|---|
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| **Total** | | | | **LLLL.LL** |

2. Implementation Duration:

The field survey implementation in RMB X will be done as below schedule:

+ From **DD/MM/YYYY** to **DD/MM/YYYY**

3. Report of field survey

   + **Daily report**: Survey team leader reports implementation quantity/progress to DRVN at the end of day on the daily basis via email.

   Report format:

**Báo cáo hoạt động hàng ngày**

Ngày bắt đầu DD/MM/YYYY    Ngày kết thúc:

| Ngày | Cục QLĐB | Chi cục | Hoạt động | Tuyến đường | Thuận/Ngược | Số làn | Tình trạng mặt đường | Thời tiết | Đoạn khảo sát | | | Thời gian làm việc | | | | Công tơ mét | Dẫn đường (Chi cục) | Lái xe | Người báo cáo | Ghi chú |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Bắt đầu | Kết thúc | Chiều dài | Bắt đầu | Kết thúc | Thời gian làm | Thời gian nghỉ + check dữ liệu | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
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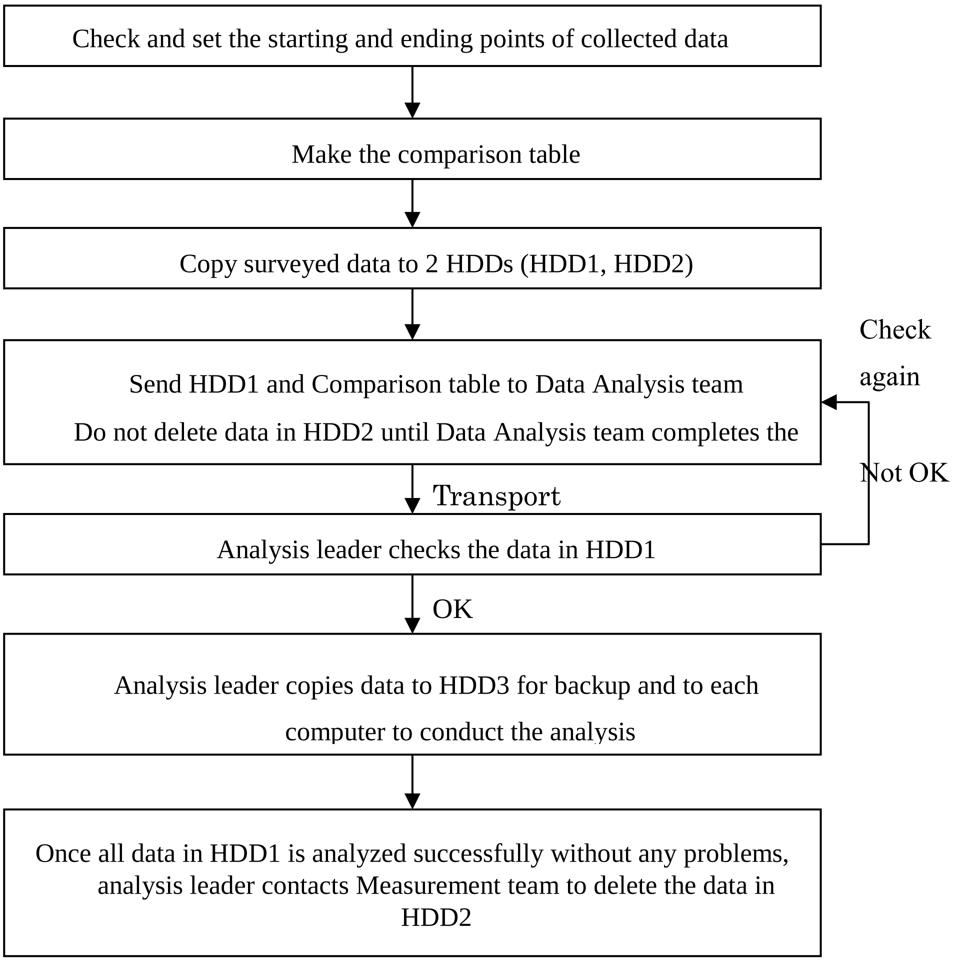
## III. Data management and delivery:

- Survey team shall make a copy and send the surveyed data to Data Analysis team at home to conduct the analysis work (about every 500km)
- HDDs storing surveyed data should be sent to Data Analysis team via transportation company
- Data HDD transfer flow:



## IV. Data Analysis Plan

1. Implementation method

- Data Analysis team has 8 members, including 6 data analysts and 2 data quality manager;
- After convert the surveyed data, analysis leader copies converted data to the other members to conduct the analysis. Once data is analyzed, the analyzed data is sent to data quality manager to check.
- After completing the analysis, the analysis leader informs Survey team to delete the data stored in HDDs on site.

2. Data analysis progress for RMB X

- Data analysis duration: from **DD/MM/YYYY** to **DD/MM/YYYY**

3. Report schedule for data analysis

\+ **Weekly report**: Data Analysis team leader reports Total implementation quantity/progress during the week and implementation plan for the next week to DRVN on the weekly basis via email.

Weekly report format:

| A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Weekly Report** | | | | | | | | | | | |
| From | DD/MM/YYYY | | To | DD/MM/YYYY | | | | | | | |
| | | | | | | | | | | | |
| **No** | **Route name** | **Right /Left** | **Lane Num ber** | **Survey sections** | | | **File name** | **Activities performed** | | | **Note** |
| | | | | **From** | **To** | **Length (Km)** | | **Analysis** | **Data Check** | **Data Process ing** | |
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## V. Data Processing Plan and Report

- After completion of all analysis work, an analist conducts the data processing and reports the results of Pavement condition data in RMBX to DRVN.
- Duration: from **DD/MM/YYYY** to **DD/MM/YYYY**.

## VI. Report Order in Emergency Cases

As unexpected events happen during the survey ( broken vehicle, traffic accident ...) or during the data analysis and processing, implementing members shall contact directly to management agency (RMB, SB). If the management agency is not able to solve the problem, it should contact DRVN to find out the solutions.

## VII. Members (tentative):

Team Leader Name –- Phone: xxxx.xxx.xxx

Email: xxxxxxxxxxx@gmail.com

1. Survey team:

| No. | Name | Title | Email | Phone |
|---|---|---|---|---|
| 1 | **** *** **** | Leader | *********@gmail.com | xxxx.xxx.xxx |
| 2 | **** *** **** | Operator | *********@gmail.com | xxxx.xxx.xxx |
| 3 | **** *** **** | Operator | *********@gmail.com | xxxx.xxx.xxx |
| 4 | **** *** **** | Driver | *********@gmail.com | xxxx.xxx.xxx |

2. Data Analysis team:

| No. | Name | Title | Email | Phone |
|---|---|---|---|---|
| 1 | **** *** **** | Leader | *********@gmail.com | xxxx.xxx.xxx |
| 2 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 3 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 4 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 5 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 6 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 7 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |

| | | | | |
|---|---|---|---|---|
| 8 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |

## VIII. Implementation Schedule

The implementation schedule of pavement condition survey followed below the schedule table.

| Work Item | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Plan and Preparation | | | | | | | | | | | |
| Field Survey | | | | | | | | | | | |
| Data Analysis | | | | | | | | | | | |
| Data Preparation | | | | | | | | | | | |
| Data Check | | | | | | | | | | | |
| Submission Data and report | | | | | | | | | | | |

## Appendix 3: Format of Survey Plan Section Table

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Planned Survey Length | Note |
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Appendix 4 Format of Calibration Report

**<u>Project Name</u>**

# Report on

# Calibration of the Survey Vehicle

**<u>MMM YYYY</u>**

**<u>Survey Consultant Name</u>**

1. Objective

Pavement Condition Survey will be done in RMBX. In order to secure the measurement accuracy, calibration and checking of equipment is implemented once in each RMB before the starting survey.

2. Contents of Calibration and Check

- Inspection vehicle check（power, system, equipment）
- Distance calibration
- Camera check
- Laser displacement sensor check
- Laser scanner check
- Camera calibration
- Long test

3. Place

1) Filed 1 (Place name)

- Inspection vehicle check（power, system, equipment）
- Distance calibration
- Camera check
- Laser displacement sensor check
- Laser scanner check
- Camera calibration

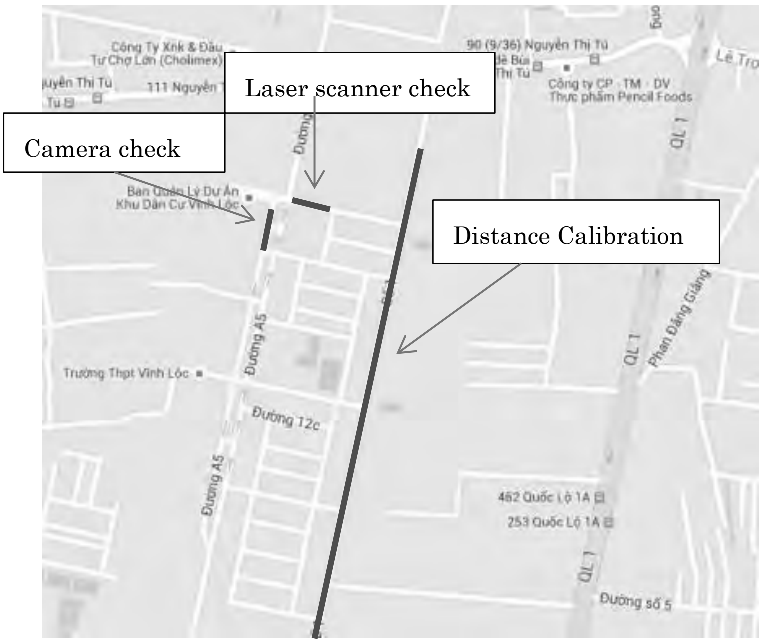



Figure 1: place of Filed 1 (Place name)

2) Field 2 (Place name)

- Long test


Figure 2: place of Filed 2 (Place name)

3. Schedule

Table 1: Timetable of calibration and checking

| Date | Place/ Route | Km-Post | Member | Activity |
|---|---|---|---|---|
| MM/DD (Mon) | | | | Inspection vehicle check<br>(power, system, equipment)<br>Distance calibration |
| MM/DD (Thu) | | | | Camera check<br>Laser displacement sensor check<br>Laser scanner check |
| MM/DD (Wed) | | | | Laser scanner check<br>Camera calibration |
| MM/DD (Thur) | | | | Camera calibration<br>Long test |

4. Result

1) Condition of system

- Vehicle

- Tire inflation pressure: OK

Table 2: Result of inflation pressure

| Tire position | Before | After | Condition |
|---|---|---|---|
| Front Right | $kg/cm^2$ | $kg/cm^2$ | OK |
| Front Left | $kg/cm^2$ | $kg/cm^2$ | OK |
| Rear Right | $kg/cm^2$ | $kg/cm^2$ | OK |
| Rear Left | $kg/cm^2$ | $kg/cm^2$ | OK |

- Direction indicators: OK
- Light: OK
- Engine oil: OK
- Fan belt: OK

- System

- Scratch and condition of system: OK
- Wiring of Equipment: OK
- Voltage of battery: OK
  12.5V
- Screw: OK

2) Accuracy of equipment

- the focus of Lens (FV, RC): OK
  The device is capable of properly recognizing cracking as small as 2mm in depth on the test chart.

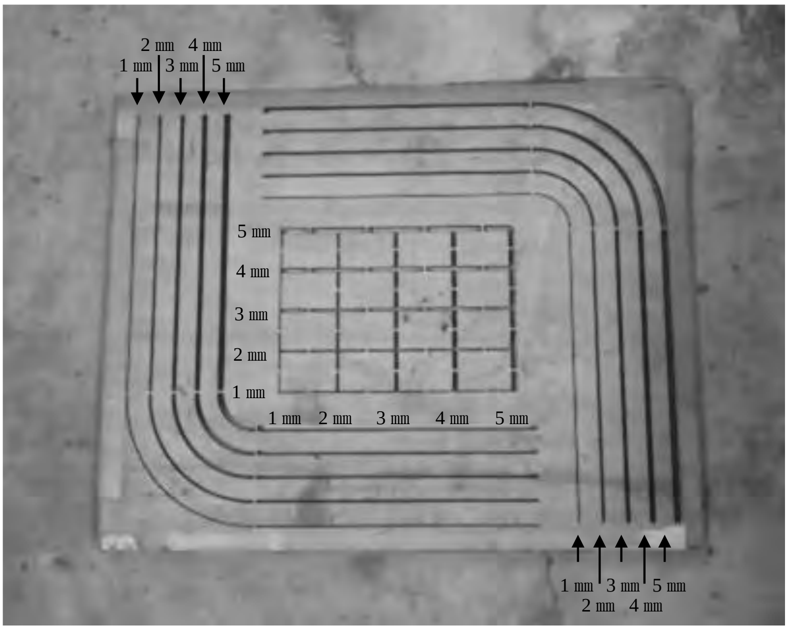



Figure 3: Test chart

- FV

Figure 4: Result of Forward view camera image

- RC (Sunshine)

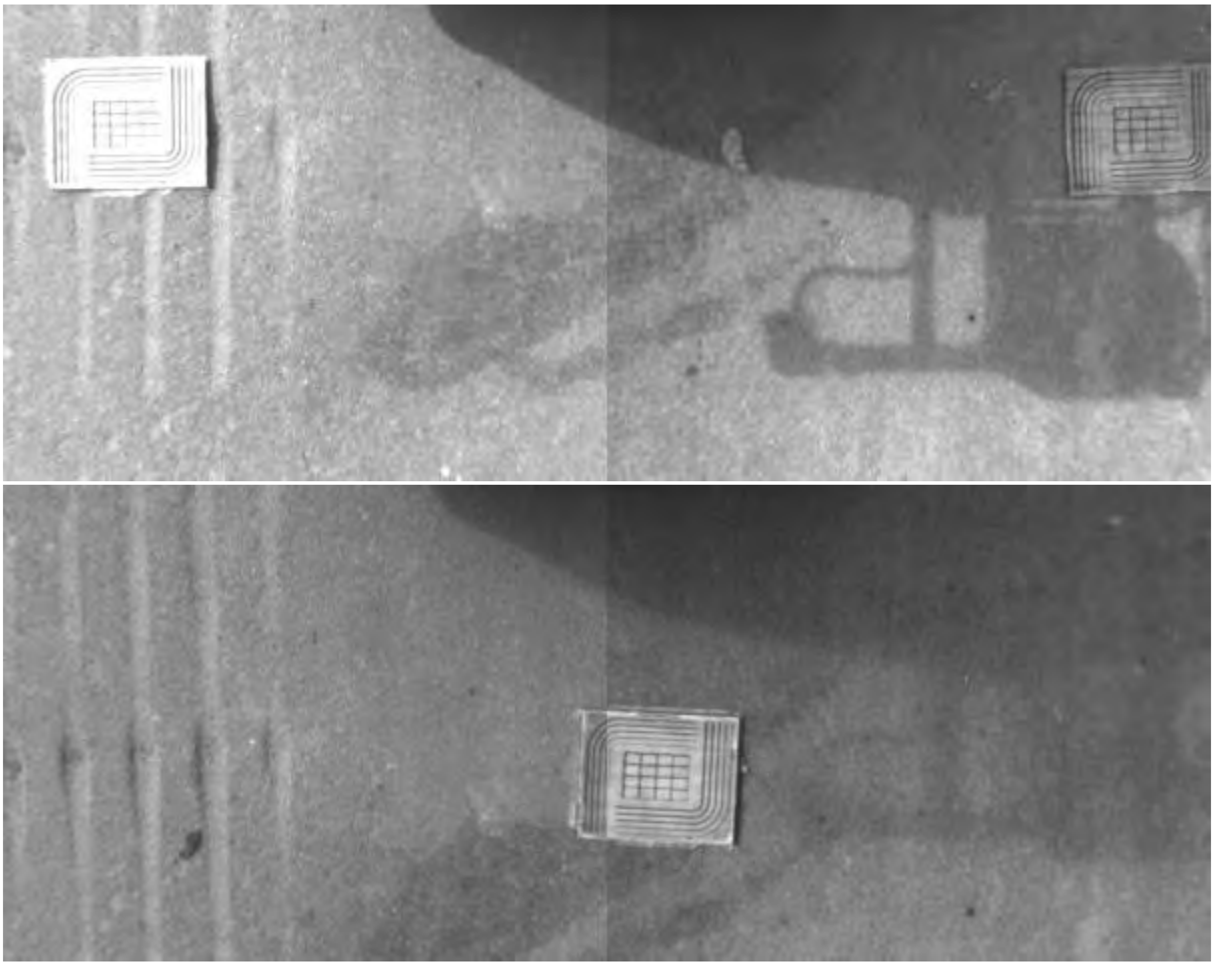
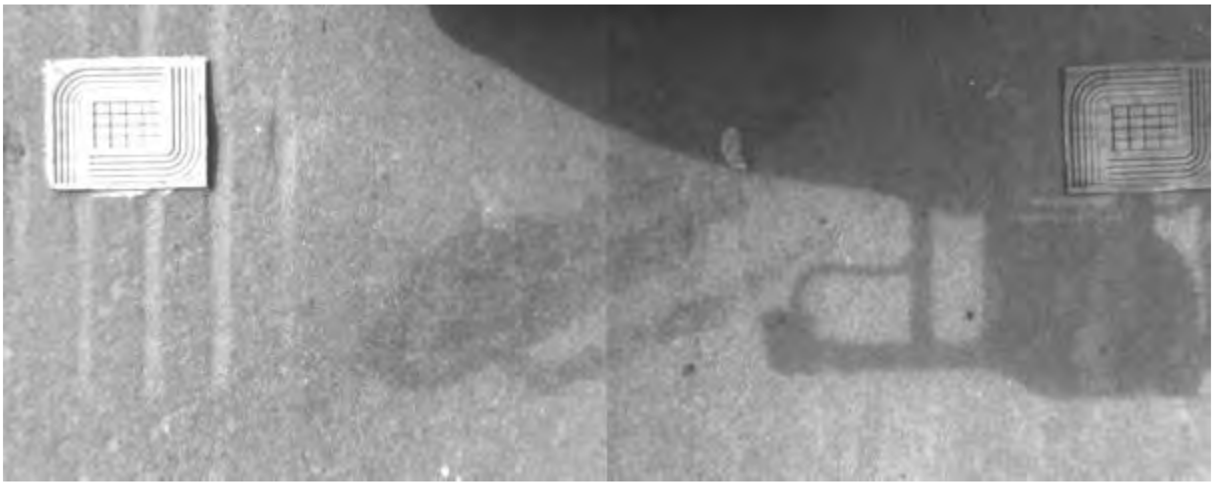


Figure 5: Result of Road camera image (sunshine)

- RC (Shadow)



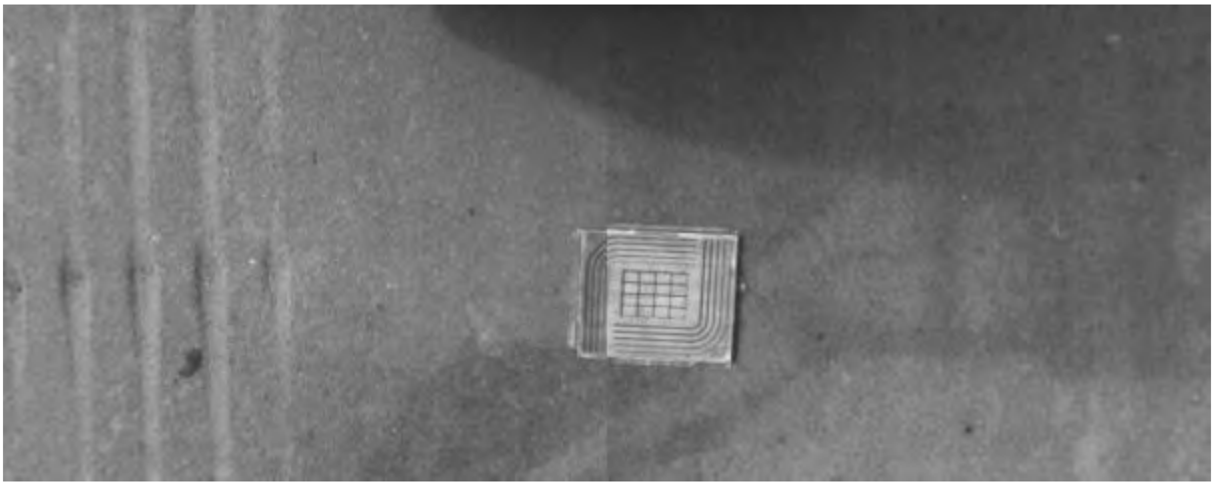


Figure 6: Result of Road camera image (shadow)

- Angle of view (CR): OK

  Calibration boards are installed at 3.8 meters apart. The device captures images covering a span of 3.8 meters or more.

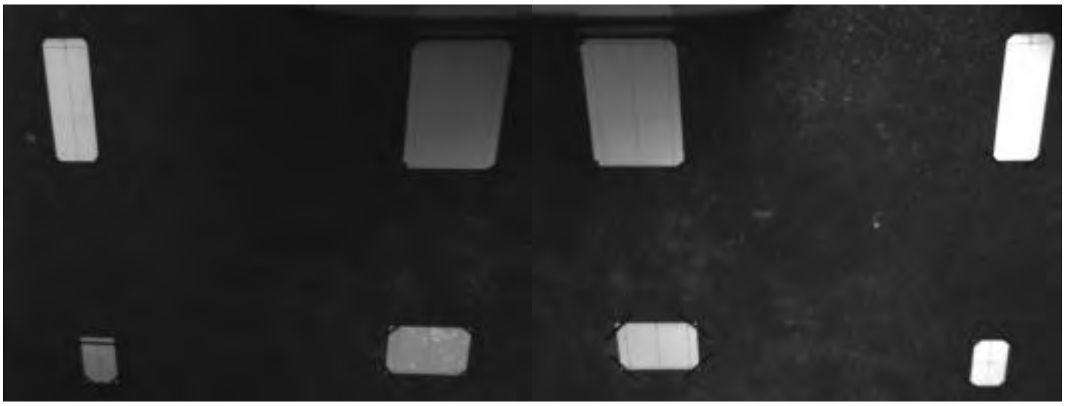


Figure 7: Result of angle of view (Road camera)

・Installation dimension of calibration boards

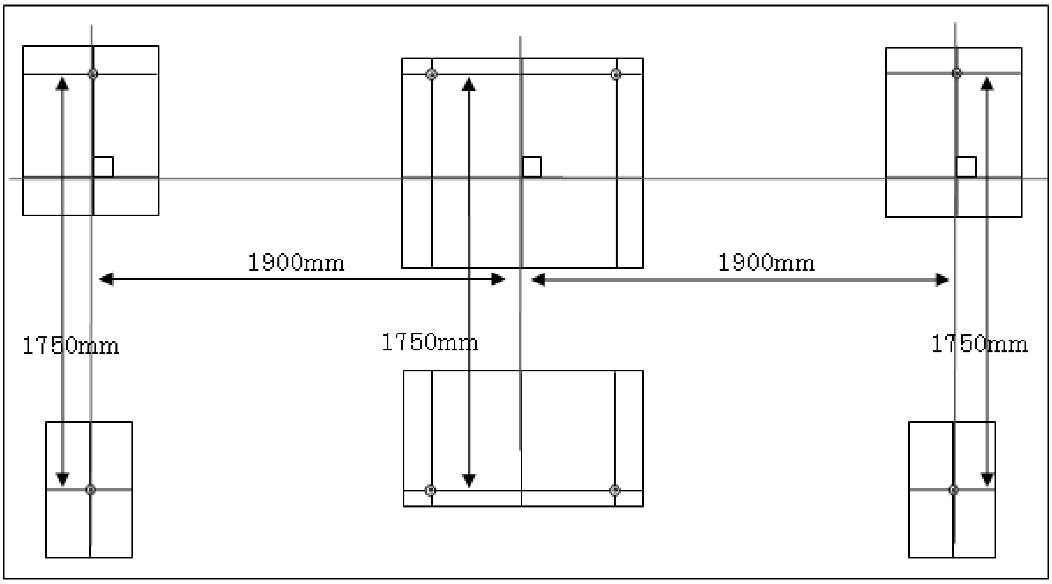



Figure 8: Installation dimension of calibration boards for road camera

- The accuracy of laser displacement sensor: OK

Heights from ten measurements were collected by inserting a wood block at each measurement. The thickness of the wood block was calculated from the differences between collected heights, and the measurement accuracy was verified by comparing the results against the actual thickness of the wood block. Results showed that the average deviation was *.**mm.

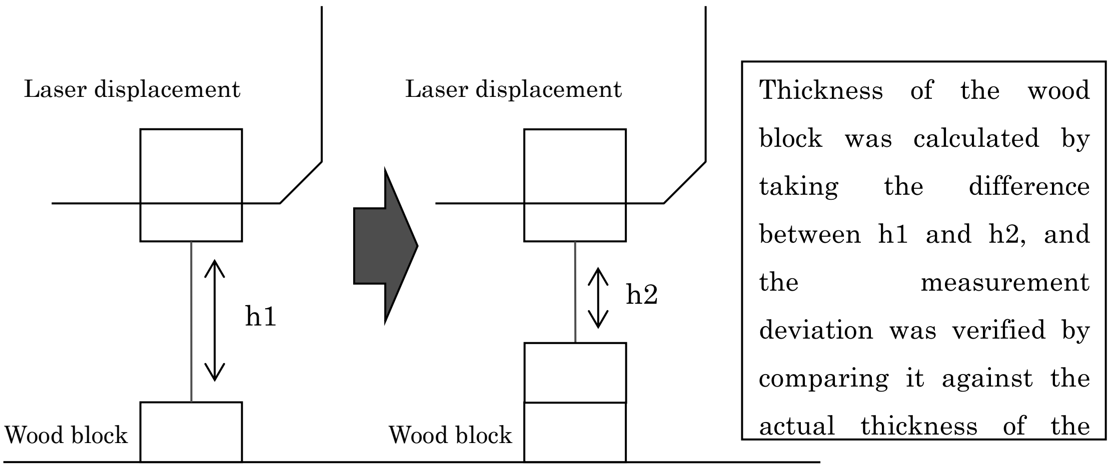



Figure 9: method of checking the accuracy of laser displacement sensor

Table 3: Result of laser displacement sensor

| | Laser displacement meter (mm) | | | | | Actual measurement (mm) | Deviation (mm) | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | Median | Thickness of block | Thickness of block | Integer | Absolute |
| 0 | | | | | — | — | — | — |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
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- The shape of laser scanner data: OK

  Comparisons between profiles collected through the dipstick and those collected through the automated measurement device showed that same profiles were being detected in general.

- No.1

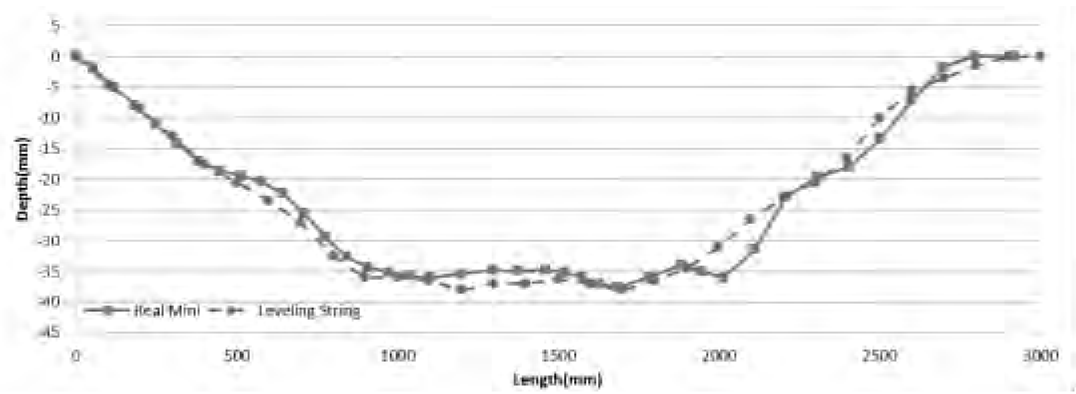


Figure 10: Result of rut shape (No.1)

- No.2

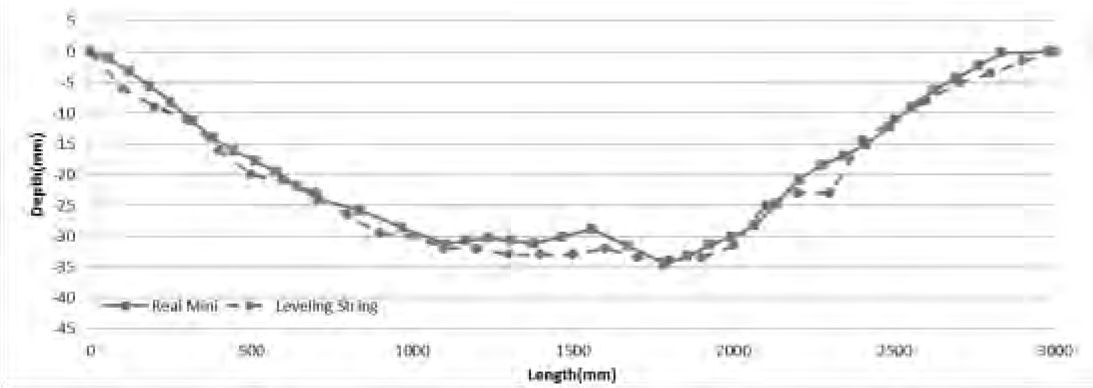


Figure 11: Result of rut shape (No.2)

- No.3

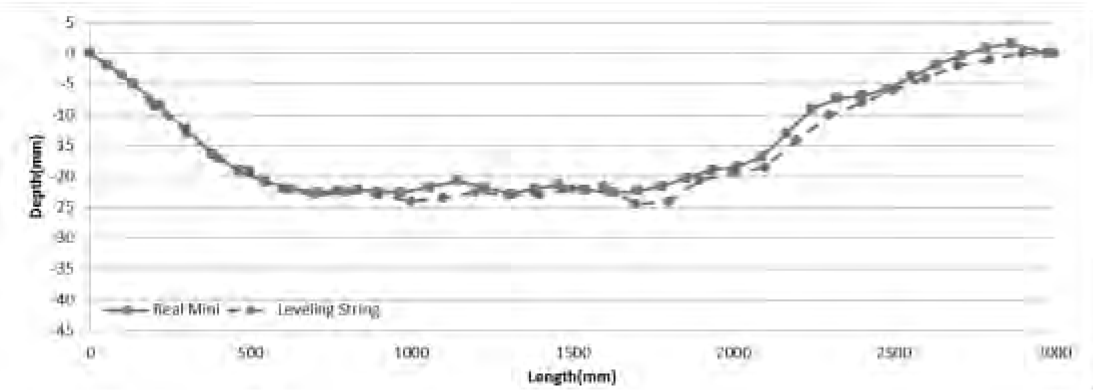


Figure 12: Result of rut shape (No.3)

- No.4

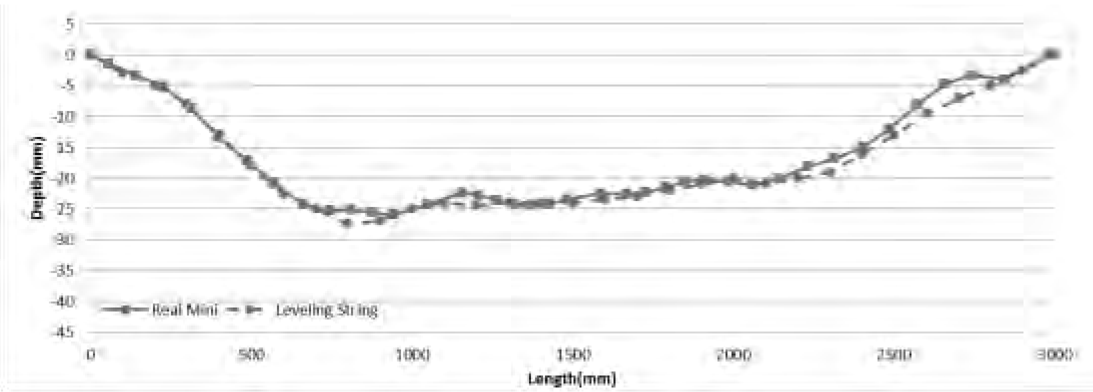


Figure 13: Result of rut shape (No.4)

- No.5

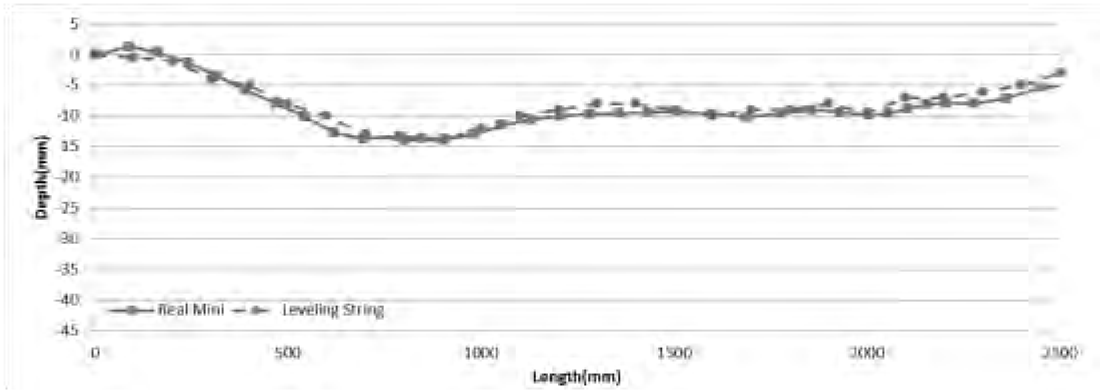


Figure 14: Result of rut shape (No.5)

- Comparison of rut depth: OK

  As the difference stands at 1.5 mm at the maximum and at 0.8 mm at an average, it was verified that the device is within the deviation range of -6mm to +6mm, which satisfies the requirement.

Table 4: Result of Rut depth

| No. | Leveling String | REAL Mini | Deference |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| | | MAX | |
| | | MIN | |
| | | AVERAGE | |

- Distance: OK

A distance of 1000 meters was traveled four times, and the average vehicle pulse signal from the four runs was 2540.

Table 5: Result of vehicle pulse

| Measurement count | Measured value | Average value |
|---|---|---|
| Previous Value | — | |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

A coefficient was configured based on this value, and as a result of measuring a distance of 1000 meters, the deviation rate was -0.01%. The device showed an accuracy that is within the range of -0.5% to +0.5% of the actual length, and thus it was verified that the instrument meets the required specifications.

Table 6: Result of measurement distance test

| Section length (m) | Measured value (m) | Deviation (m) | Deviation rate (%) | Test result (Deviation rate <±0.5%) |
|---|---|---|---|---|
| 1000 | | | % | Pass |

- Test survey: OK

Table 7: Result of test survey

| Number of Times | Measurement Length (km) | Condition |
|---|---|---|
| 1st | | No Error |

# Appendix 5: Format of Surveyed Section Table

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Planned Survey Length | Note | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**Daily activity report**

Activity Classification
(1) Calibration
(2) Survey
(3) Waiting for becom dry pavement surface
(4) Others

Dry / Wet

Name team : ① ② ③ ④ ⑤

| Date | RMB | SB | Activity | Route Code | R / L | Lane Number | Surface Condition | Weather Condition | Survey Section | | | Work time | | | | Vehicle Mileage | Navigator (Sub Bureau) | Driver's Name | Reported by | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Begin | End | Length | Begin | End | Work Time | Rest Time | | | | | |
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# Appendix 7: Format of Data Analysis Report

**Weekly Report**

**From** DD/MM/YYYY **To** DD/MM/YYYY

| No | Route name | Right /Left | Lane Num ber | Survey sections | | | File name | Activities performed | | | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | From | To | Length (Km) | | Analysis | Data Check | Data Process ing | |
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Appendix 8: Format of Analyzed Section Table

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Analysis Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**JAPAN INTERNATIONAL COOPERATION AGENCY**

**DIRECTORATE FOR ROADS OF VIETNAM**

**MINISTRY OF TRANSPORT (MOT)**

**THE SOCIALIST REPUBLIC OF VIETNAM**

# THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE II

## PAVEMENT CONDITION SURVEY MANUAL

## Volume 2.1.3: Operation (Field Survey & Data Analysis)

**MARCH 2017**

**JICA PROJECT TEAM**

**Record of updates**

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|---|---|---|
| 1.00 | 2017.12.19 | First edition |
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# Table of Content

# Figure List

## Table List



## Glossary

| | |
|---|---|
| Administration Database | Database of PMS data storing administrative information. |
| Analyzed section Table (Table-3) | The final section table prepared by PC data. |
| Calibration | Adjustment of devices for true value |
| Camera for front image | The device for measuring the front image |
| Camera for road image | The device for measuring the road image |
| Crack | Damage index based on the pavement surface crack. |
| End point | The end position of the target route. |
| Excluded section | The out of scope section. For example, the section that is under construction or being transferred to the management of another agency are in this excluded section. |
| IRI (International Roughness Index) | Damage index based on the longitudinal shape on the pavement surface. |
| KP (Kilometer post) | Positon of route. It is consist of Kilo-post station number and distance from the Kilo-post station number. |
| Kilo-post station | A road sign on the side of the road to indicate distances from major cities. |
| Kilo-post station number | The number indicated on the kilo-post stations in the side of the road. |

| | |
|---|---|
| Laser displacement sensor | The device for measuring the longitudinal profile |
| Laser scanner | The device for measuring the transverse profile |
| Main control unit | The Unit for control the measurement device |
| Marking | Marking of the start point and end point for easier recognition. |
| Overlapping section | A section in which two routes overlap in terms of management. |
| Patching | The repaired part of partially damage area (Pothole, crack, and so on). |
| Pavement condition | The condition of pavement surface. The pavement condition is evaluated for cracks, ruts and IRI. |
| Pavement condition survey vehicle | Vehicle assembled with measurement devices. |
| PDCA cycle | Management cycle acronym for PLAN, DO, CHECK and ACT. |
| PMS | Pavement Management System. |
| PMS Database | Database stored for PMS dataset. |
| Power control unit | The Unit for supply and control the electric power to the measurement device |
| REAL Mini | Name of the pavement condition survey vehicle made by PASCO Corporation. |
| Rut | Damage index based on the transverse shape on the pavement surface. |
| Start point | The start position of the target route. |
| Survey plan section Table (Table-1) | Table of planned survey length |
| Surveyed route table | Table of summary surveyed route for each surveyed day |
| Surveyed section Table (Table-2) | Table-1 with extensions added |

# Acronyms

| | |
|---|---|
| AC | Asphalt Concrete |
| BOT | Build-Operate-Transfer |
| BST | Bituminous surface treatment |
| CC | Cement Concrete |
| DPI | Department of Planning and Investment |
| DRVN | Directorate for Roads of Vietnam |
| HDD | Hard Disk Drive |
| IWP | In wheel path |
| KP | Kilometer post |
| MMD | Management and Maintenance Department |
| OWP | Out wheel path |
| PC data | Pavement condition data |
| PCS | Pavement Condition Survey |

| | |
|---|---|
| PCSV | Pavement Condition Survey Vehicle |
| PDOT | Provincial Department of Transport |
| PPC | Provincial People's Committee |
| QC | Quarter-Car |
| RMBs | Road Management Bureaus |
| SB | Sub Bureaus |
| STEICD | Science, Technology, Environment, International Cooperation Department |
| TOR | Terms of Reference |

# 1. Introduction

## 1.1. About This Manual

Operation (Field Survey & Data Analysis) (PCS-Vol.3) is one of six manuals comprising the suite of the documentation for pavement condition survey. Figure 1.1 shows the component of pavement condition survey manual. Pavement condition survey manual is divided into three parts, Overview, Operation manual and Technical manual. Documents to be referenced depend on the responsibility and work steps of stakeholders involved in pavement condition survey. Overview describes the basic items of survey that all stakeholders should refer to. Operation manual shows important matters to be referred to mainly when survey work managing. Technical manual indicates technical matters such as system and device operation methods, data definition and data preparation. Figure 1.2 shows the description of contents of each document.

This manual explains the survey and analysis work of Survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey. If there is any lack of information, addition and updates would be recommended.

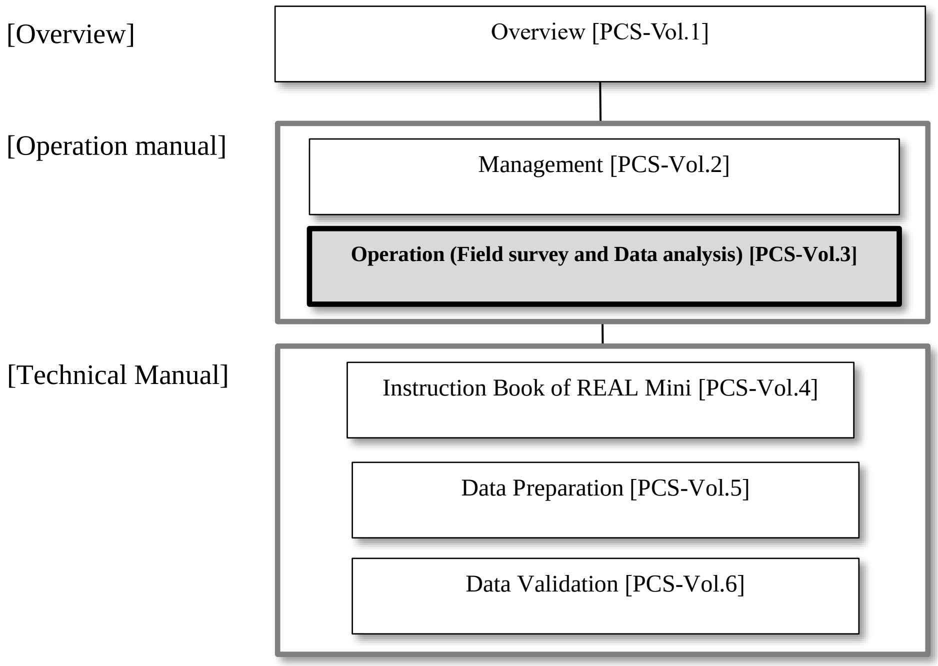



Figure 1.1 Pavement condition survey manual

[Overview]

Overview (PCS-Vol.1]

- ➔ Describe the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey.

[Operation manual]

Management [PCS-Vol.2]

- ➔ Describe the management work of road administrator on pavement condition survey. It contains all management works such as the planning, supervising, and data checking on pavement condition survey describing. It is to be used by administrator who to carry out the management of pavement condition survey.

Operation (Field survey and Data analysis) [PCS-Vol.3]

- ➔ Describe the survey and analysis work of survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey.

[Technical manual]

Instruction Book of REAL Mini [PCS-Vol.4]

- ➔ Describe the operation procedure of REAL Mini system. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

Data Preparation [PCS-Vol.5]

- ➔ Describe the contents of pavement condition data (PC data). It contains the code definition, explanation of each item of PC data and so on.

Data Validation [PCS-Vol.6]

- ➔ Describe the data check procedure when creating the PC data. It is to be used by person whose task is to carry out the data check in pavement condition survey.

Figure 1.2 Contents of Pavement condition survey manual

## 1.2. Summary of Pavement Condition Survey and Work Allocation

1) Pavement Condition Survey

Pavement condition survey (PCS) measures pavement damages such as cracks, ruts and IRI using the pavement condition survey vehicle (hereafter PCSV) on moving and make the pavement condition data files. The pavement damage expresses surface (crack), transverse (rut) and longitude (IRI) (Figure 1.3). The PCSV assembled some devices such as laser scanner and cameras for the pavement damages measurement (Figure 1.4).

Pavement condition survey measures not only pavement condition but also road inventory information, forward view image and position information at the same time.

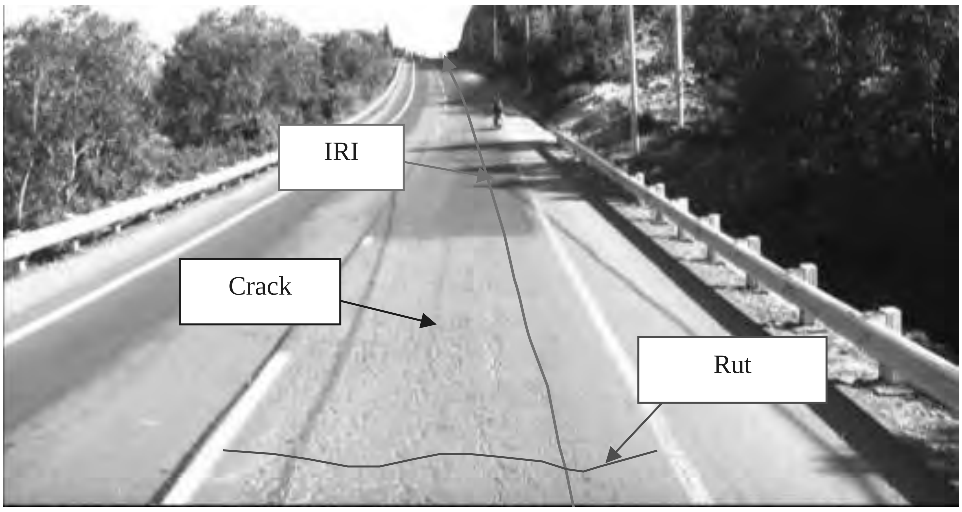



Figure 1.3 Pavement damage to be evaluated by PCS

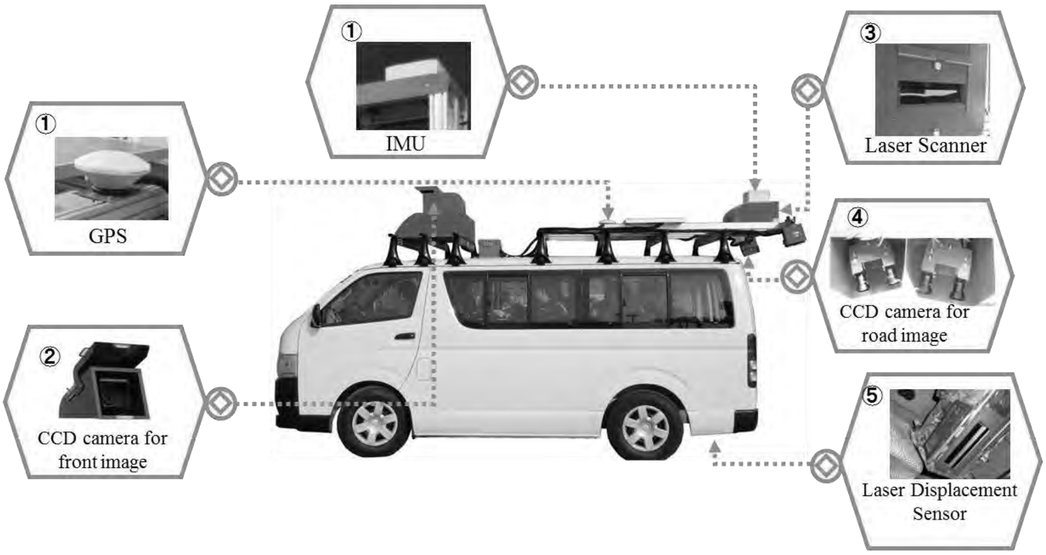



Figure 1.4 PCSV (REAL Mini)

2) Pavement Condition Data

PC Data file is result of road surface damage status by pavement condition survey. Damage of road surface is evaluated by crack rate, rut depth, IRI and MCI. These evaluated data are prepared for every 100 m unit section. Description of evaluation item of road surface damage is shown in Table 1.1. For more detail information, refer to the manual of "Overview [PCS-vol.1]".

Table 1.1 Evaluation item of road surface damage

| Item | Content | Description | Note |
|---|---|---|---|
| Crack | Crack ratio [%]<br>Patching [%]<br>Pothole [%] | Crack ratio is calculated by damaged area per total area grids. | For AC, BST |
| | Crack index [cm/m2] | Crack index is calculated by crack length of damaged per total area | For CC |
| Rut | Rut depth (Average,)[mm] | Average rutting depth within unit section (100m) | |
| | Rut depth (Max) [mm] | Maximum rutting depth within unit section (100m) | |
| IRI | IRI [mm/m] | Total Axial displacement of QC model in unit section (100m) | |
| MCI | Integrated condition index using above 3 damage items | automatic calculated by 3 damaged values | |

3) Work Allocation of Survey consultant on Pavement Condition Survey

Pavement condition survey can be divided into four steps, 1) Survey Plan, 2) Measurement, 3) Data Analysis and Data Processing, and 4) Data Check and Data Install. List of work item and assignment on Pavement Condition Survey is shown in Table 1.2. Work Allocation of Pavement Condition Survey is as below.

- Survey consultant

Survey consultant conducts the below contents.

・ Preparation of implementation plan
・ Measurement
・ Data analysis
・ Data processing

- DRVN (DPI, MMD, STECID and, IT Center)

DRVN has a responsibility of Top manager of pavement condition survey (hereinafter, this is called "Top manager"). In the future, RMBs or PDOT can become Top manager of the pavement condition survey. Role of Top manager are as follows;

・ Approve the survey plan
・ Check the progress of the pavement condition survey based on RMBs report
・ Manage the PCSV
・ Approve the completion of the pavement condition survey
・ Install the PC data to PMS server (IT Center)

- RMB (DPI, MM, SB)

RMBs manages all work in pavement condition survey (hereinafter, this is called "Work manager"). Role of Work manager are as follows;

・ Prepare the survey plan
・ Supervise the work of the Survey consultant
・ Submit the plan, progress report and complete PC data to Top manager

Responsible division of DRVN in pavement condition survey is shown in Figure 1.5.

Table 1.2 Work item and Assignment on Pavement Condition Survey

| No. | Work Item | DRVN (Top manager) | RMMBs (Work manager) | Survey consultant |
|---|---|---|---|---|
| 1 | Survey plan | ・Approve the survey plan | ・Preparation of survey plan<br>・Submit the survey plan to DRVN<br>・Assign Survey consultant | ・Preparation of Implementation plan |
| 2 | Field survey | ・Management of PCSV<br>・Check the progress report form RMBs | ・Supervise field work (Progress, Problem)<br>・Report the progress to DRVN | ・Field survey |
| 3 | Data analysis<br>Data Processing | ・Check the progress report form RMBs | ・Supervise data work (Progress, Problem) | ・Data analysis<br>・Data processing |
| 4 | Data check<br>Data install | ・Approve the completion of the pavement condition survey<br>・Install PC data (IT center) | ・Data check<br>・Submit PC data to DRVN | ・Correct data |

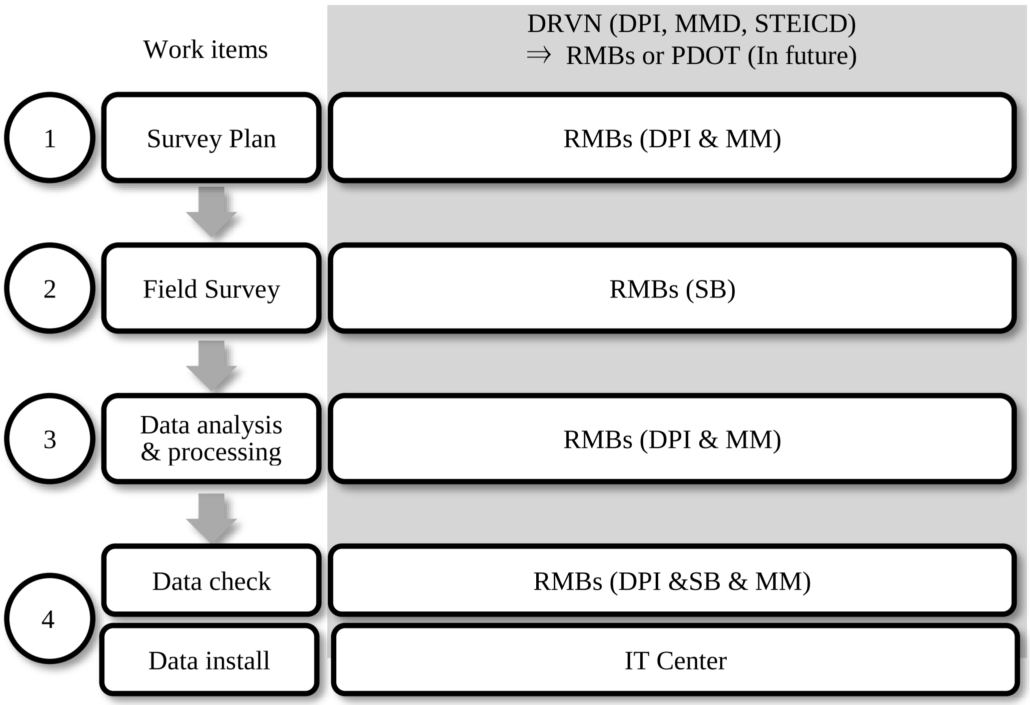



Figure 1.5 Responsible division of Pavement Condition Survey

## 1.3. Referential Document of This Operation Manual

This operation manual refers to the below manual and standard document as detail specification or procedure. Refer to the below manuals or documents in detail.

1) Survey Plan
- Format of implementation Plan (Appendix 1）
- Format of Survey Plan Section Table(Appendix 2)

2) Field Work
- Format of Calibration Report (Appendix 3)
- Format of Surveyed Route Table(Appendix 4)
- Format of Measurement Report (Appendix5)

- Format of Surveyed Section Table(Appendix 6)
- Instruction book of REAL Mini [PCS-Vol.4]

3) Data Analysis and Data Processing

- Format of Data Analysis Report (Appendix 7）
- Format of Analyzed Section Table(Appendix 8)
- Instruction book of REAL Mini [PCS-Vol.4]
- Data Preparation [PCS-Vol.5]

## 2. Survey Plan

Work flow of survey plan is shown in Figure 2.1.

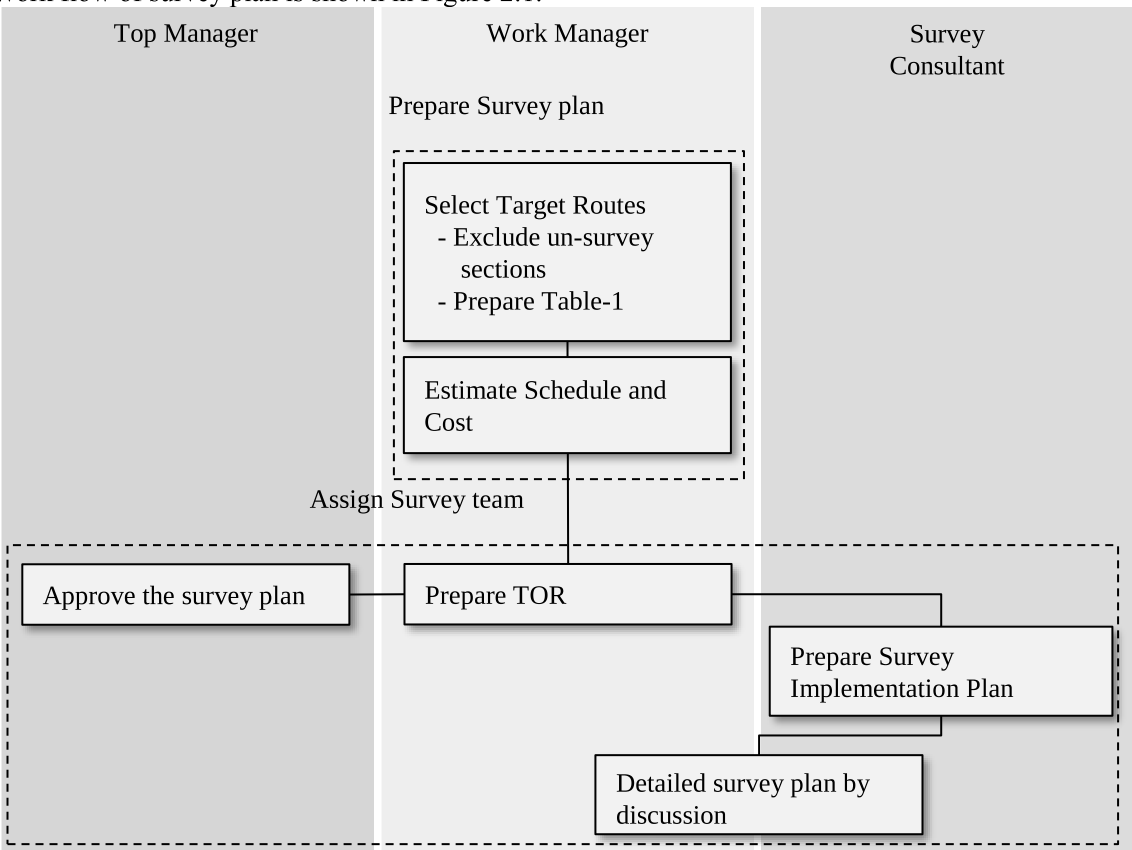



Figure 2.1 Work flow of survey plan

Based on the "Survey Plan Section Table (Table-1)" and the TOP prepared by Work Manager, Survey Consultant shall prepare "Implementation Plan" and submit it to Work manager.
Discussion between Work manager and Survey Consultant shall be held based on the Implementation Plan and confirm about contents of work items.

[Section Table]

Three (3) section tables are prepared in PCS. The section tables are summary of section length of survey targeted routs. These section tables are used to calculate section length for each work step (plan, survey and data analysis). Definition of section tables are shown in Table 2.1.

Table 2.1 Contents of section table

| Section Table | Information | Prepared by | Timing | Note |
|---|---|---|---|---|
| Survey plan section table (Table-1) | Survey Planned Section | Work manager | When preparing of Survey Plan | Information of Target section for PCS |
| Surveyed section table (Table-2) | Surveyed Section | Survey consultant | After field survey | Section information of after field work |
| Analyzed section table (Table-3) | Analyzed Section | Survey consultant | After Data Analysis | Section information of after analysis work (Section of PC data) |

1) Prepare Implementation Plan

Based on the TOR, Survey Consultant shall prepare the "Implementation Plan". When preparation of the "Implementation Plan", the format of the Implementation Plan (Appendix-1) is used and the following information items updated. Survey Consultant shall submit the Implementation Plan to Work manager as soon as it is prepared.

- Date of submission of Implementation Plan
- Signature of Survey consultant
- Period of Calibration
- Target route information (route name, KP, number of lane, length)
- Period of Measurement
- Period of Data Analysis
- Period of Data Processing
- The name, mobile number and email address of Team Leader
- The name, mobile number and email address of Survey team member
- The name, mobile number and email address of Data Analysis team member

Implementation structure in Survey Consultant is described in Figure 2.2. Survey Consultant has two partied, Survey team and Data Analysis team.
Survey Team has five (5) members, including one (1) driver three (3) operators and one (1) navigator. Work Manager shall dispatch a navigator who takes a responsibility of confirmation of road information, such as start/end point of road, direction, etc.
Data Analysis team has ten (10) members, who take responsibilities of data analysis and data processing work using collected data on site by Survey Team.

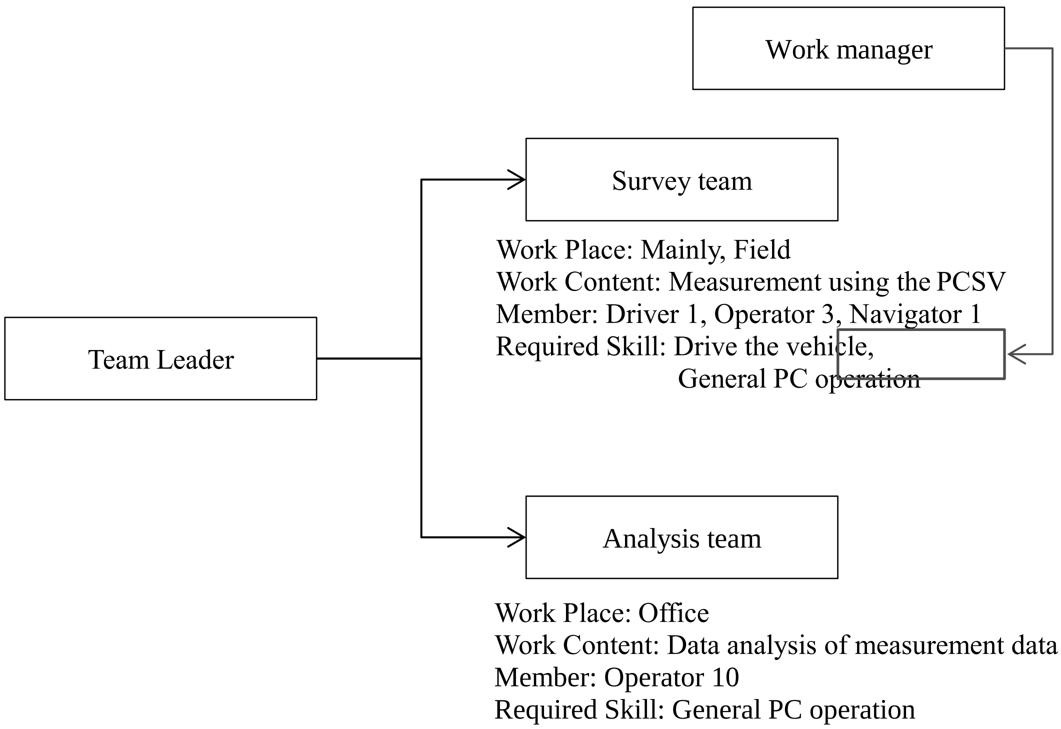



Figure 2.2 Formation of Survey consultant

2) Discussion before Survey

Discussion between Work Manager and Survey Consultant shall be held based on the Implementation Plan prepared by Survey Consultant. Work manager shall check all information in the Implementation Plan and confirm it.

- Survey length (Route length, Planned survey length)
- Excluded section, length
- Implementation schedule
- Report contents (particularly how to treat the traffic accident)
- The place of calibration

# 3. Field Work

Work flow of field work is shown in Figure 3.1.

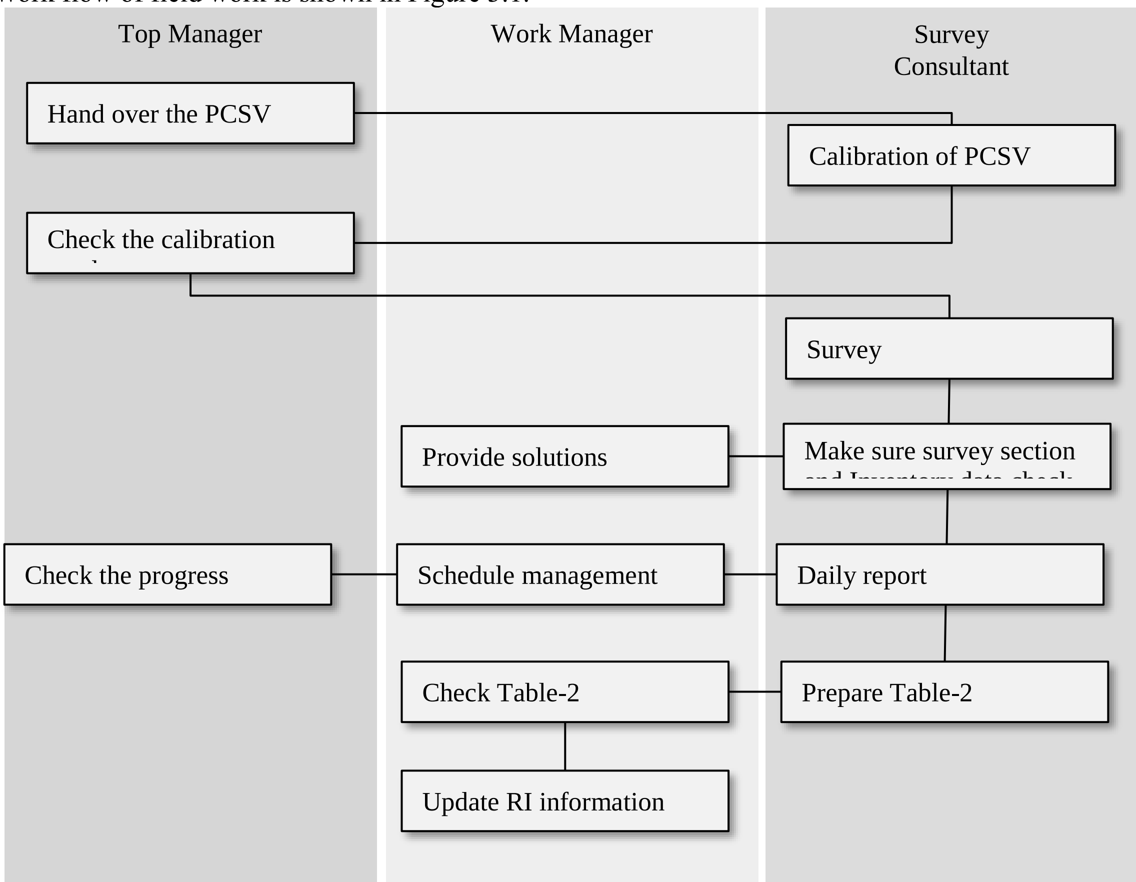



Figure 3.1 Work flow of field work

After complete the implementation contents at the first discussion, Survey team will start the measurement following the implementation schedule. Work manager supervises their activity in the office. Survey team will conduct the survey work as below items.

- Calibration of the measurement devices (Before the measurement)
- Survey
- Report the problem (Traffic Accident/Broken)
- Confirmation of unclear point on survey
- Daily report
- Prepare "Surveyed Section Table (Table-2)"

Table 3.1 is showing the items to be measured on site. Road damage data (Crack, Rut and IRI) are evaluated by using measured three items (Road image, cross-section profile and longitudinal profile). And front view image data with coordinates, which is one of the output data on PCS, is used to identify pavement type or road surround information when data analysis.

Table 3.1 Measurement item in field survey

| Measurement item | Equipment | Analysis item |
|---|---|---|
| Road image | CCD camera for road image | Crack |
| Transverse profile | Laser scanner | Rut |
| Longitudinal profile | Laser Displacement sensor & IMU | IRI |
| Front image with coordinate | CCD camera for front image & GPS | (Finally the front image is registered to PMS server) |

Calibration

Marking

Measurement

Operation

Figure 3.2 Steps of field work

### 3.1. Preparation the PCSV before Measurement

Survey team prepares the PCSV as shown in Figure 3.3.

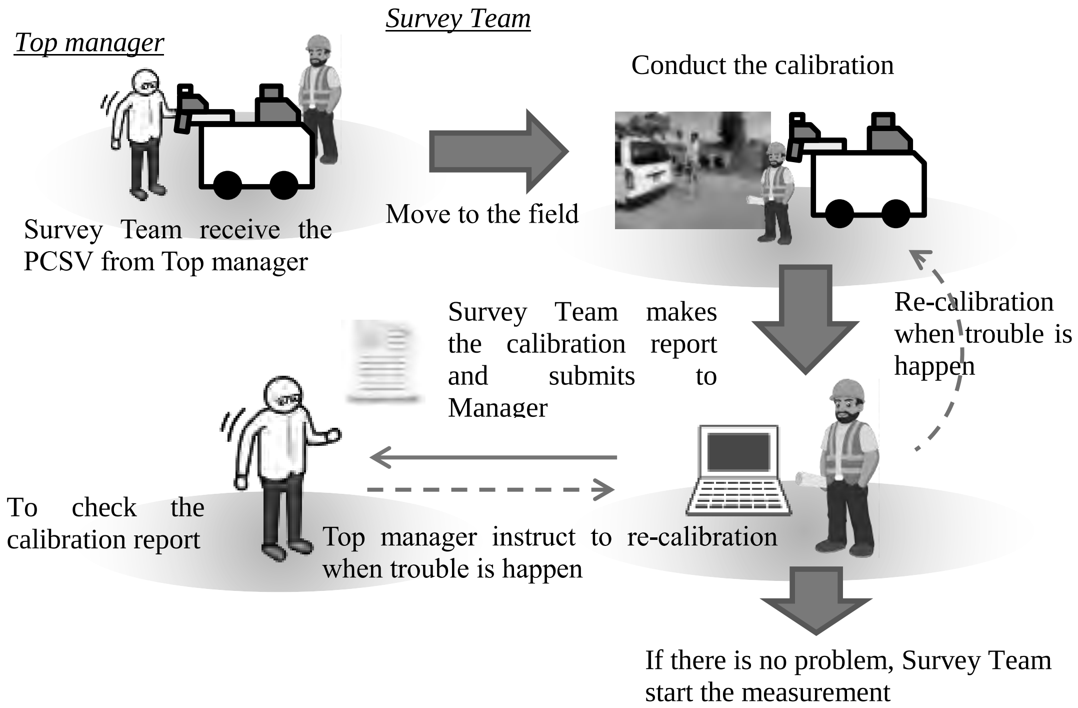



Figure 3.3 Work flow of survey preparation

1) Hanover of PCSV

Top Manager shall handover the PCSV to Survey Consultant. Top Manager and Survey Consultant make sure survey method and operation procedure of the PCSV based on the manual of "Instruction Book of REAL Mini [PCS-Vol.4]" and "Management [PCS-Vol.2]". And Top Manager and Survey

Consultant check basic operation of the PCSV and apparent condition of the vehicle, and make sure that there are no damages or failures in the PCSV. The results of above checks shall be recorded on a document with both signature between Top Manager and Survey Consultant.

2) Calibration of PCSV

Measurement device of the PCSV will have some change on setting location or device conditions by long-team use, and it might cause error of measurement data. To avoid measurement error, calibration of the PCSV shall be done to verify accuracy of measurement data and adjust device parameters. Calibration work shall be done when the following timing;

Timing of calibration
- Before survey in case of survey over 350km in total during one survey term
- When measured length is over 5000km from the last calibration
- When over 6 months pass from the last calibration
- In case of changing tires or changing air pressure of tires

Table 3.2 is showing the items for calibration. For more detail about calibration work, refer to "Instruction Book of REAL Mini [PCS-Vol.4]" and "Calibration Report (Appendx-4)".

Table 3.2 Calibration item

| No. | Work Item | Check item | Tolerance |
|---|---|---|---|
| 1 | Inspection vehicle check | Condition of system | No Error |
| 2 | Camera check | Detection accuracy of crack width in image | 2mm or more |
| 3 | Camera calibration | Measurement span | 3.8m or more |
| 4 | Laser displacement sensor check | Accuracy of measurement | 0.4mm |
| 5 | Laser scanner check | Accuracy of Rut depth measurement | 6mm |
| 6 | Distance calibration | Accuracy of mileage measurement | Within range of -0.5% to 0.5% |
| 7 | Long test | Operating condition of inspection vehicle | No Error |

3) Report Calibration Result

Survey Team of Survey Consultant shall prepare the Calibration Report using the format of the report and submit it to Top Manage. In case that there are some problems in the Calibration Report, Top manager shall instruct Survey Team to do calibration again.

### 3.2. Field Survey

Survey team conducts the survey every day excluding rainy days. Survey team reports about progress to Work manager via email with an attached "Format of Measurement Report" (Appendix 5) every day. Field survey work in a day is below items.

- Arrangement of PCSV
- Measurement by PCSV
- Finalize of survey and PCSV
- Send the daily report

Work manager checks the progress from the report. If there is a big delay from the plan, Work manager confirms the reason for the delay. Work manager and Survey team discuss the countermeasure for the reason.

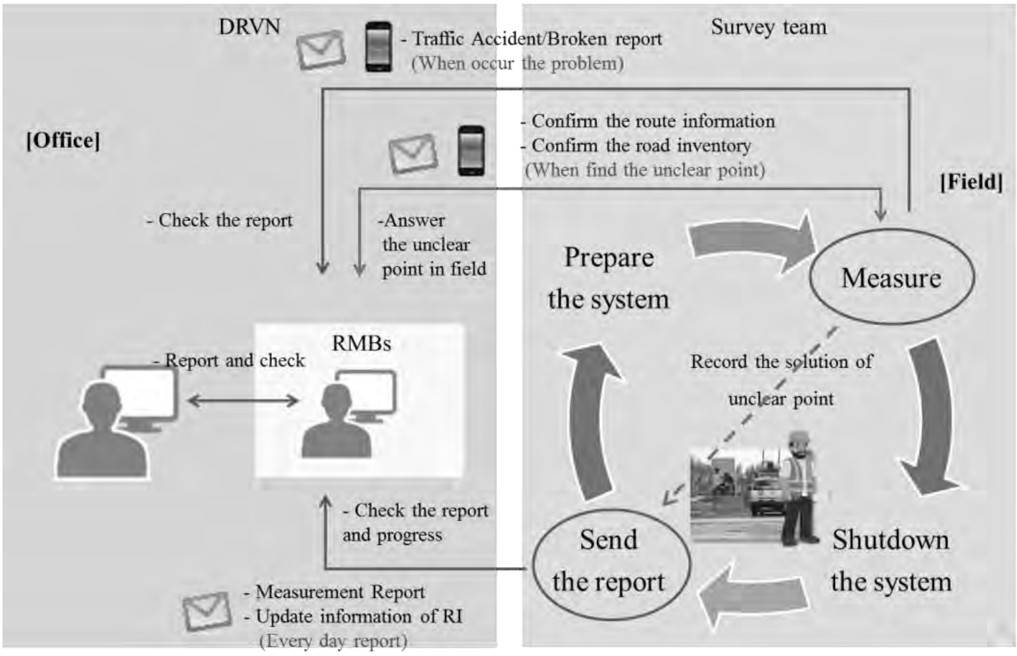



Figure 3.4 Work flow of field survey

In case the conducting the pavement condition survey in new route (new construction, expressway, PDOT management roads, etc.), the below contents should be confirmed carefully about each route situation in order to clear the problem point of survey in advance.

・Kilo post station is exist or not
・Pavement is exist or not
・Possibility of the starting and ending point (particularly expressway)
・Road code setting is appropriate or not

3.2.1. Arrangement of PCSV

Survey Team shall arrange the PCSV before start field survey. The procedure of arrangement of PCSV is as follows. For more detail information, refer to chapter 6 of the manual of “Instruction Book of REAL Mini [PCS-Vol.4]”

- Open the covers (CCD cameras for road image and for front image, laser scanner and laser displacement sensor)
- Connect the HDD to both PCs (PC1 and PC2)
- Turn on the system (power control unit, main control unit, PC1 and PC2)

Measurement application starts automatically when PC power is on. After start of measurement application, Survey Operator selects the measurement function and input measurement data (Road category, Road number, Road number supplement, brunch number, lane, direction). When completion of data input, the window changes to measurement window.
When the color of “status” is not green, all systems (PC1, PC2, main control unit and power control unit) are turned off power and connection of devices and HDD are checked. And all systems are turned on again and “status” is checked.
If the situation is not improved, Survey Team shall reports to Work Manager.

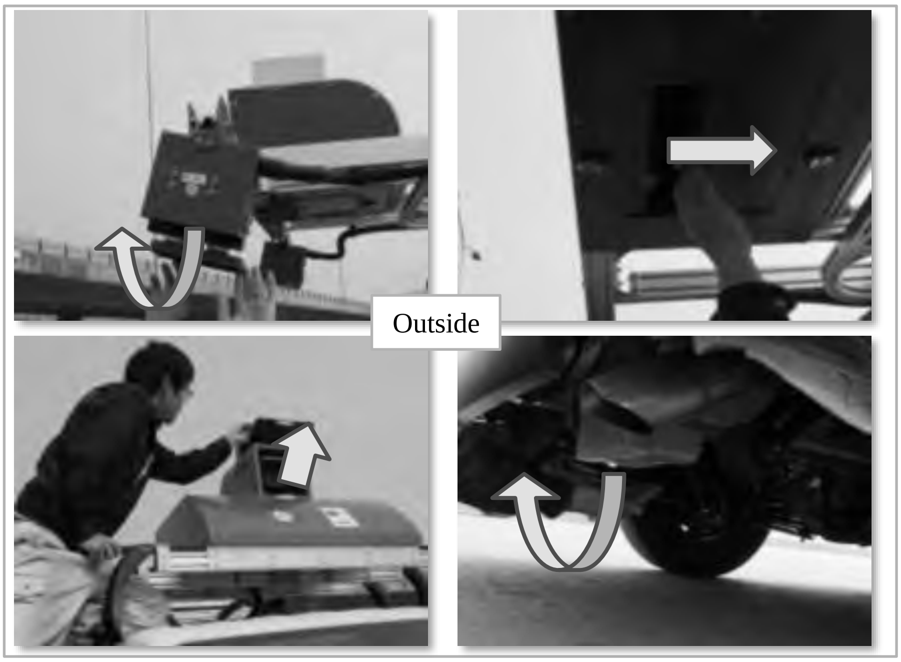



Figure 3.5 Open the covers (outside of PCSV)

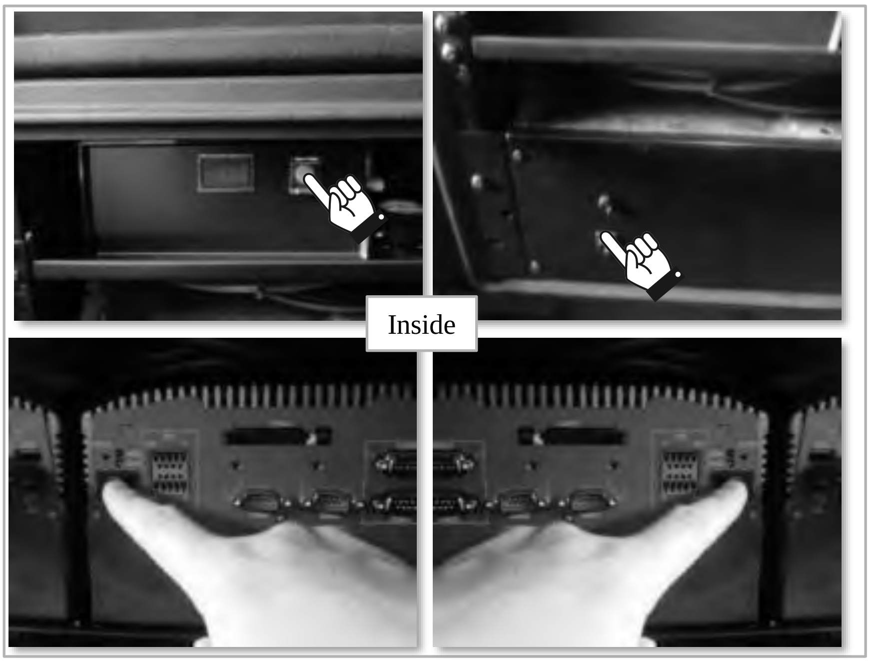



Figure 3.6 Turn on the system (inside of PCSV)

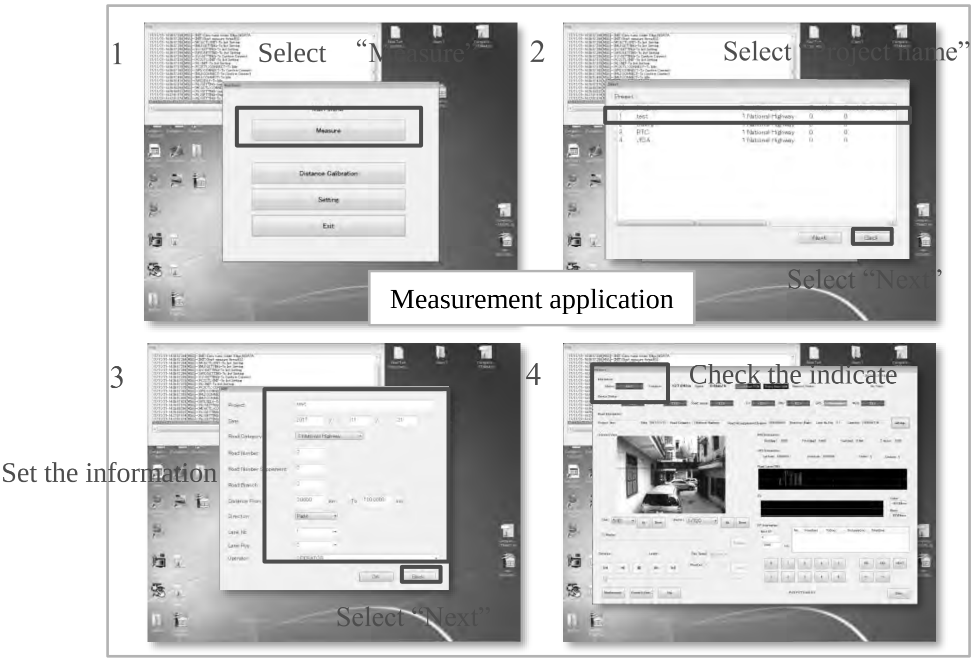



Figure 3.7 Preparation of measurement application

3.2.2. Measurement by PCSV

After arrangement of PCSV, Survey team move to start point of target route and start the measurement by PCSV.

1) Measurement Method

Work flow of measurement is shown in Figure 3.8. Refer the chapter 6 in “Instruction Book of REAL Mini” about detail operation procedure of REAL Mini.

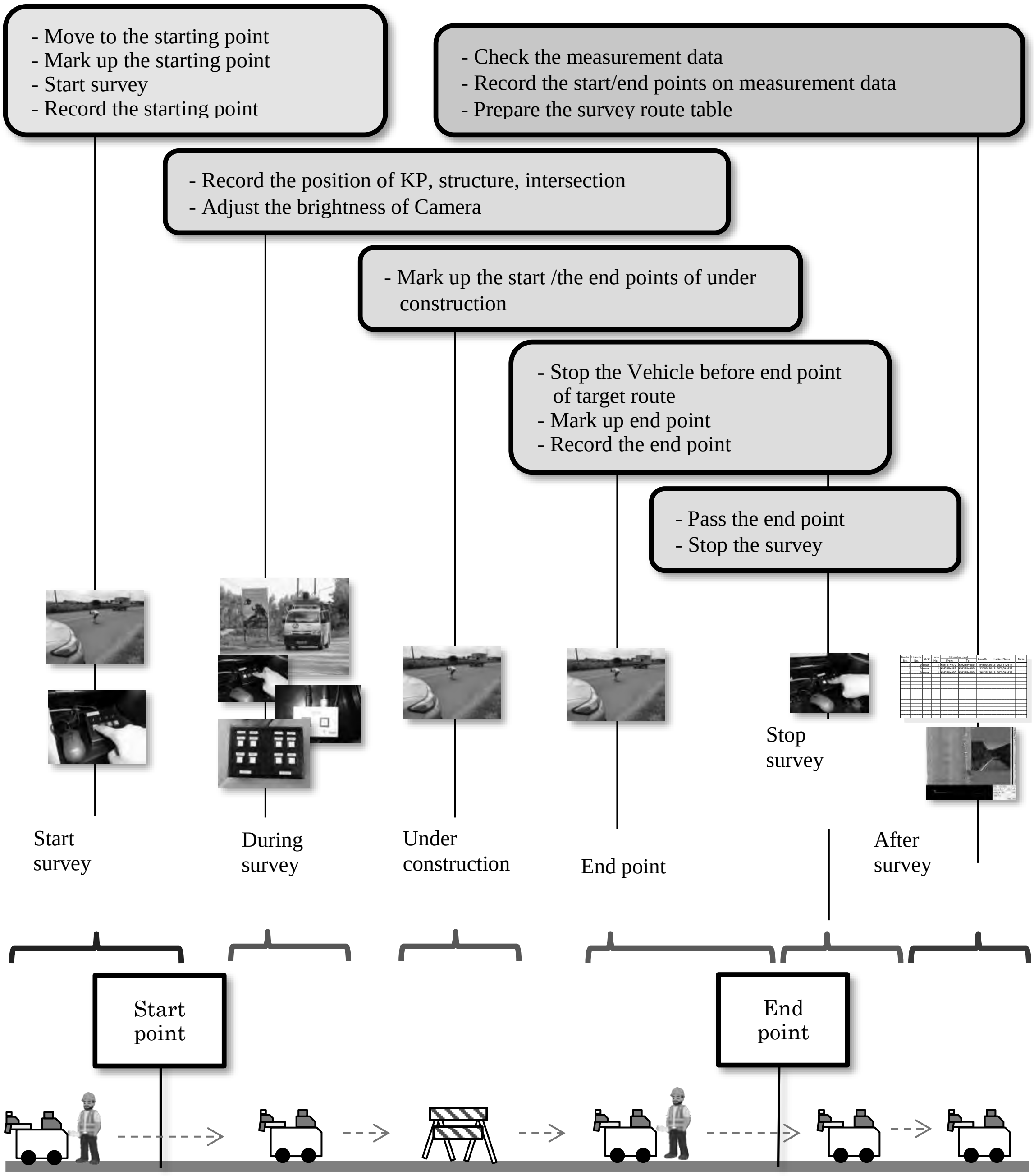



Figure 3.8 Work flow of measurement

a) Work on starting point

Survey team moves to the starting point of the targeted survey route with the PCSV and stop there. The Operator leaves the vehicle, and confirms the starting point position, and marks up the starting point on pavement.

Marking on pavement is used to identify the starting point of analysis data on the Analysis Application.

Survey Team starts survey with PCSV after finish of marking. Figure 3.9 shows the work steps on starting point.

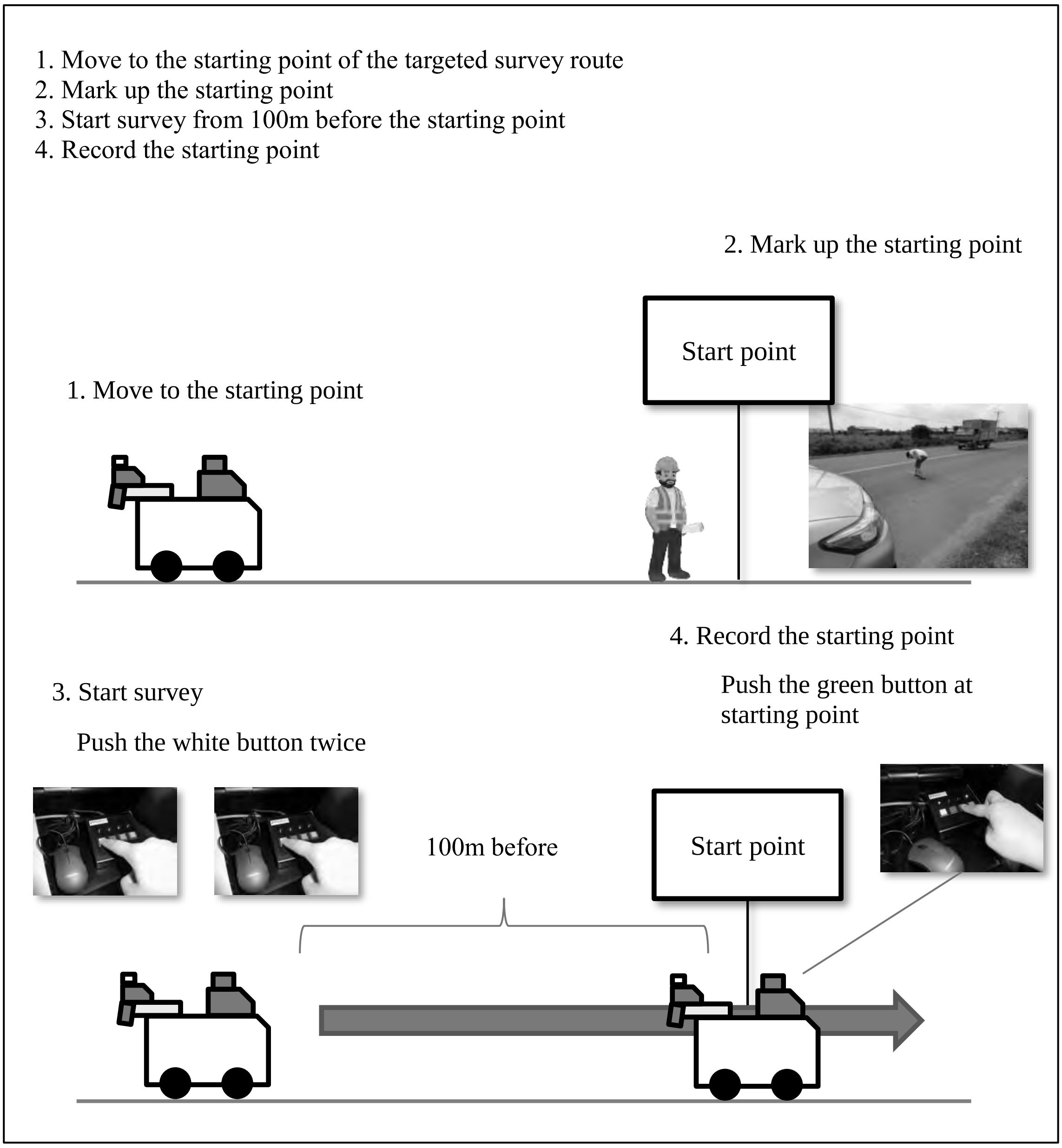



Figure 3.9 Work steps on starting point

b) Work during survey

During survey with PCSV, the operator shall record the position of Kilo-post stations, structure and intersection on measurement data.

Also to keep the brightness of the image constant, the brightness of the camera shall be adjusted. Figure 3.10 shows the work items during survey.

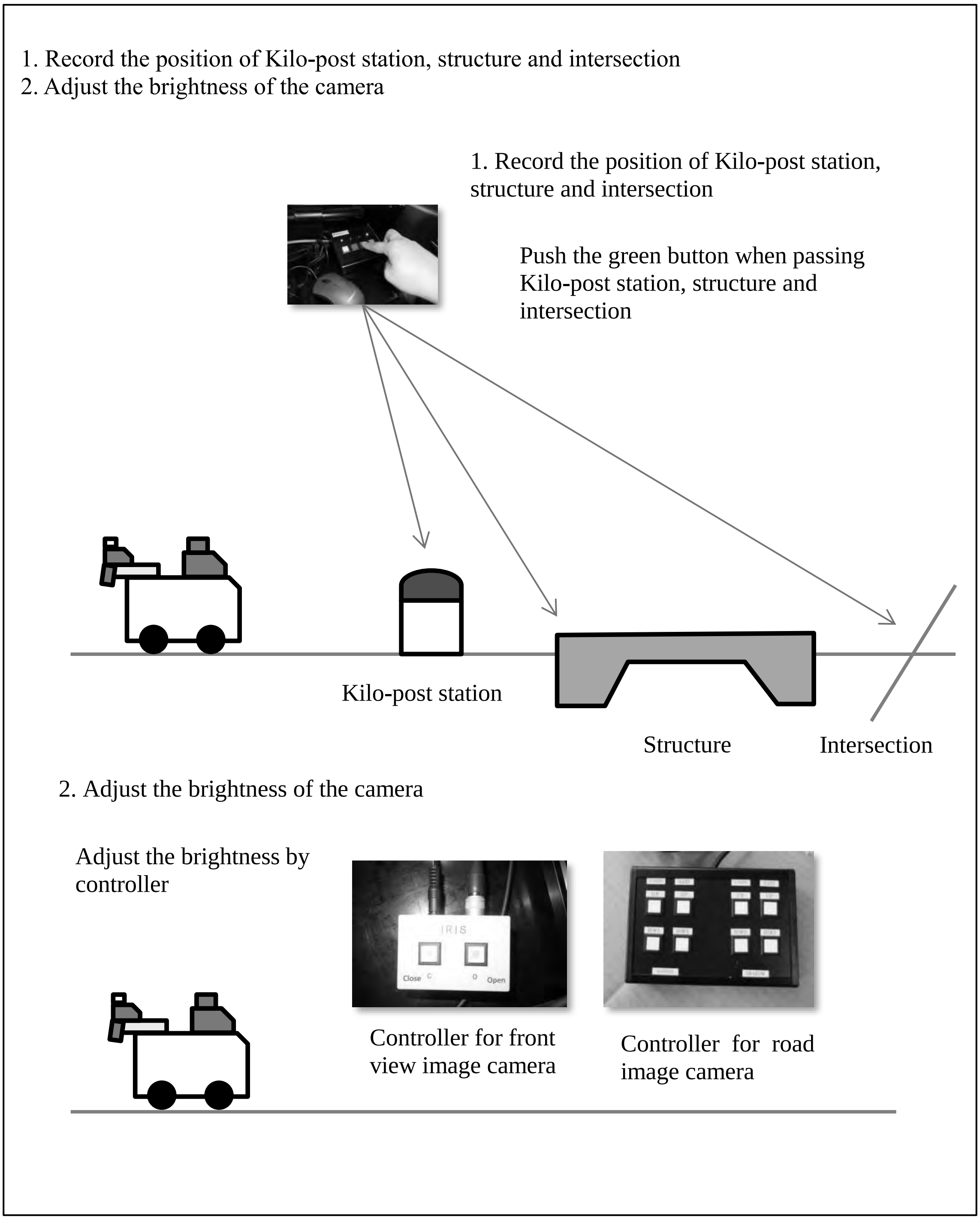



Figure 3.10 Work items during survey

c) The work on under construction section

Under construction sections are excluded from survey. However in the view point of efficiency of field survey, survey is not stopped in under construction sections between survey sections, and survey is conducted continuously. In order to exclude under construction sections from data analysis targets, information specifying under construction sections on the Data Analysis application must be recorded in the measurement data. When there is a under construction section, Survey Team marks up at the end point of under construction section.

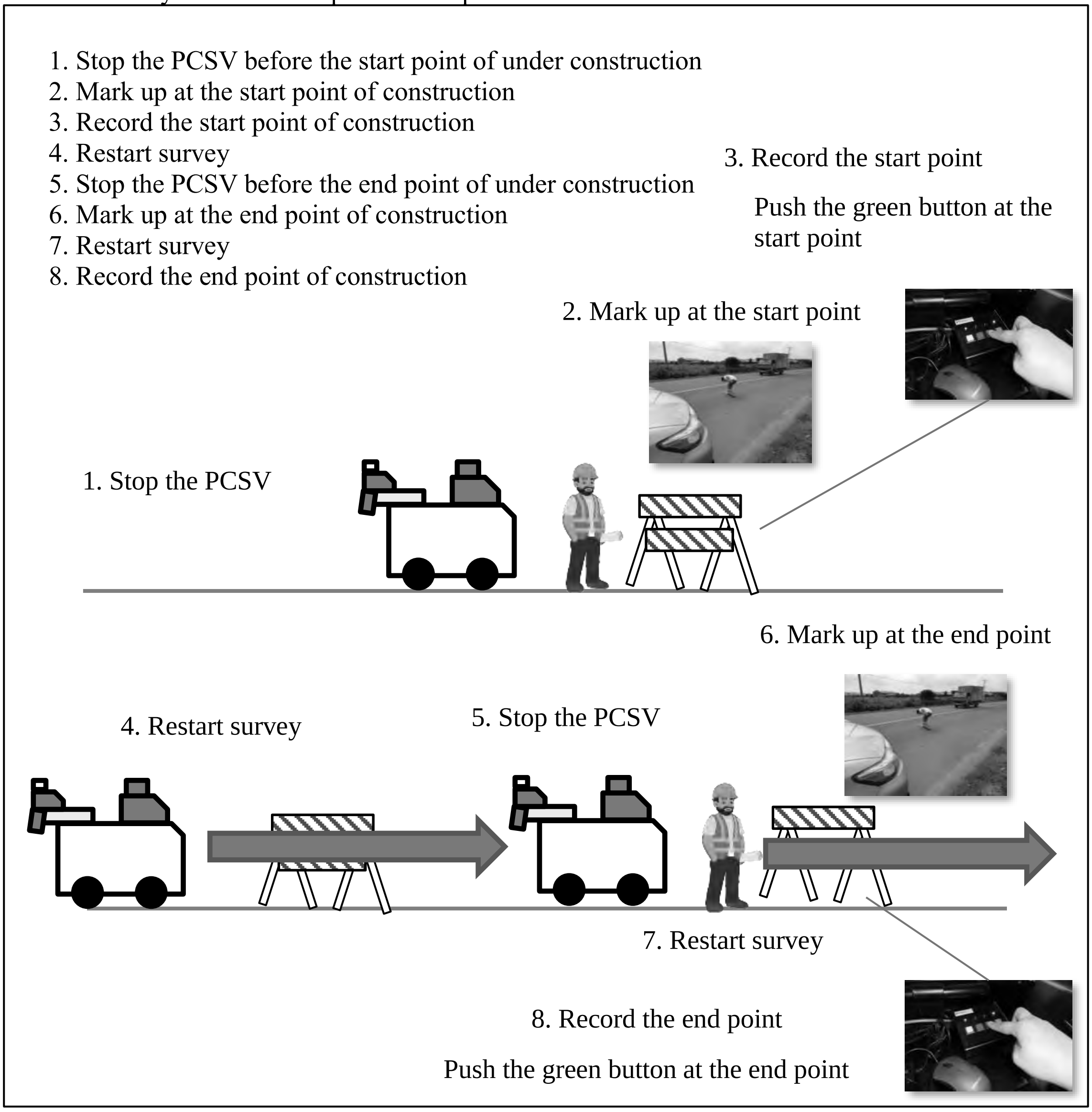



Figure 3.11 Work on under construction section

d) Work on end point or when survey stops

Survey Team stops the PCSV at the end point approaches. And the operator marks up at the end point on pavement. After marking up, Survey Team restart survey. Finally, after 100 meters from the end point, survey is stopped and the PCSV is moved to a safe place. Figure 3.12 is showing the procedure of these works.

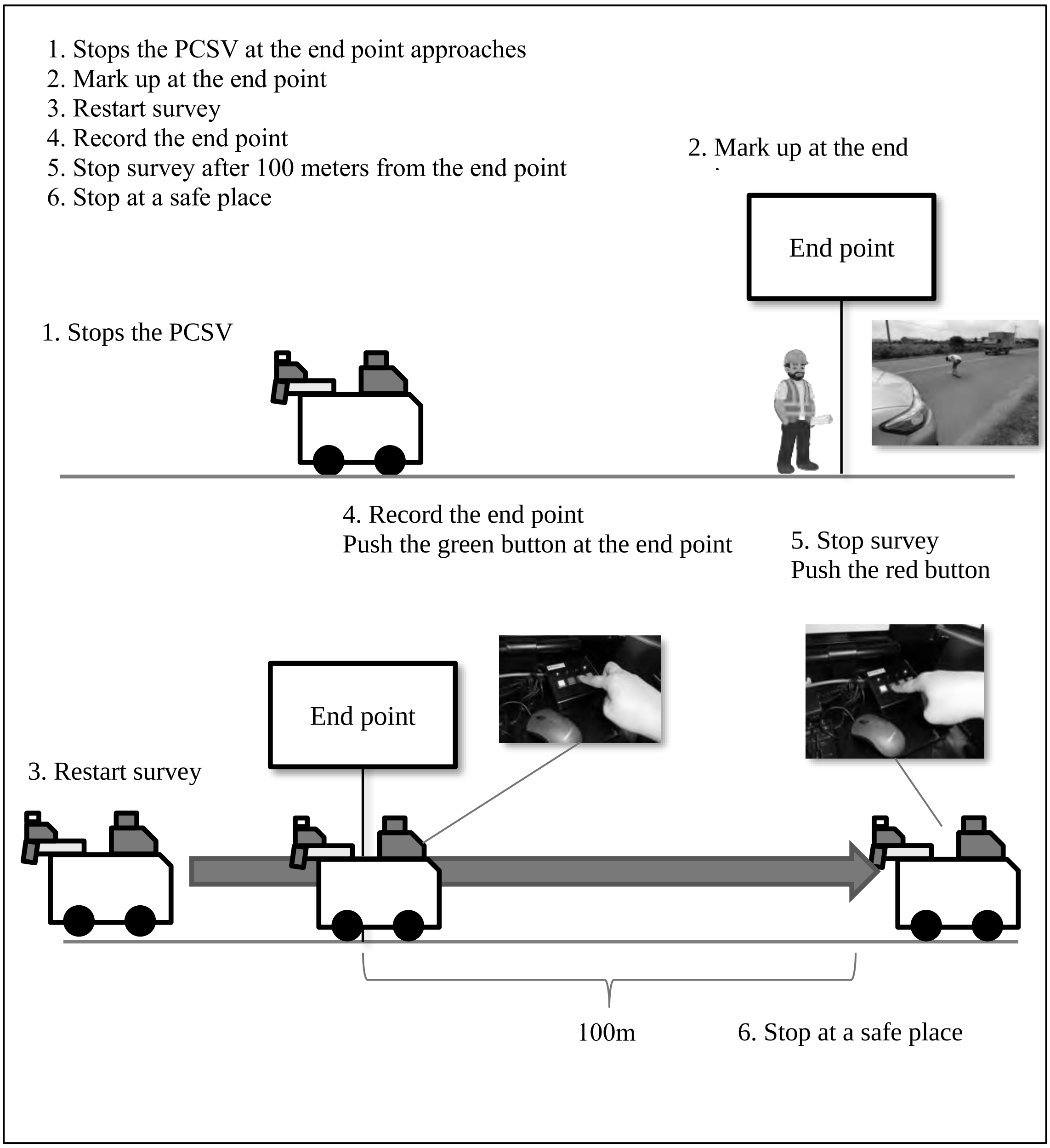



Figure 3.12 Work on end point or when survey stops

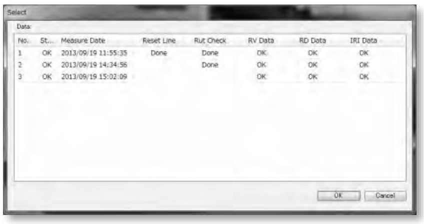
e) The work of finishing the measurement

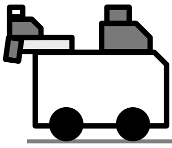
After field survey, Survey Team checks the measured data and records the start/end points through the Start/End points setting application. Data number to be collected shall be checked. When data number is insufficient, that section shall be surveyed again. Without any problems on measured data, the start/end points are recorded. For more detail procedures, refer to chapter 7 of the manual of “Instruction Book of REAL Mini [PCS-Vol.4]”.

Next, in order for the Data Analysis team to determine the information on the route and section of the measurement data, the Surveyed Route Table of route information (road code, measurement direction, lane information, KP) and measurement data (folder name) is prepared. At the time of analysis, Data Analysis team refers to the Surveyed Route Table and specifies the route information of each measurement data.

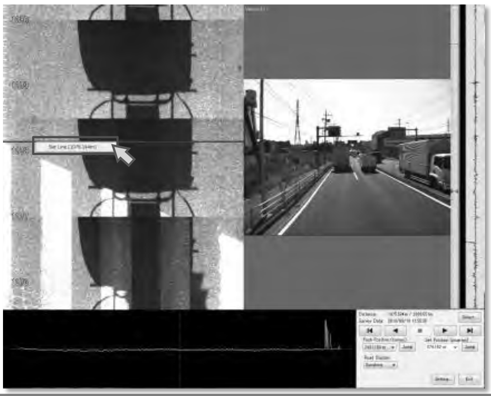
1. Checks the measured data
2. Records the start/end points
3. Prepare the surveyed route table

1. Checks the measured data



2. Records the start/end points



3. Prepare the surveyed route table

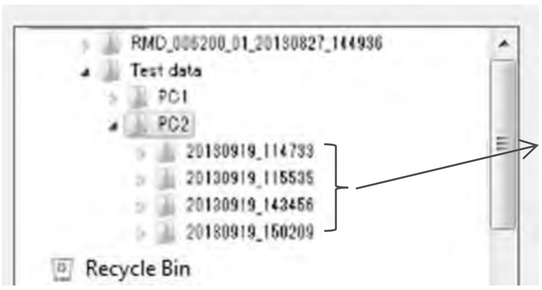
| Survey date | Folder | Road Name | Road Category | Road No. | Road No. Supplement | Branch Code | Survey Section | | | | Left/Right | Lane | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | From | | To | | | | |
| | | | | | | | Km | m | Km | m | | | |
| 2015/11/6 | 20151106_102010 | QL N2 | 1 | 482 | 0 | 2 | 5 | 18 | 59 | 0 | R | 1 | |
| 2015/11/7 | 20151107_072418 | QL N2 | 1 | 482 | 0 | 2 | 59 | 0 | 101 | 920 | R | 1 | |
| 2015/11/7 | 20151107_092731 | QL N2 | 1 | 482 | 0 | 2 | 101 | 920 | 48 | 0 | R | 1 | |
| 2015/11/7 | 20151107_143211 | QL N2 | 1 | 482 | 0 | 2 | 48 | 0 | 5 | 18 | L | 1 | |
| 2015/11/8 | 20151108_095022 | QL 30 | 1 | 30 | 0 | 0 | 34 | 320 | 93 | 0 | R | 1 | |
| 2015/11/8 | 20151108_133737 | QL 30 | 1 | 30 | 0 | 0 | 93 | 0 | 118 | 0 | R | 1 | |
| 2015/11/8 | 20151108_150020 | QL 30 | 1 | 30 | 0 | 0 | 118 | 0 | 119 | 418 | R | 1 | |
| 2015/11/8 | 20151108_151004 | QL 30 | 1 | 30 | 0 | 0 | 119 | 418 | 108 | 0 | L | 1 | |
| 2015/11/9 | 20151109_081113 | QL 30 | 1 | 30 | 0 | 0 | 110 | 0 | 34 | 320 | L | 1 | CO DOAN DANG THI CONG |
| 2015/11/9 | 20151109_135512 | QL 30 | 1 | 30 | 0 | 0 | 0 | 0 | 1 | 200 | R | 1 | |
| 2015/11/9 | 20151109_140259 | QL 30 | 1 | 30 | 0 | 0 | 1 | 200 | 0 | 0 | L | 1 | |
| 2015/11/10 | 20151110_083505 | QL 80 | 1 | 80 | 0 | 0 | 0 | 0 | 50 | 875 | R | 1 | |
| 2015/11/10 | 20151110_105859 | QL 80 | 1 | 80 | 0 | 0 | 50 | 875 | 0 | 0 | L | 1 | |
| 2015/11/11 | 20151111_102406 | QL 91B | 1 | 91 | 0 | 2 | 0 | 0 | 15 | 793 | R | 1 | |
| 2015/11/11 | 20151111_114323 | QL91 | 1 | 91 | 0 | 0 | 39 | 0 | 45 | 118 | R | 1 | |
| 2015/11/11 | 20151111_120245 | QL91 | 1 | 91 | 0 | 0 | 45 | 118 | 39 | 0 | L | 1 | |
| 2015/11/11 | 20151111_134638 | QL91 | 1 | 91 | 0 | 0 | 51 | 140 | 70 | 233 | R | 1 | |
| 2015/11/11 | 20151111_143220 | QL91 | 1 | 91 | 0 | 0 | 70 | 233 | 51 | 140 | N | 1 | |

Figure 3.13 Work after field survey

[Surveyed Route Table]

The Surveyed Route Table which is a summary of surveyed route for each surveyed day is prepared in order to identify surveyed data in the HDD.

The Surveyed Route Table is used to identify the information of surveyed route in the HDD by Data Analysis team when start data analysis work. Data Analysis team can find the data of targeted route for analysis in the HDD using surveyed date information (Date, hour, minute and second) as an identification key. (A sample format of the Surveyed Route Table is available in Appendix-4).




Surveyed date (Date, hour, minute and second) is just recorded as a folder name

Figure 3.14 Saved window of surveyed data

Preparation steps of the Surveyed Route Table;

- Enter a surveyed date into “Survey Date” column
- Enter a folder name which has surveyed data into “Folder” column
- Enter a road name into “Road Name” column
- Enter a code of road category into “Road Category” column
- Enter a Road Number into “Road No.” column
- Enter a Road No. Supplement into “Road No. Supplement” column
- Enter a Branch Code into “Branch Code” column
- Enter a KP(Km, m) at survey start point into “From” and enter a KP(Km, m) at survey end point into “To” column
- Enter a surveyed direction into “Left/Right” column
- Enter a surveyed lane number into “Lane” column
- Enter memos or message into “Note” column if needed(e.g. Excluding section, etc.)

| Survey date | Folder | Road Name | Road Category | Road No. | Road No. Supplement | Branch Code | Survey Section | | | | Left/Right | Lane | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | From | | To | | | | |
| | | | | | | | Km | m | Km | m | | | |
| 2015/11/6 | 20151106_102010 | QL N2 | 1 | 482 | 0 | 2 | 5 | 18 | 59 | 0 | R | 1 | |
| 2015/11/7 | 20151107_072418 | QL N2 | 1 | 482 | 0 | 2 | 59 | 0 | 101 | 920 | R | 1 | |
| 2015/11/7 | 20151107_092731 | QL N2 | 1 | 482 | 0 | 2 | 101 | 920 | 48 | 0 | R | 1 | |
| 2015/11/7 | 20151107_143211 | QL N2 | 1 | 482 | 0 | 2 | 48 | 0 | 5 | 18 | L | 1 | |
| 2015/11/8 | 20151108_095022 | QL 30 | 1 | 30 | 0 | 0 | 34 | 320 | 93 | 0 | R | 1 | |
| 2015/11/8 | 20151108_133737 | QL 30 | 1 | 30 | 0 | 0 | 93 | 0 | 118 | 0 | R | 1 | |
| 2015/11/8 | 20151108_150020 | QL 30 | 1 | 30 | 0 | 0 | 118 | 0 | 119 | 418 | R | 1 | |
| 2015/11/8 | 20151108_151004 | QL 30 | 1 | 30 | 0 | 0 | 119 | 418 | 108 | 0 | L | 1 | |
| 2015/11/9 | 20151109_081113 | QL 30 | 1 | 30 | 0 | 0 | 110 | 0 | 34 | 320 | L | 1 | CO DOAN DANG THI CONG |
| 2015/11/9 | 20151109_135512 | QL 30 | 1 | 30 | 0 | 0 | 0 | 0 | 1 | 200 | R | 1 | |
| 2015/11/9 | 20151109_140259 | QL 30 | 1 | 30 | 0 | 0 | 1 | 200 | 0 | 0 | L | 1 | |
| 2015/11/10 | 20151110_083505 | QL 80 | 1 | 80 | 0 | 0 | 0 | 0 | 50 | 875 | R | 1 | |
| 2015/11/10 | 20151110_105859 | QL 80 | 1 | 80 | 0 | 0 | 50 | 875 | 0 | 0 | L | 1 | |
| 2015/11/11 | 20151111_102406 | QL 91B | 1 | 91 | 0 | 2 | 0 | 0 | 15 | 793 | R | 1 | |
| 2015/11/11 | 20151111_114323 | QL91 | 1 | 91 | 0 | 0 | 39 | 0 | 45 | 118 | R | 1 | |
| 2015/11/11 | 20151111_120245 | QL91 | 1 | 91 | 0 | 0 | 45 | 118 | 39 | 0 | L | 1 | |
| 2015/11/11 | 20151111_134638 | QL91 | 1 | 91 | 0 | 0 | 51 | 140 | 70 | 233 | R | 1 | |
| 2015/11/11 | 20151111_143220 | QL91 | 1 | 91 | 0 | 0 | 70 | 233 | 51 | 140 | N | 1 | |

Figure 3.15 Sample of Surveyed Route Table

2) Notes for Field Survey

a) Rules for field survey

The driver not only drives safely, but also pays attention to the driving situation of other vehicles.

- <u>In case that there are obstacles or parked vehicles on the shoulder</u>

In case that there are street parking vehicles on the shoulder, there is a possibility that a person may come down from the parked vehicles, so the driver shall drive avoiding the parked vehicle while paying attention to the movement of a person from inside the vehicle. Also, there is a possibility that a person may come out from behind the parked vehicle, the driver shall pay attention to jumping out from the blind spot.

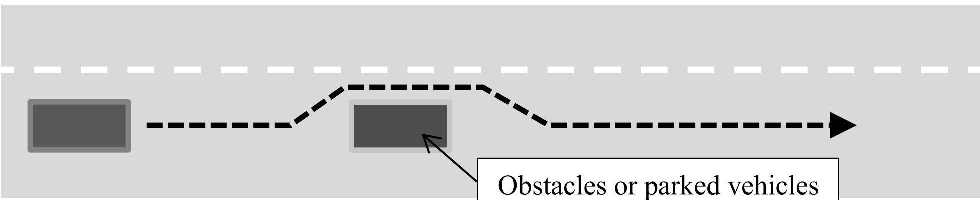



Figure 3.16 Drive to avoid obstacles or parked vehicles

- <u>Drive Speed</u>

The PCSV strictly adheres to the legal speed of each route. Also, in case of bad weather condition, such as sudden rain or thick fog, driver shall pay attention to keep a safe speed. The maximum speed of the PCSV is 70km/h when survey, and it runs at 70km/h or less when survey to avoid stopping the system.

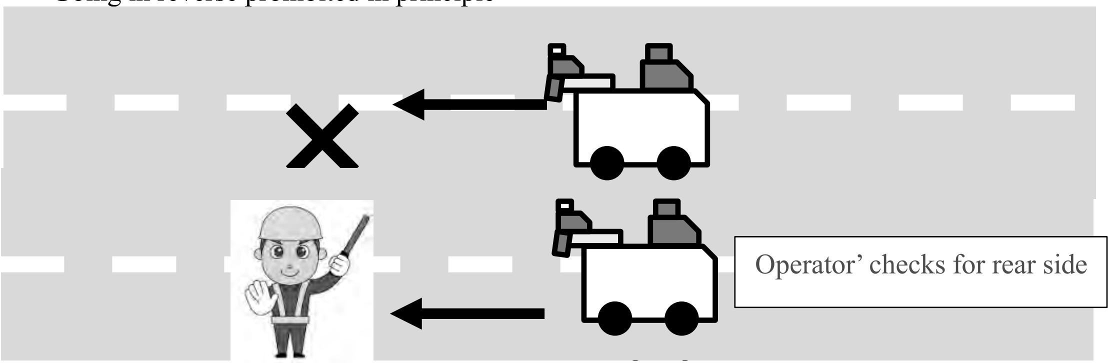
- <u>Safety drive</u>

In order to maintain not only the safety of the vehicle but also the quality of measured data constant, the driver shall not drive dangerous, such as sudden start, abrupt stop, sudden acceleration, rapid deceleration and sudden steering wheel, etc. When low-speed vehicles are running in front of the PCSV, the driver shall not overtake them, and keep inter-vehicle distance enough. Since the

equipment is attached on the ceiling of the vehicle, the driver shall pay attention to height limitation (allowable height is 2.7m or less).
Note that the distance between the preceding vehicle and the preceding vehicle to travel safely is the same distance as the speed per hour. For example, in case of 40 km/h, that is 40 m.

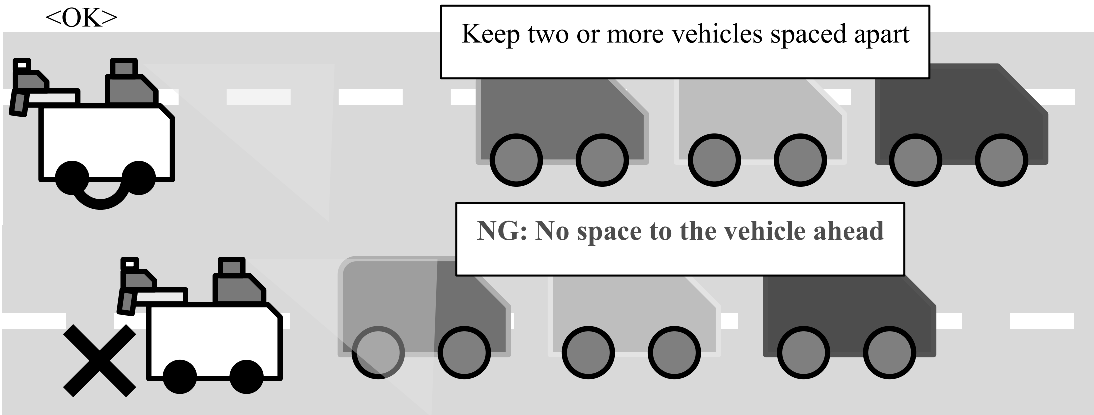
- <u>Going in reverse prohibited</u>
  The rear side of the vehicle tends to be a blind spot. Therefore, for the purpose of preventing accidents in principle going in reverse is prohibited. However, in case it is unavoidable such as when parking, the operator shall surely go out once to check the safety of the rear side.

< Going in reverse prohibited in principle>




- <u>Drive in traffic congestion</u>
  If the distance between the PCSV and the vehicle ahead is short, the road surface does not appear on the front image. Therefore, in case of traffic congestion when survey, the PCSV shall go through with two or more vehicles spaced apart from the preceding vehicle.

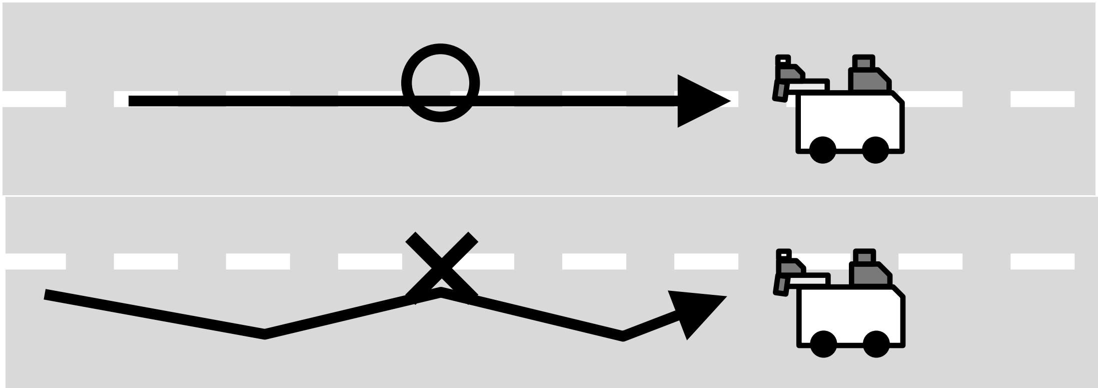
<OK>



**Drive Straight**

The driver shall drive straight to avoid incorrect survey length due to zigzag drive.

<OK>



b) Judgement to stop survey

When it rains, laser scanners and laser displacement sensor are irregularly reflected due to wet condition of road surface. Also since water drops are reflected on the image, the quality of the image deteriorates. Therefore, the survey shall be stopped in case of rain.

- <u>In case of suddenly rain during survey</u>

➢ <u>In the case of weak rain that raindrops do not appear on the camera</u>

If possible, survey shall be continued until the end point and the weather conditions shall be monitored.

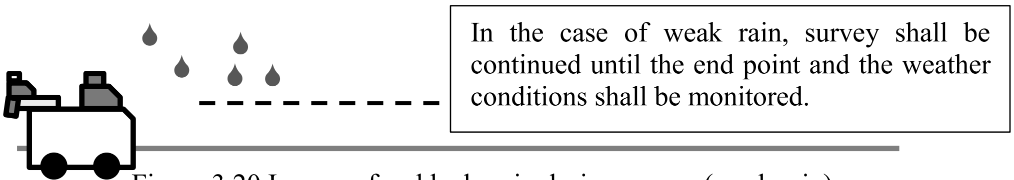



Figure 3.20 In case of suddenly rain during survey (weak rain)

➢ <u>In the case of heavy rain that raindrops appear on the camera and water stay on pavement</u>

Survey is stopped and the driver stops the PCSV at a place where the vehicle can be parked safely on the shoulder. In case the weather condition is not recovered, the survey is ended. When the weather condition is expected to recover, and when the condition of the road surface is in a dry, survey is restarted from the position of the previous Kilo- post station.

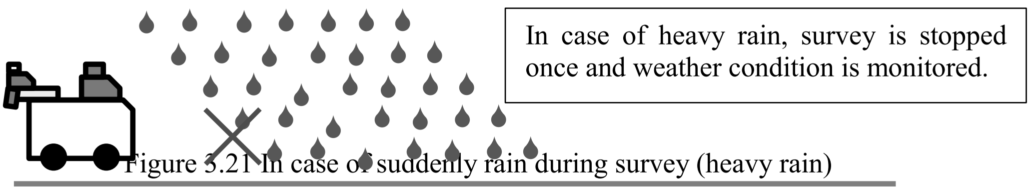



Figure 3.21 In case of suddenly rain during survey (heavy rain)

- <u>Pavement condition after stop rain</u>

After stop rain, survey can be restarted if road surface is dry. How to judge to restart survey is explained as bellows;

➢ Examples of road conditions where survey CANNOT be restarted (NG)

<u>Water still stay on a part of the road surface</u>


Figure 3.22 Road conditions where survey cannot be restarted (sample-1)

Water stay on whole part of the road surface


Figure 3.23 Road conditions where survey cannot be restarted (sample-2)

- Examples of road conditions where survey CAN be restarted (OK)
  Dry on the road surface (no water on the road surface)

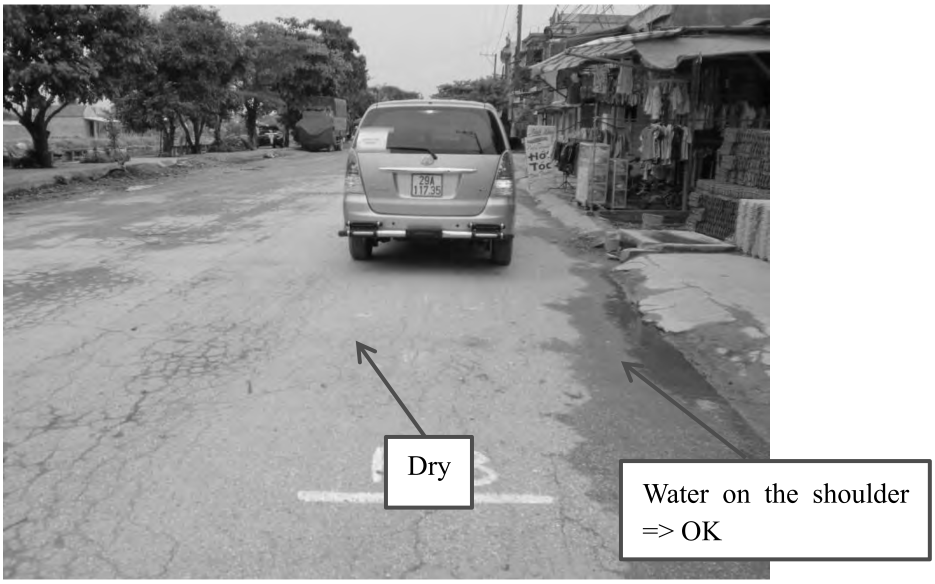



Figure 3.24 Road conditions where survey can be restarted (sample-1)

Dry on the road surface (totally recovered)


Figure 3.25 Road conditions where survey can be restarted (sample-2)

3) Make Sure the Unclear Point

Survey team reports any problem and questions to Work manager if needed. Work manager instructs the solution to the Survey team.

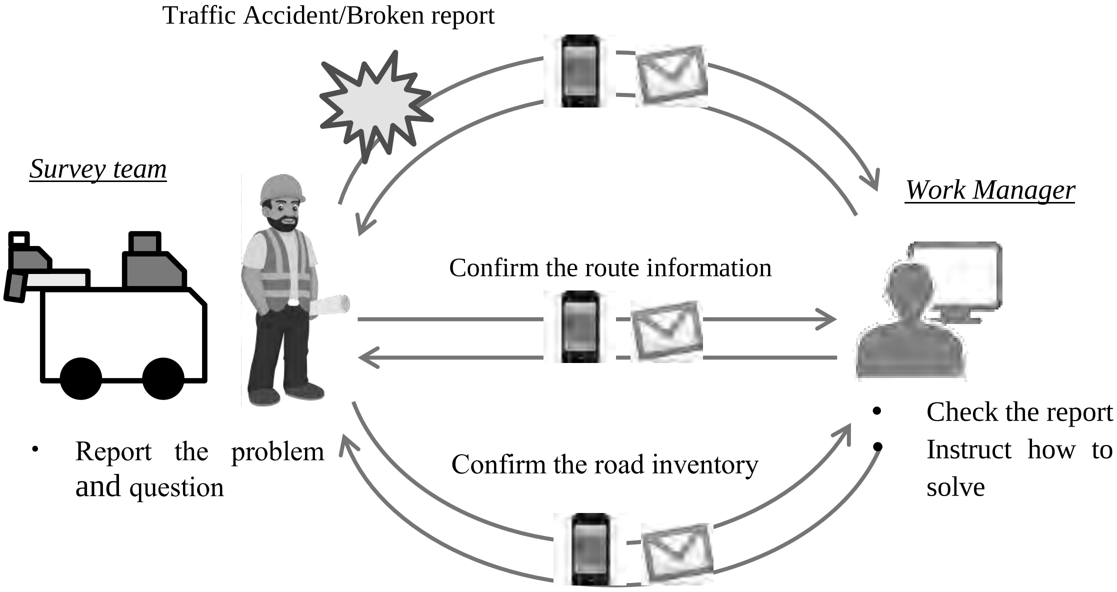



Figure 3.26 Flow of report and responding for the report

a) Safety management

In case of traffic accident, Survey Team shall report to Work manager about situation of accident, including (1) Accident situation, (2) with or without injured persons and (3) Possibility to continue the survey, etc. In case of with injured persons, Survey Team requests an ambulance and reports to the police for highest priority of life rescue. If measurement device or vehicle has problems due to accident, Survey Team shall report to Top manager and Work manager about condition of the PCSV promptly.

If it is impossible to move the vehicle to a safe place, the PCSV is repaired there in case of minor damage. Or the PCSV is moved by tow-away and repaired.

In case that the vehicle has no damage but measurement device has failures, Survey Team shall go back to the garage of the PCSV and repair the device.

Finally, Survey Team shall make sure that the PCSV is operated properly by operation test.

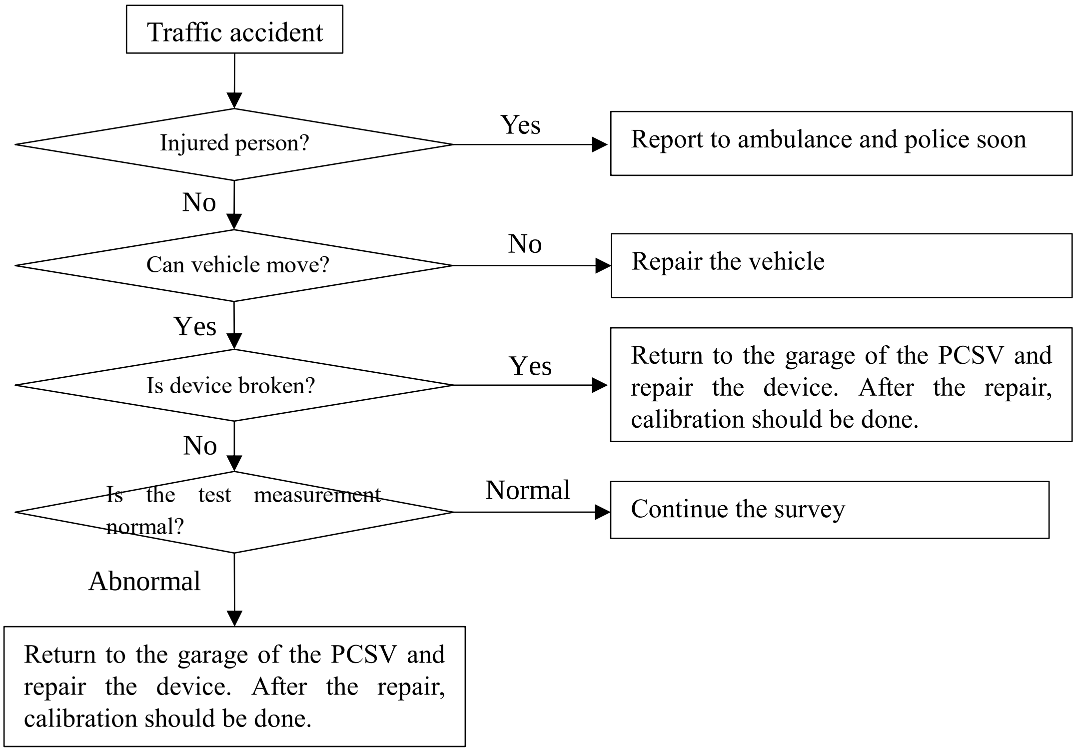



Figure 3.27 Flow in case of traffic accident

b) Confirmation of the route information

Survey team checks the differences between information on the Table-1 and information on site. Check item is below.

- Starting/ending point of the target route
  Check the starting/ending point in the route
- Excluded section
  Confirm the additional section of rehabilitation section and transferred section.
- Overlapping section
  Check the starting/ending point of overlapping section in the route.

When hard to continue survey due to above issues, Survey Team shall ask navigator or Work Manager to provide solutions to correct information between planned information and on site situation. Navigator or Work Manager shall confirm the situation and direct solutions to Survey Team.

[Example of the difference]

➢ Route change

When new opened route is found on site within the targeted route, Survey Team shall make sure the jurisdiction and road inventory (road code, branch code, etc.) of both routes (new route and old route) by asking to Work Manager. Work Manager shall provide necessary information to Survey Team.

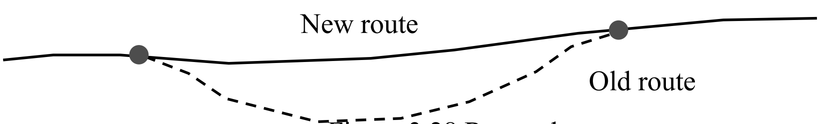



Figure 3.28 Route change

➢ Jurisdiction change

When targeted sections are transferred to other road administration agencies, including BOT construction sections, these sections shall be excluded from survey. The start and end point of excluding sections shall be marked up on pavement, and these sections shall be measured at that time. The excluding section will be confirmed when data analysis.

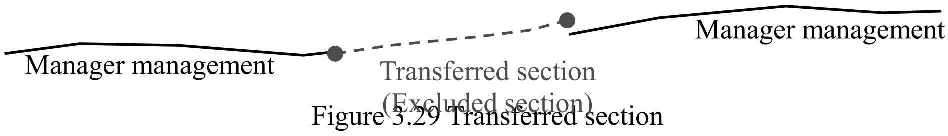



Figure 3.29 Transferred section

c) Confirm the road inventory information

Survey team reports to navigator or Work Manager if there is different inventory information (ex: road width, change position of number of lane, etc.) between Table-1 and information on site. The navigator or Work Manager checks the report and instruct proper solutions to Survey team.

3.2.3. Finalize of Survey and PCSV

After the day's work is over, the PCSV shall be closed as the following ways. For more detail information, refer to chapter 6 of the manual of "Instruction Book of REAL Mini [PCS-Vol.4]".

- Shut down the systems (PC1, PC2, power control unit and main control unit)
- Remove the HDD which is connected with PC1 and PC2
- Cover device (CCD cameras for road image and for front image, laser scanner and laser displacement sensor)

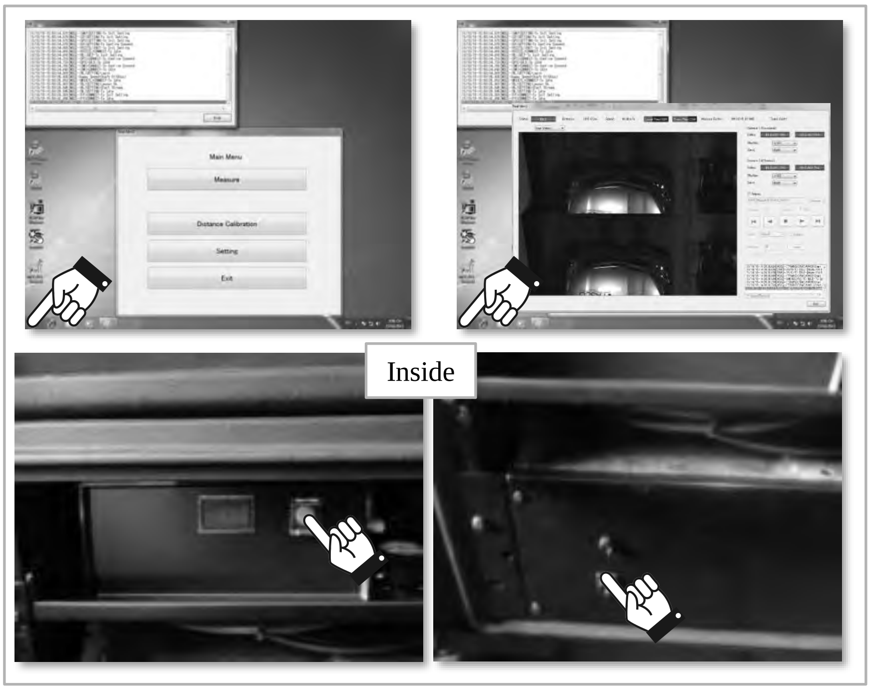



Figure 3.30 Shut down the systems (Inside of PCSV)

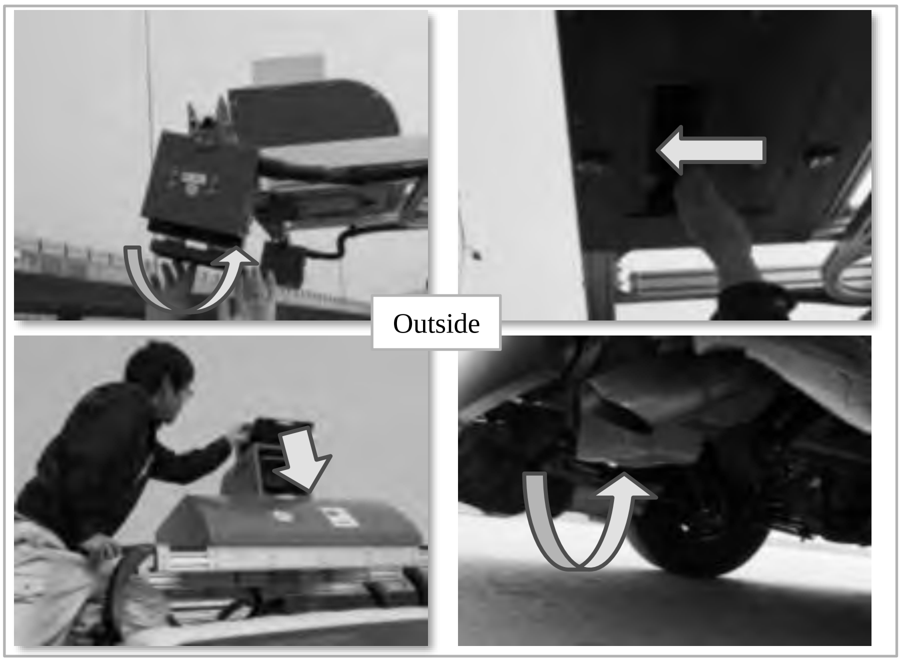
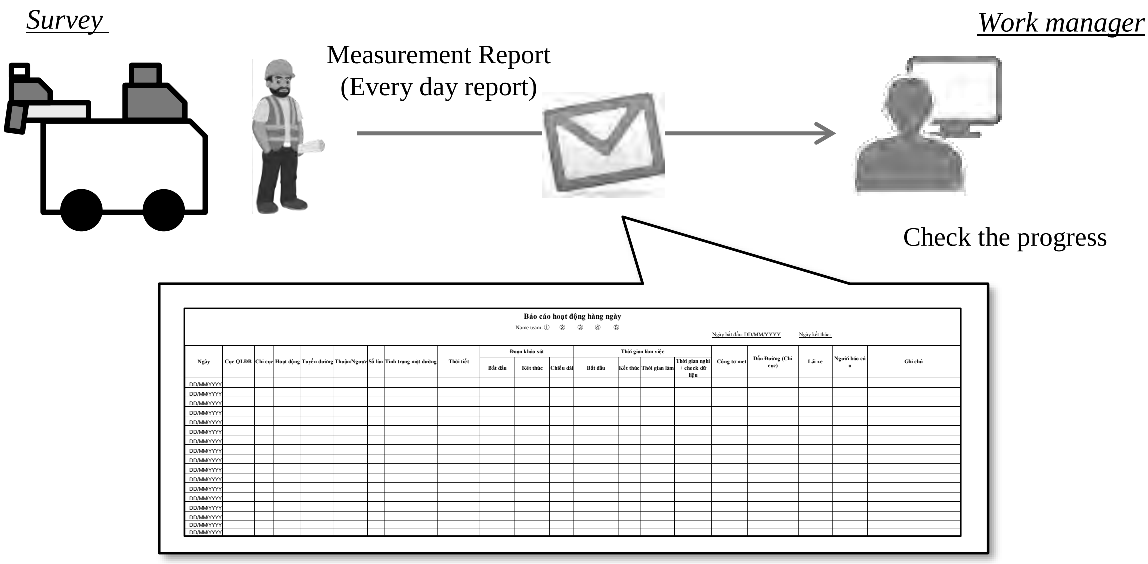



Figure 3.31 Cover device (Outside of PCSV)

3.2.4. Send the Daily Report

Survey team reports to Work manager via email about which route and how many km was surveyed every day. Refer the format of measurement report in Appendix 5.




**Báo cáo hoạt động hàng ngày**

Name team: ① ② ③ ④ ⑤

Ngày bắt đầu: DD/MM/YYYY Ngày kết thúc:

| Ngày | Cục QLĐB | Chi cục | Hoạt động | Tuyến đường | Thuận/Ngược | Số làn | Tình trạng mặt đường | Thời tiết | Đoạn khảo sát | | | Thời gian làm việc | | | | Công tơ met | Dẫn Đường (Chi cục) | Lái xe | Người báo cáo | Ghi chú |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Bắt đầu | Kết thúc | Chiều dài | Bắt đầu | Kết thúc | Thời gian làm | Thời gian nghỉ + check dữ liệu | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
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| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |

Figure 3.32 Format of measurement report

Dear XXXX,

I send today's daily report.
Please kindly refer the attachment for the detail.

Date: DD/MM/YYYY
Reporter: Name
Report at: Place
Survey length: Length
Survey route: Route name

BR,
XXXX

Figure 3.33 Sample of mail format

### 3.3. Work after Field Survey (Table-2 preparation)

Survey Team shall prepare the "Surveyed Section Table (Table-2)" using measured information (route name, KP and surveyed length) after field survey completion as the following steps;

- Insert a row in the 8 columns next to "Planned survey length (km)" in Table-1
  KP (From and To), Surveyed length (surveyed length, excluding sections length and overlapping length), Note
- KP information and surveyed length are inputted into the targeted columns based on measured information
- Information on additional excluding sections and additional survey sections are inputted into added column
  ("Added excluding section" or "Additional survey sections" are written in Note)
- "Surveyed Section Table (Table-2)" is completed after all information are inputted.

Survey Team shall submit the Table-2 to Work Manager. Work Manager shall check it and verify KP information and section length of additional excluding sections and additional survey sections.

- Select sections which has "Added excluding section" and "Additional survey sections" in Note in Table-2
- KP (From and To) information and section length of corresponding records shall be confirmed.

Survey Team shall update the Table-2 if needed according to the instruction of Work Manager. In the case of misstatement of KP or survey length, Survey Team shall correct the relevant part and resubmits it.
When a section different from the actual section is set as excluding section or additional survey section, Survey Consultant shall survey that section again and update the Table-2.
Table-2 and survey length is fixed by Work Manager.

Table 3.3 Sample of Table-2

| Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Planned Survey Length | Note | From_KP | From_M | To_KP | To_M | Excluded Length | Overlapping Length | Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | NH1 | RMB II | SB II.1 | Right | 1 | 321 | 800 | 330 | 0 | | | | 8200 | | 321 | 800 | 330 | 0 | | | 8540 | |
| 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 423 | 600 | 425 | 875 | | | | 2275 | | 423 | 600 | 425 | 875 | | | 2095 | |
| 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 449 | 300 | 451 | 0 | | | | 1700 | | 449 | 300 | 451 | 0 | | | 1665 | |
| 0 | 0 | NH1 | RMB II | SB II.2 | Right | 1 | 458 | 0 | 467 | 0 | | | | 9000 | | 458 | 0 | 467 | 0 | | | 9600 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 468 | 0 | 484 | 0 | | | | 16000 | | 468 | 0 | 484 | 0 | | | 16000 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 504 | 400 | 518 | 0 | | | | 13600 | | 504 | 400 | 517 | 1080 | | | 13680 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 561 | 0 | 587 | 0 | | | | 26000 | | 561 | 0 | 587 | 0 | | | 26000 | |
| 0 | 0 | NH1 | RMB II | SB II.3 | Right | 1 | 591 | 600 | 595 | 0 | | | | 3400 | | 591 | 600 | 595 | 5 | | | 3405 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 595 | 0 | 597 | 590 | 2590 | | | 2590 | | 595 | 5 | 597 | 590 | | | 2385 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 625 | 125 | 625 | 880 | 755 | | | 755 | | 625 | 125 | 625 | 880 | | | 755 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 657 | 25 | 663 | 815 | 6790 | | | 6790 | | 657 | 25 | 663 | 815 | | | 6645 | |
| 0 | 0 | NH1 | RMB II | SB II.4 | Right | 1 | 671 | 230 | 672 | 305 | | | | 1075 | | 671 | 230 | 672 | 305 | | | 1075 | |
| 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 819 | 850 | 840 | 500 | | | | 20650 | | 819 | 850 | 840 | 500 | | | 20300 | |
| 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 868 | 100 | 872 | 600 | | | | 4500 | | 868 | 100 | 872 | 600 | | | 4330 | |
| 0 | 0 | NH1 | RMB II | SB II.6 | Right | 1 | 883 | 700 | 886 | 500 | | | | 2800 | | 883 | 700 | 886 | 500 | | | 2310 | |
| 0 | 0 | NH1 | RMB II | SB II.1 | Right | 2 | 321 | 800 | 330 | 0 | | | | 8200 | | 321 | 800 | 330 | 0 | | | 8530 | |

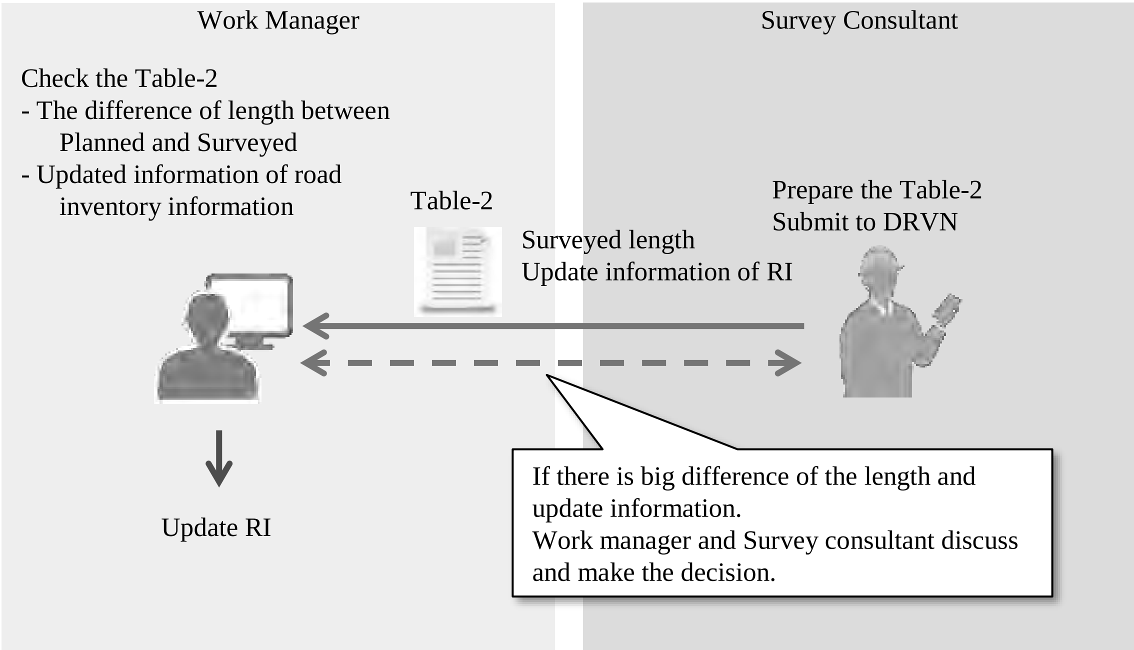



Figure 3.34 Work flow of preparing Table-2

## 4. Data Analysis and Data Processing

Work flow of data analysis and data processing is shown in Figure 4.1.

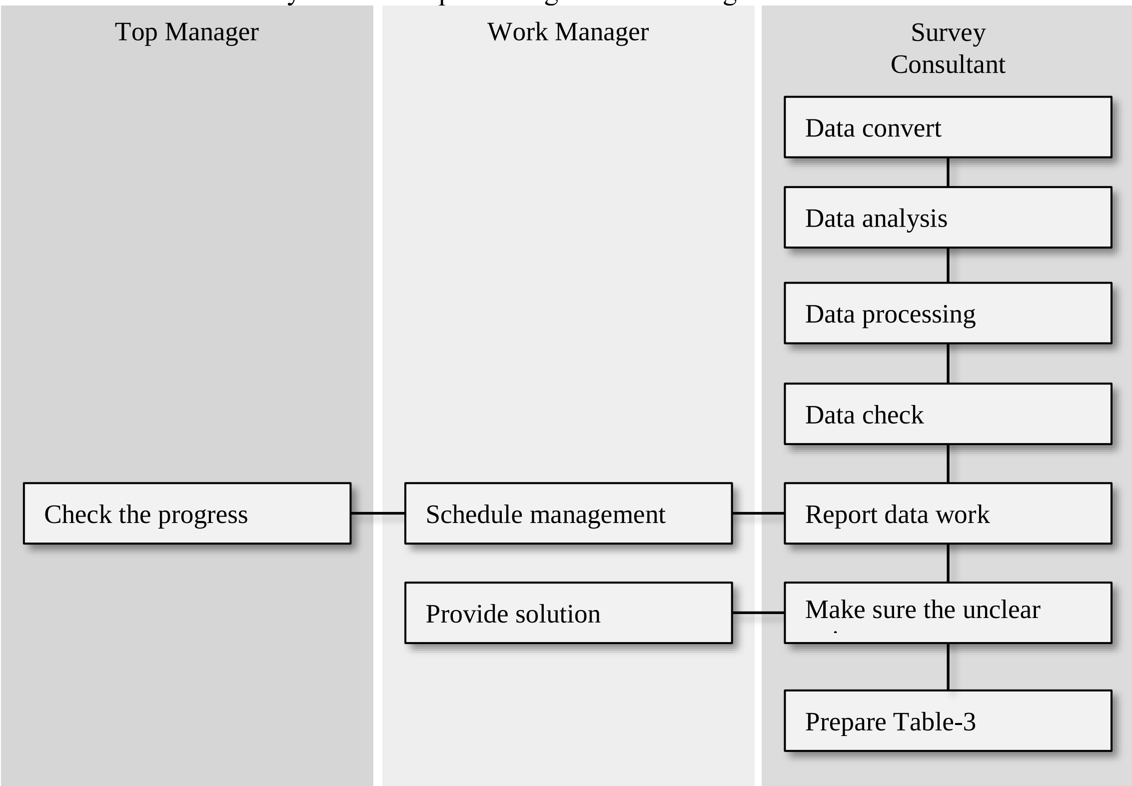



Figure 4.1 Work flow in data analysis and data processing

The measurement data will be stored into the external HDD. Survey team hands over the external HDD to Data Analysis team. Data Analysis team conducts the data analysis and data processing to prepare the PC data. Data Analysis team uses the application of data analysis and data processing on PC. The work items are as below,

- Data Conversion
- Data Analysis
  - The start and end position setting
  - Road width setting
  - Interpretation of crack
  - Road surface type classification
  - KP and structure setting
- Location setting
- Data processing
  - Data processing for 100m
  - Data coupling
  - Output the data
- Data check
- Weekly report
- Confirmation of unclear point on analysis
- Prepare "Analyzed Section Table (Table-3)"

Top manager provides licenses of Data Analysis application and Data Processing Applications to Data Analysis team. After completion of survey project, Data Analysis team shall delete the installed applications from PCs.
In case of analysis work for new routes, such as new constructed routes, Expressway or routes managed

by other road administration agencies, Analysis operators in Data Analysis team shall add new road code information and route name to the configuration file of Location Setting Application. For more detail procedure to update the configuration file, refer to the chapter 10 of manual of “Instruction Book of REAL Mini [PCS-Vol.4]”.

Figure 4.2 Data Analysis and Data Processing work in Office

### 4.1. Analysis and Processing of Measurement Data

1)Analysis and Processing Work

Data Analysis team conducts the data analysis and data processing work in the office every day. Work flow of analysis and processing is shown in Figure 4.3. If you would like to know about detail operation procedure of each application, refer the chapter 8 to 11 in “Instruction Book of REAL Mini [PCS-Vol.4]”.

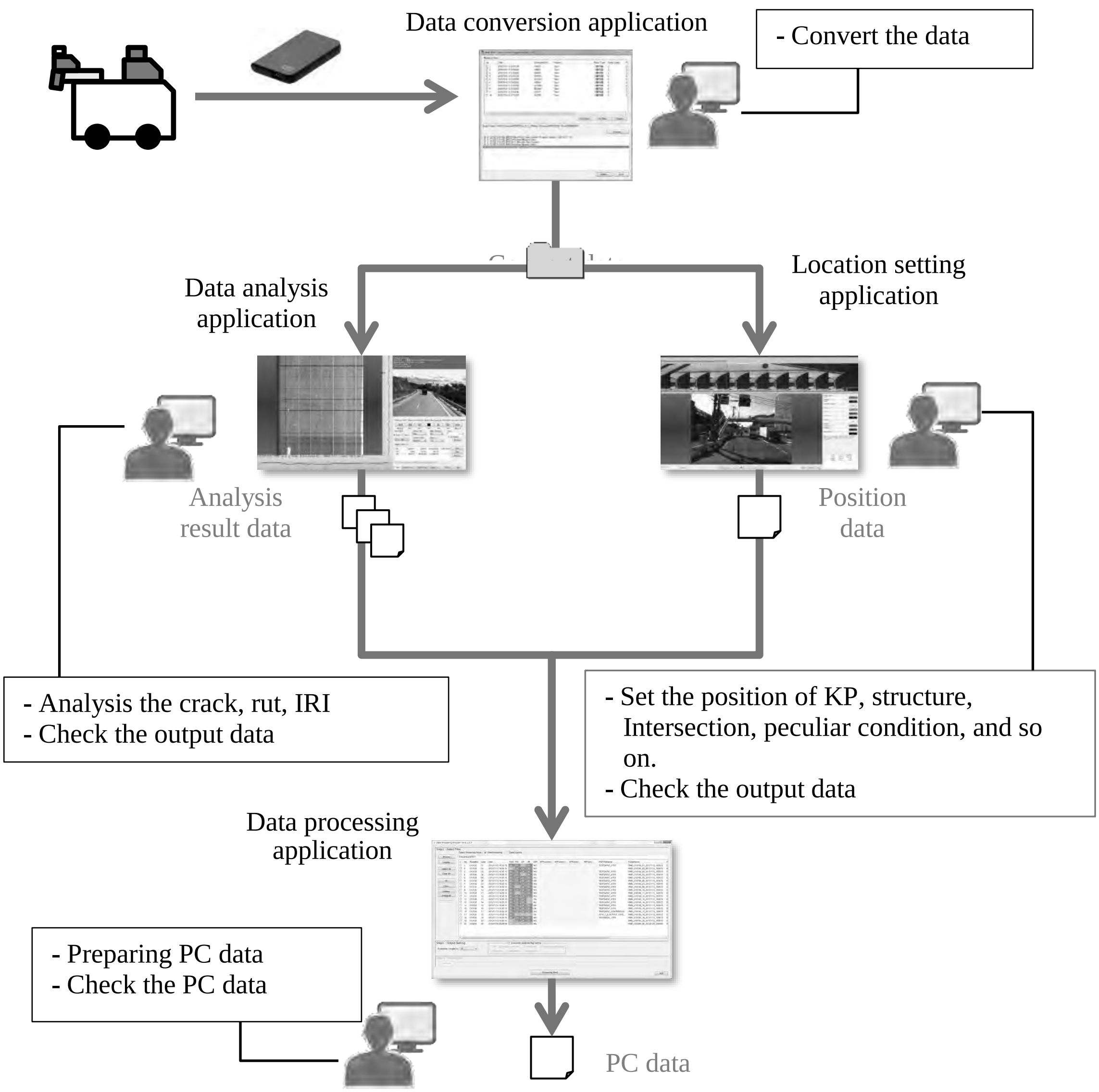



Figure 4.3 Walk flow of preparing PC data

a) Data conversion

Convert data measured with REAL Mini to a format readable by the Data Analysis application.

1. Connect the HDD to the PC
2. Start the Data conversion application
3. Select the target data for conversion
4. Convert the data
5. Check the convert progress

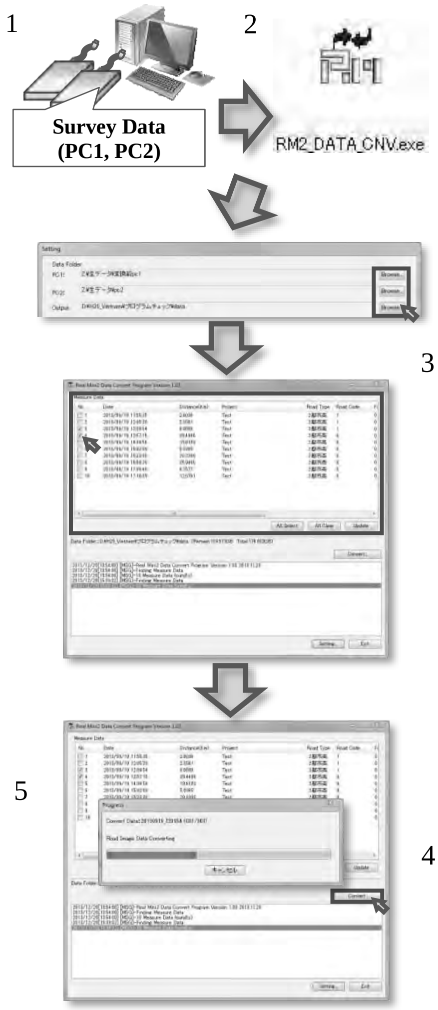
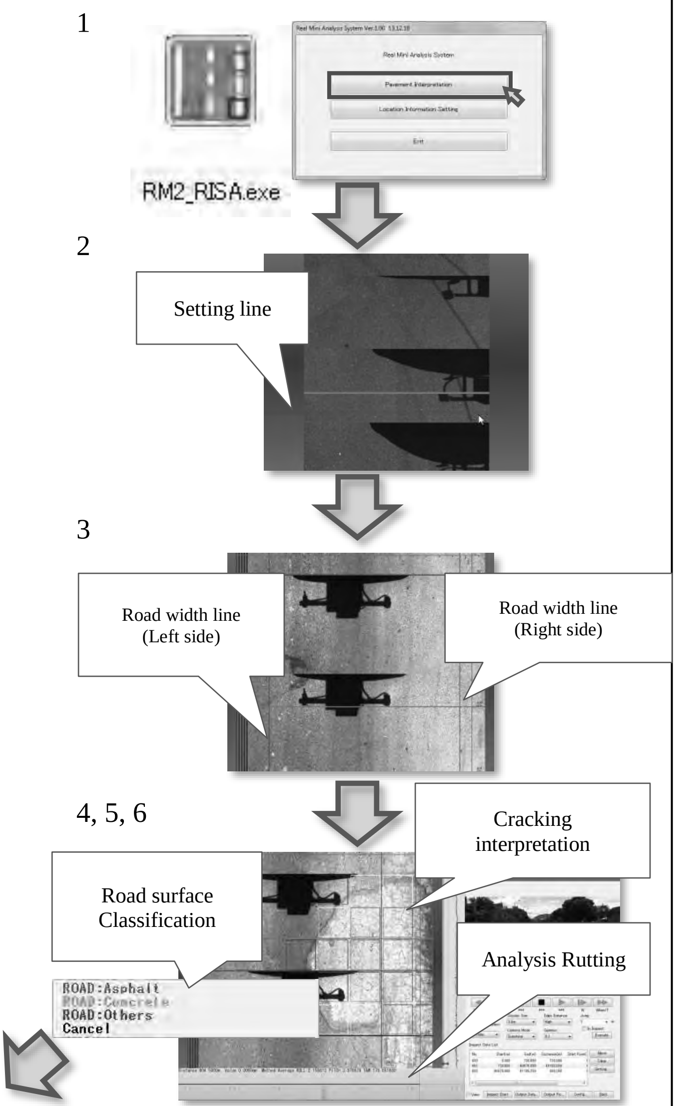



Figure 4.4 Procedure of data conversion

b) Data Analysis

Using the converted survey data, cracks, rut, IRI and coordinate data are prepared on the Data Analysis application.

1. Start the Data Analysis application
2. Set the Start/End point of analysis
3. Set road width
4. Crack evaluation
5. Rut analysis
6. Set pavement type
7. Analyzed data output




7

| No. | Data | Notes |
|---|---|---|
| 1 | C3_******.csv | Cracking analysis |
| 2 | R3_******.csv | Rutting analysis |
| 3 | S3_******.csv | IRI analysis |
| 4 | FA_******.csv | GPS coordinates |

Figure 4.5 Procedure of data analysis

c) Prepare location data

Using the Position Setting application, location data of bridges, intersections and chainage of change of lane structure, etc. is prepared by checking the road image data of front view image data.

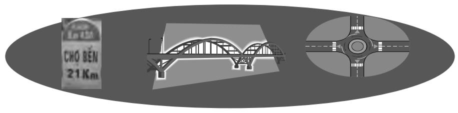
1. Start the Position Setting application

2. Set position of the followings;
    1. Geographical Area
    2. Jurisdiction
    3. Maintenance Company
    4. Route Name
    5. Kilo-post station
    6. Number of Lane
    7. Structure
    8. Intersection
    9. Overlapping
    10. Station Number Discrepancy
    11. Peculiar condition

3. Data output

1


2



3

| No. | Data | Notes |
|---|---|---|
| 1 | P_******.csv | Positional information data |

Figure 4.6 Procedure of location setting

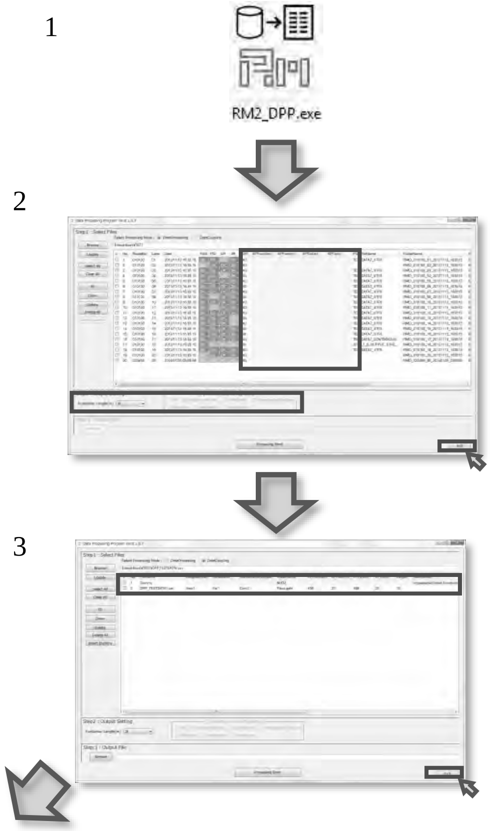
d) Data Processing

Using the Data Processing application, PC data is prepared from output files of the Data Analysis application and the Position Setting application.

1. Start the Data Processing application

2. Import data and process data
    1. Prepare primary processing data
    2. Combine primary processing data

3. Data after combine is outputted as PC data



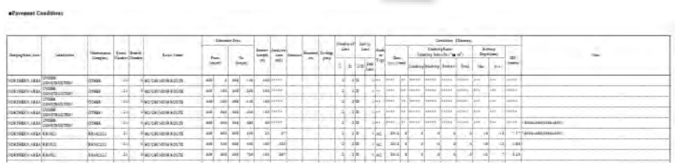



Figure 4.7 Procedure of data processing

2) Data Quality Check

During and after completion of the work of data analysis and data processing, Data Analysis team shall check the data quality for all the data in the following manner;

a) Quality of image

If there is an ambiguous image (too bright or too dark) when the analysis operator evaluates pavement damage based on the image data, the analysis operator reports to the team leader about this situation. When this situation goes over a long section (100m or more), the team leader consults with Work Manager about the necessity of resurvey.

Figure 4.8 Image samples (left: too bright, right: too dark)

Figure 4.9 Image sample (sunlight reflected)

b) Quality of damage evaluation result

During data analysis work, one or two persons are assigned as responsible for data check, and they check the analyzed data. If there are errors in evaluated data, data analysis operator shall be instructed to analyze data again.

❖ Incomplete analysis

- An example that Damage point is not correctly read

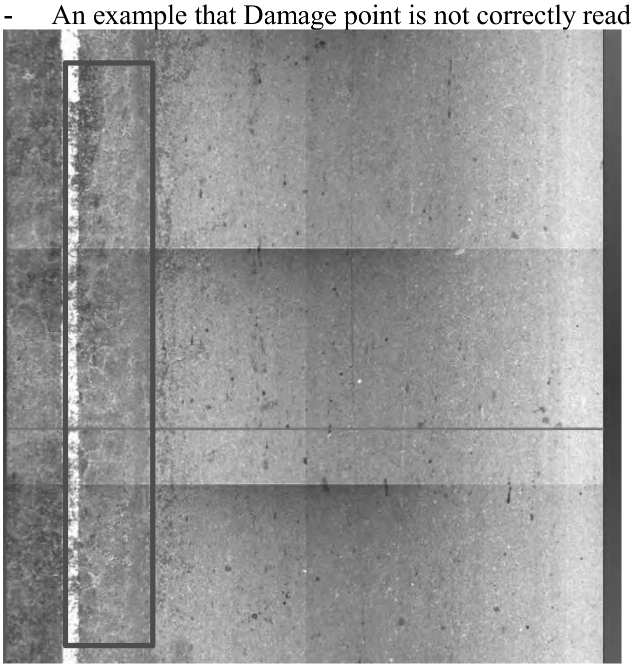


Figure 4.10 Sample of incomplete analysis-1

- An example of reading as a crack without damage

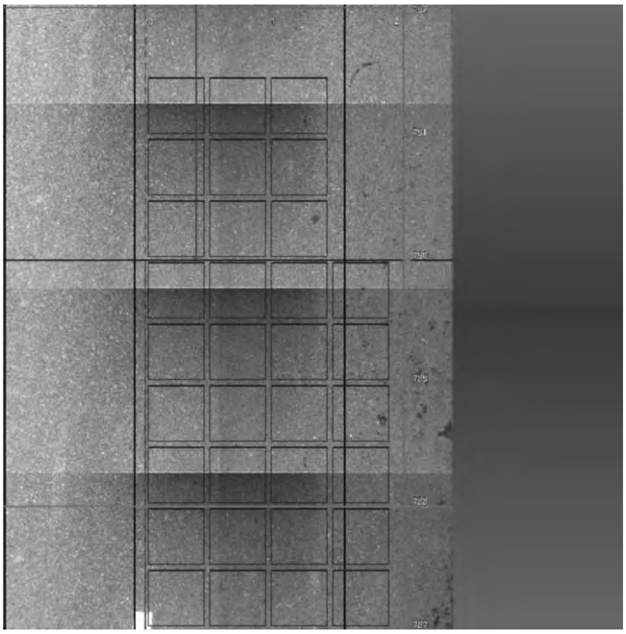


Figure 4.11 Sample of incomplete analysis-1

c) Abnormal value

The Data Analysis application has a function of judging a value exceeding a certain range at the timing of data output as an abnormal value and outputting a list of abnormal data records. The operator shall check whether the data judged to be an abnormal value is due to a mistake in analysis work as the following way;

・Open the file of abnormal value list (ERROR.txt) and find the location information
・Check the road condition on the Data Analysis application
・In case of a mistake in analysis, it shall be analyzed again

Table 4.1 shows the criteria for judging abnormal values, and Table 4.2 shows possible reasons of analysis errors for each item.
When rutting or IRI value is 0, data convert shall be done again. If the data still cannot be corrected, Survey Consultant shall inform Work Manager about a possibility of equipment failure. Work Manager shall contact the manufacturer of PCSS and ask the detail investigation for it. As a result of the investigation, if the equipment is broken, the equipment shall be repaired. And Survey Consultant shall survey again that section where the abnormal value was happened.

Table 4.1 Criteria for judging abnormal values

| Items | Criteria |
|---|---|
| Crack ratio | Over 70% |
| Rutting depth (max) | 0mm or over 50mm |
| Rutting depth (average) | 0mm or over 30mm |
| IRI | 0mm/m or over 15mm/m |

Table 4.2 Possible reasons of analysis errors

| Items | Criteria | Possible reasons |
|---|---|---|
| Crack ratio | Over 70% | Incomplete analysis read |
| Rutting depth (max) | Over 50mm | Incomplete width setting<br>Incomplete position of rut evaluation point |
| Rutting depth (average) | Over 30mm | |
| Rutting depth (max)<br>Rutting depth (average)<br>IRI | 0 mm<br>0 mm<br>0mm/m | Data conversion error<br>Data fault due to equipment error |

d) Missing or inconsistent KP

Missing KP information and difference in both directions entered by the Position Setting Application are checked.

First, continuity of KP from the KP list file outputted from the Position Setting Application is checked. If there are missing KPs, KPs are checked again on the Position Setting Application. If KPs are found, the numbers of KPs are set.

Next, consistency of KP in both directions on the same route is checked. By comparing of the KP files in directions, KP numbers and number of KPs are checked. If there is KP only on single side, KP is set on the Position Setting Application by referring to the position information in the direction of KP.

e) Position of structure

Consistency of the structure in both directions on the same route is checked. Using the structure list file outputted by the Position Setting Application, the type and the number of structures in both directions on the same route are compared.

If there is a structure only in one direction, the analysis operator sets up the structure again for the data in the insufficient direction. Even if the total number of settings of structures is the same, different types of structure setting is not acceptable.

f) Position of intersection

Consistency of intersections in both directions on the same route is checked. Using the intersection list file outputted by the Position Setting Application, the number and positions of intersections in both directions on the same route are compared. If the number of intersection is short in one direction, the intersection to be added to the data on the missing direction is set.

g) Structure of PC data

Structure of PC data shall be checked as the following points;

1. Route code : from small number to large number
2. Direction : from Right to Left
3. Lane number : from small number to large number

3) Send the Progress Report

Data Analysis team conducts the data analysis and data processing work in the office every day. The leader of Data Analysis team records the progress every day for "Data Analysis Weekly Report" (Appendix 7). The Data Analysis team leader sends the "Weekly Report" with attachment to Work manager via email like a Figure 4.13.

Furthermore the sample of "Weekly Report" would be indicated in Figure 4.14. It is possible to check the analysis length of section length of the data. Work manager checks the progress to confirm the sum of analysis length and "Table-2". If the progress is delayed significantly, Work manager finds out the reason and instructs to push up the progress.

Work manager submits the progress of analysis work and processing work to Top manager. Top manager checks the progress based on the report from Work manager.

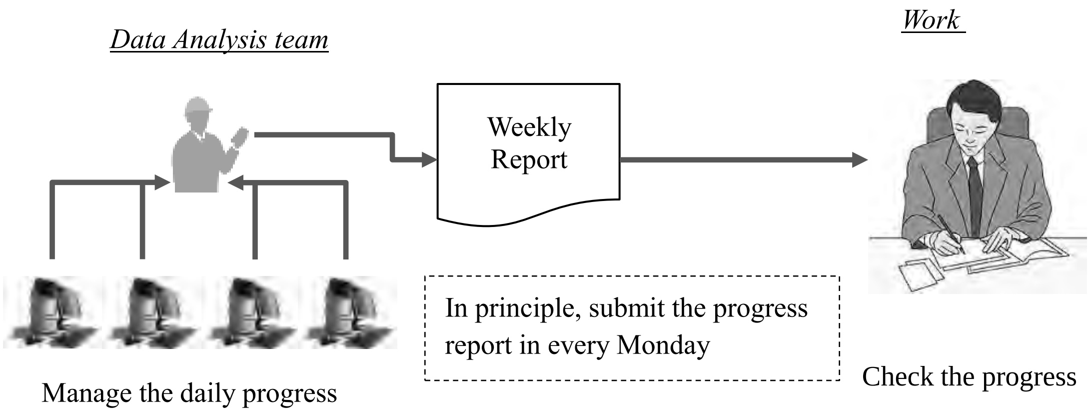



Figure 4.12 Flow of data analysis progress report

Dear XXXX,

I send weekly report.
Please kindly refer the attachment for the detail.

Date: DD/MM/YYYY
Reporter: Name
Analysis length in week: Length
Total analysis length: Length

BR,
XXXX

Figure 4.13 Sample of email of data analysis report

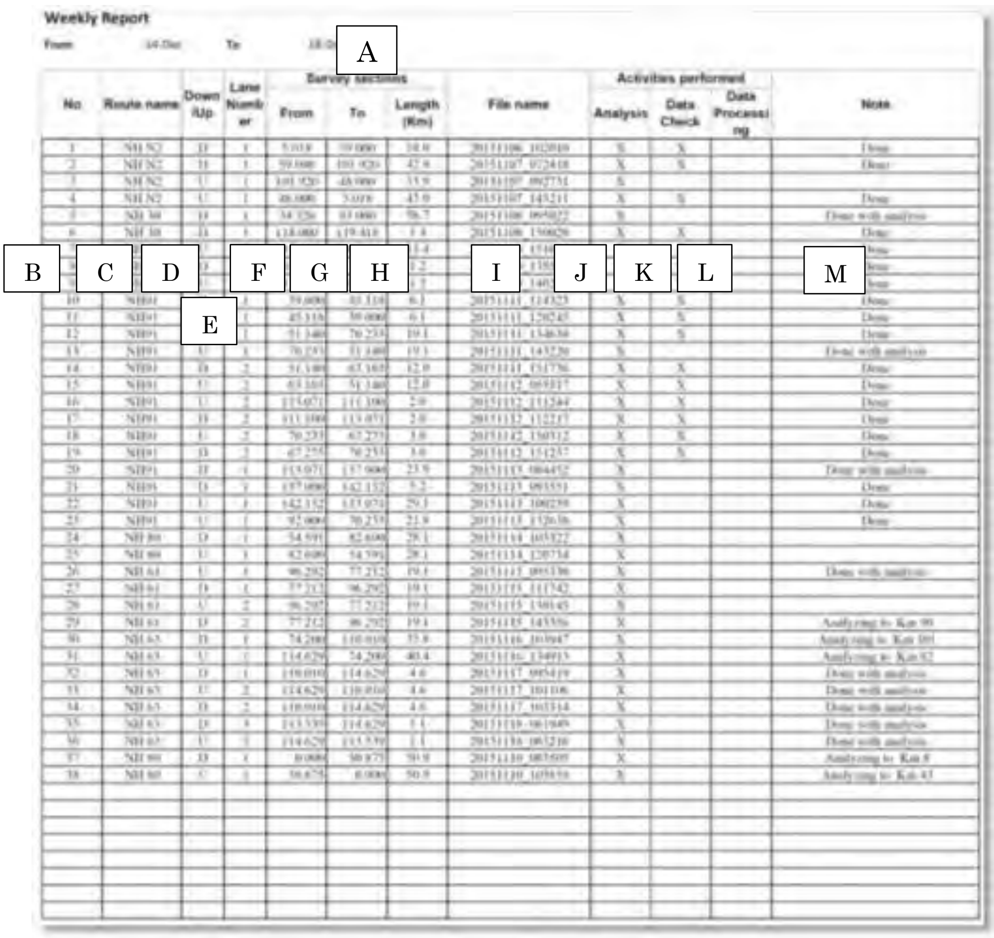



Figure 4.14 Format of data analysis Weekly Report

A. Analysis Period (From – To)
B. Analysis Number (sequential number)
C. Route Name
D. Right Left
E. Number of Lane
F. Survey Section (Start position; KP number)
G. Survey Section (End position; KP number)
H. Survey Section (Length (km))

I. File Number (Folder number of Measurement)
J. Progress of Interpretation (X; Complete, Blank; Not complete)
K. Progress of Data Check (X; Complete, Blank; Not complete)
L. Progress of Data Processing (X; Complete, Blank; Not complete)
M. Note (Memo, Message)

4) Make Sure the Unclear Point

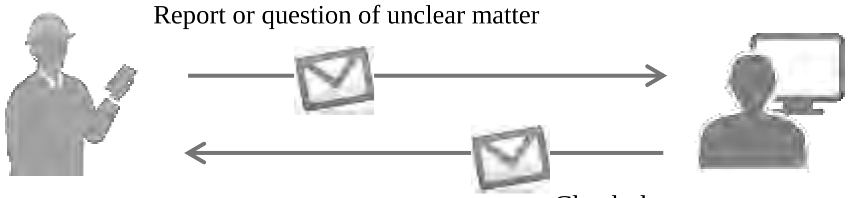
Data Analysis team reports to Work manager about the unclear matter in the data analysis and data processing at every time. Work manager confirms the report or question and instructs to the matter.

Figure 4.15 In case of report or question of unclear matter

*Data Analysis team*

*Work manager*

Report or question of unclear matter



- Check the report

◆Unclear point

- Within the specification
  Answer based on specification
- Without the specification
  Discuss with Analysis team

[Example of Report and Instruction]

<Case 1: Setting of pavement surface type>

How to set the pavement type where two pavement types exist in the same position?
(Ex. AC and BST exist in the same position)

➔ Set the wider pavement type at the place

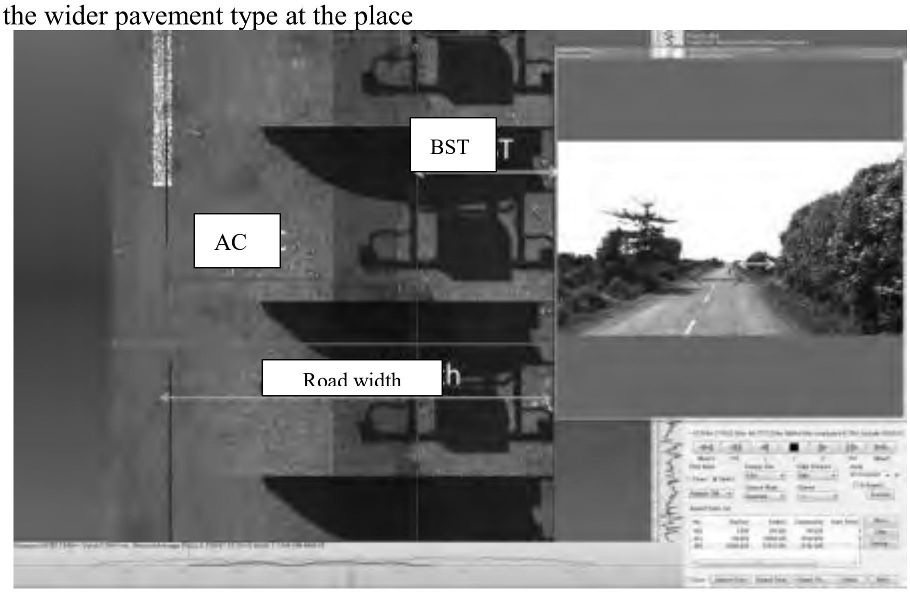



Figure 4.16 Example of pavement type setting

<Case 2: Setting of road width>

How to set the road width where there is no center line as narrow section?

➔ Set the all width of road image

Figure 4.17 Example of road width setting at narrow section

<Case 3: Setting of patching>

Whether the repaired part is patching or not?

➔ The part is patching at the interpretation (in the red square)

Figure 4.18 Example of patching setting

<Case 4: Visible only forward view image>

Visible the crack in the forward view image but invisible in the road image because the image is dark.

➔ Set the crack compare between forward view image and road image

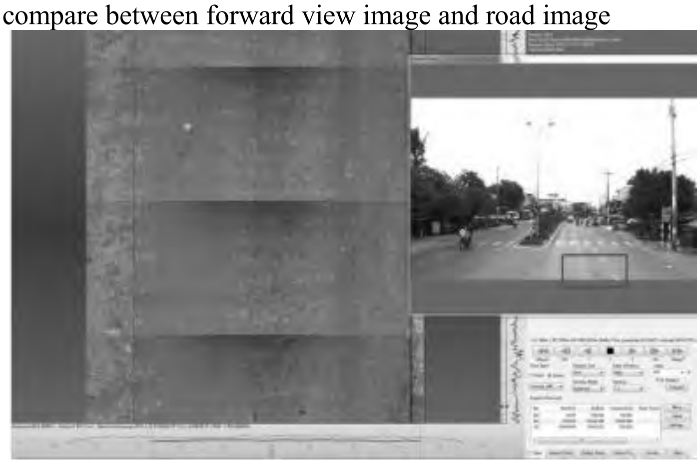


Figure 4.19 Example of visible the crack only forward view image

<Case 5: Setting of peculiar condition>

Which peculiar condition is correct?

➔ Work manager check the road image and decide the category of peculiar condition

Table 4.3 Definition of peculiar condition

| Items | Description | Image |
|---|---|---|
| 1.Broken | Once paved sections, but there is serious damage which cannot be evaluated. |  |
| 2.Unpaved or unidentified Pav. Type | Unpaved: never paved. Unidentified Pavement type: besides, AC, CC and BST. |  |
| 3.Wet Condition | The lane is covered with water or wet. |  |
| 4.Other damage | Other type damages that cannot be judged as cracking. (Ex. Raveling, Scratch, etc.) |  |
| 5.Invisible | Surface cannot be seen due to coverage of pavement surface by other objects, such as sand, soil, construction material, etc. |  |
| 6.Under construction | Ongoing construction work on the survey lane. |  |

## 4.2. Prepare Analyzed Section Table (Table-3)

Data Analysis team shall prepare the Analyzed section table (Table-3) based on the final PC data after completion of data analysis and data processing work. The content of the Table-3 is shown as below.

・Road Inventory Information
(Road Category, Road No., Road No. Supplement, Branch No., Road Name, RMBs, SBs, Direction and Lane Position)
・KP information
・Section Length information
(Analyzed length)

Table 4.4 Sample of Table-3

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Analysis Length |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 1 | 321 | 800 | 330 | 0 | 8535 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 1 | 423 | 600 | 425 | 875 | 2095 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 1 | 449 | 300 | 451 | 0 | 1665 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 458 | 0 | 467 | 0 | 9590 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 468 | 0 | 484 | 0 | 15710 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 504 | 400 | 517 | 1075 | 13630 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 561 | 0 | 587 | 0 | 26095 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.3 | R | 1 | 591 | 600 | 595 | 5 | 3595 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 595 | 5 | 597 | 590 | 2330 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 625 | 125 | 625 | 880 | 755 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 657 | 25 | 663 | 815 | 6645 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.4 | R | 1 | 671 | 230 | 672 | 305 | 1075 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | R | 1 | 819 | 850 | 840 | 475 | 20290 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | R | 1 | 868 | 100 | 872 | 570 | 4330 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.6 | R | 1 | 883 | 700 | 886 | 460 | 2510 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 2 | 321 | 800 | 330 | 0 | 8535 |
| 1 | 1 | 0 | 0 | NH1 | RMB II | SB II.2 | R | 2 | 423 | 600 | 425 | 875 | 2095 |

Table 4.5 is showing the reference in PC data for Table-3.

Table 4.5 Reference in PC data

| Table-3 | Reference in PC data | | Note |
|---|---|---|---|
| | Column in Excel file | Column in CSV file | |
| Road Category | E | 5 | |
| Road No. | F | 6 | |
| Road No. Supplement | G | 7 | |
| Branch No. | H | 8 | |
| Road Name | I | 9 | |
| RMBs | C | 3 | |
| SBs | D | 4 | |
| Direction | U | 21 | |
| Lane Position | V | 22 | |
| From_KP | J | 10 | |
| From_M | K | 11 | |
| To_KP | L | 12 | |
| To_M | M | 13 | |
| Analysis Length | N | 14 | Total of targeted section |

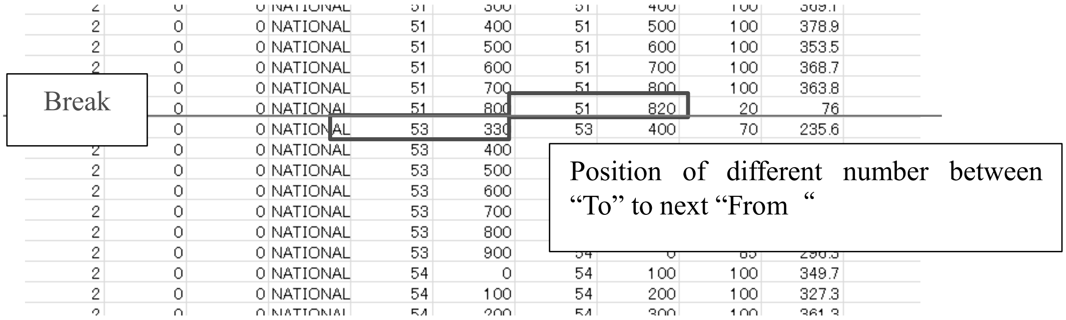
The procedure of preparation of Table-3 is as the following steps;

i. Open the PC data
ii. Enter road inventory information of the first line of PC data
iii. Enter "From_KP" and "From_To" of the first line of PC data
iv. Find data break position in PC data
- Discontinuous point of KP
- Chang point of jurisdiction (SBs)

v. Enter “To_KP” and “To_M” of the break position of PC data

vi. Enter the summed value of section length from the first line of PC data to the line of break position into “Analysis Length” in Table-3.

The line next to the break position is set as the first line, and from ii to vi is repeated to complete Table-3.




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0 | 0 | NATIONAL | 51 | 300 | 51 | 400 | 100 | 369.1 |
| 2 | 0 | 0 | NATIONAL | 51 | 400 | 51 | 500 | 100 | 378.9 |
| 2 | 0 | 0 | NATIONAL | 51 | 500 | 51 | 600 | 100 | 353.5 |
| 2 | 0 | 0 | NATIONAL | 51 | 600 | 51 | 700 | 100 | 368.7 |
| | 0 | 0 | NATIONAL | 51 | 700 | 51 | 800 | 100 | 363.8 |
| | 0 | 0 | NATIONAL | 51 | 800 | 51 | 820 | 20 | 76 |
| | 0 | 0 | NATIONAL | 53 | 330 | 53 | 400 | 70 | 235.6 |
| 2 | 0 | 0 | NATIONAL | 53 | 400 | | | | |
| 2 | 0 | 0 | NATIONAL | 53 | 500 | | | | |
| 2 | 0 | 0 | NATIONAL | 53 | 600 | | | | |
| 2 | 0 | 0 | NATIONAL | 53 | 700 | | | | |
| 2 | 0 | 0 | NATIONAL | 53 | 800 | | | | |
| 2 | 0 | 0 | NATIONAL | 53 | 900 | 54 | 0 | 85 | 296.3 |
| 2 | 0 | 0 | NATIONAL | 54 | 0 | 54 | 100 | 100 | 349.7 |
| 2 | 0 | 0 | NATIONAL | 54 | 100 | 54 | 200 | 100 | 327.3 |
| 2 | 0 | 0 | NATIONAL | 54 | 200 | 54 | 300 | 100 | 361.3 |

Figure 4.20 Sample of break point in PC data KP (Discontinuous KP)

After enter all data into all columns, the Table-3 is saved as "Table-3", and Data Analysis team sends Table-3 to Work Manager. Work Manager checks the difference between "Surveyed section length" and "Analyzed section length" in Table 3. Work manager asks Data Analysis team when there is an uncertain point in Table 3.
Length in Table-3 is fixed as the final number in PCS.

# 5. Project Completion and Submission

Work flow of project completion and submission is shown in Figure 5.1.

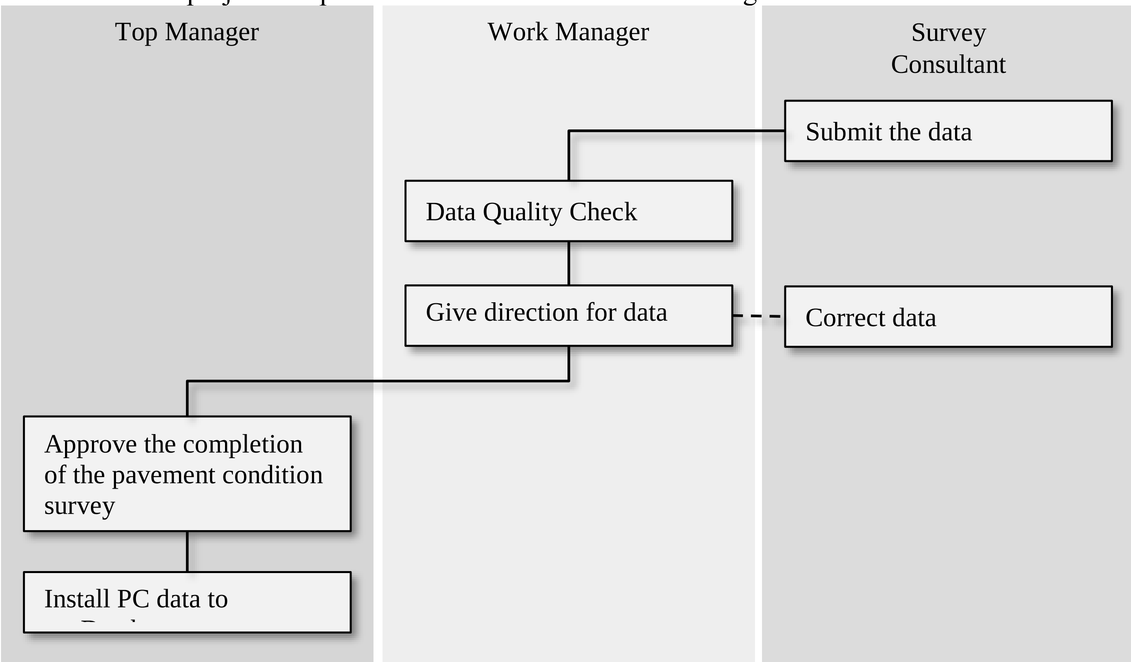



Figure 5.1 Work flow of project completion and submission

Data Analysis team submits the PC data to Work manager after complete the data analysis and data processing. Work manager checks the quality of the data. If the quality of the data has no problem, Work manager can accept the data. If the quality of the data has some problems, Data Analysis team updates the problem points.

The submission data is the following file. Table 5.1 shows the folder structure.

Pavement Condition File (formatted as .csv)
Image data with coordination File (formatted as .csv)
Forward view image (formatted as JPG)

Table 5.1 Data structure

| Folder Structure | File |
|---|---|
| Root | |
| ├ PCfile ——— | PCfile_RMB I_2017.csv |
| ├ ImageFile ——— | ImageFile_RMB I_2017.csv |
| └ 2017 — RMB I ┬ NH1 ┬ Left_laen1 | 00000001.jpg |
| │ │ | 00000002.jpg |
| │ │ | : |
| │ ├ Left_lane2 | 00000001.jpg |
| │ │ | 00000002.jpg |
| │ │ | : |
| │ ├ Left_lane1 | |
| │ └ Left_lane2 | |
| │ | |
| ├ NH2 ┬ Left_lane1 | |
| │ └ Right_lane1 | |

Appendix 1: Format of implementation Plan

# IMPLEMENTATION PLAN ON PAVEMENT CONDITION SURVEY

**May 2017**

**Survey Consultant Name**

# I. Calibration and Survey Plan

1. Calibration Plan:

Survey Consultant plans to calibrate the equipment of REAL-Mini in Hanoi together with DRVN before surveying.

Implementation duration: From **DD/MM/YYYY** to **DD/MM/YYYY**

2. Survey Plan:

The pavement condition survey will be done based on the TOR of pavement condition survey. Survey Consultant plan the below contents before conduct the survey,

- Responsibility assignment on pavement condition survey (filed survey, data analysis and data preparation)
- External HDD to store the measurement data and analysis data.
- Route confirmation such as the start point, end point, eliminated start point, eliminated end point, overlap start point and overlap end point.
- Operation check of survey vehicle, data analysis program and data processing program.

Implementation duration: on **DD/MM/YYYY**

# II. Survey Implementation Plan

1. Target Routes (RMB X):

| National Highway | From | To | Number of Lanes | Total Length (km) |
|---|---|---|---|---|
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| NH.X | KM xxx + xxx | KM yyy + yyy | X | LLL.LL |
| **Total** | | | | **LLLL.LL** |

2. Implementation Duration:

The field survey implementation in RMB X will be done as below schedule:

+ From **DD/MM/YYYY** to **DD/MM/YYYY**

3. Report of field survey

+ **Daily report**: Survey team leader reports implementation quantity/progress to DRVN at the end of day on the daily basis via email.

Report format:

**Báo cáo hoạt động hàng ngày**

Ngày bắt đầu DD/MM/YYYY　Ngày kết thúc

| Ngày | Cục QLĐB | Chi cục | Hoạt động | Tuyến đường | Thuận/Ngược | Số làn | Tình trạng mặt đường | Thời tiết | Đoạn khảo sát | | | Thời gian làm việc | | | | Công tơ mét | Dẫn đường (Chi cục) | Lái xe | Người báo cáo | Ghi chú |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Bắt đầu | Kết thúc | Chiều dài | Bắt đầu | Kết thúc | Thời gian làm | Thời gian nghỉ + check dữ liệu | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
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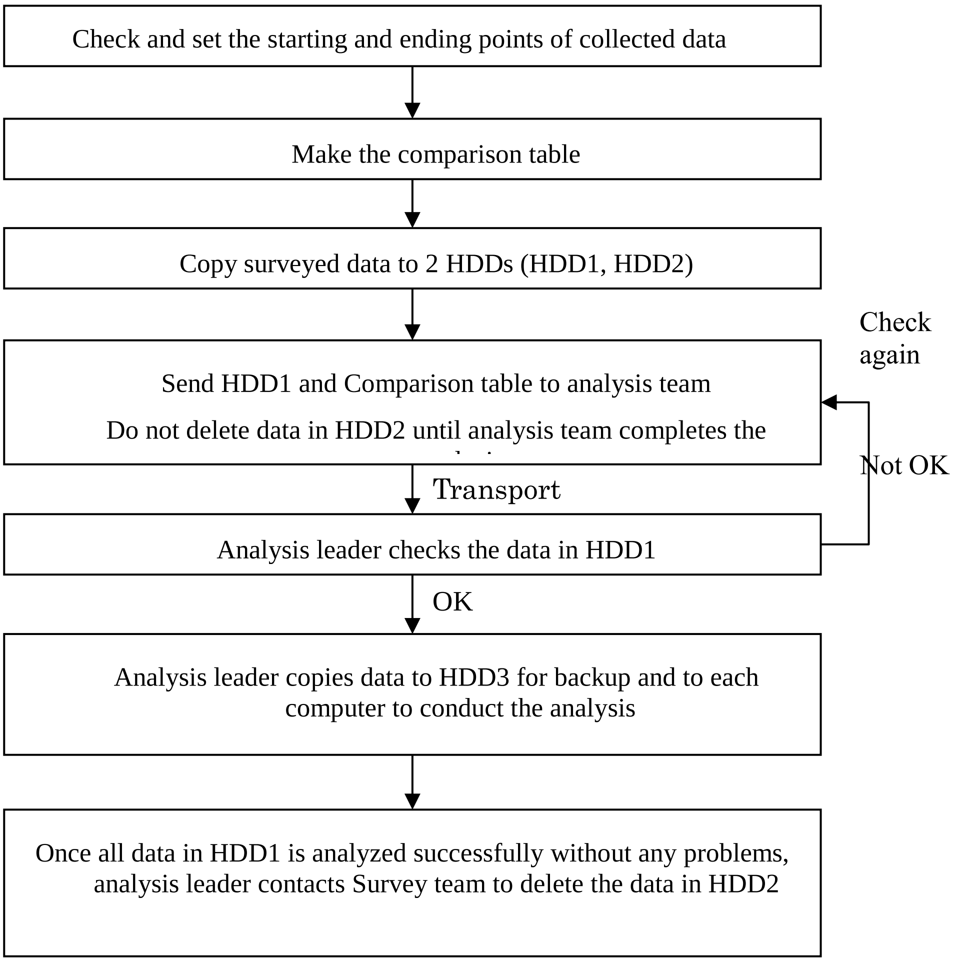
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |
| DD/MM/YYYY | | | | | | | | | | | | | | | | | | | | |

## III. Data management and delivery:

- Survey team shall make a copy and send the surveyed data to Data Analysis team at home to conduct the analysis work (about every 500km)
- HDDs storing surveyed data should be sent to Data Analysis team via transportation company
- Data HDD transfer flow:




## IV. Data Analysis Plan

1. Implementation method

- Data Analysis team has 8 members, including 6 data analysts and 2 data quality manager;
- After convert the surveyed data, analysis leader copies converted data to the other members to conduct the analysis. Once data is analyzed, the analyzed data is sent to data quality manager to check.
- After completing the analysis, the analysis leader informs Survey team to delete the data stored in HDDs on site.

2. Data analysis progress for RMB X
   - Data analysis duration: from **DD/MM/YYYY** to **DD/MM/YYYY**

3. Report schedule for data analysis

   \+ **Weekly report**: Data Analysis team leader reports Total implementation quantity/progress during the week and implementation plan for the next week to DRVN on the weekly basis via email.

   Weekly report format:

| A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Weekly Report** | | | | | | | | | | | |
| From | DD/MM/YYYY | | To | DD/MM/YYYY | | | | | | | |
| **No** | **Route name** | **Right /Left** | **Lane Number** | **Survey sections** | | | **File name** | **Activities performed** | | | **Note** |
| | | | | **From** | **To** | **Length (Km)** | | **Analysis** | **Data Check** | **Data Processing** | |
| 1 | | | | | | | | | | | |
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## V. Data Processing Plan and Report

- After completion of all analysis work, an analist conducts the data processing and reports the results of Pavement condition data in RMBX to DRVN.
- Duration: from **DD/MM/YYYY** to **DD/MM/YYYY**.

## VI. Report Order in Emergency Cases

As unexpected events happen during the survey ( broken vehicle, traffic accident ...) or during the data analysis and processing, implementing members shall contact directly to management agency (RMB, SB). If the management agency is not able to solve the problem, it should contact DRVN to find out the solutions.

## VII. Members (tentative):

Team Leader Name –- Phone: xxxx.xxx.xxx
Email: xxxxxxxxxxx@gmail.com

1. Survey team:

| No. | Name | Title | Email | Phone |
|---|---|---|---|---|
| 1 | **** *** **** | Leader | *********@gmail.com | xxxx.xxx.xxx |
| 2 | **** *** **** | Operator | *********@gmail.com | xxxx.xxx.xxx |
| 3 | **** *** **** | Operator | *********@gmail.com | xxxx.xxx.xxx |
| 4 | **** *** **** | Driver | *********@gmail.com | xxxx.xxx.xxx |

2. Data Analysis team:

| No. | Name | Title | Email | Phone |
|---|---|---|---|---|
| 1 | **** *** **** | Leader | *********@gmail.com | xxxx.xxx.xxx |
| 2 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 3 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 4 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 5 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 6 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 7 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |
| 8 | **** *** **** | Analyst | *********@gmail.com | xxxx.xxx.xxx |

## VIII. Implementation Schedule

The implementation schedule of pavement condition survey followed below the schedule table.

| Work Item | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Plan and Preparation | ■ | | | | | | | | | | |
| Field Survey | | ■ | ■ | ■ | | | | | | | |
| Data Analysis | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Data Preparation | | | | | | | | | | ■ | |
| Data Check | | | | | | | | | | | ■ |
| Submission Data and report | | | | | | | | | | | |

Appendix 2: Format of Survey Plan Section

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Planned Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Appendix 3: Calibration Report

**Project Name**

# Report on
# Calibration of the Survey Vehicle

**MMM YYYY**

**Survey Consultant Name**

1. Objective

Pavement Condition Survey will be done in RMBX. In order to secure the measurement accuracy, calibration and checking of equipment is implemented once in each RMB before the starting survey.

2. Contents of Calibration and Check

- Inspection vehicle check（power, system, equipment）
- Distance calibration
- Camera check
- Laser displacement sensor check
- Laser scanner check
- Camera calibration
- Long test

3. Place

1) Filed 1 (Place name)

- Inspection vehicle check（power, system, equipment）
- Distance calibration
- Camera check
- Laser displacement sensor check
- Laser scanner check
- Camera calibration

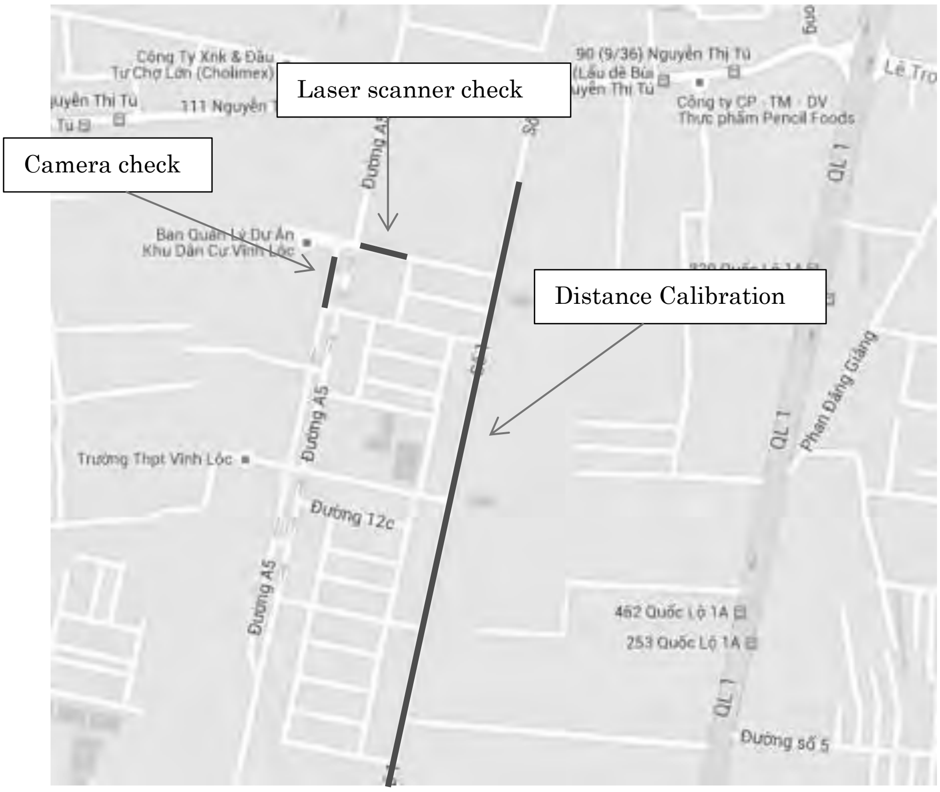



Figure 1: place of Filed 1 (Place name)

2) Field 2 (Place name)

- Long test


Figure 2: place of Filed 2 (Place name)

3. Schedule

Table 1: Timetable of calibration and checking

| Date | Place/ Route | Km-Post | Member | Activity |
|---|---|---|---|---|
| MM/DD (Mon) | | | | Inspection vehicle check (power, system, equipment)<br>Distance calibration |
| MM/DD (Thu) | | | | Camera check<br>Laser displacement sensor check<br>Laser scanner check |
| MM/DD (Wed) | | | | Laser scanner check<br>Camera calibration |
| MM/DD (Thur) | | | | Camera calibration<br>Long test |

4. Result

1) Condition of system

- Vehicle
  - Tire inflation pressure: OK

Table 2: Result of inflation pressure

| Tire position | Before | After | Condition |
|---|---|---|---|
| Front Right | $kg/cm^2$ | $kg/cm^2$ | OK |
| Front Left | $kg/cm^2$ | $kg/cm^2$ | OK |
| Rear Right | $kg/cm^2$ | $kg/cm^2$ | OK |
| Rear Left | $kg/cm^2$ | $kg/cm^2$ | OK |

- Direction indicators: OK
- Light: OK
- Engine oil: OK
- Fan belt: OK

- System
  - Scratch and condition of system: OK
  - Wiring of Equipment: OK

- Voltage of battery: OK
  12.5V
- Screw: OK

2) Accuracy of equipment

- the focus of Lens (FV, RC): OK
  The device is capable of properly recognizing cracking as small as 2mm in depth on the test chart.

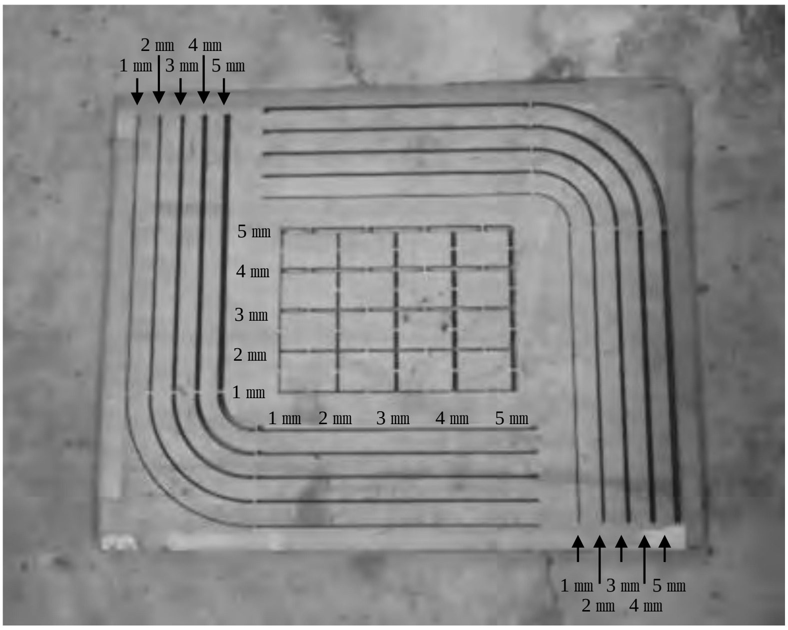



Figure 3: Test chart

- FV

Figure 4: Result of Forward view camera image

- RC (Sunshine)

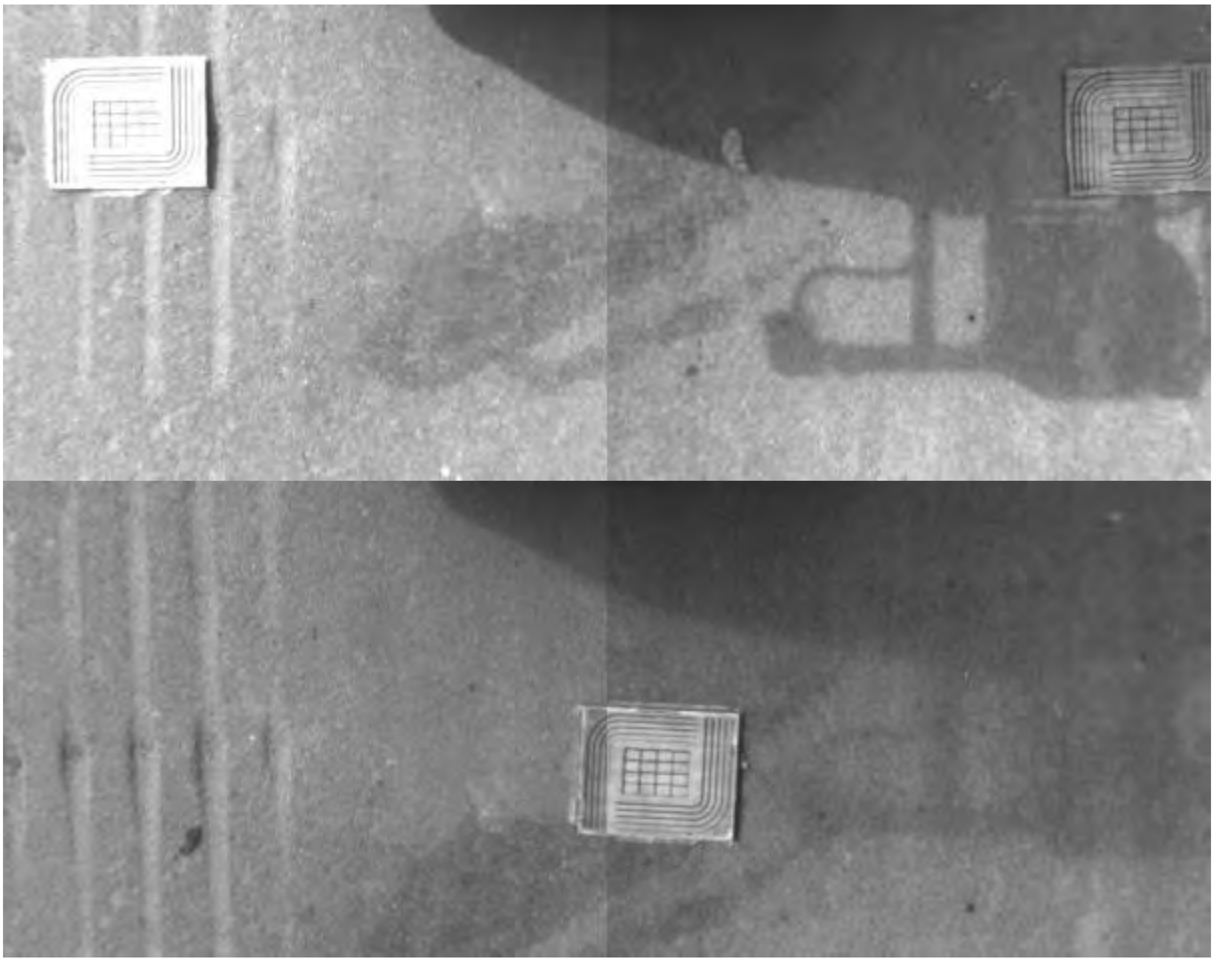
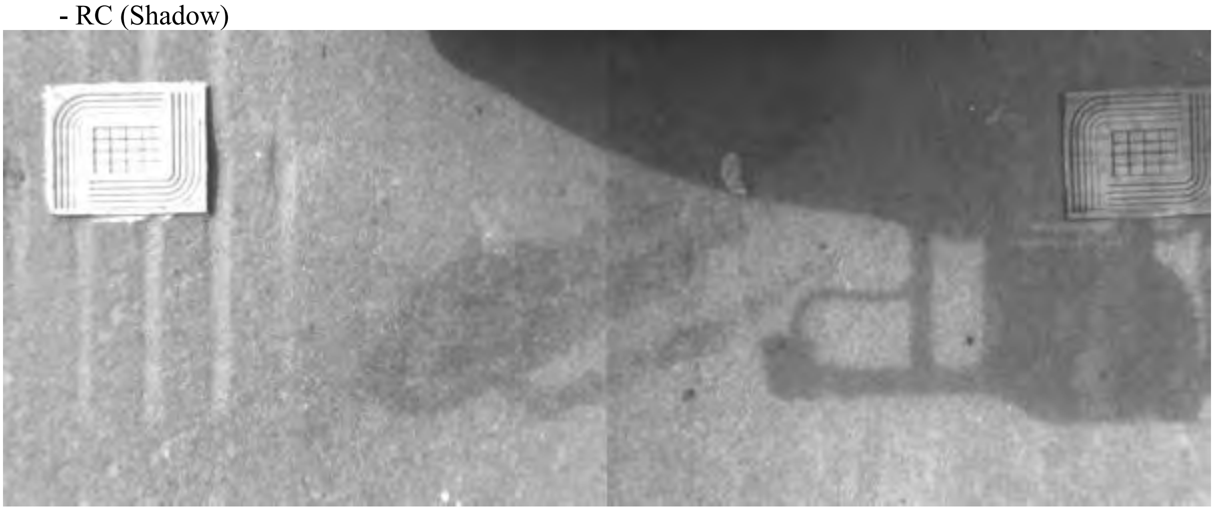


Figure 5: Result of Road camera image (sunshine)

- RC (Shadow)



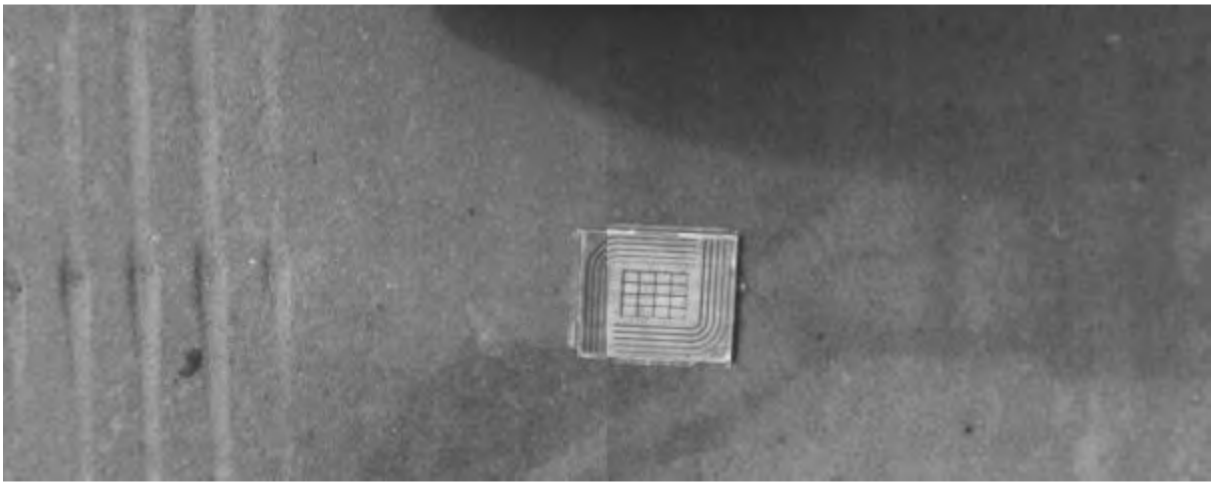


Figure 6: Result of Road camera image (shadow)

- Angle of view (CR): OK
  Calibration boards are installed at 3.8 meters apart. The device captures images covering a span of 3.8 meters or more.

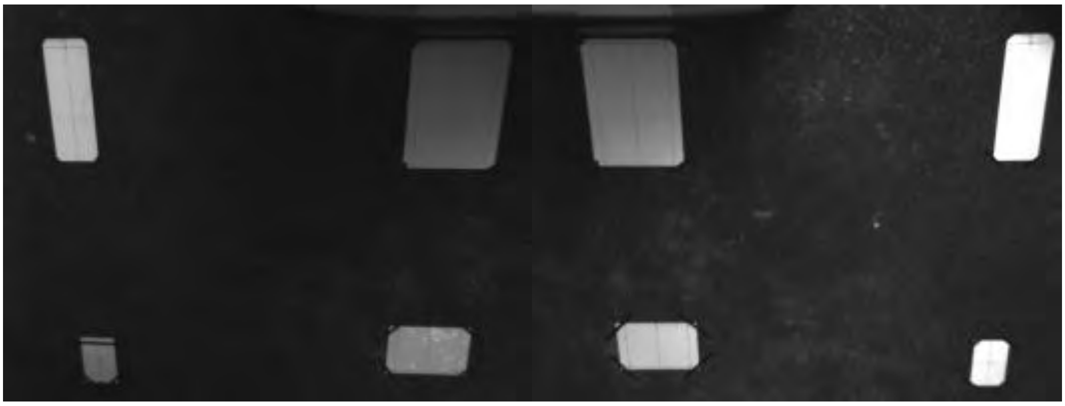


Figure 7: Result of angle of view (Road camera)

・Installation dimension of calibration boards

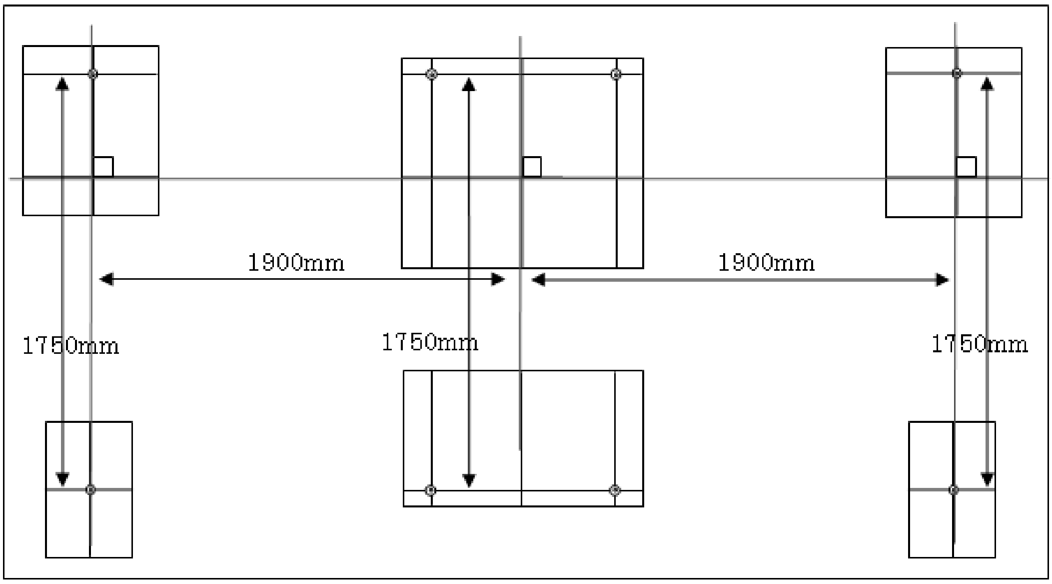



Figure 8: Installation dimension of calibration boards for road camera

- The accuracy of laser displacement sensor: OK

Heights from ten measurements were collected by inserting a wood block at each measurement. The thickness of the wood block was calculated from the differences between collected heights, and the measurement accuracy was verified by comparing the results against the actual thickness of the wood block. Results showed that the average deviation was *.**mm.

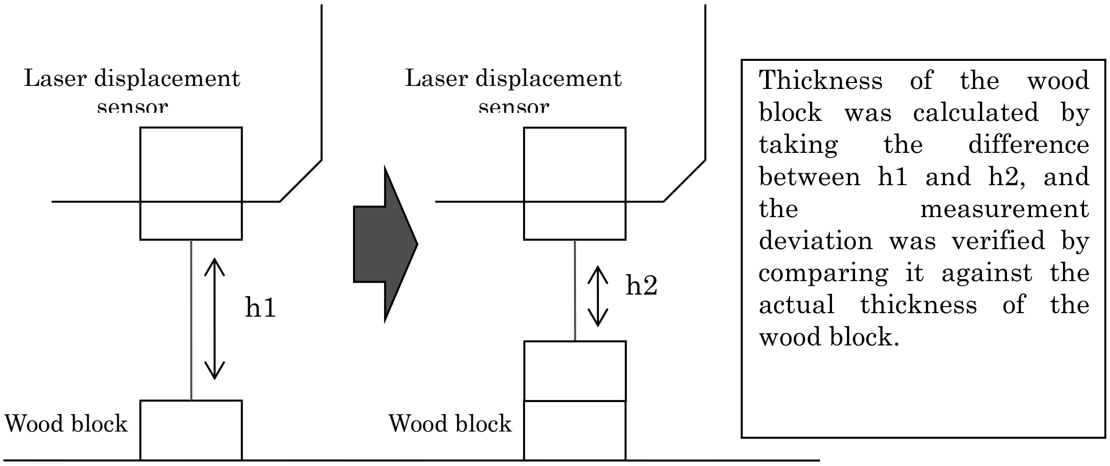



Figure 9: method of checking the accuracy of laser displacement sensor

Table 3: Result of laser displacement sensor

| | Laser displacement meter (mm) | | | | | Actual measurement (mm) | Deviation (mm) | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | Median | Thickness of block | Thickness of block | Integer | Absolute |
| 0 | | | | | — | — | — | — |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
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- The shape of laser scanner data: OK
  Comparisons between profiles collected through the dipstick and those collected through the automated measurement device showed that same profiles were being detected in general.

- No.1

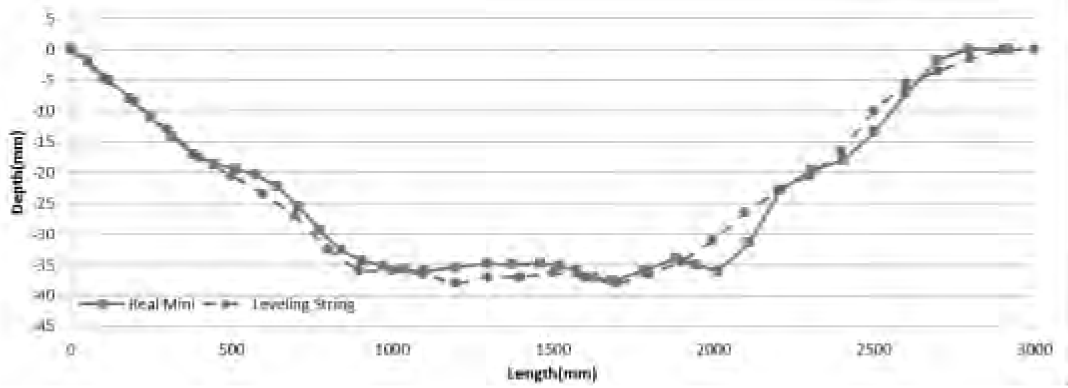


Figure 10: Result of rut shape (No.1)

- No.2

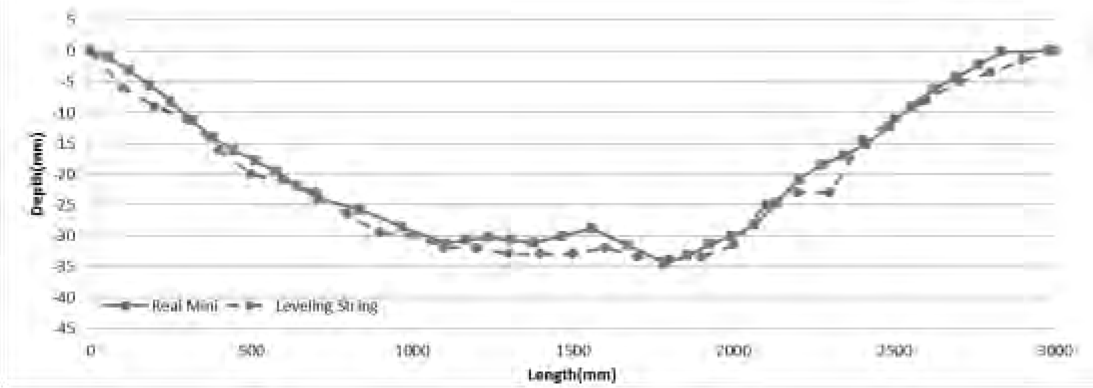


Figure 11: Result of rut shape (No.2)

- No.3

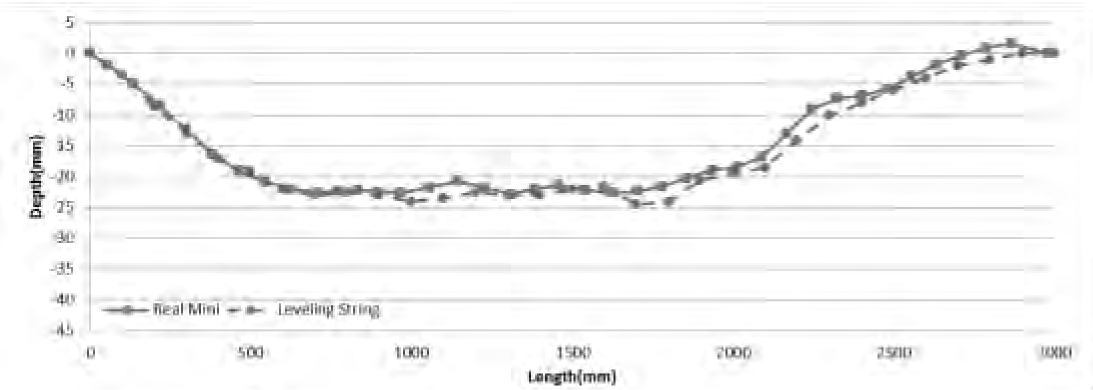


Figure 12: Result of rut shape (No.3)

- No.4

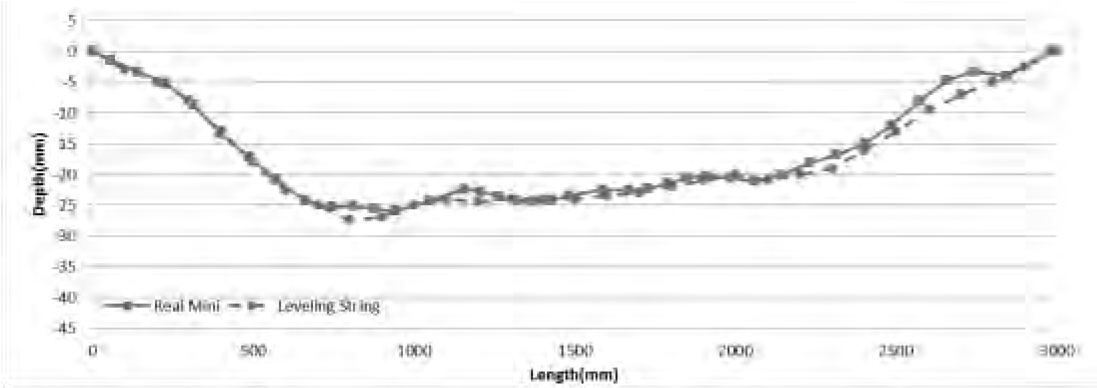


Figure 13: Result of rut shape (No.4)

- No.5

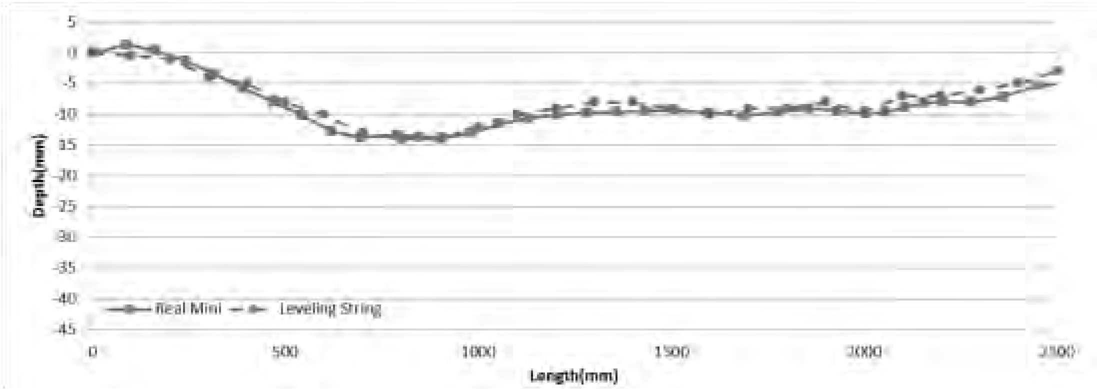


Figure 14: Result of rut shape (No.5)

- Comparison of rut depth: OK
  As the difference stands at 1.5 mm at the maximum and at 0.8 mm at an average, it was verified that the device is within the deviation range of -6mm to +6mm, which satisfies the requirement.

Table 4: Result of Rut depth

| No. | Leveling String | REAL Mini | Deference |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| | | MAX | |
| | | MIN | |
| | | AVERAGE | |

- Distance: OK

A distance of 1000 meters was traveled four times, and the average vehicle pulse signal from the four runs was 2540.

Table 5: Result of vehicle pulse

| Measurement count | Measured value | Average value |
|---|---|---|
| Previous Value | — | |
| 1 | | |

| | | |
|---|---|---|
| 2 | | |
| 3 | | |
| 4 | | |

A coefficient was configured based on this value, and as a result of measuring a distance of 1000 meters, the deviation rate was -0.01%. The device showed an accuracy that is within the range of -0.5% to +0.5% of the actual length, and thus it was verified that the instrument meets the required specifications.

Table 6: Result of measurement distance test

| Section length (m) | Measured value (m) | Deviation (m) | Deviation rate (%) | Test result (Deviation rate <±0.5%) |
|---|---|---|---|---|
| 1000 | | | % | Pass |

- Test survey: OK

Table 7: Result of test survey

| Number of Times | Measurement Length (km) | Condition |
|---|---|---|
| 1st | | No Error |

# Appendix 4: Format of Surveyed Route Table

| Survey date | Folder | Road Name | Road Category | Road No. | Road No. Supplement | Branch Code | Survey Section | | | | Left/Right | Lane | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | From | | To | | | | |
| | | | | | | | Km | m | Km | m | | | |
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# Appendix 5: Format of Measurement Report

## Daily activity report

Activity Classification
(1) Calibration
(2) Survey
(3) Waiting for becom dry pavement surface
(4) Others

Dry / Wet

Name team : ① ② ③ ④ ⑤

| Date | RMB | SB | Activity | Route Code | R / L | Lane Number | Surface Condition | Weather Condition | Survey Section | | | Work time | | | | Vehicle Mileage | Navigator (Sub Bureau) | Driver's Name | Reported by | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Begin | End | Length | Begin | End | Work Time | Rest Time | | | | | |
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## Appendix 6: Format of Surveyed Section Table

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Planned Survey Length | Note | From_M | To_KP | To_M | Length | Excluded Length | Overlapping Length | Survey Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

## Appendix 7: Format of Data Analysis Report

**Weekly Report**

**From** DD/MM/YYYY **To** DD/MM/YYYY

| No | Route name | Right /Left | Lane Num ber | Survey sections | | | File name | Activities performed | | | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | From | To | Length (Km) | | Analysis | Data Check | Data Process ing | |
| 1 | | | | | | | | | | | |
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| 31 | | | | | | | | | | | |

## Appendix 8: Format of Analyzed Section Table

| Road Category | Road No. | Road No. Supplement | Branch No. | Road Name | RMBs | SBs | Direction | Lane Position | From_KP | From_M | To_KP | To_M | Analysis Length | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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JAPAN INTERNATIONAL COOPERATION AGENCY

DIRECTORATE FOR ROADS OF VIETNAM

MINISTRY OF TRANSPORT (MOT)

THE SOCIALIST REPUBLIC OF VIETNAM

# THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE II

## PAVEMENT CONDITION SURVEY MANUAL

## Volume 2.1.4: Instruction Book of REAL Mini

MARCH 2018

JICA PROJECT TEAM

# Record of updates

| Rev. | Date | Contents change |
|---|---|---|
| 1.00 | 2014.4.1 | First edition |
| 1.01 | 2017.12.19 | Update the function of analysis system |
| | | |

# Table of Contents

# List of Figure

# List of Table

# 1. About This Instruction Book

Instruction Book of REAL Mini (PCS-Vol.4) is one of six manuals comprising the suite of the documentation for pavement condition survey. Figure 1.1 shows the component of pavement condition survey manual. Pavement condition survey manual is divided into three parts, Overview, Operation manual and Technical manual. Documents to be referenced depend on the responsibility and work steps of stakeholders involved in pavement condition survey. Overview describes the basic items of survey that all stakeholders should refer to. Operation manual shows important matters to be referred to mainly when survey work managing. Technical manual indicates technical matters such as system and device operation methods, data definition and data preparation. Figure 1.2 shows the description of contents of each document.

This instruction book explains the REAL Mini system on pavement condition survey. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

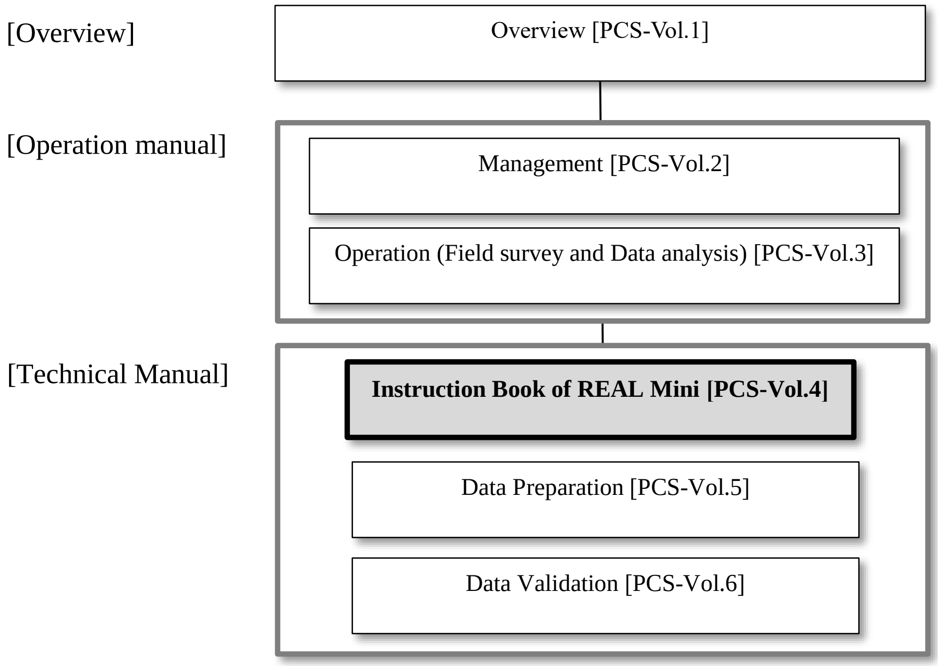



Figure 1.1 Pavement condition survey manual

[Overview]

| |
|---|
| Overview (PCS-Vol.1] |

➔ Describe the overview and measuring methods of pavement condition survey. It is a general purpose document which provides in an understanding of pavement condition survey.

[Operation manual]

| |
|---|
| Management [PCS-Vol.2] |

➔ Describe the management work of road administrator on pavement condition survey. It contains all management works such as the planning, supervising, and data checking on pavement condition survey describing. It is to be used by administrator who to carry out the management of pavement condition survey.

| |
|---|
| Operation (Field survey and Data analysis) [PCS-Vol.3] |

➔ Describe the survey and analysis work of survey consultant on pavement condition survey. It contains the survey and analysis rule. It is to be used by surveyor and analysis operator who to carry out the pavement condition survey.

[Technical manual]

| |
|---|
| Instruction Book of REAL Mini [PCS-Vol.4] |

➔ Describe the operation procedure of REAL Mini system. It contains the operation procedure of inspection vehicle and analysis system, calibration and maintenance of the inspection vehicle and so on. It is to be used by surveyor and analysis operator whose task is to carry out the deep study for operation procedure of REAL Mini system.

| |
|---|
| Data Preparation [PCS-Vol.5] |

➔ Describe the contents of pavement condition data (PC data). It contains the code definition, explanation of each item of PC data and so on.

| |
|---|
| Data Validation [PCS-Vol.6] |

➔ Describe the data check procedure when creating the PC data. It is to be used by person whose task is to carry out the data check in pavement condition survey.

Figure 1.2 Contents of Pavement condition survey manual

## 1.1 Composition of this Manual

This Manual consists of the chapters listed in Table 1.1.

Table 1.1 Composition of this Manual

| Chapter | Title | Description |
|---|---|---|
| 1 | About This Instruction Book | Purpose and composition of this Manual |
| 2 | Introduction | Purpose, workflow, definition of equipment to be used, terminology, management of pavement condition survey |
| 3 | Output data of the system | Output file and Definitions of items on data |
| 4 | General rulu in survey | Impassable case, safety control, and storage and management of data |
| 5 | Instruction Manual of Trip meter | Operation guide for trip meter |
| 6 | Instruction Manual of Operation of REAL Mini | Operation guide for REAL Mini |
| 7 | Instruction Manual of Starting and Ending Point Setting Application | Guide for application to set the starting and ending points |
| 8 | Instruction Manual of Data Conversion Application | Guide for data conversion application |
| 9 | Instruction Manual of Data Analysis Application | Guide for data analysis application |
| 10 | Instruction Manual of Location Setting Application | Guide for location setting application |
| 11 | Instruction Manual of Data Processing Application | Guide for data processing application |
| 12 | Instruction Manual of Assembly | Guide for assembly of REAL Mini |
| 13 | Instruction Manual of Calibration | Guide for calibration of REAL Mini |
| 14 | Instruction Manual of Maintenance | Guide for maintenance of REAL Mini |
| 15 | Troubleshooting | Troubleshooting for devices, field work and applications |
| 16 | Wiring diagram | Wiring diagram of REAL Mini |
| Appendix 1 | Configuration diagram | Configuration diagram of REAL Mini |

## 1.2 Relationship between Work flow and each Chapter

Figure 1.3 shows the relationship between work flow and each chapter in this Instruction Book. Please read each manual carefully before work.

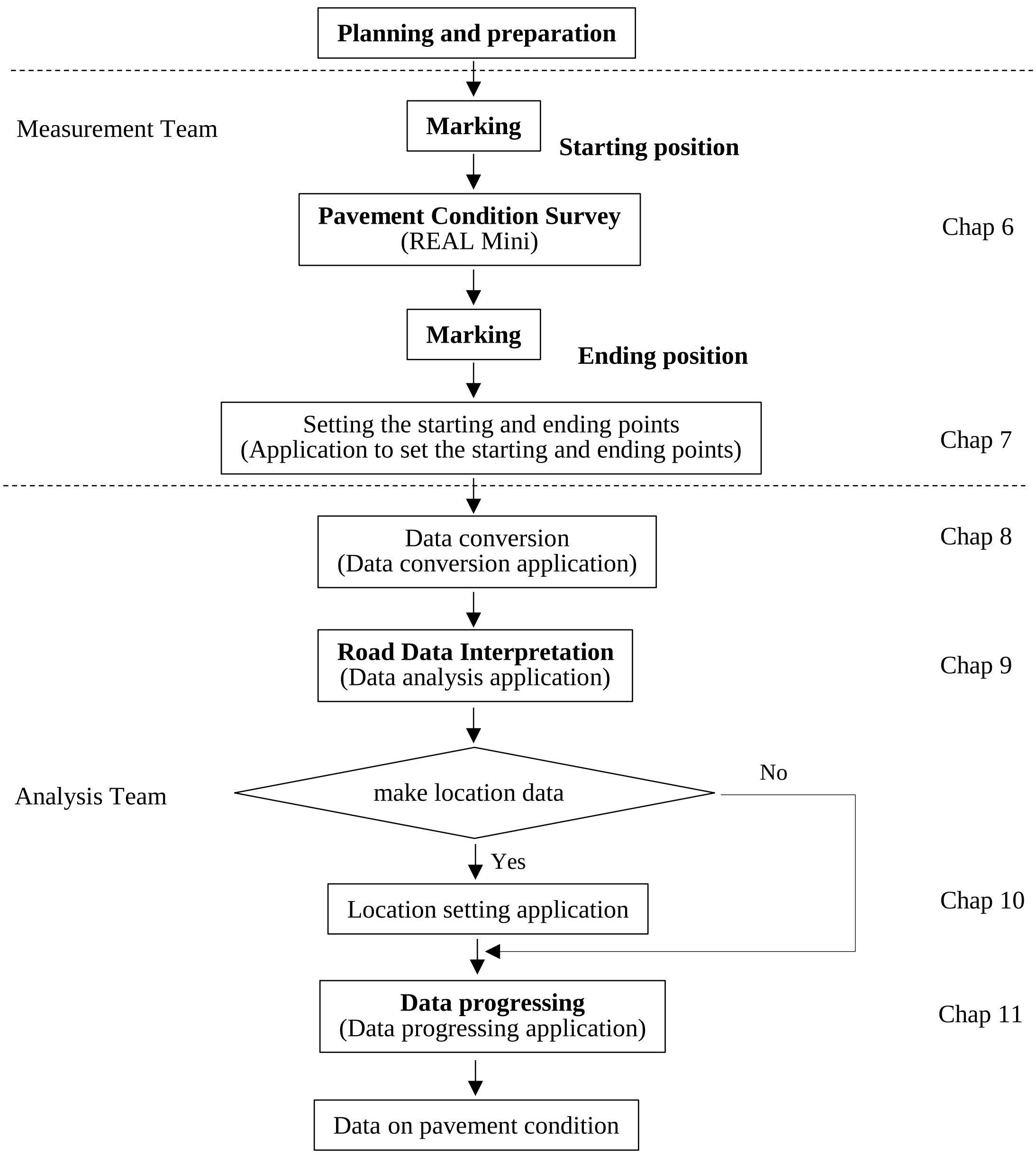



Figure 1.3 Detailed Implementation Flow

## 1.3 Management of this Manual

This Manual shall be updated whenever the operation has been revised. All the parties concerned shall be notified of any update.

# 2. Introduction

## 2.1 Purpose

This System is intended, using a measuring vehicle, to acquire data on pavement condition, interpretation and process the data, and create data files on pavement condition.

## 2.2 Workflow

As illustrated in Figure 2.1, a pavement condition survey consists of four stages: field reconnaissance, rpavement condition survey, Pavement damage interpretation and road data processing.

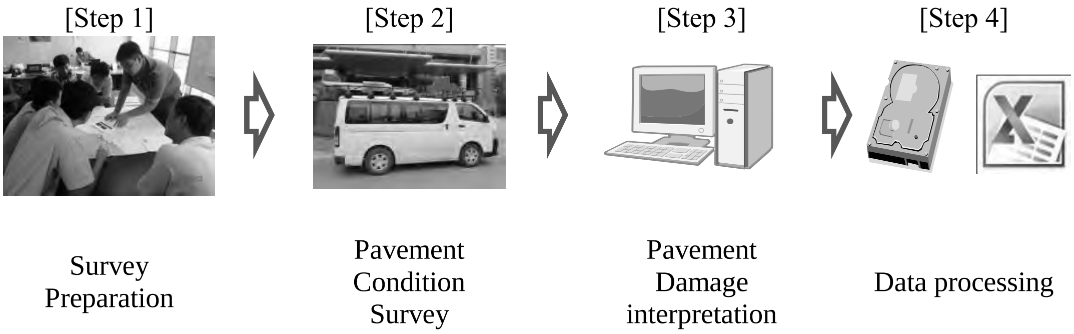



Figure 2.1 Workflow

(1) Survey Preparation

Survey preparation will confirm the location of the starting and ending points of the survey route, make a “Survey Plan”, prepare the HDD to store the measurement data and prepare the human resource. The computer of data analysis and data processing should move for one room from RTC-C to conduct place, if needed.

(2) Pavement Condition Survey

Images of the road surface, cross-section profile, longitudinal profile, forward image of the road and positional coordinates will be recorded with a survey vehicle.

(3) Pavement Damage Interpretation

Images of the road surface will be taken in a pavement condition survey and used to check the road surface condition and find out any damage.

(4) Data processing

Data files on pavement condition will be created by combining the data obtained in the field survey and interpretation of the pavement condition. The files will be created in text and excel formats.

*Figure 2.1 lists equipment (including applications) to be used in each step.

Table 2.1 List of Equipment Used in Stages

| Work type | Equipment | Description | Used by |
|---|---|---|---|
| Pavement Condition Survey | REAL Mini | Vehicle and measuring device to measure road condition | Measurement Team |
| | HDD | HDD for data surveyed (for PCs 1 and 2) | |
| | Field notes | The Field notes with data recorded in field survey | |
| | Application to set the starting and ending points | Application setting the starting and ending points for data surveyed | |
| | Digital camera | To take evidence photographs | |
| Pavement Damage Interpretation | PC | Computer for data analysis | Analysis Team |
| | HDD | HDD for data surveyed and that for data storage | |
| | Data conversion application | Application converting data surveyed to data for analysis | |
| | Data analysis application | Application setting the scope of analysis (road width) and checking on cracks | |
| | Location setting application | Application setting locations (kilo-post stations and bridges) to mark out data | |
| Data processing | PC | Computer for data processing | |
| | Data processing application | Application compiling and editing data outputted from data analysis application | |

Table 2.2 Images of Equipment
(for Pavement Condition Survey and Pavement Damage interpretation )

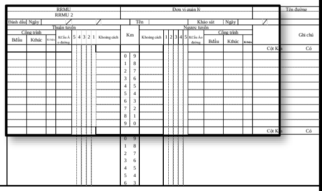
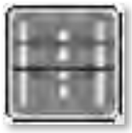
| Pavement Condition Survey | | Pavement Damage Interpretation | |
|---|---|---|---|
| Equipment | Image | Equipment | Image |
| REAL Mini |  | PC |  |
| HDD |  2 HDDs for 1 survey | HDD |  For converted data |
| Field notes |  | Data conversion application |  |
| Application to set the starting and ending points |  | Data analysis application |  |
| Digital camera |  | Location setting application |  |

Table 2.3 Images of Equipment (for Data Processing)

| Equipment | Image | Equipment | Image |
|---|---|---|---|
| PC |  | Data processing application | |

## 2.3 Work Formation

Table 2.4 shows the work formation of the survey stages.

Table 2.4 Work Formation

| Survey Stage | Tasks/Persons in charge | No. of personnel | Remarks |
|---|---|---|---|
| Pavement Condition Survey | Driver | 1 | |
| | Operator | 3 | 1 each for PCs 1 and 2<br>1 for Trip meter and set the KP point |
| Data analysis | Operator | 8 | Up to 8 operators |
| Data processing | Operator | 2 | |

## 2.4 Definition of terms

Table 2.5 lists the terms used in this Manual.

Table 2.5 Definition of Terms

| Terminology | Definition |
|---|---|
| Road Code | Road Code is 10 digit codes. Road code consists of road category, road number, road number supplement and branch number. Each road code have road name. |
| Geographical Area | A geographic unit that is used to identify management unit. |
| Road Categoly | A information used to identify the road category; whether the road national highway, expressway, provincial road, or others road. |
| Road Number | A number that identifies a road in a country. Generally, two to the digits are used. |
| RoadNumber Supliment | A alphabetical part or combination of alphabet and number given to the road name. |
| Branch Number | A branch road number is used to differentiate a road number in detail. |
| Left bound | The direction that the number displayed on the kilo-post station becomes smaller. |
| Right bound | The direction that the number displayed on the kilo-post station becomes larger. |
| Single bound | The section where only one vehicle pass |
| Lane classification | Differentiation of lanes with marking on road surface to indicate where traffic flow follows. |
| Lane Number | The targeted lane number for the survey |
| Station Number | It shows the kilo-post station number and distance from the nearest kilo-post station and the one on the side of the starting point. |
| Kilo-post station | A road sign on the side of the road to indicate distances from major cities. |
| Kilo-post station number | The number indicated on the kilo-post stations in the side of the road. |
| Management Area / Administrative Jurisdiction | Administrative division to manage roads or a section of a road. |
| Management Company | An entity that conduct road maintenance work including road facilities. |
| Overlapped Road | A road where two roads use the same section of a road, or a road where inbound and outbound traffic uses the same segment of road within a same road. |
| Carriageway marking | A lane marking on the road surface |
| Bridge | A fly-over structure to pass an obstacle or hazard. |
| Tunnel | Underground structure placed to a planned location with a minimum finished section area of 2 $m^2$. |
| Rock shed | A tunnel like structure to protect a road from avalanche, rock fall or mudslide. |
| Intersection | Different roads intersecting at grade |
| Round-about | A circular intersection where traffic flows in one direction around a central island. |
| Viaduct | Sections of a road where two roads meet at different levels. |
| | It is a name of intersection structure that over passes the targeted survey road. |
| | When the targeted road crosses at grade or over the other road, the intersecting structure is not included to the viaduct structure. |
| Railroad Crossing | The section where railroad and road crosses at the same level. |
| Toll Gate | A facility that collects toll on the roads |

| | |
|---|---|
| Road Structure | Bridge, tunnel, rock shed |
| Pothole | A pothole is a type of disruption in the surface of a roadway where a portion of the road material has broken away, leaving a hole. |
| Crack | A break or fissure on a road. |
| Rut | A rut is a depression or groove worn into a road or path by the travel of wheels. |
| Profile | Displacement data of the vertical section or direction |

# 3. Output data of the system

## 3.1 Final Outputs

Figure 3.1 to 3.3 illustrates the final outputs of the System. Please refert to “Data Preparation manual on pavement condition survey” for detail contants. The output file consists of the below figure and table.

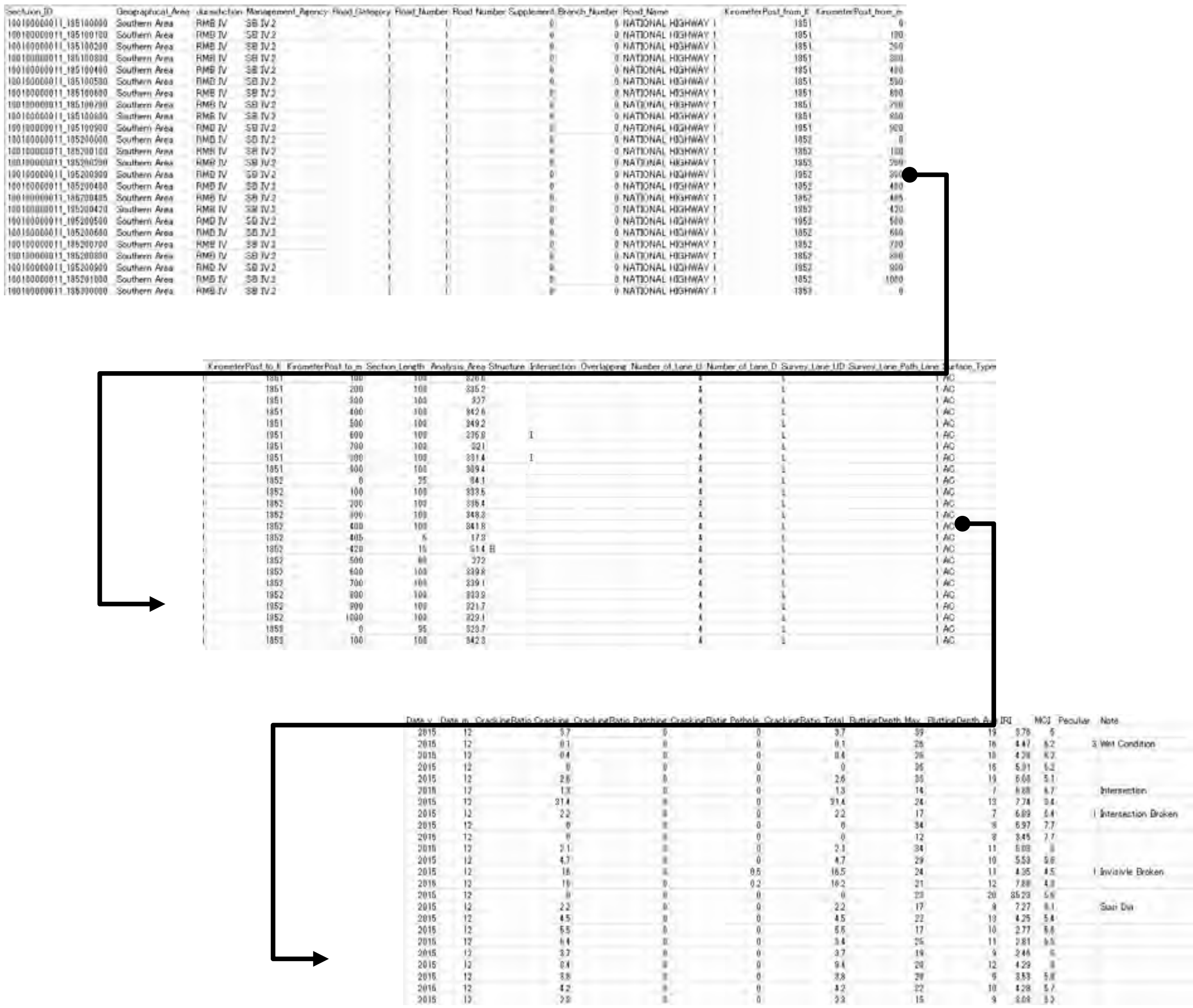


Figure 3.1 Pavement condition data file

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100900000121_000000000 | 1 | 1 | 9 | 0 | 1 | R | | 1 | 16.8423 | 107.0839 | 6.163 | 2016¥NH9BypassNorth¥Right_1¥00000001.jpg |
| 100900000121_000000000 | 2 | 1 | 9 | 0 | 1 | R | | 1 | 16.84228 | 107.0838 | 5.86 | 2016¥NH9BypassNorth¥Right_1¥00000002.jpg |
| 100900000121_000000000 | 3 | 1 | 9 | 0 | 1 | R | | 1 | 16.84226 | 107.0838 | 5.927 | 2016¥NH9BypassNorth¥Right_1¥00000003.jpg |
| 100900000121_000000000 | 4 | 1 | 9 | 0 | 1 | R | | 1 | 16.84224 | 107.0837 | 6.129 | 2016¥NH9BypassNorth¥Right_1¥00000004.jpg |
| 100900000121_000000000 | 5 | 1 | 9 | 0 | 1 | R | | 1 | 16.84222 | 107.0837 | 6.296 | 2016¥NH9BypassNorth¥Right_1¥00000005.jpg |
| 100900000121_000000000 | 6 | 1 | 9 | 0 | 1 | R | | 1 | 16.8422 | 107.0837 | 6.33 | 2016¥NH9BypassNorth¥Right_1¥00000006.jpg |
| 100900000121_000000000 | 7 | 1 | 9 | 0 | 1 | R | | 1 | 16.84219 | 107.0836 | 6.304 | 2016¥NH9BypassNorth¥Right_1¥00000007.jpg |
| 100900000121_000000000 | 8 | 1 | 9 | 0 | 1 | R | | 1 | 16.84217 | 107.0836 | 6.266 | 2016¥NH9BypassNorth¥Right_1¥00000008.jpg |
| 100900000121_000000000 | 9 | 1 | 9 | 0 | 1 | R | | 1 | 16.84215 | 107.0835 | 6.207 | 2016¥NH9BypassNorth¥Right_1¥00000009.jpg |
| 100900000121_000000000 | 10 | 1 | 9 | 0 | 1 | R | | 1 | 16.84214 | 107.0835 | 6.162 | 2016¥NH9BypassNorth¥Right_1¥00000010.jpg |
| 100900000121_000000000 | 11 | 1 | 9 | 0 | 1 | R | | 1 | 16.84212 | 107.0834 | 6.095 | 2016¥NH9BypassNorth¥Right_1¥00000011.jpg |
| 100900000121_000000000 | 12 | 1 | 9 | 0 | 1 | R | | 1 | 16.8421 | 107.0834 | 6.01 | 2016¥NH9BypassNorth¥Right_1¥00000012.jpg |
| 100900000121_000000000 | 13 | 1 | 9 | 0 | 1 | R | | 1 | 16.84209 | 107.0834 | 5.945 | 2016¥NH9BypassNorth¥Right_1¥00000013.jpg |
| 100900000121_000000000 | 14 | 1 | 9 | 0 | 1 | R | | 1 | 16.84207 | 107.0833 | 5.896 | 2016¥NH9BypassNorth¥Right_1¥00000014.jpg |
| 100900000121_000000000 | 15 | 1 | 9 | 0 | 1 | R | | 1 | 16.84205 | 107.0833 | 5.862 | 2016¥NH9BypassNorth¥Right_1¥00000015.jpg |
| 100900000121_000000000 | 16 | 1 | 9 | 0 | 1 | R | | 1 | 16.84204 | 107.0832 | 5.873 | 2016¥NH9BypassNorth¥Right_1¥00000016.jpg |
| 100900000121_000000000 | 17 | 1 | 9 | 0 | 1 | R | | 1 | 16.84202 | 107.0832 | 5.864 | 2016¥NH9BypassNorth¥Right_1¥00000017.jpg |
| 100900000121_000000000 | 18 | 1 | 9 | 0 | 1 | R | | 1 | 16.842 | 107.0831 | 5.853 | 2016¥NH9BypassNorth¥Right_1¥00000018.jpg |
| 100900000121_000000000 | 19 | 1 | 9 | 0 | 1 | R | | 1 | 16.84198 | 107.0831 | 5.864 | 2016¥NH9BypassNorth¥Right_1¥00000019.jpg |
| 100900000121_000000000 | 20 | 1 | 9 | 0 | 1 | R | | 1 | 16.84197 | 107.083 | 5.845 | 2016¥NH9BypassNorth¥Right_1¥00000020.jpg |
| 100900000121_000000100 | 1 | 1 | 9 | 0 | 1 | R | | 1 | 16.84195 | 107.083 | 5.837 | 2016¥NH9BypassNorth¥Right_1¥00000021.jpg |
| 100900000121_000000100 | 2 | 1 | 9 | 0 | 1 | R | | 1 | 16.84193 | 107.083 | 5.83 | 2016¥NH9BypassNorth¥Right_1¥00000022.jpg |
| 100900000121_000000100 | 3 | 1 | 9 | 0 | 1 | R | | 1 | 16.84191 | 107.0829 | 5.836 | 2016¥NH9BypassNorth¥Right_1¥00000023.jpg |
| 100900000121_000000100 | 4 | 1 | 9 | 0 | 1 | R | | 1 | 16.8419 | 107.0829 | 5.879 | 2016¥NH9BypassNorth¥Right_1¥00000024.jpg |
| 100900000121_000000100 | 5 | 1 | 9 | 0 | 1 | R | | 1 | 16.84188 | 107.0828 | 5.922 | 2016¥NH9BypassNorth¥Right_1¥00000025.jpg |
| 100900000121_000000100 | 6 | 1 | 9 | 0 | 1 | R | | 1 | 16.84186 | 107.0828 | 5.98 | 2016¥NH9BypassNorth¥Right_1¥00000026.jpg |
| 100900000121_000000100 | 7 | 1 | 9 | 0 | 1 | R | | 1 | 16.84184 | 107.0827 | 6.042 | 2016¥NH9BypassNorth¥Right_1¥00000027.jpg |
| 100900000121_000000100 | 8 | 1 | 9 | 0 | 1 | R | | 1 | 16.84182 | 107.0827 | 6.096 | 2016¥NH9BypassNorth¥Right_1¥00000028.jpg |
| 100900000121_000000100 | 9 | 1 | 9 | 0 | 1 | R | | 1 | 16.84181 | 107.0827 | 6.161 | 2016¥NH9BypassNorth¥Right_1¥00000029.jpg |
| 100900000121_000000100 | 10 | 1 | 9 | 0 | 1 | R | | 1 | 16.84179 | 107.0826 | 6.243 | 2016¥NH9BypassNorth¥Right_1¥00000030.jpg |
| 100900000121_000000100 | 11 | 1 | 9 | 0 | 1 | R | | 1 | 16.84177 | 107.0826 | 6.288 | 2016¥NH9BypassNorth¥Right_1¥00000031.jpg |
| 100900000121_000000100 | 12 | 1 | 9 | 0 | 1 | R | | 1 | 16.84175 | 107.0825 | 6.381 | 2016¥NH9BypassNorth¥Right_1¥00000032.jpg |
| 100900000121_000000100 | 13 | 1 | 9 | 0 | 1 | R | | 1 | 16.84173 | 107.0825 | 6.447 | 2016¥NH9BypassNorth¥Right_1¥00000033.jpg |
| 100900000121_000000100 | 14 | 1 | 9 | 0 | 1 | R | | 1 | 16.84171 | 107.0825 | 6.541 | 2016¥NH9BypassNorth¥Right_1¥00000034.jpg |
| 100900000121_000000100 | 15 | 1 | 9 | 0 | 1 | R | | 1 | 16.8417 | 107.0824 | 6.625 | 2016¥NH9BypassNorth¥Right_1¥00000035.jpg |

Figure 3.2　Image data with coordinate file

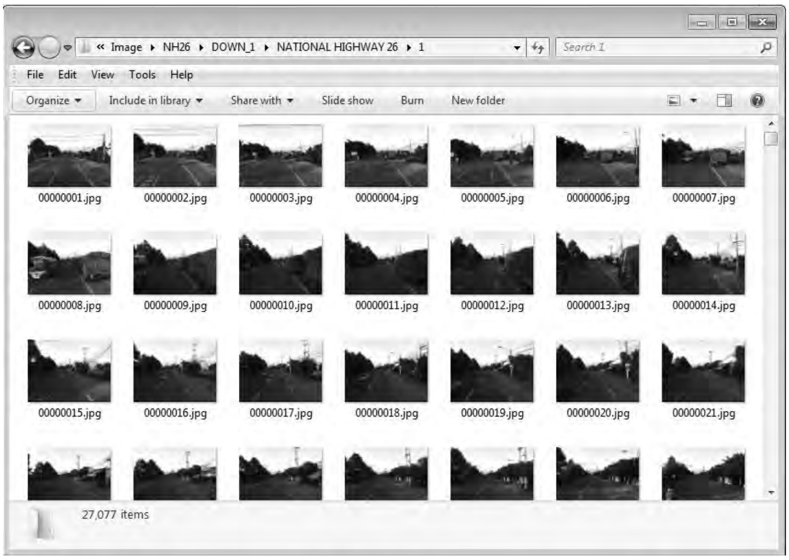



Figure 3.3　Image file

Table 3.1　Data format of the pavement condition data file

| Column No. | Data Content | Column No. | Data Content |
|---|---|---|---|
| 1 | Section_ID | 19 | Number_of_Lane_L |
| 2 | Geographical_Area | 20 | Number_of_Lane_R |
| 3 | Jurisdiction | 21 | Survey_Lane_LR |
| 4 | Management_Agency | 22 | Survey_Lane_Path_Lane |
| 5 | Road_Category | 23 | Surface_Type |
| 6 | Road_Number | 24 | Date_Y |
| 7 | Road Number Supplement | 25 | Date_M |
| 8 | Branch_Number | 26 | CrackingRatio_Cracking |
| 9 | Road_Name | 27 | CrackingRatio_Patching |
| 10 | KirometerPost_From_K | 28 | CrackingRatig_Pothole |
| 11 | KirometerPost_From_m | 29 | CrackingRatio_Total |
| 12 | KirometerPost_To_K | 30 | RuttingDepth_Max |
| 13 | KirometerPost_To_m | 31 | RuttingDepth_Ave |

| | | | |
|---|---|---|---|
| 14 | Section_Length | 32 | IRI |
| 15 | Analysis_Area | 33 | MCI |
| 16 | Structure | 34 | Peculiar |
| 17 | Intersection | 35 | Note |
| 18 | Overlapping | | |

Table 3.2 Data format of the image data with coordinate file

| Column No. | Data Content |
|---|---|
| 1 | Section_ID |
| 2 | Sequential No. (from 1 to 20) |
| 3 | Road Category |
| 4 | Road Number |
| 5 | Road Number Supplement |
| 6 | Branch Number |
| 7 | Direction (L/R) |
| 8 | Lane Number |
| 9 | Latitude |
| 10 | Longitude |
| 11 | Height |
| 12 | Data relative Path |

## 3.2 Definitions of Items on Pavement Condition Data

This section provides the definition of items in data on pavement condition.

(1) Section_ID

Section ID is created by road, direction, lane number, KP. Section ID is unique data. The format is shown in Table 3.3. Details of items are to refer to the explanation of each item.

Table 3.3 Section ID Format

| Road Category | Road Number | Road Number Supplement | Branch Number | Direction | Lane position Number | Under bar | From Km | From M |
|---|---|---|---|---|---|---|---|---|
| 1 digit | 3 digits | 3 digits | 3 digits | 1 digit | 1 digit | 1 digit | 4 digits | 5 digits |

(2) Geographical_Area

"Geographical_Area" indicates which area the point in data pavement condition belongs to. It will be selected from those listed in Table 3.4.

Table 3.4 Geographical_Area Category

| No. | Management Areas |
|---|---|
| 1 | Northern Area |
| 2 | Northern Middle Area |
| 3 | Southern Middle Area |
| 4 | Southern Area |

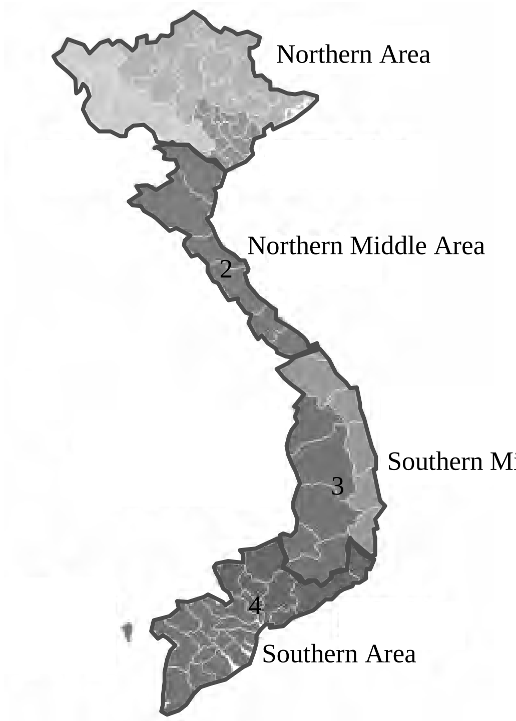



Figure 3.4 Management Area Classification Map

(3) Jurisdiction

"Jurisdiction" indicates the type of an organization in charge of the subject zone in data on pavement condition. It will be selected from those listed in Table 3.5.

Table 3.5 Jurisdiction

| Administration category | Description |
|---|---|
| RMB I | RMB I manages the target segment |
| RMB II | RMB II manages the target segment |
| RMB III | RMB III manages the target segment |
| RMB IV | RMB IV manages the target segment |
| Province | Province manages the target segment |
| Company | Company manages the target segment |
| Militaly | Militaly manages the target segment |
| Under construction | The target segment is under construction |

(4) Management Agency

"Management Agency" indicates the type of an organization in charge of maintenance of the subject segment in data on pavement condition. It will be selected from those listed in

Table **3.6**. "Other" will be selected if the maintenance organization falls under none of the organizations listed.

Table 3.6 Management Agency

| Admin | SB | Admin | SB | Admin | SB | Admin | SB |
|---|---|---|---|---|---|---|---|
| RMB I | SB I.1 | RMB II | SB II.1 | RMB III | SB III.1 | RMB IV | SB IV.1 |
| | SB I.2 | | SB II.2 | | SB III.2 | | SB IV.2 |
| | SB I.3 | | SB II.3 | | SB III.3 | | SB IV.3 |
| | SB I.4 | | SB II.4 | | SB III.4 | | SB IV.4 |
| | SB I.5 | | SB II.5 | | SB III.5 | | SB IV.5 |
| | SB I.6 | | SB II.6 | | | | SB IV.6 |
| | SB I.7 | | | | | | SB IV.7 |
| | SB I.8 | | | | | | |

(5) Road category

Road Category is the information used to identify the road category; whether the road national highway, expressway, provincial road, or others road. Road category consists only one digit number.

(6) Road number

Road Number is the number assigned to each road. It consists of 3 digit numbers.

(7) Road_Number_Supplement

Road_Number_Supplement is the alphabetical part number given to the number part of the road name. It consists of 3 digit numbers. In which Road Number Supplement is natural numbers such as 010, 020, 030, etc for A, B and C respectively.

(8) Branch number

“Branch number” is given to distinguish among branch roads of a main road. A branch number is given to a branch road, and Branch number “000” is given to any main road. Normally, the number begins with “001”.

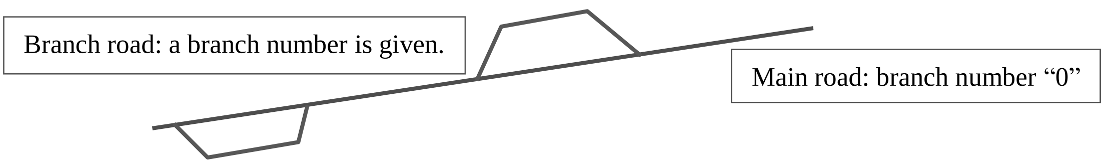



Figure 3.5 Conceptual Diagram of Branch Number

(9) Road Name

“Road Name” is the names that road administrators use to identify individual roads.

(10) Kilometer Post

Kilometer Post Information (From-To) is indicating the information of kilometer-post installed on site and distance from the nearest kilometer-post on the starting point side in units of 5m. Kilometer Post Information is defined by combination between kilometer-post number as “Km” and distance from kilometer-post as “m”.

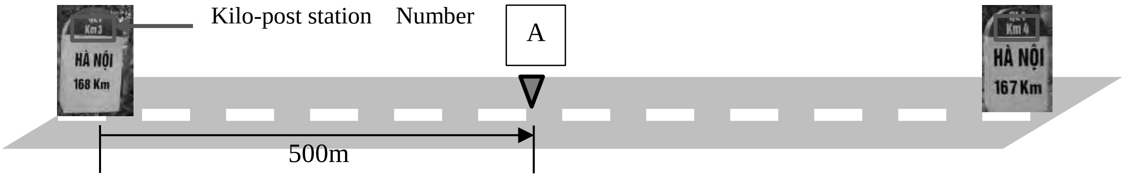



Figure 3.6 Conceptual Diagram of Kilometer Post

To input data on the kilometer post at Point A, numerical value “3” will be input in the box for “km” and numerical value “500” in the box for “m”.

If the number of kilo-post station is negative or a road segment starts from the zero kilo-post station to the negative direction, the absolute value of the distance to the negative direction is expressed from the nearest kilo-post station of the positive direction. The example shows from [-2k+210] to [-0k+100]; the negative signs show the negative direction from the kilo-post stations.

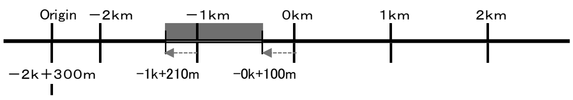



Figure 3.7 Road Segment Expression
(An Example: Negative Direction from "0" Kilo-Post station)

(11) Section Length

“Section Length” is the total distance between the points stated after “From” and that stated after “To”.

(12) Analysis Area

“Analysis Area” is the area of the subject segment, where an analysis has been conducted. It is calculated by the segment length multiplied by the segment width.

(13) Structure

If any of the structures listed in Table 3.7 exists in the subject segment, the corresponding code will be displayed. The structure name shall be stated in the box “Note”.

Table 3.7 Types and Codes of Structures

| Structure | Code |
|---|---|
| Bridge | B |
| Tunnel | T |
| Rock shed | R |
| Others | OT |

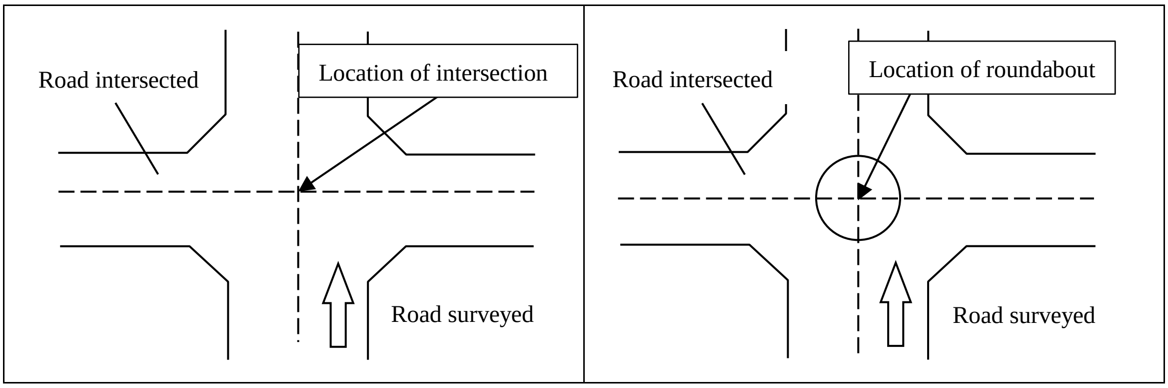
(14) Intersection

If any of the intersections listed in Table 3.8 exists in the subject segment, the corresponding code will be displayed. The System covers intersections with major roads, in which traffic signals and tollgates are placed.

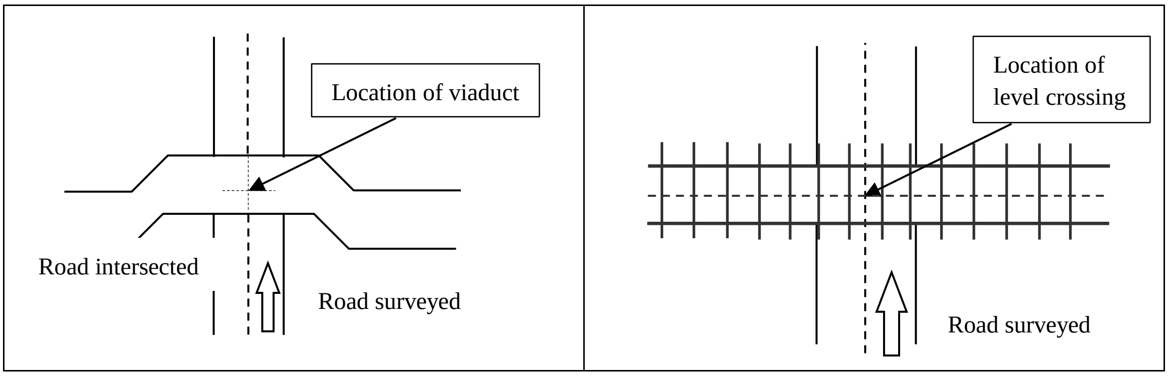
Table 3.8 Types and Codes of Intersections, and Descriptions in “Note”

| Intersection | Code | Description in “Note” |
|---|---|---|
| Intersection<br>(with traffic signals) | I | Name of the intersection or U/N |
| Roundabout | RA | Name of the main road connected or U/N |
| Viaduct | V | Name of the intersection or U/N |
| Railway crossing | RC | Name of the railway or U/N |
| Toll Gate | TG | Name of facility or U/N |
| Other | OT | Other |

The location of an intersection will be the point in which the center line of the subject road intersects with that of the road intersected.




Intersection with traffic signals Roundabout




Viaduct Railway crossing

Figure 3.8 Types and Locations of Intersections

(15) Overlapping

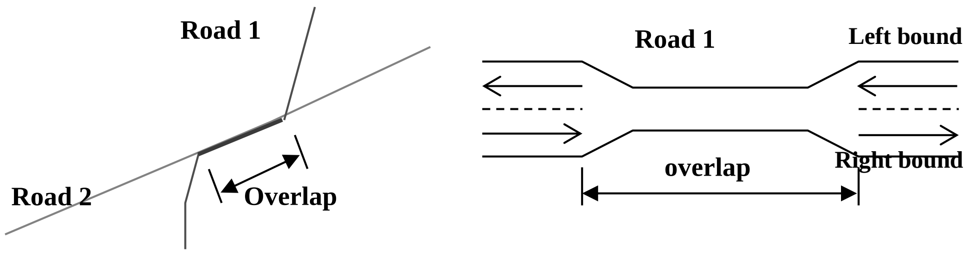
Table **3.9** lists places called “Overlapping”.

Table 3.9 Types of Overlapping

| Type | Description |
|---|---|
| Overlap with multiple roads | The state where two or more roads are overlapped in part |
| Overlap with left bound and right bound lanes | Single-lane roads that are too narrow to allow left and right vehicles to simultaneously pass |

Figure 3.9 illustrates the two types of overlapping segment. The organization in charge of overlapping segment will create data, and administrators will follow the handling rule given in Table 3.10.

Table 3.11 lists the codes displayed in data on pavement condition.




by multiple roads　　　　by left bound and right bound lanes

Figure 3.9 Overlapping segment

Table 3.10 Handling Rule for overlapping segment

| Overlapping segment | Road | | Organization managing overlapping segment | Road subject to data creation (overlapping segment) |
|---|---|---|---|---|
| | 1 | 2 | | |
| by multiple roads | Administered by DRVN | Administered by Province | DRVN | Road 1 |
| | Administered by DRVN | Administered by Province | Province | Road 2 |
| by left bound and rightbound lanes | by left bound and rightbound lanes | - | | Right bound lane |

Table 3.11 Codes of Overlapping segment

| Overlapping segment | Code Name |
|---|---|
| by multiple roads | R |
| by left bound and right bound lanes | LR |

(16) Number of lanes

Table 3.12 provides the definition of the number of lanes.

Table 3.12 Definition of Number of Lanes

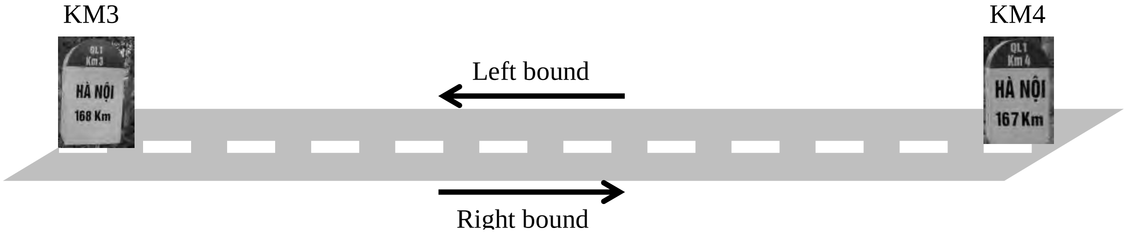
| Lane mark | No. of lanes |
|---|---|
| Yes | Number of lane marks except centerline |
| No | Number of vehicles that can travel parallel to each other |

(17) Direction

Direction is the direction of inspection. The direction in which the kilopost number increases is "Right" and the direction in which the kilopost number decreases is "Left".

Table 3.13 Direction Code

| Classification | Code Name |
|---|---|
| Left(Up) | L |
| Right(Down) | R |
| Single | S |




(18) Lane Position Number

Lane Position Number is input the measured lane number as an integer. The lane number is given from the center to the shoulder.

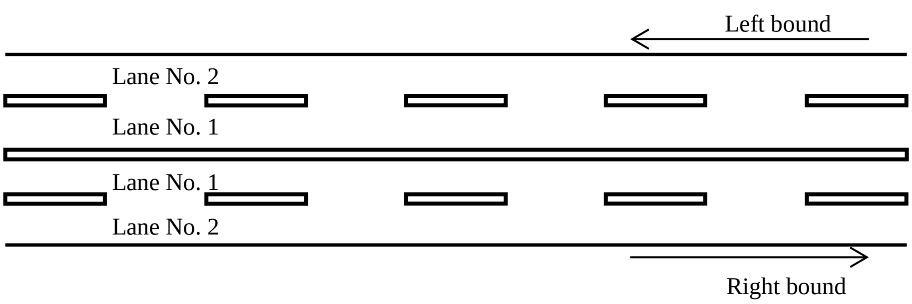



Figure 3.10 Definition of Lane Number

(19) Pavement type

For pavement type, one of the codes listed in Table 3.14 will be displayed.

Table 3.14 Category of pavement Type

| Surface type | Code |
|---|---|
| Asphalt concrete | AC |
| Bituminious Surface Treatment | BST |
| Cement concrete | CC |
| Other | Other |
| N/A | * |

(20) Condition_Year, Condition_Month

Condition Year / Month is the measured date. The date will be displayed as “yyyy/mm”.

(21) Cracking ratio

The cracking ratio is the proportion of area cracked to the entire area of the survey area.

(22) Patching ratio

The patching ratio is the proportion of area to which patching has been applied to the entire area of the survey area.

(23) Pothole ratio

The pothole ratio is the proportion of potholes to the entire area of the survey area.

(24) Total

The total crack ratio is the sum of the cracking, patching and pothole ratio of the subject area.

(25) Maximum of rutting depth

A rutting depth is a depression or groove worn in the pavement in the transverse direction by the repeated travel of vehicles or flows of asphalt mixture.

The maximum of rutting depth is the maximum amount of rutting depth in the survey segment.

(26) Average of rutting depth

The average of rutting depth is the average amount of rutting depth in the survey segment.

(27) International Roughness Index (IRI)

The IRI is the roughness index for the roughness of roads in the longitudinal direction in the survey segment.

(28) MCI

MCI stands for Maintenance Control Index. MCI is calculated to used by crack ratio, rutting depth and IRI. 10 of MCI value is the perfect condition. 0 of MCI value is the worst condition.

(29) Peculiar

Peculiar is a road surface damage which can’t be expressed with crack interpretation. the Classification of peculiar condition corresponding to Note field will be inputted.

Table 3.15 Category of peculiar conditon

| Surface type | Discription |
|---|---|
| 1.Broken | Once paved sections, but there is serious damage which cannot be evaluated. |
| 2.Unpaved<br>or unidentified Pav. Type | Unpaved: never paved.<br>Unidentified Pavement type: besides, AC, CC and BST. |
| 3.Wet Condition | The lane is covered with water or wet. |
| 4.Other damage | Other type damages that cannot be judged as cracking. (Ex. Raveling, Scratch, etc.) |
| 5.Invisible | Surface cannot be seen due to coverage of pavement surface by other objects, such as sand, soil, construction material, etc. |
| 6.Under construction | Ongoing construction work on the survey lane. |

(30) Note

Note is used to state the names of bridges, road name of the road intersected with the survey road, other structures, and peculiar condition as well as reasons for impassable roads.

# 4. General rule in survey

## 4.1 Impassable Road Segments

The end of a segment that cannot be surveyed shall be marked with a stick or equivalent. The location shall be photographed so that the location can be identifiable during data collection with the survey vehicle. For example, if there is a national boarder, a vehicle or person cannot enter the other side to record a starting point or end point. If it is the case, the starting point can be shifted to a point where a survey vehicle can enter. From the national boarder to the starting or end point, a walking measure is used. In the following example, a 10 meter distance is measured using a walking measure.

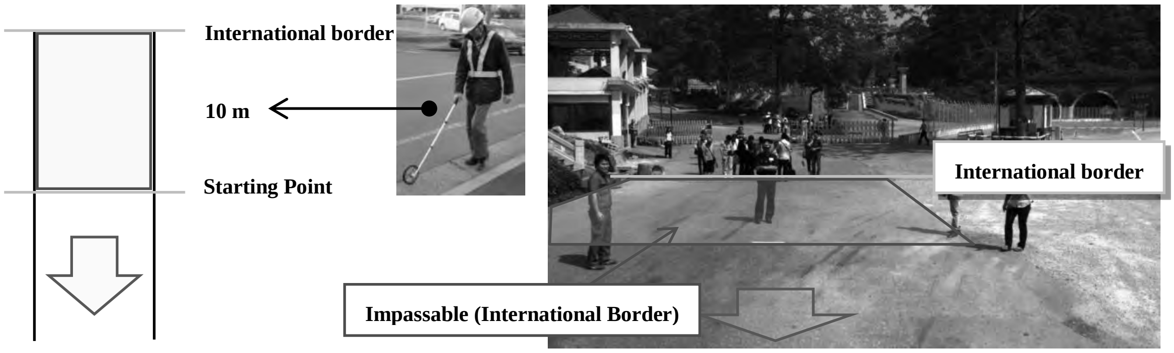



Figure 4.1 Work at Impassable Road Segments

## 4.2 Safety Control

The safety control measures listed in Table 4.1 will be thoroughly taken when using this System, in particular to conduct the field works. If any shortage is found, the list will be updated from time to time to incorporate items currently unlisted.

Table 4.1 Hazardous Events and Preventive Measures in the work

| Work type | Situation | Hazardous event | Measure |
|---|---|---|---|
| Pavement condition survey | Traveling | having measuring devices caught in a cable hanging low | Drivers will pay attentions to up in the air. |
| | Making preparation | taking a misstep and falling | Using footsteps. |
| | | Other vehicle hit the surveyor during the marking | While the operator mark in the road at the marking position, other operator make sure and keep the surrounding safety. |
| | The vehicle is parked | being rear-ended by a vehicle | Warning vehicles behind with hazard indicator |

### 4.3 Storage and Management of Data

Basically, the Analysis Team will store and manage the data. As Table 4.2, trip meter data and measurement data may be deleted when data on pavement condition has been completed and it has been confirmed that the data has no problem.

Table 4.2 Timing of Data Deletion

| Data | Description | Timing of Deletion |
|---|---|---|
| Trip meter data | Data obtained from measurement by trip meter | After data on pavement condition has been completed |
| Measurement data | Data acquired by REAL Mini | After data on pavement condition has been completed |
| Converted data | Data converted for reading the road surface | **Not deleted** |
| Road surface reading data | Data for reading, for which the width of the survey zone has been set | **Not deleted** |
| Road surface property data | Data processed and listed in a table format | **Not deleted** |

# 5. Instruction Manual of Trip Meter

## 5.1 Introduction

One set of Trip Meter including a Trip Meter and an iPad that are stored in an aluminum case.

- Trip Meter is a device to record distance using the pulse signal from a vehicle.

- iPad is a viewing and parameter encoding device used in association with Trip Meter.


Figure 5.1 Trip Meter in an Aluminum Case

Trip Meter is installed to a car to conduct field reconnaissance- the first phase before pavement condition survey. By using Trip Meter stations of kilometer posts, road structures would be defined. Please don’t update the “iOS”. The application will not use in the new iOS enviorment.

## 5.2 Work flow

To use the Trip meter for measuring distance, it’s necessary to be follow the work flow below:

Equipment installation

↓

Connection setting

↓

Calibration and parameter setting

↓

Measure

↓

Data arrangement

### 5.3 Installing Equipment

Installation of Trip Meter requires following connections:

1) Vehicle Speed Pulse Signal Input Cable
2) Power cable connection
3) USB cable connection
4) Wi-Fi connection.

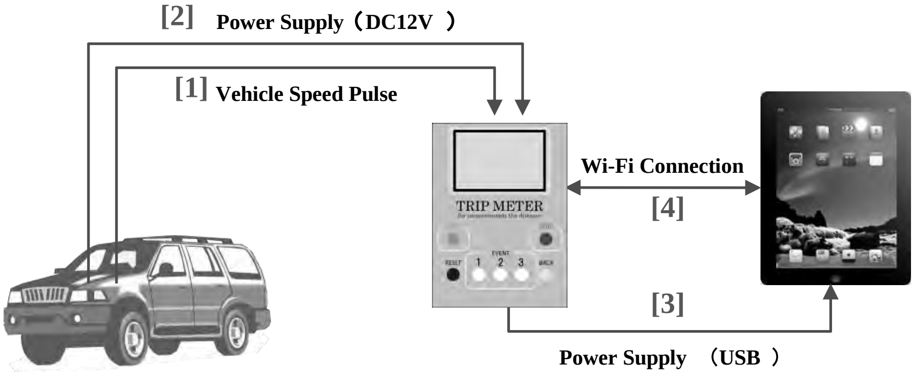



Figure 5.3 Vehicle, Trip Meter and iPad Connection

### 5.4 Vehicle Speed Pulse Signal Cable Connection

The vehicle speed pulse input cable from Trip Meter shall be connected to the vehicle speed pulse output cable of the vehicle. The cable shall be securely connected so that it would not be disconnected due to vibration from the vehicle. It is to note that the location of the cable of pulse out may be different from vehicle to vehicle. It is advised to prepare a vehicle speed pulse cable beforehand.

### 5.5 Power Cable Connection

Trip Meter shall have 12 Volt power supply. The power cable from Trip Meter shall be connected to the cigar socket. When power is supplied, Trip Meter automatically starts.

Figure 5.4 Power Cable Connection

## 5.6 USB Cable Connection

Trip Meter and iPad should be connected to supply power to iPad. It is to note that the USB cable is only to supply power; not data will be transferred.

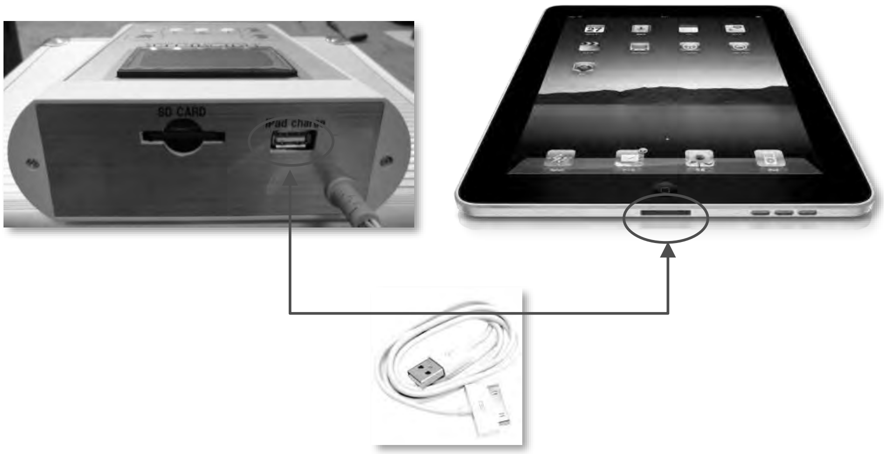



Figure 5.5 USB Cable Connection

## 5.7 Data Connection Setting

Trip Meter and iPad should be connected through Wi-Fi to transfer data.

(1) Wi-Fi Setting

Wi-Fi connection of Trip Meter and iPad is established. Five seconds after Trip Meter is turned on, Trip Meter emits Wi-Fi signal. iPad shall be turned on after Trip Meter emits the Wi-Fi signal. Setting of iPad is as follows:

1) Tap "Setting" icon of iPad.

Figure 5.6 Setting Icon

2) Tap Wi-Fi icon at the left side.


Figure 5.7 Selecting the Wi-Fi Icon

3) Among the list of network connections, SSID with a colon will be shown:

70:d5:7e:xx:xx:xx.

Tap the connection to establish connection with Trip Meter.


Figure 5.8 The Network Name

(2) Initial Connection

When Wi-Fi connection between Trip Meter and iPad is established for the first time, following setting shall be established.

1) Tap  and show details.

2) Tap the "Static" button.

3) Tap the IP address and input"192.168.100.2."

4) Tap subnet mask, and enter"255.255.255.0."

5) Tap the top-left corner button to go back to the previous page.

6) When the network name (SSID), which was initially set, is tapped, the system asks a password. Enter [pasco_9821431].

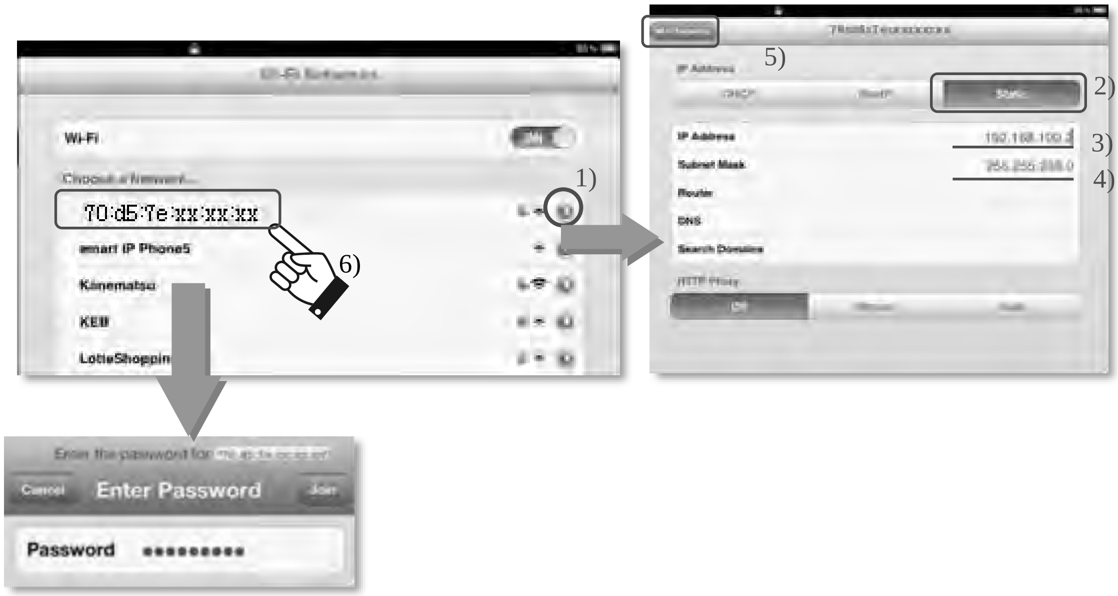



Figure 5.9 Initial Setting Procedure

## 5.8 Starting Application

Tap the Dtmeter on iPad to start the application.


Figure 5.10 Trip meter Icon

When the application is started, a connection between Trip Meter and iPad is established. After the connection establishment, "0" will be displayed when the vehicle is stopped. When the vehicle is moving, the display shows the distance. The time counter starts in seconds and displayed as indicated with the red arrow.

When the counter does not start, Trip Meter and iPad are not connected. Refer the trouble shooting section and try to establish the connection.

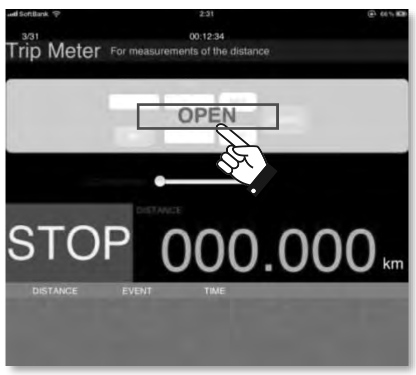



Figure 5.11 Application View

### 5.9 Initial Setting for Measurement

The initial setting for measurement shall be conducted when: Trip Meter is installed to a vehicle for the first time; Trip Meter is transferred to another vehicle; a tire is changed; Trip Meter has not been used for more than a month.

(1) Time Setting

Time is set using the iPad application Dtmeter as in the following procedure:

1) Tap the Open button.
When Trip Meter has been active and measuring distances, the display would not change to the Setting mode even when the Open button is tapped.

2) Tap the Date text box.
3) Enter the date in a date format: yy/mm/dd.
4) Tap "Enter" to end.
5) Tap the TIME text box.
6) Enter the time in a time format: hh:mm:ss.
7) After entering, Tap "Enter" to end the operation.
8) The SET button is displayed; Tap the SET button.
9) The setting button and other menu are hidden under the OPEN button and the time will be displayed.

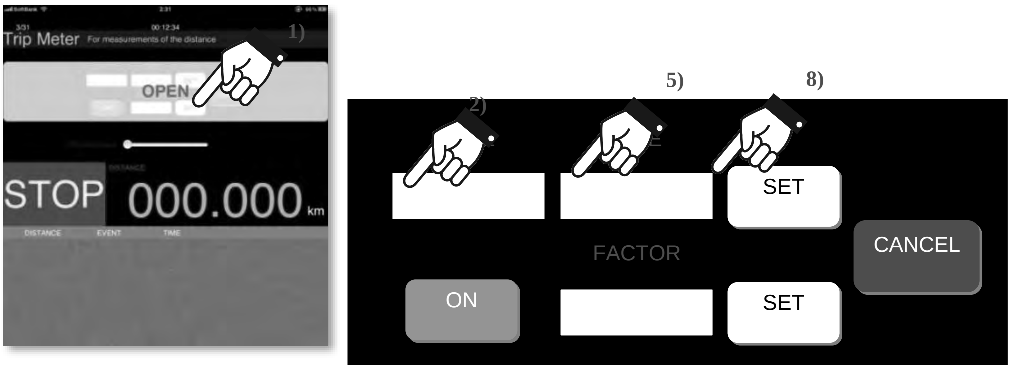



Figure 5.12 Time Setting Procedure (iPad)

(2) Distance Calibration

Trip Meter should be calibrated to determine the adjustment value. The calibration is conducted on a straight segment of road with one kilometer distance actually measured.

The starting point and end point should be marked as in Figure 5.13.


Figure 5.13 Marking Example – 1 km Distance

Notes:

- The calibration place needs conditions such as low traffic, Easy to turn.
- Trip Meter should be calibrated to determine the adjustment value once a year.
- When the vehicle changes the tire, Trip Meter should be calibrated to determine the adjustment value.

a. Setting before the Calibration Run

1) Tap the OPEN button. It is to note that while measuring the system cannot be changed to the Setting mode.
2) If the FACTOR text box is not shown, tap the ON button.
3) Tap the FACTOR text box.
4) When the keyboard is shown, enter 10000 as a preparation value of adjustment. 10000 mean an adjustment value of 1.0000.
5) After entering tap "Enter."
6) When the SET button is displayed, tap the SET button.
7) The SETTING button and others are hidden under the OPEN button, and the adjustment value 1.0000 is set. After the SETTING is completed, run the calibration distance.

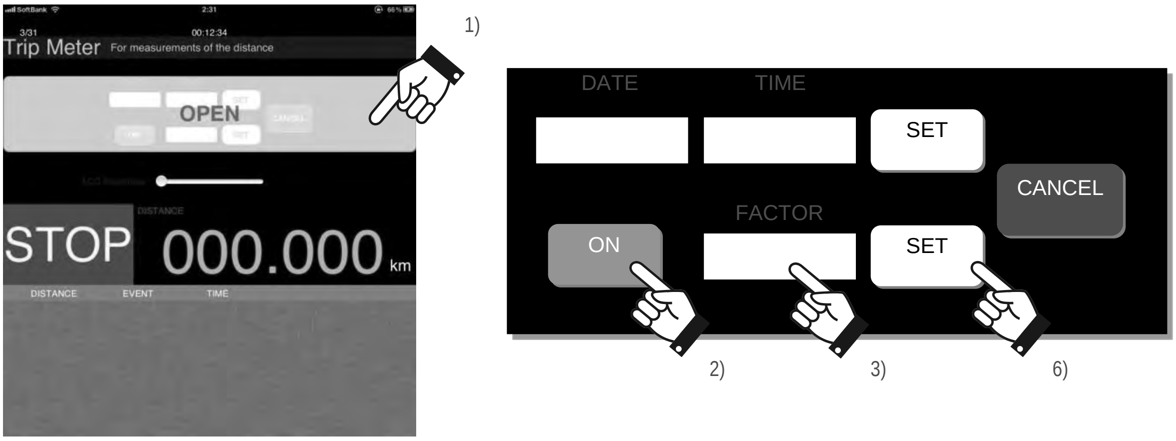



Figure 5.14 Operation Procedure before the Calibration Run

b. During the Calibration Run

1) Press the START button at the starting point.
2) Confirm [0] m, [S] on the iPad screen.
3) Drive one kilometer along the calibration segment set.
4) At the end point of the segment, press the STOP button of Trip Meter.
5) On the iPad screen, [travelled distance] m, and [E] will be shown.

The calibration runs shall be conducted more than three times.

When three similar values are acquired from reading the [distance travelled] on the screen, calculate the average.

The average value times ten will become the adjustment value. For example, the average of the three values 1234, 1230, and 1232 is 1232; the adjustment value is 1232 time 10 which is 12320. It is to note that during calibration, the unit of [distance travelled] becomes the number of pulse; during actual measurement, the number of pulse is converted to meter automatically.

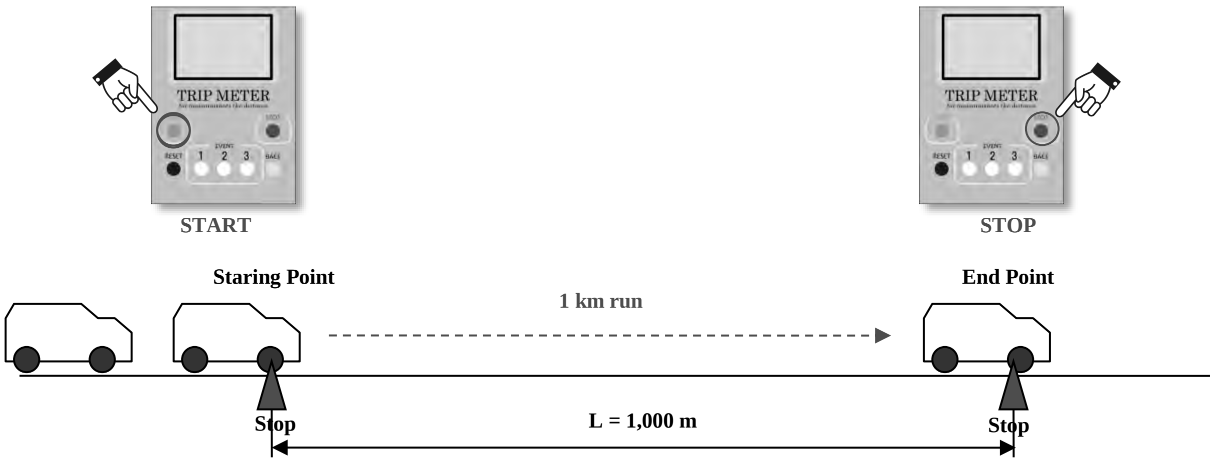



Figure 5.15 Operation Procedure during the Calibration Run

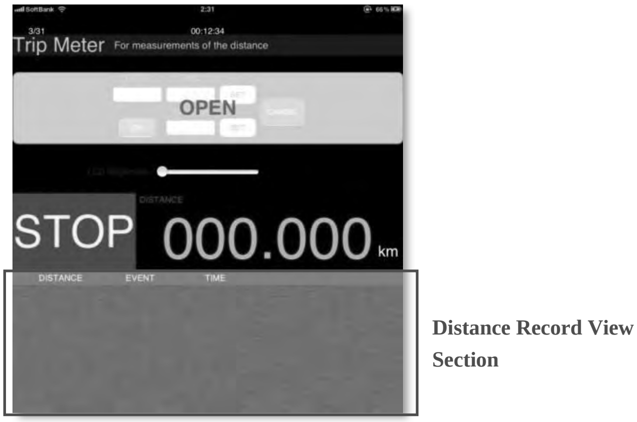



Figure 5.16 Distance Record View Section

(3) Distance Adjustment Parameter Setting

Distance adjustment parameter setting shall follow the following procedure.

1) Tap the OPEN button.
2) Tap the ON button.
3) Tap the FACTOR text box when it is shown.
4) Enter the five digit parameter for the distance adjustment.
5) Tap [SET].
6) Tap the SET button, when it appears.
7) The adjustment value appears under the OPEN button.

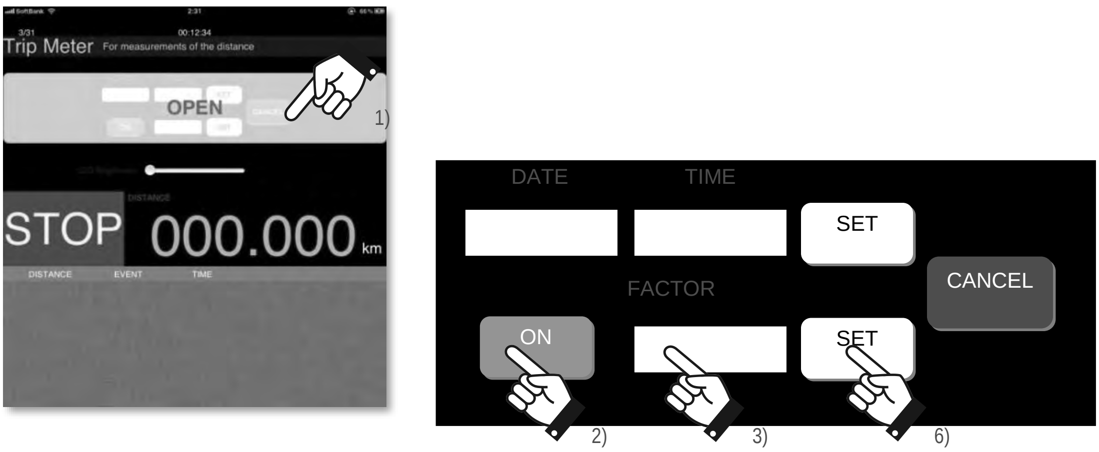



Figure 5.17 Procedure of Distance Calibration Parameters

After setting the trip meter, indicate starting points and ending points shall be marked and noted. The leader shall indicate the roads of the day onto the road map.

## 5.10 Measure

(1) Functions of each button

Functions of each button has are follows.

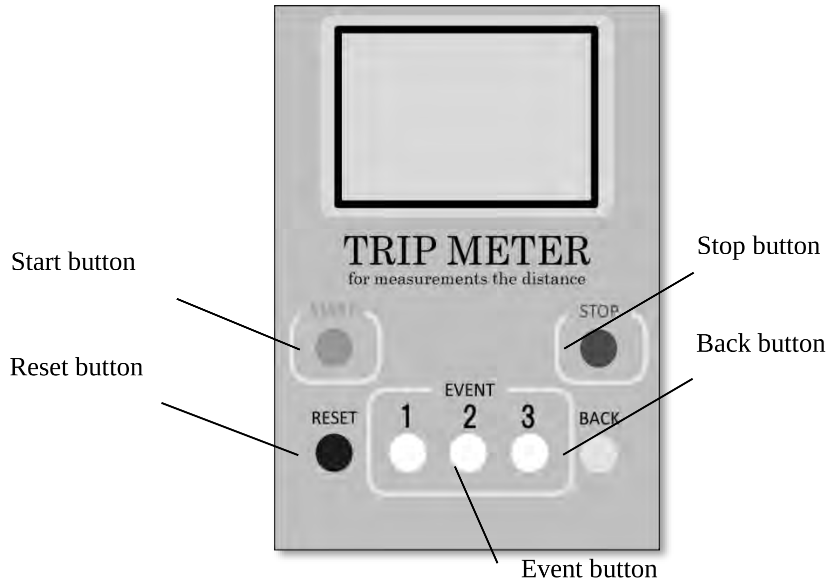



Figure 5.18 Functions of event buttons

1) Start button
When the operator pressed the “Start” button, the trip meter start the measurement of distance.

2) Stop button
When the operator pressed the “STOP” button, the trip meter Stop the measurement of distance.

3) Reset button
When the operator pressed the “Reset” button, the trip meter save the distance at that time.

The operator press the “Reset” button when there are kilometer posts or starting, ending points.

4) Event button
When the operator pressed the “Event” button, the trip meter save the event number and the distance at that time.

-Button No.1

The operator press the button No.1 when there are road structures such as bridge, tunnel…

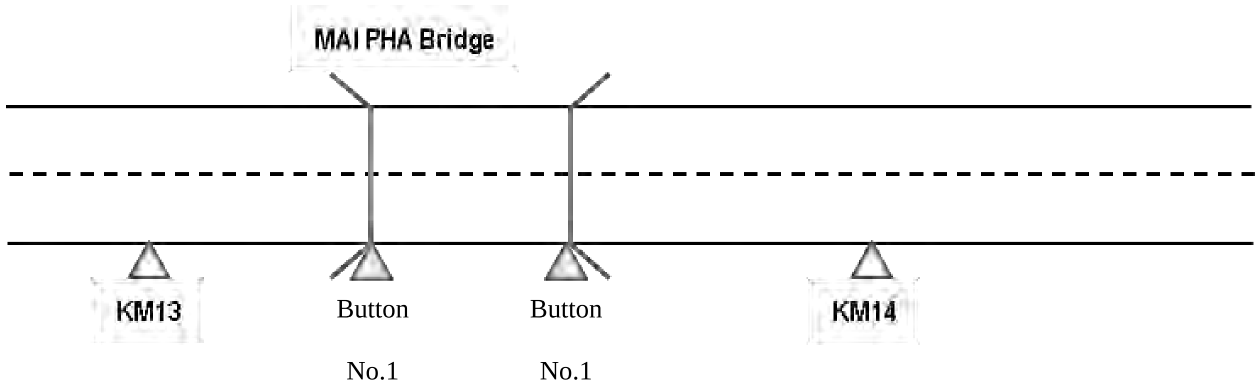



Figure 5.19 Pressing the Event Button No.1 at Bridge

-Button No.2

The operator press the button No.2 at intersections

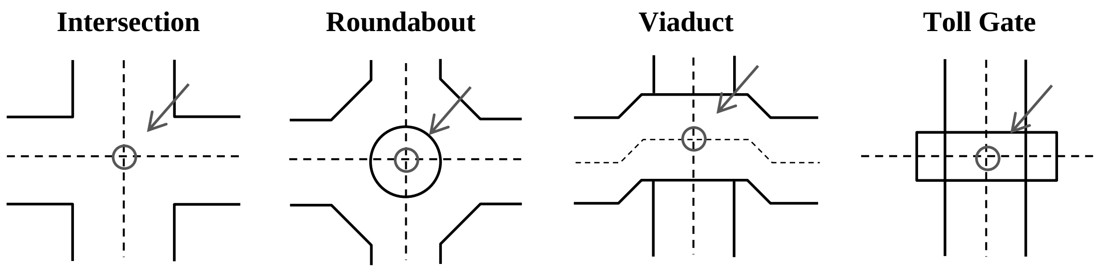



Figure 5.20 Locations of Pressing the Event Button 2 at Intersections

- Button No.3

The operator press the button No.3 at the other events such as Jurisdiction classification, overlapping, lane number change…

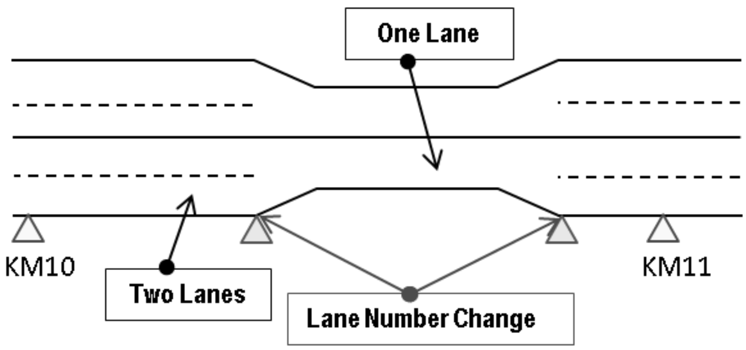



Figure 5.21 Lane number change – button No.3

5) Back button

When the car move back ward, Press "Back" button then the Trip Meter would count negative distance. Therefore the car can be move back ward during measure time without effect to accuracy of result.

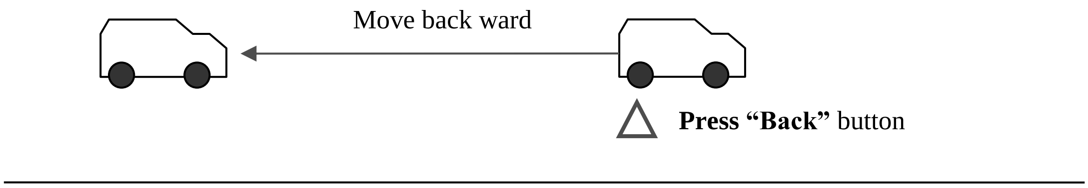



Figure 5.22 Back button

(2) Measure

The Measurement of distance follows the following procedure.

1) Press the "Start" button
2) Press the "Reset" button at starting point
3) Press the "Reset" button at each kilometer post
4) Press the button No.1 at structure such as bridge, tunnel…
5) Press the button No.2 at intersection
6) Press the button No.3 at the other events such as Jurisdiction classification, overlapping, lane number change…
7) Press the "Reset" button at ending point
8) Press the "Stop" button

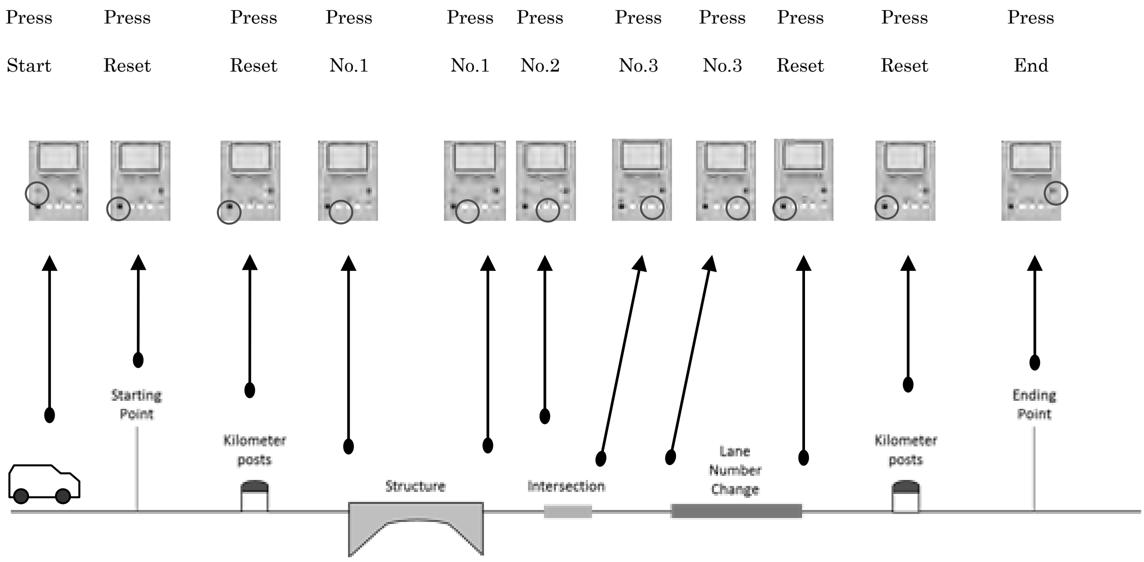



Figure 5.23 Procedure of measurement

(3) Notes of the measurement

During the measurement, the vehicle should keep the right lane. The driver doesn't drive the vehicle in zigzag.

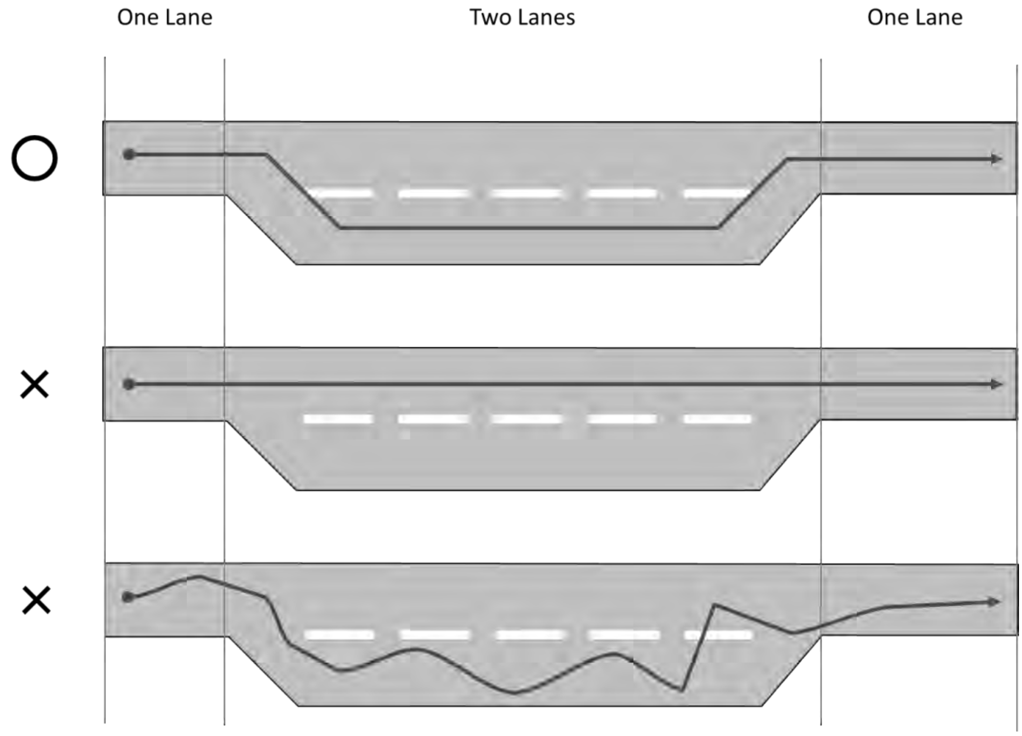



Figure 5.24 Notes of the measurement

(4) Data format

Measured data save to the SD card. Data construct and Data format shows the Figure 5.25.

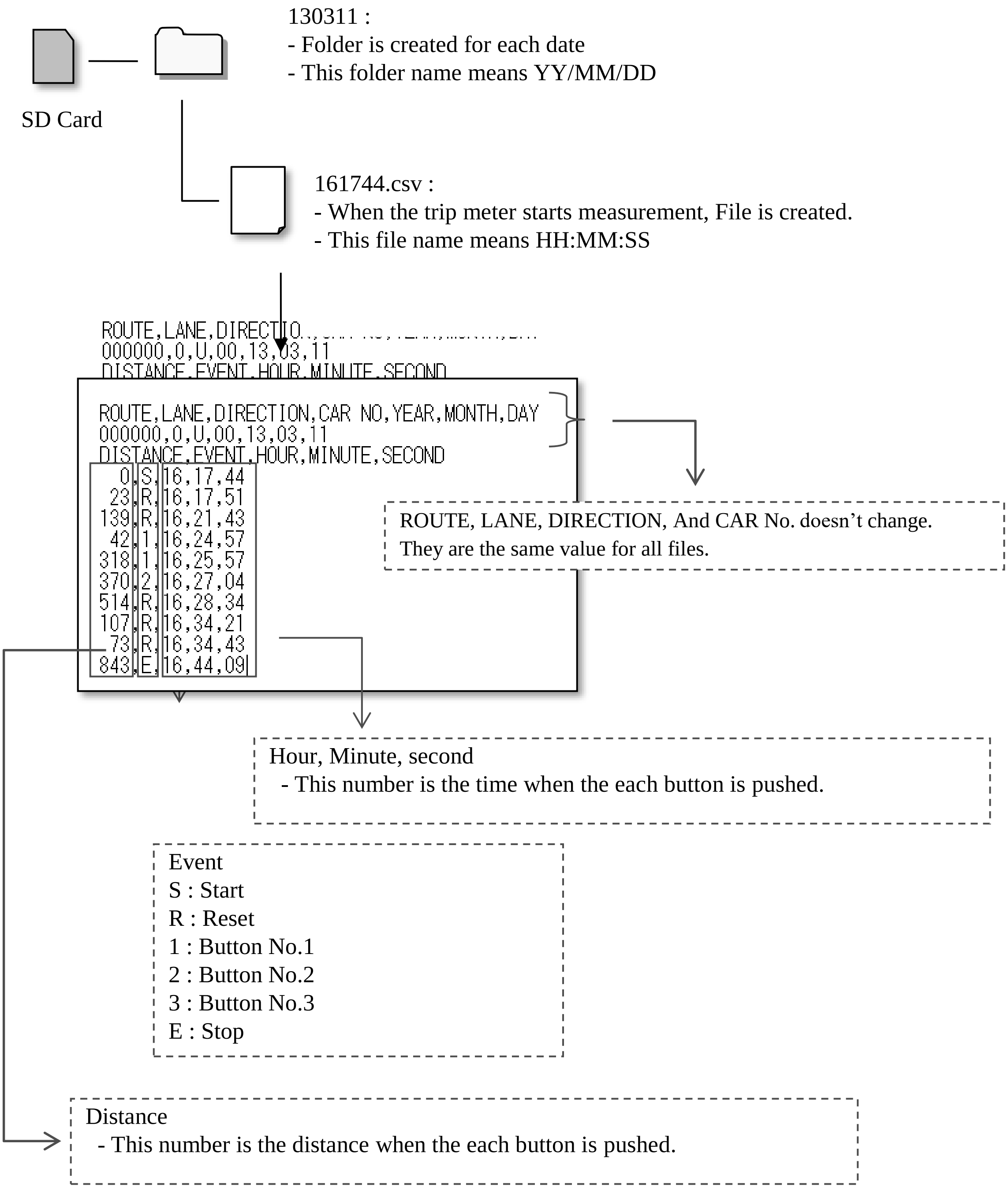



Figure 5.25 Data Construct and Data Format

# 6. Instruction Manual of Operation of REAL Mini

## 6.1 Objective of Survey

The objectives of road surface survey are to:
- take a picture of the Road Surface images for crack analysis
- measure the crossing road profiles for rut
- measure the vertical road profiles for IRI
- measure the location by GPS
- take a picture of forward view images

## 6.2 Intended Users of the Manual

This manual was intended to be used by surveyer of pavement condition survey.

## 6.3 Overview of REAL Mini

REAL Mini has the following sensors: Camera for front image (FC), GPS, Inertial Measurement Unit (IMU), Laser Scanner (LS), Cameras for road image (RC), Laser Displacement Sensors (LDS). FC record front images; GPS records locations; IMU and LDS identify longitudinal profile; RC record road images in black and white to identify cracks; LS records cross section profiles to identify rut depths. On the roof of the vehicle, a solar panel is installed to secure additional power to the on-board equipment.

All the sensors are mounted to the vehicle in a secure way. As the FC record the front view, the location of the FC should be high enough not to include the front of the vehicle itself. The clearance of vehicle should be high enough to have sufficient space between the road surfaces to the LDS.

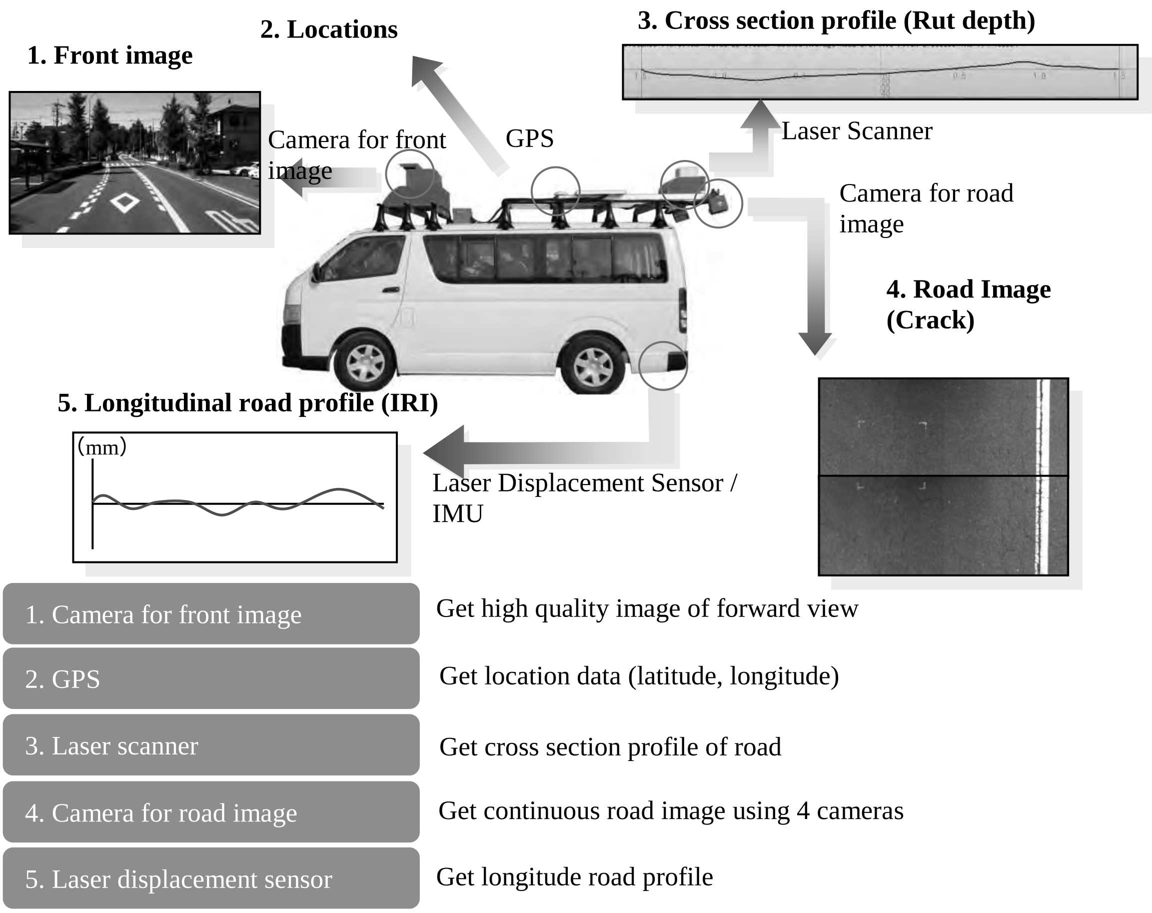



Figure 6.1 Outside of REAL Mini

Table 6.1 Equipment of Outside Vehicle

| Name | Explanation |
|---|---|
| Camera for front image (FC) | Equipment which measure the forward view images |
| GPS | Equipment which measure the location of measurement point. |
| IMU & Leaser Displacement Sensor (LDS) | Equipment which measure the vertical Profiles (IRI) |
| Camera for road image (RC) | Equipment which measure the road surface images (Crack) |
| Laser Scanner (LS) | Equipment which measure the crossing Profiles (Rut) |

There are two computer monitors and control devices in the vehicle. The Right monitor shows the images from the camera for road images. The Left monitor shows the front view, data and information from GPS, IMU & LDS, and LS.

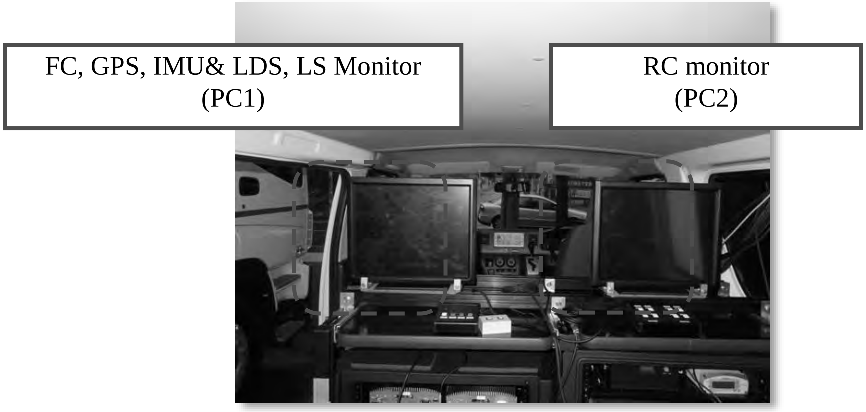



Figure 6.2 Inside of the Vehicle

Figure 6.3 Survey application (PC1, PC2)

On the front of the inside vehicle various pieces of equipment are set-up and installed.

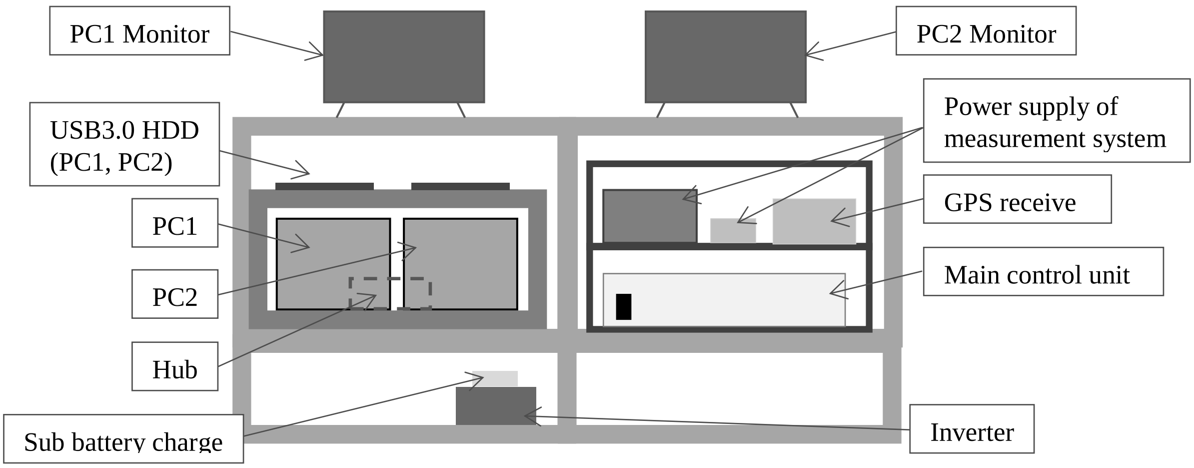



Figure 6.4 On-board Equipment in the Rack of the Vehicle

Table 6.2 On-board Equipment

| Name | Explanation |
|---|---|
| Monitor | Equipment which show the measurement application. |
| Power supply of measurement system | Equipment which supplies stable electric power in order to prevent the malfunction according the output (100V AC) of an inverter to the instability of electric power to each equipment (Main Control Unit, |

| Name | Explanation |
|---|---|
| | E-SATA HDD, Hub, Monitor). |
| Power supply of solar panel | Equipment which transforms the electric power of solar panel into 12V AC electric power.<br>This electric power is automatically supplied to sub-battery at the time of parking. |
| GPS receiver | Equipment which receives positioning electric wave to compute longitude, latitude, and altitude from positioning satellites. |
| Main Control Unit | Power-source supply is carried out to each equipment (Camera for front image, Laser displacement Sensor, IMU, camera for road image, Laser Profiler, PCs 1 and 2). The unit calculates distances based on the pulse data to be sent to PC1 and PC2. |
| USB3.0 HDD | The external storage for moving data to the data conversion PC data.<br>Both PC1 and PC2 are equipped with one E-SATA HDD each. After the data collection survey, the data are transferred to the storage. |
| PC1 | A PC to record GPS positioning data, travel distance, IMU data, data from Laser Displacement Sensor as it controls the sensors. It records the basic survey data such as starting and ending the survey. |
| PC2 | A PC for the camera for road image displaying to the monitor and records the camera for road image setting such as road, aperture and gain. |
| Hub | A hub for an interface to build a network with the road surface camera (four sets) and PC2 which are GigE, in order to record the images on PC2. |
| Sub battery charger | The device supplies the power from vehicle to sub-battery. |
| Inverter | The device transfers power of the sub-battery (12 V direct current) to 100 V alternative current. The AC power is supplied to the equipment after stabilized through the power supply measurement system. |

## 6.4 Method

(1) Work Flow

Work flow of REAL Mini is shown below Figure 6.5.

STEP 1 : Preparation of outside vehicle

↓

STEP 2 : Preparation of Measurement System

↓

STEP 3 : Road Data Collection

↓

STEP 4 : Check the Measurement Data

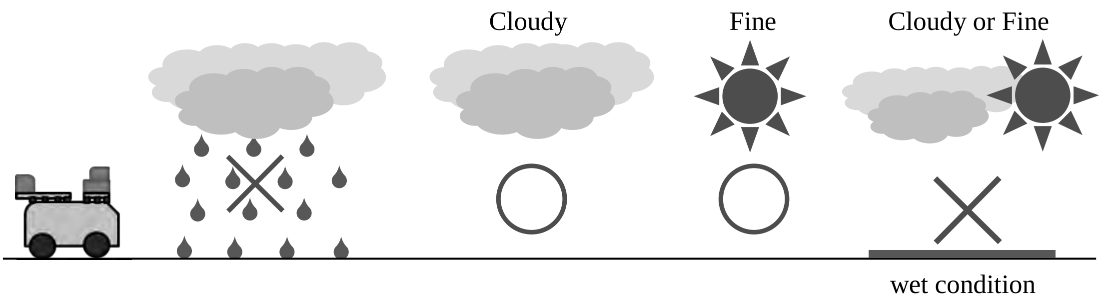
↓

STEP 5 : After measurement

↓

STEP 6 : Tidy up the equipment

*NOTE:*
- *REAL Mini cannot to measure the data when the weather is rain.*
- *Even if the weather is fine or cloudy, REAL Mini cannot to measure the data if the road surface is wet.*




(2) Method

**1) STEP 1 : Preparation of outside vehicle**

- Tighten the screw of roof rail
- Open the cover (RC,LP)
- Open the cover (LDS)
- Clean the lens (FC,RC,LP)

a) Tighten the screw of roof rail

Figure 6.6 Tighten the screw of roof rail

b) Open the cover (RC,LP)

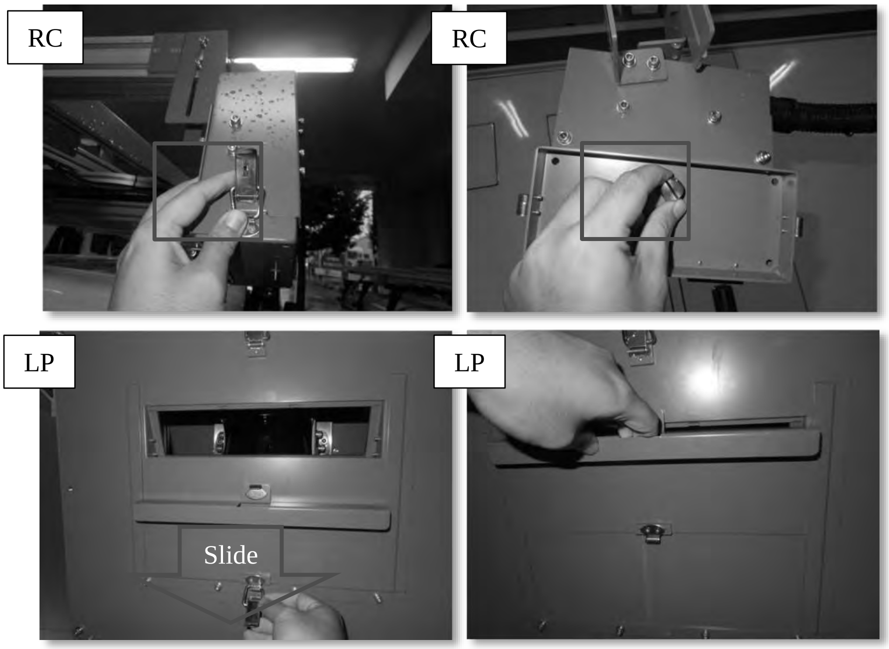



Figure 6.7 Open the cover (RC,LP)

c) Open the cover (LDS)


Figure 6.8 Open the cover (LDS)

d) Clean the lens (RC ,LP, FC)

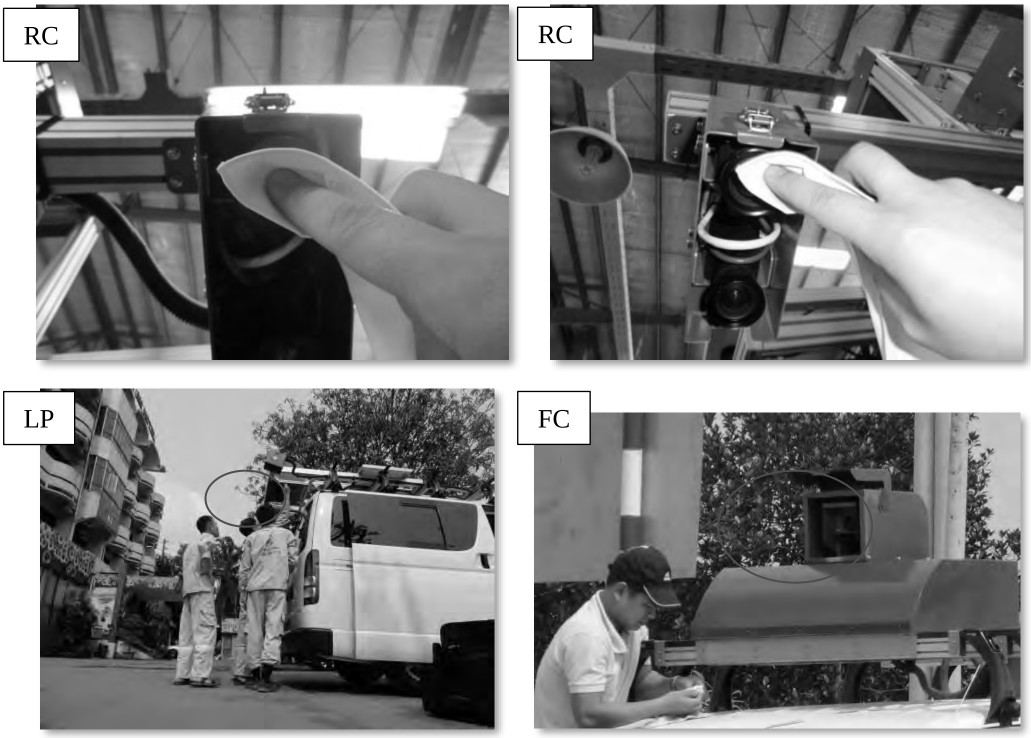
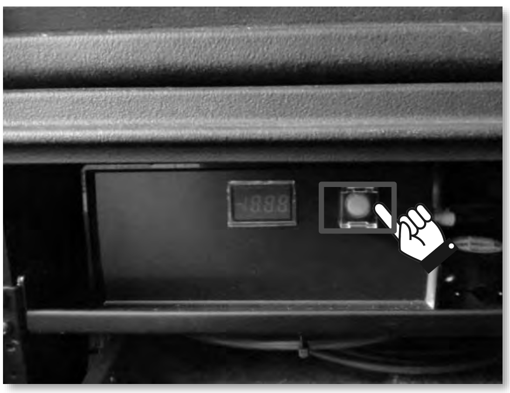



Figure 6.9 Clean the lens (RC, LP, FC)

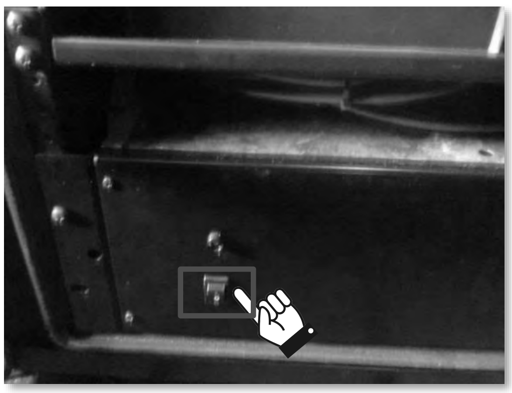
**2) STEP 2 : Preparation of measurement system**

- Turn on power (Power measurement system, Main control unit, PC1 and PC2)
- Check the activation of PC and Main Control Unit (MCU)
- Select “Measure”
- Select “Vietnam" from the list
- Press “OK”
- Input the road information
- Check the connection with the measurement devices
- Set the shutter speed and gain of the camera

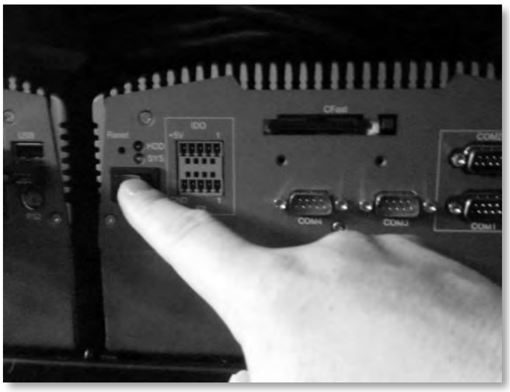
a) Turn on the power



Power measurement system



Main control unit



After turn on the power,
wait more than three minutes

PC1 and PC2

Figure 6.10　Turn-on every devices

b)　Check the activation of PC and Main Control Unit (MCU)


Figure 6.11　Main Control Unit Monitor

*NOTE:*
*If PC isn't connect to MCU, turn off power and turn on power.　If the connection still cannot be confirmed, please check the slack of the wiring.*

c)　Select "Measure"


Figure 6.12 Selecting the Measure Button

d) Select the Project from the list
e) Press “Next”

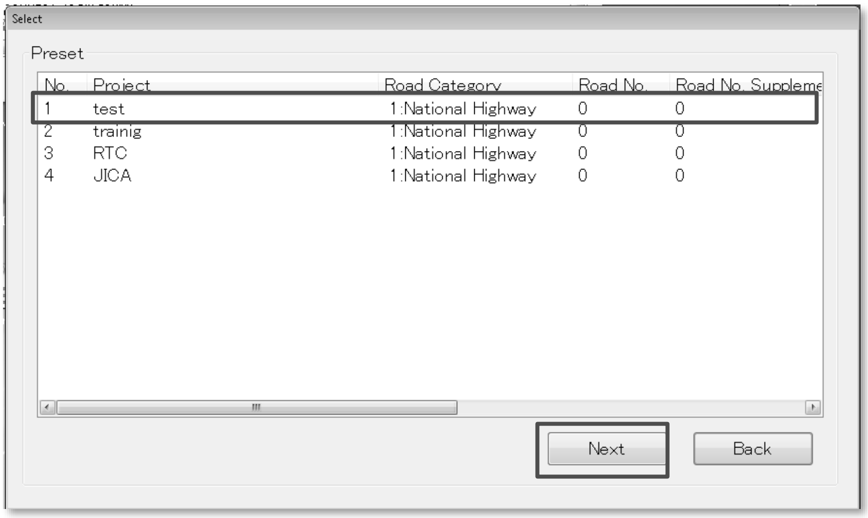



Figure 6.13 Selecting Appropriate Data

f) Input the road information: The form has the text boxes to enter:

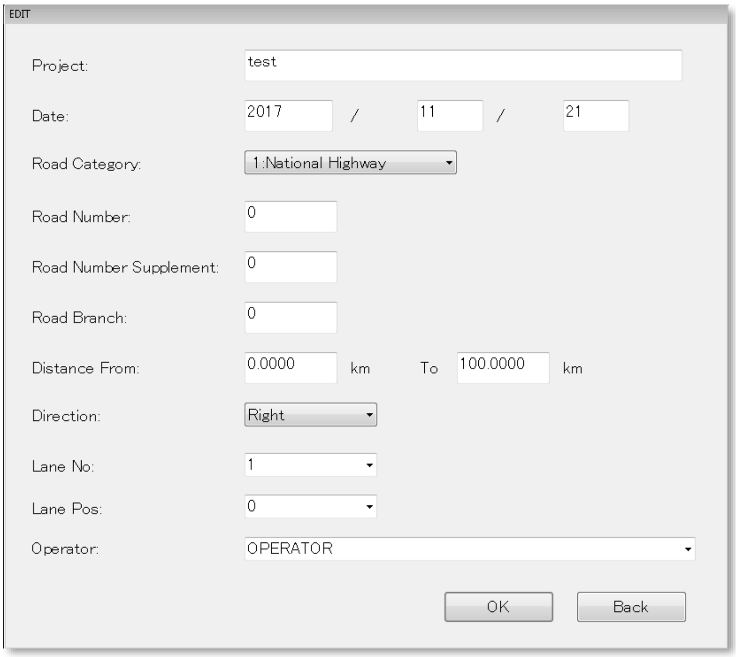



Figure 6.14 Road Information Dialogue Box

Table 6.3 Entering the Data to Text Boxes

| Text Box | Note |
|---|---|
| Project (Project name) | Automatic input |
| Date (Measurement date) | Automatic input |
| Road Category (Road kind) | Automatic input |
| Road Code ( Code of measurement road) | Input the 3 digit number |
| Road Number Supplement | Input the 3 digit number |
| Road Buranch | Input the 3 digit number |
| Distance from to (KP information of measurement road) | Input KP of start and end |
| Left Right (Direction of road) | Select from the list (1 Left, 2 Right, 3 Single) |
| Lane No (Number of lane) | Select from the list |
| Lane Pos (Position of lane) | Select from the list |
| Operator (Operator) | Select from the list |

g) Check the connection with the measurement devices


Figure 6.15 Operation State (Green)

The colors indicate the connection conditions.

Table 6.4 Measurement Device Connection Status

| Color | Condition |
|---|---|
| Red (Busy) | Not connection |
| Yellow (Unsettled) | Search |
| Green (Idle) | Connection |

*NOTE:*
*- Measurement is possible even "Search" state of the GPS*
*- If measurement device is not connect, turn off power and turn on power*
*- If the connection still cannot be confirmed, please check the slack of the wiring*

h) Set the shutter speed and gain of the camera.

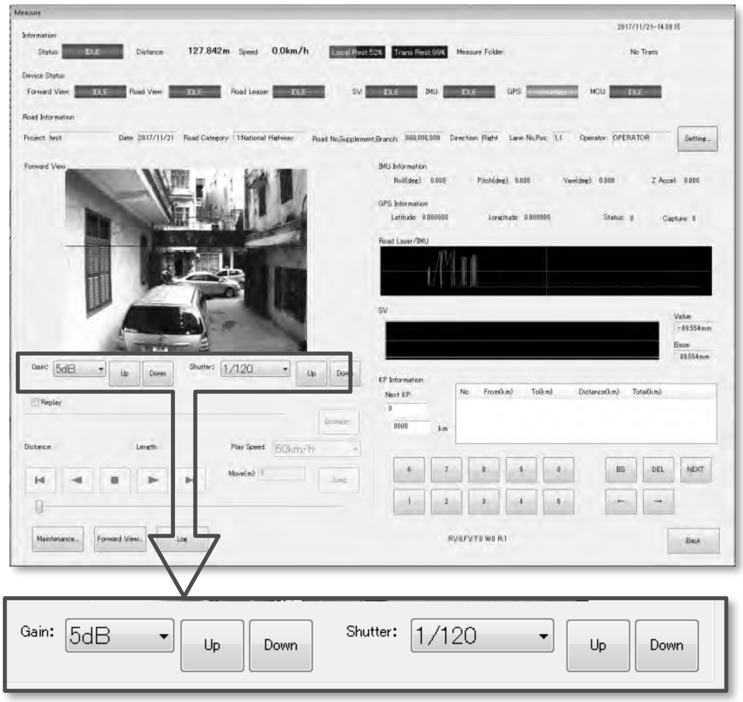



Figure 6.16 Shutter Speed and Gain Control PC1


Figure 6.17 Shutter Speed and Gain Control PC2

**3) STEP 3 : Road Data Collection**

- Push the white switch of control box
- Check the translation to state “Ready”
- Start the measurement by push the white switch of control box
- During measurement,
  - Push the green switch of control box to register the KP information
  - Change the camera settings to suit the image of state
- End the measurement by hold down the red switch of control box

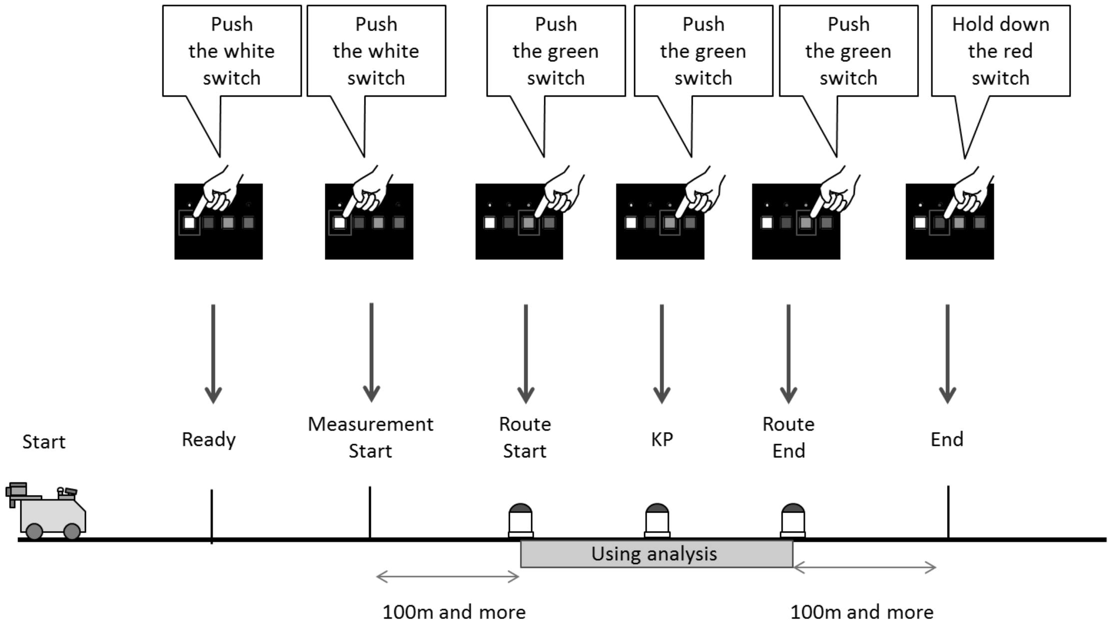



Figure 6.18　Operation Sequence of the Buttons

a)　Push the white switch of control box


Figure 6.19　White Button (Ready)

b)　Check the translation to state “Ready”

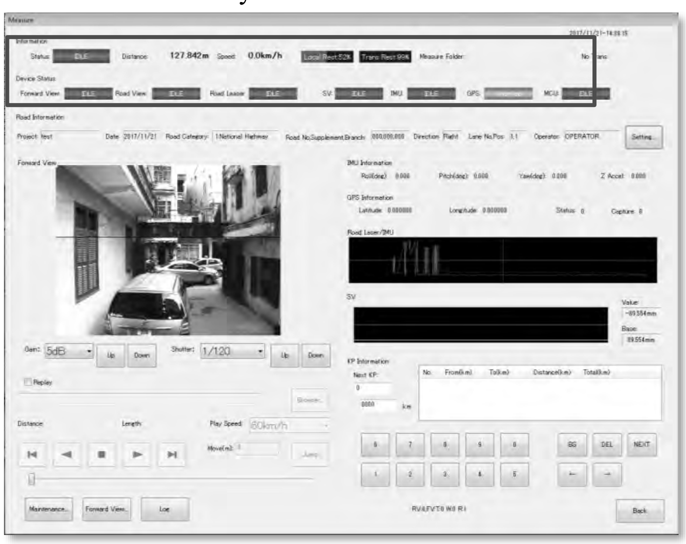



Figure 6.20 Confirm the Ready View

c) Start the measurement by pushing the white button of the control box


Figure 6.21 Pressing the White Button to Start the Measurement

*NOTE:*
- *REAL Mini should start the measurement before 100m and more of raod start.*
- *REAL Mini should stop the measurement after more than 100 meters from the end point.*
- *When a capacity of HDD is small (under 5%), the road condition data would not be collected.*
- *In that case, the operator should delete the data in HDD of PC.*
- *When the voltage of sub-battery is under 11.7V, the measurement system shut down.*
  *(Usually, the voltage of sub-battery is 12.3V - 12.4V)*


- *Operator sometimes should check the voltage of sub-battery during measurement.*

d) During the measurement
   Push the green button to register the kilo-post station information


Figure 6.22    Kilo-post Station Recording

Change the camera settings to suit the image of state by controlling the switch as in Figure 6.22. The camera for front image changes the iris of the lens by Iris controller.

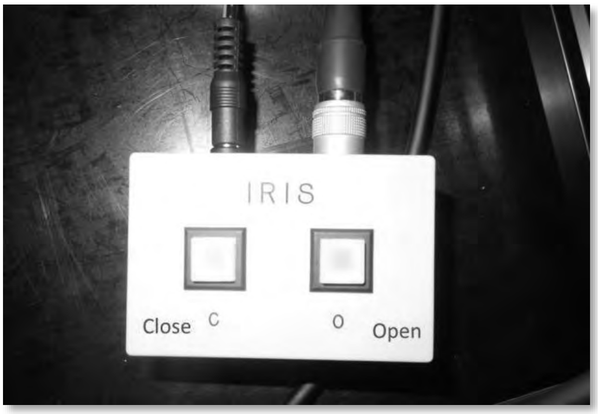



Figure 6.23    Aperture Setting

Change the shutter speed: click **"Forward view"** button then enlarged forward view window would appear. Change shutter speed to get the clearest image.


Figure 6.24    Changing the Shutter Speed of Camera for front image

The shutter speed and gain of the rear cameras can be changed by measurement application or controller.

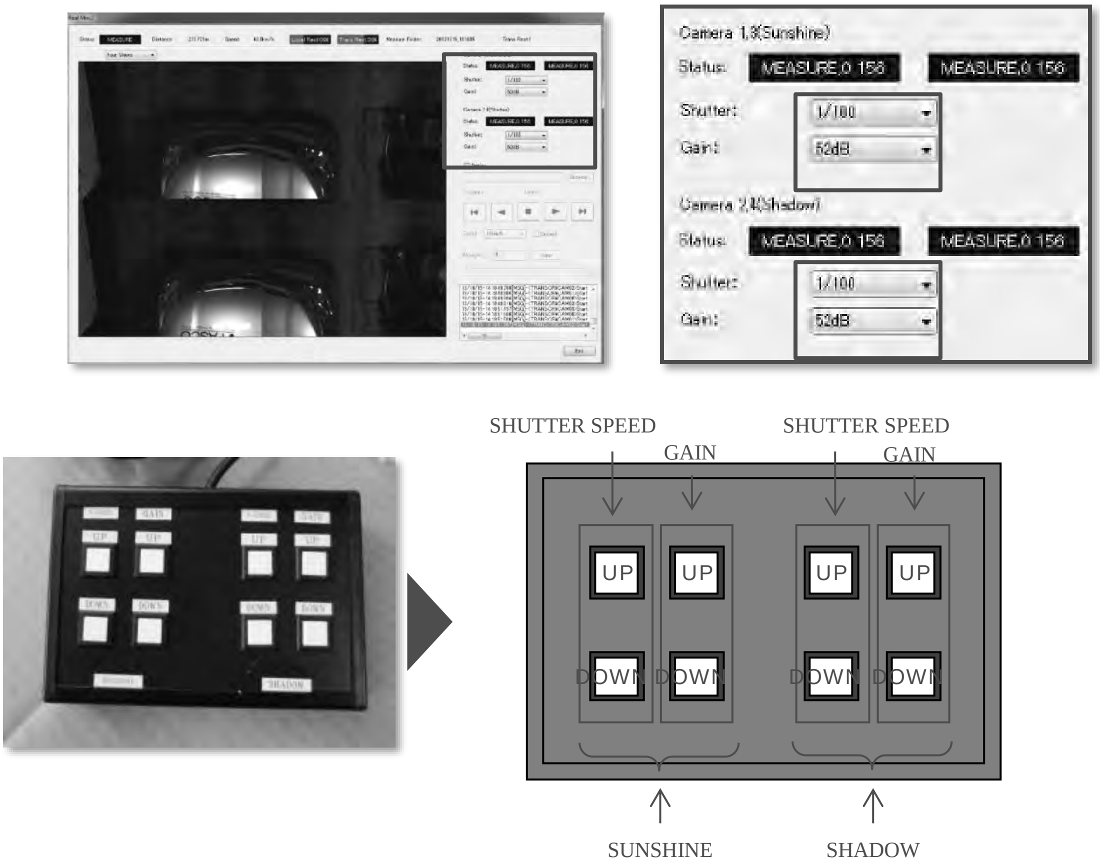
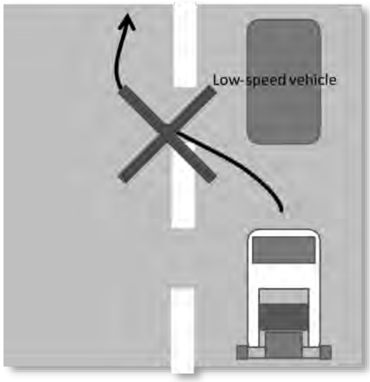


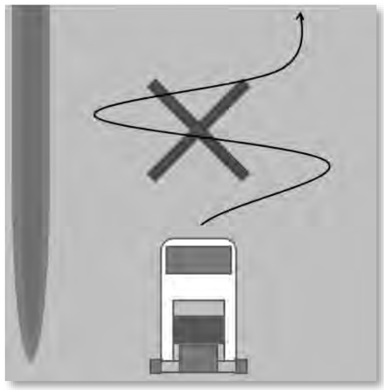

Figure 6.25 Changing the Shutter Speed and Gain of Rear Cameras

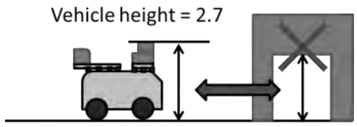
e) End the measurement by hold down the red switch of control box

Figure 6.26 End the Measurement

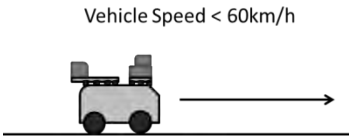
*NOTE:*
*The driver should keep to the rule of driving as follows.*
*- Keep the lane*
*In order to obtain the correct measurement data, the vehicle keep to the lane during measurement. The driver doesn't drive the vehicle in zigzag.*



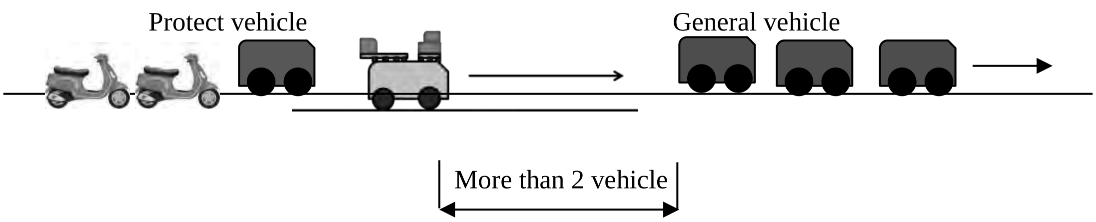






*- Attention to the height of vehicle*
*The driver should be careful to the height of the vehicle in order to not hit the obstacles (tree, overpass, and so on…) the vehicle while driving.*
*- Attention to the speed of vehicle (Keep the speed under 60km/h)*




*If the speed of the vehicle is greater than 60 km / h, the measurement data will be missing.*
*- Attention to the forward vehicle (keeo the distance more than two vehicle)*
*If the distance for the forward vehicle is too short, operator in the data analysis can not the pavement in the forward view image. On the other hand, if there are some motor bike in the backward of the survey vehicle, the crack in the road image is hidden by the mortor bike. Protect vehicle should follow the survey vehicle, if need.*




**4) STEP 4 : Check the measurement data**

- Select the check box [Replay]
- Select the data folder
- Replay the data

a) Select the check box [Replay]
b) Click **“Browser”** button then select the data folder

Figure 6.27 Selecting a Folder (PC1)

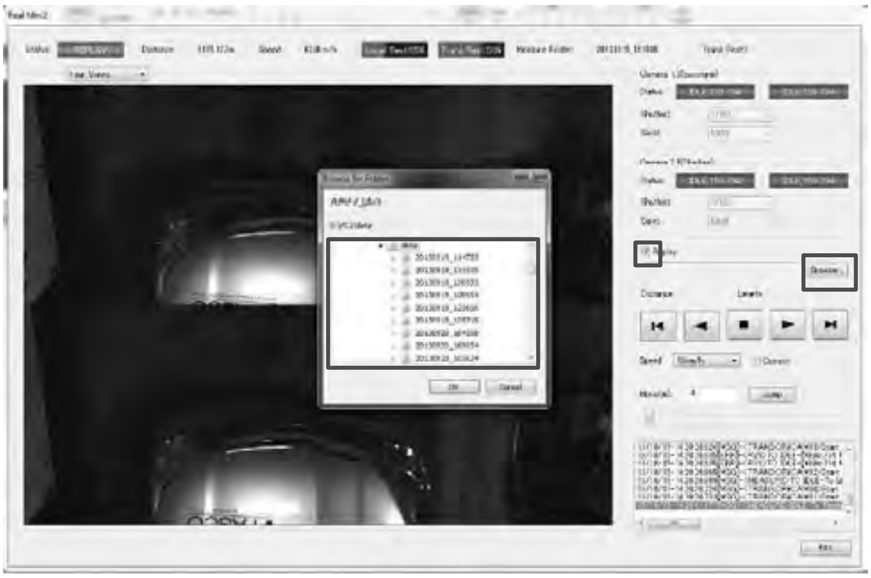


Figure 6.28 Selecting a Folder (PC2)

c) Replay the data
- PC1

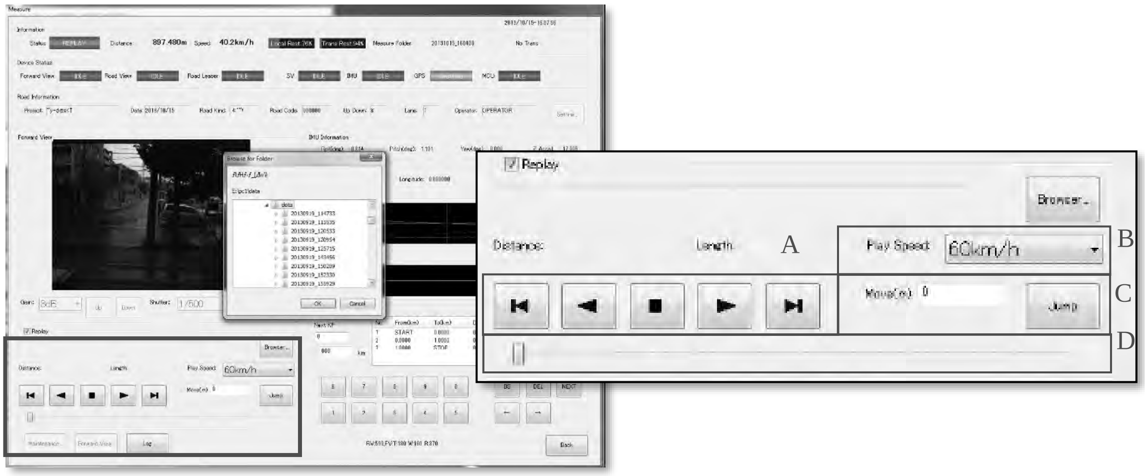
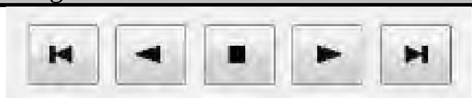
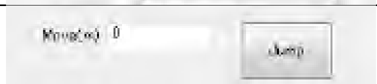
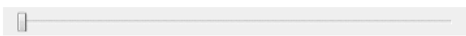



Figure 6.29 Control Panel in the User Interface (PC1)

Table 6.5 Description of Interface (PC1)

| Function Name | Image | Description |
|---|---|---|
| A : Button Control |  [ Piece Back ] [ Back ] [ Stop ] [ Replay ] [ Piece Forward ] | |
| B : Replay Speed |  | Select the replay speed |
| C : Jump |  | Jump to position of the input number |
| D : Slid Bar |  | According to the position of the button in the Slid Bar, Move the position of the data |

- PC2

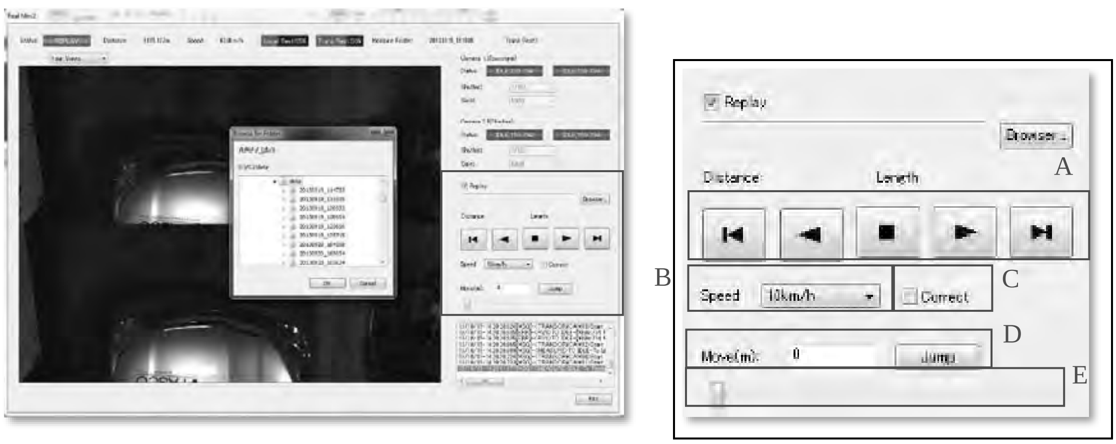
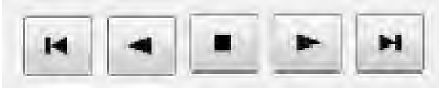
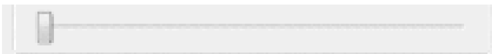



Figure 6.30 Control Panel in the User Interface (PC2)

Table 6.6 Description of Interface (PC2)

| Function Name | Image | Description |
|---|---|---|
| A : Button Control |  [ Piece Back ] [ Back ] [ Stop ] [ Replay ] [ Piece Forward ] | |
| B : Reaplay Speed |  | Select the replay speed |
| C : Correct |  | Display the road surface image obtained by projecting correction. |
| D : Jump |  | Jump to position of the input number |
| E : Slid Bar |  | According to the position of the button in the Slid Bar, Move the position of the data |

### 5) STEP 5 : After measurement

a) Continuous measurement

- Click “Setting”
- Input the road information
- Follow the steps to end the measurement

Figure 6.31 Click “Setting”


Figure 6.32  Input the road information

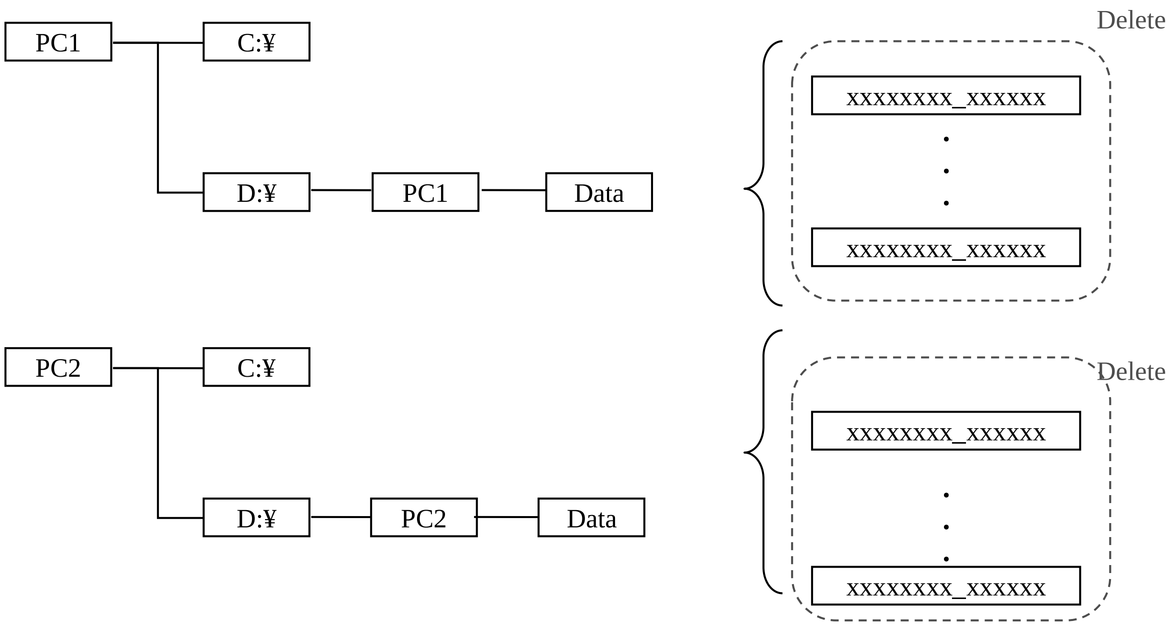
b) Termination of Data Recording

- Shut down the system
  The operator don't have to copy the measurement data from PC to External HDD (This system automactically copyes the data to HDD during measuring time)

Figure 6.33  Shutting Down the System

NOTE:

- *When a capacity of HDD is small (under 5%), the road condition data would not be collected.*
- *If a capacity of HDD is small, the operator should delete the data in HDD of PC before the shut down the system.*



**6) STEP 6 : Tidy up the equipment**

- Close the cover (RC,LP)
- Close the cover (LDS)

a) Close the cover (RC,LP)

Figure 6.34 Close the cover (RC,LP)

b) Close the cover (LDS)

Figure 6.35 Close the cover (LDS)

# 7. Instruction Manual of Start and End Point Setting Application

## 7.1 Purpose

This Application is run by the Measurement Team to confirm the data measured in the field. On the other hand, the Analysis Team analysis the data measured between the starting point and the ending point set by the Measurement Team in this Application so that smooth transferring of positional setting will be realized.

## 7.2 Input and Output of Data

Table 7.1 shows input and output data in this Application.

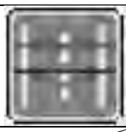
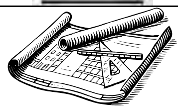
Table 7.1 Input and output data in this application

| Input data | Output data | Remarks |
|---|---|---|
| PC1 Data | PC1 Data | |
| PC2 Data | PC2 Data | |

## 7.3 Device

Table 7.2 shows devices used for running this Application

Table 7.2 List of devices

| Device | Image | Remarks |
|---|---|---|
| PC |  | Vehicle-mounted PC is also available. |
| HDD |  | HDD which data is stored (PC1, PC2) |
| This Application |  | |
| Materials for checking starting and ending points |  | Diagram, official documents, etc. |

## 7.4 Interface

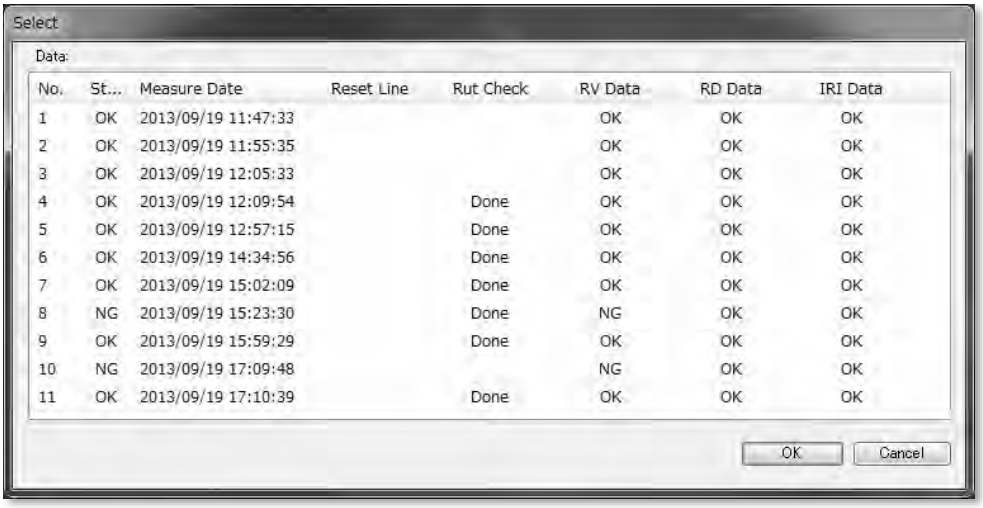
<Setting screen >


Figure 7.1 Interface of setting screen

Table 7.3 Items and their contents for settings

| Item | Contents | Remarks |
|---|---|---|
| Replay | Playback of the screen | |
| Forward, Back | Continuous playback of distance | |
| Forward, Back(Step) | Frame forward, back of distance | |
| Rut | About rutting volume | |
| Width | Select the display width / Distance between each point in a cross section | 10mm, 20mm, 50mm |
| Invalid Threshold | Specify the threshold for detecting invalid values | Standard deviation of rutting value of each point in a cross section |
| Invalid Continuous | Continuous range of invalid volume | |
| Sample Distance | Sample distance of invalid volume checking | 10cm、50cm |
| IRI | About pavement longitudinal profile | |
| Width | Select the display width | 12.5mm, 5mm,50mm,100mm |
| Forward View | About forward view | |
| Offset | Specify distance of offset displaying analysis window and front view | |
| PC1 DATA | Specify the folder in which PC1 is stored | |
| PC2 DATA | Specify the folder in which PC2 is stored | |

<Data selecting screen>




| No. | St... | Measure Date | Reset Line | Rut Check | RV Data | RD Data | IRI Data |
|---|---|---|---|---|---|---|---|
| 1 | OK | 2013/09/19 11:47:33 | | | OK | OK | OK |
| 2 | OK | 2013/09/19 11:55:35 | | | OK | OK | OK |
| 3 | OK | 2013/09/19 12:05:33 | | | OK | OK | OK |
| 4 | OK | 2013/09/19 12:09:54 | | Done | OK | OK | OK |
| 5 | OK | 2013/09/19 12:57:15 | | Done | OK | OK | OK |
| 6 | OK | 2013/09/19 14:34:56 | | Done | OK | OK | OK |
| 7 | OK | 2013/09/19 15:02:09 | | Done | OK | OK | OK |
| 8 | NG | 2013/09/19 15:23:30 | | Done | NG | OK | OK |
| 9 | OK | 2013/09/19 15:59:29 | | Done | OK | OK | OK |
| 10 | NG | 2013/09/19 17:09:48 | | | NG | OK | OK |
| 11 | OK | 2013/09/19 17:10:39 | | Done | OK | OK | OK |

Figure 7.2 Interface of data selection

Table 7.4 Items and their contents for data settings

| Item | Contents | Remarks |
|---|---|---|
| No. | Serial numbers in folders | |
| Status | Data acquisition status | Check whether any defection in data acquisition |
| Measure Date | Measured time (year, month, date, hour, minutes, and second) | |
| Reset Line | Whether the starting and ending positions are set in the Application | |
| Rut Check | Whether invalid volume of rutting are confirmed | |
| RV Data | Confirmation of the number of road surface images | |
| RD Data | Confirmation of the number of rutting data | |
| IRI Data | Confirmation of the number of longitudinal profile data | |
| FV Data | Confirmation of the number of forward views | |

<Main screen>


Figure 7.3 Interface of main screen

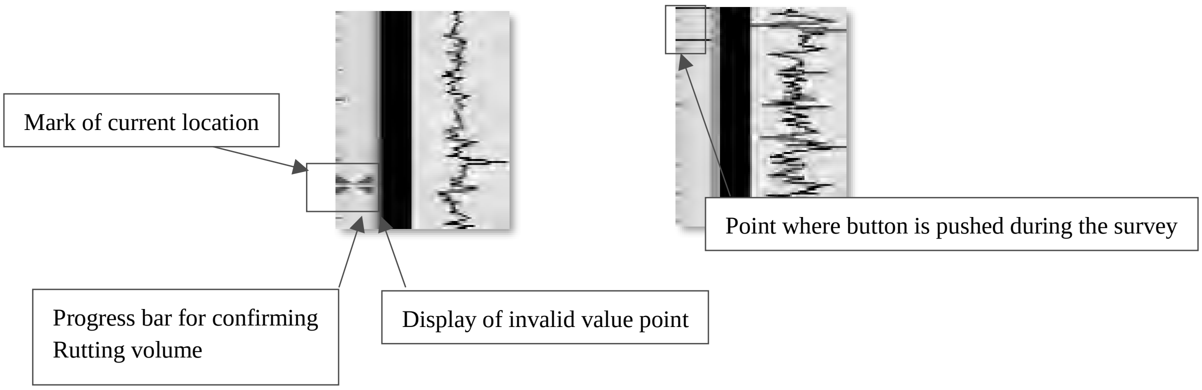



Figure 7.4 Contents of additional information

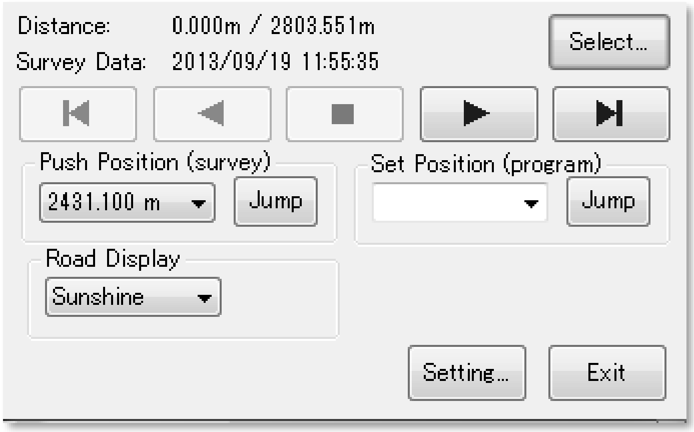



Figure 7.5 Interface of control panel

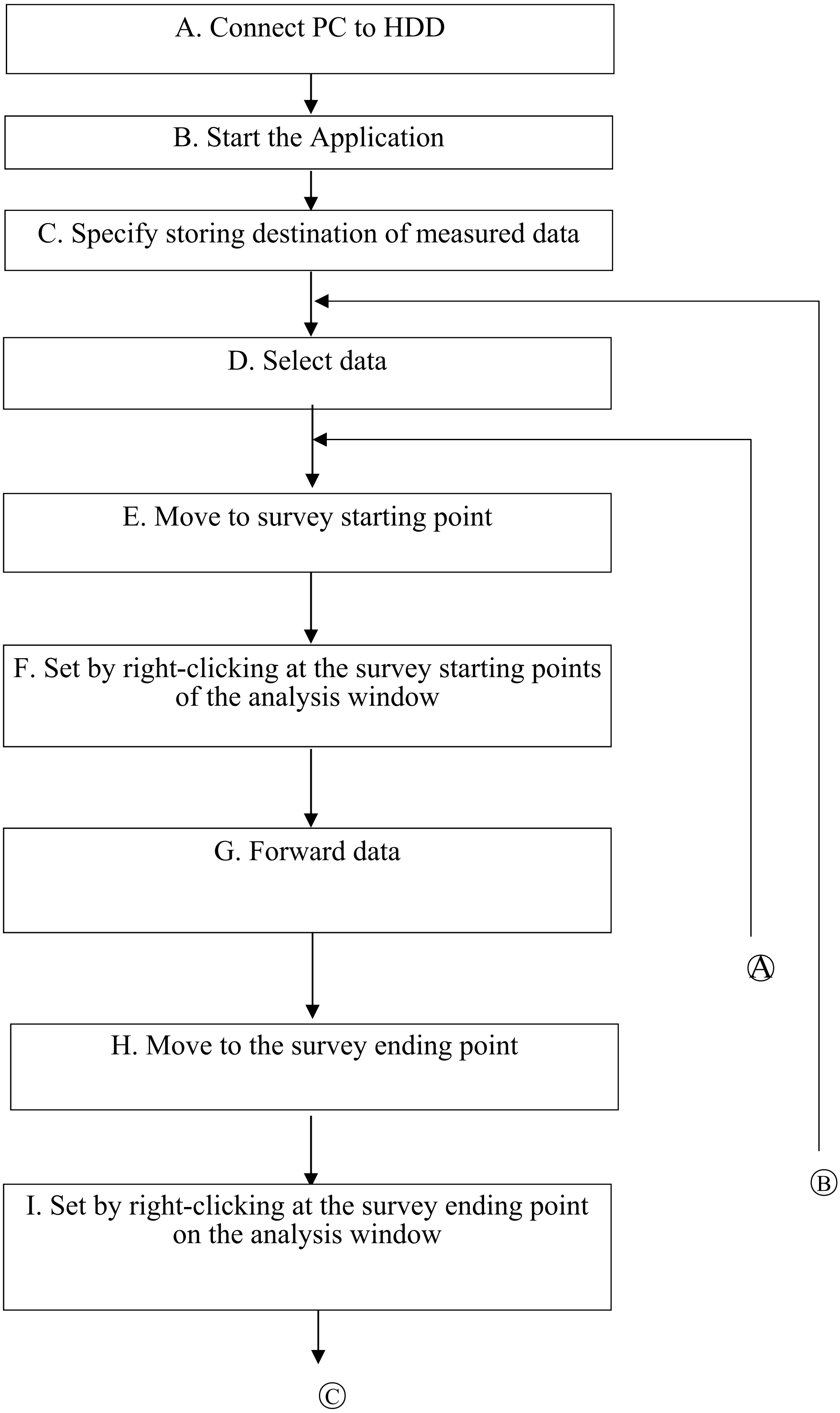
Table 7.5 Contents of control panel

| Item | Contents | Remarks |
|---|---|---|
| Distance | Position where the screen is displaying at the moment | Cumulative distance since the commencement of survey |
| Survey Date | Measured time (year, month date, hour, minute, and second) | |
| Select | To go to data selecting screen | |
|  | Frame back | |
|  | Continuous back | |
|  | Stop | |
|  | Continuous forward | |
|  | Frame forward | |
| Push Position(survey) | List of positions where button was clicked during the survey | Click "Jump" to go to the list |
| Set Position(Application) | List of positions set in the Application | Click "Jump" to go to the list |
| Road Display | Switch the road display (Sunshine/Shade) | |
| Setting | Jump to the setting screen | |
| Exit | To exit | |

## 7.5 Operating Procedure

(1) Workflow

Figure 7.6 shows the workflow of the Starting and Ending Point Setting Application.



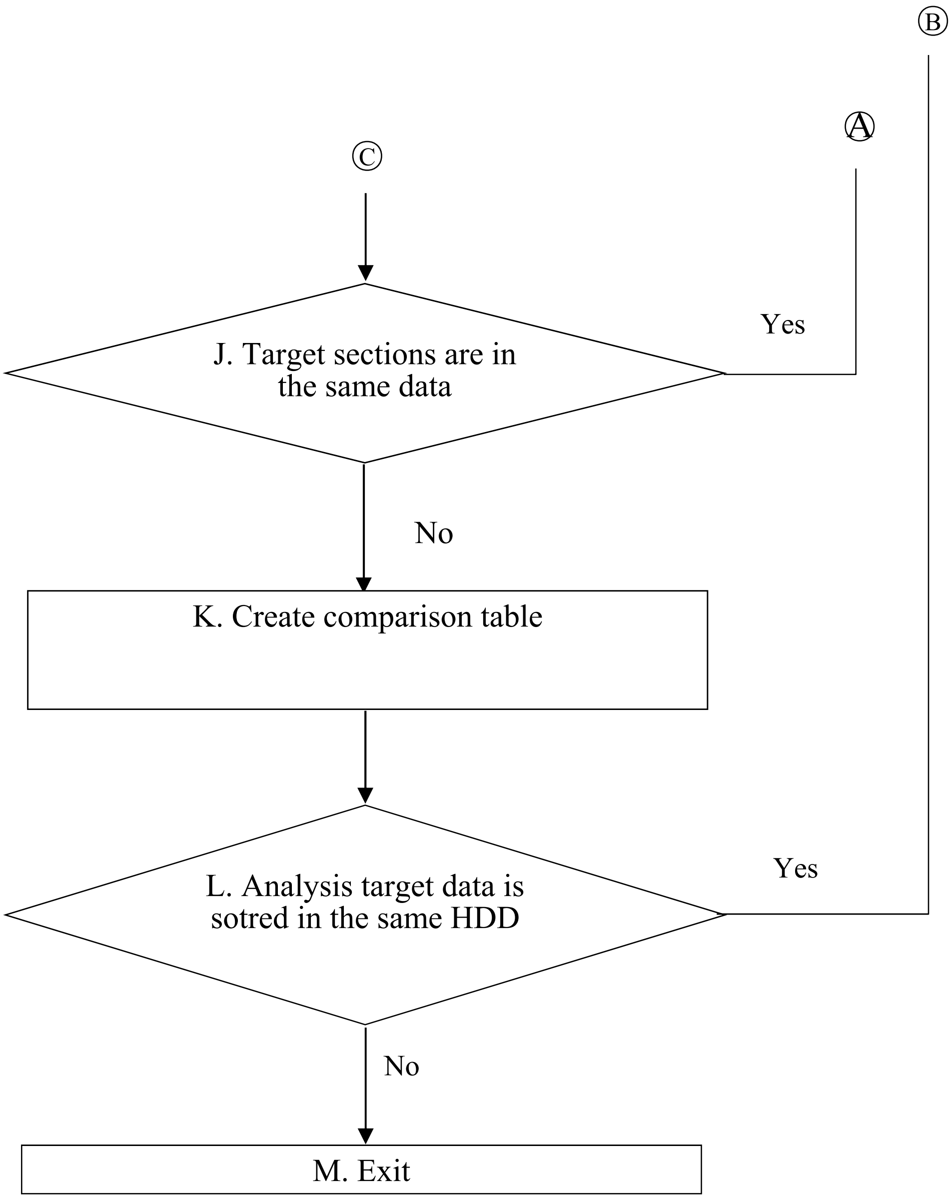



Figure 7.6 Workflow

A. Connect PC to HDD
Connect a PC to the HDD in which the data (PC1, PC2) is stored. The PC to be connected shall be either laptop or a PC mounted on REAL Mini.

B. Start the Application
Double-click the Application (the icon is shown in
) on the desktop of the PC connected to the HDD.

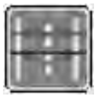


Figure 7.7 Icon of the Application

C. Specify storing destination of measured data
Click "Setting" of the Application and specify the storing destination by clicking "Browser" of both "PC1 DATA" and "PC2 DATA" shown in the lower parts of the setting screen.

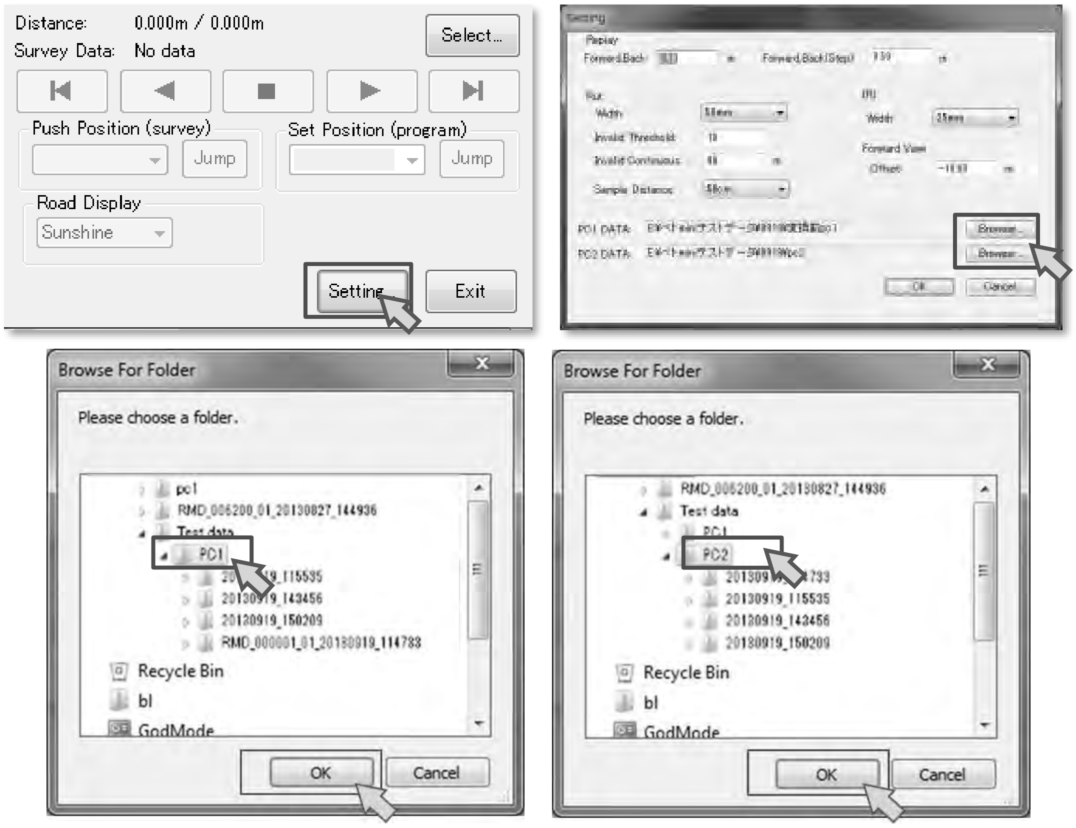



Figure 7.8 Method to specify storing destination of measured data

D. Select data
Specify data for setting starting and ending points. Click "Select" to select the data.


Figure 7.9 Data selecting method

E. Move to the survey starting point

Each data is displayed on the screen when data selection is completed in D. Then, jump to the survey staring point as shown in Table 7.6.

Table 7.6 Methods to move to the survey staring point by button operation

| Button operation | Transferring method |
|---|---|
| Button operation | ・Select the position of button operation in the field from the list of "Push Position(Survey)" and click "Jump".<br>・Use , and other button to adjust an accurate position. |
| Non-button operation | ・Checking front view, roughly move by clicking the section where presented in is displayed.<br>・When the display shows near starting point, use , and other button to adjust an accurate position. |


Figure 7.10 Methods to move to the survey staring point by button operation

F. Set by right-clicking at the survey starting points of the analysis window

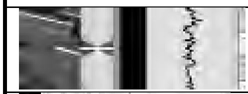
After jumping to the survey starting position, match the position of cursor to the survey starting position and right-click. After that, click "Set Line".

Figure 7.11 Position setting screen

G. Forward data

After setting the survey starting position, forward data to set the ending position where data analysis is conducted.

Table 7.7 Data playback method

| Playback method | Contents |
|---|---|
|  | Frame back, continuous back, continuous forward, frame forward |
|  | Jump to the clicked position |
|  | Jump to the position where button operation was performed in the field. |

H. Move to the survey ending point

By using any of Table 7.6, go to the sending position where data is to be analyzed. Stop the screen when the ending position is showing on the analysis window.

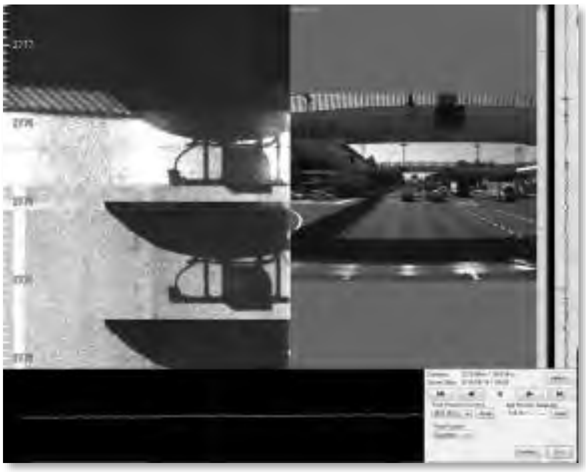


Figure 7.12  Ending point (example)

I. Set by right-clicking at the survey ending point on the analysis window

Right-click after locating the cursor at the survey ending point on the analysis window. "Set Line (distance)" is then displayed and set the position by clicking it.

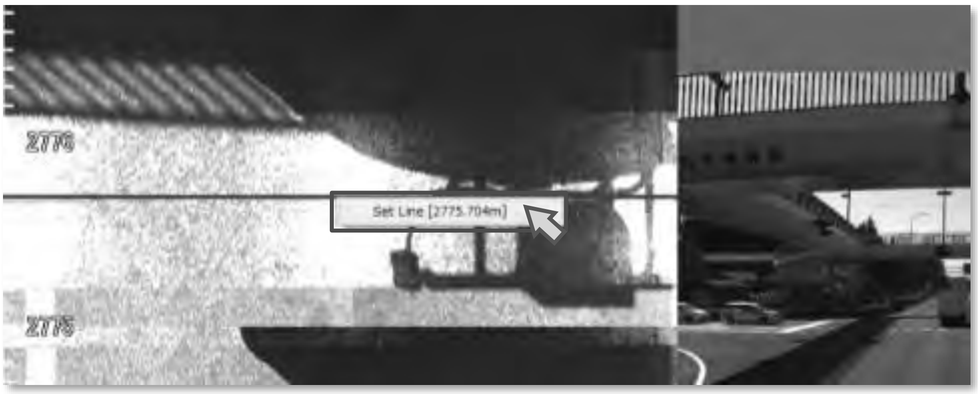



Figure 7.13  Ending position setting screen

※ Positions set by "Set Line" are displayed accordingly in Set Position (application) of the control panel.

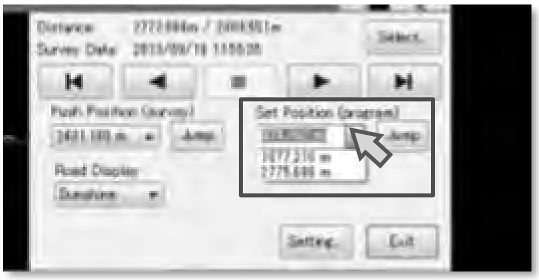



Figure 7.14  Selection of set position

※ Positions set by "Set Line" are displayed by red line in the field for current location of additional information.

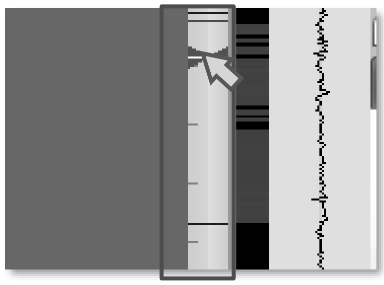


Figure 7.15 Field for current location of additional information

Table 7.8 Meaning of the color of horizontal lines

| Color | Meaning |
|---|---|
| Blue | Position of button operation in the field |
| Red | Position set in this Application |

J. Target sections are in the same data

When multiple target sections are in the data of 1 scene (Figure 7.16), go to the starting point of the next section in a manner described in Table 7.6. On the other hand, when only a single target section is in the data of 1 scene, go to K of the workflow.

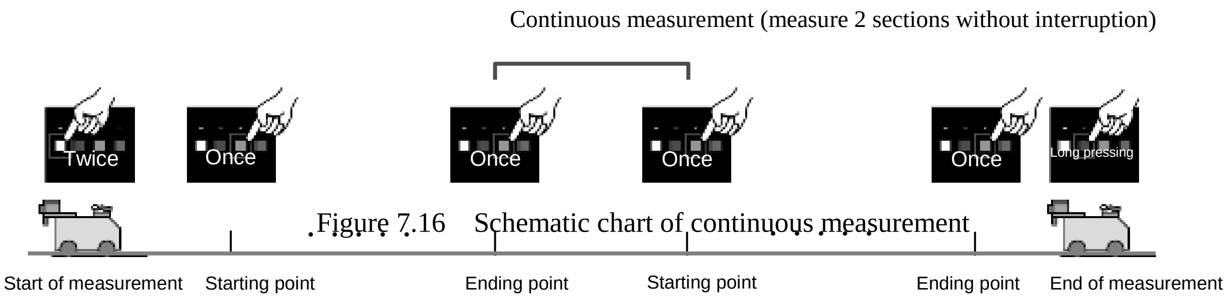



Figure 7.16 Schematic chart of continuous measurement

Table 7.9 Action to be taken after setting the ending position

| Target section (in 1 scene) | Action |
|---|---|
| Multiple sections | Transfer data and go to the starting point of the next section |
| Single section | Select the next scene (select data by clicking “Select”) |

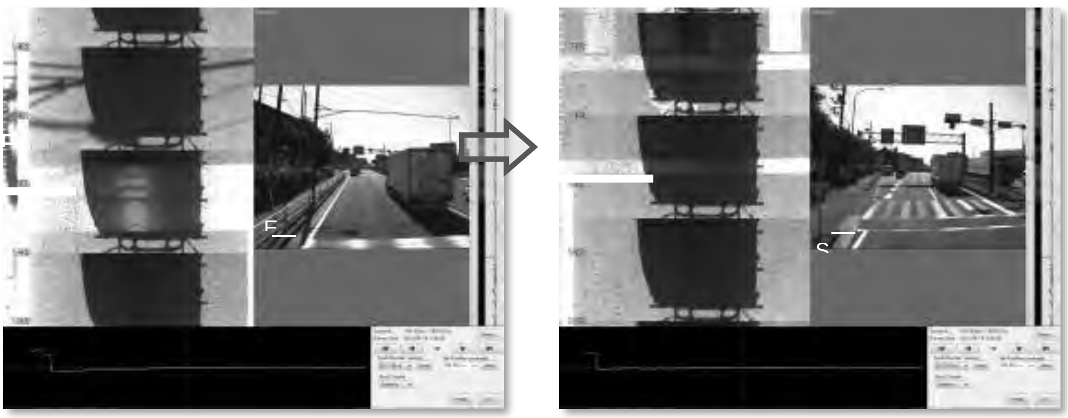


Figure 7.17 Go to the next section

K. Create comparison table

Measurement Team creates a comparison table so that Analysis Team is able to identify road, kilometer-post, lane, direction and other relevant information for confirming measured data.

Table 7.10 shows items to be listed in the comparison table. In addition,
 shows an example of the table.

Table 7.10 Items listed in comparison table

| Column | Header | | Contents | Remarks |
|---|---|---|---|---|
| A | Road Cate | | Road Category | |
| B | Road No. | | Road number | |
| C | Road No. Sup | | Road number supplement | |
| D | Branch No. | | Branch number | |
| E | Left/Right | | Left and Right | |
| F | Lane No. | | Lane number | |
| G | Kilometer-post | From | Kilometer-post (from) | |
| H | | To | Kilometer-post (to) | |
| I | Length | | Length of data | |
| J | Folder Name | | Name of folder | |
| K | Note | | Special notes | |

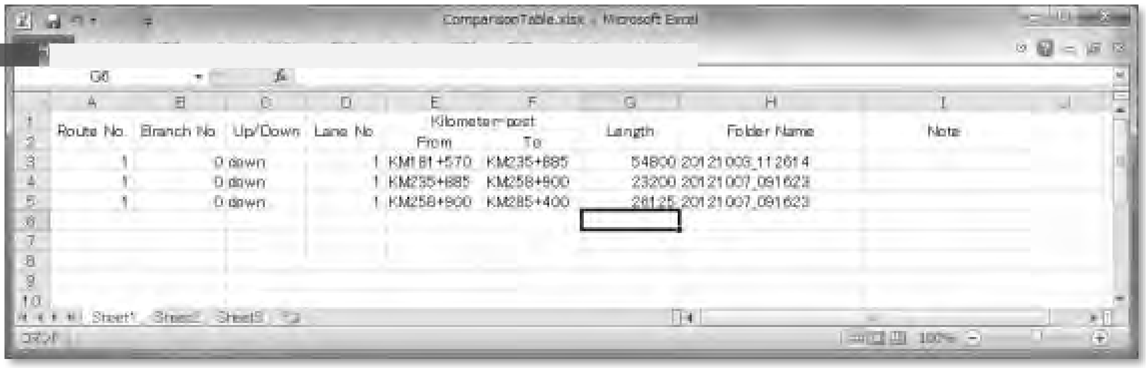



Figure 7.18 An example of comparison table

L. Analysis target data is stored in the same HDD

Select data from those stored in the HDD, of which the starting and ending positions are not set, and repeat the work D to I as described in the workflow.

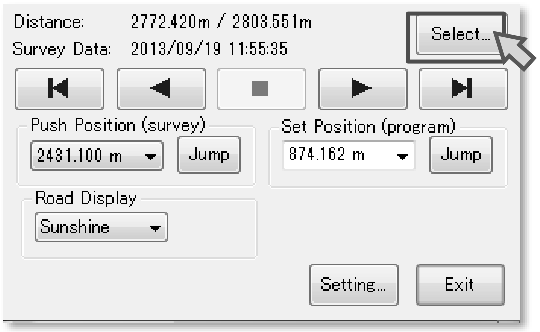



Figure 7.19 Data selecting button

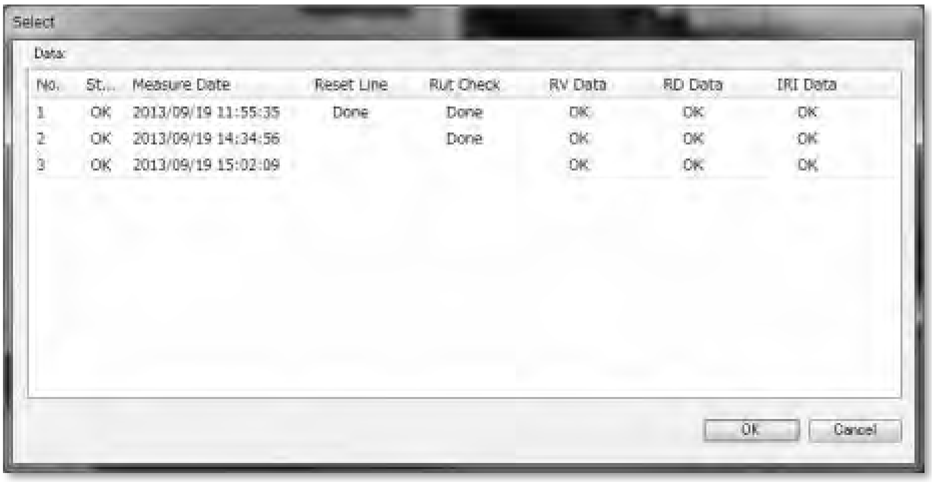



Figure 7.20  Data selecting screen

Data displaying "Done" in "Set Line" on the data selecting screen means that it has already been set. Hence, it is necessary to select blank column and set the position of starting and ending points.

M. Exit

Make sure that "Done" is displayed in all "Set Line" before exiting this Application.

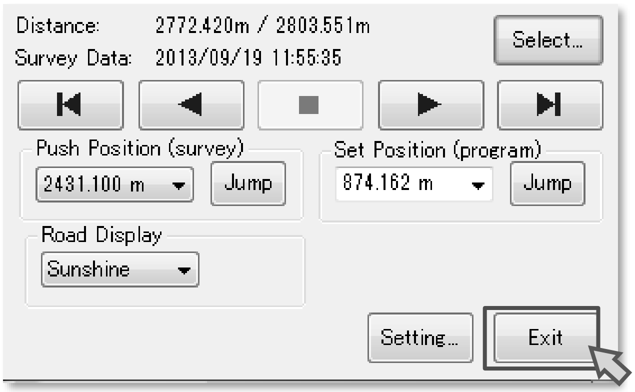



Figure 7.21  Application exit button

(2) Data delivery

By using this Application, data setting the starting and ending positions is transferred to Analysis Team. Data needed by the Analysis Team is listed in Table 7.11.

Table 7.11  Delivered data of delivering method

| Delivered data | Delivering method | Remarks |
|---|---|---|
| PC1 data | HDD | |
| PC2 data | HDD | |
| Comparison table | HDD | |

# 8. Instruction Manual of Data Conversion Application

## 8.1 Purpose

This application is designed to convert data gathered by road surface measuring vehicles into a format readable by the analysis application.

## 8.2 Input and Output Data

Data that are used (input) and created (output) by the analysis application are as described in Table 8.1.

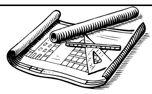
Table 8.1 Input and Output Data of the Data Conversion Application

| Name | Type | Notes |
|---|---|---|
| PC1 measurement data | Input | PC1 data collected by REAL Mini |
| PC2 measurement data | Input | PC2 data collected by REAL Mini |
| Analysis data | Output | |

## 8.3 Equipment

Equipment required is as described in Table 8.2.

Table 8.2 List of Equipment

| Equipment name | Image | Notes |
|---|---|---|
| Computer |  | |
| HDD |  | HDD which data stored PC1 and PC2 data |
| This application （RM2_DATA_CNV.exe） |   | |
| Road information resources |  | Field surveys, field notes, drawings, official documents, etc. |

## 8.4 Interface and Contents

<Main Window>

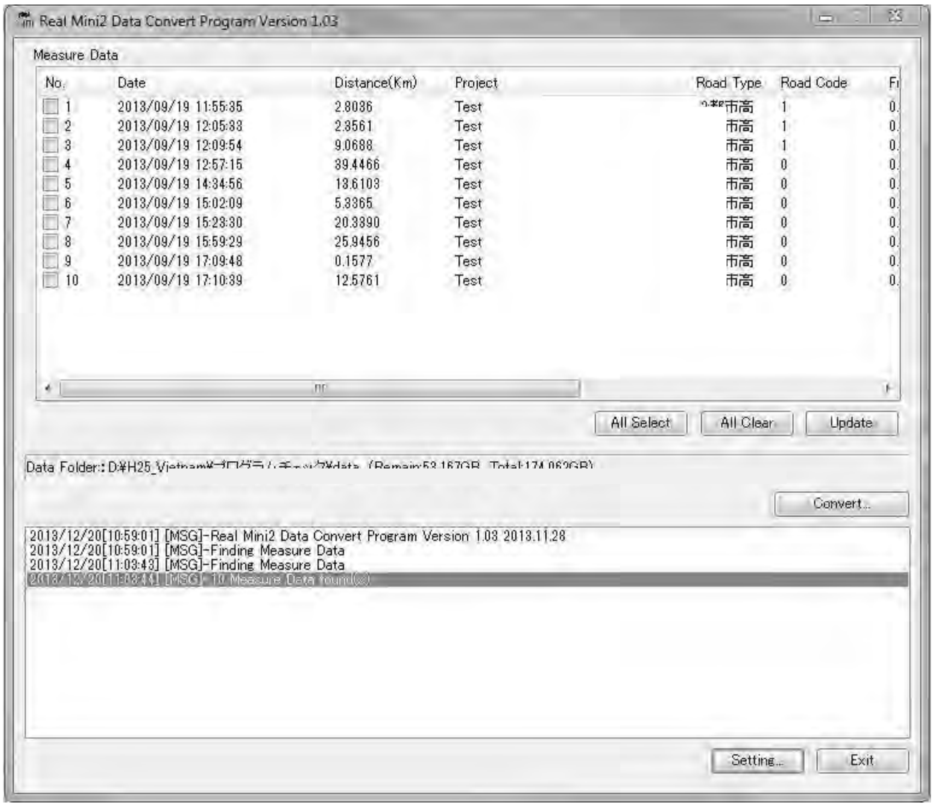



Figure 8.1 Main Menu

Table 8.3 Features of the Main Menu

| Feature | Description | Notes |
|---|---|---|
| Measure Data | Displays a list of measurement data | |
| All Select | Selects all data | |
| All Clear | Cancels selection | |
| Update | Updates the current display | |
| Convert… | Execute conversion | |
| Setting… | Opens the Setting menu | |
| Exit | Shuts down the application | |

<Setting Menu>

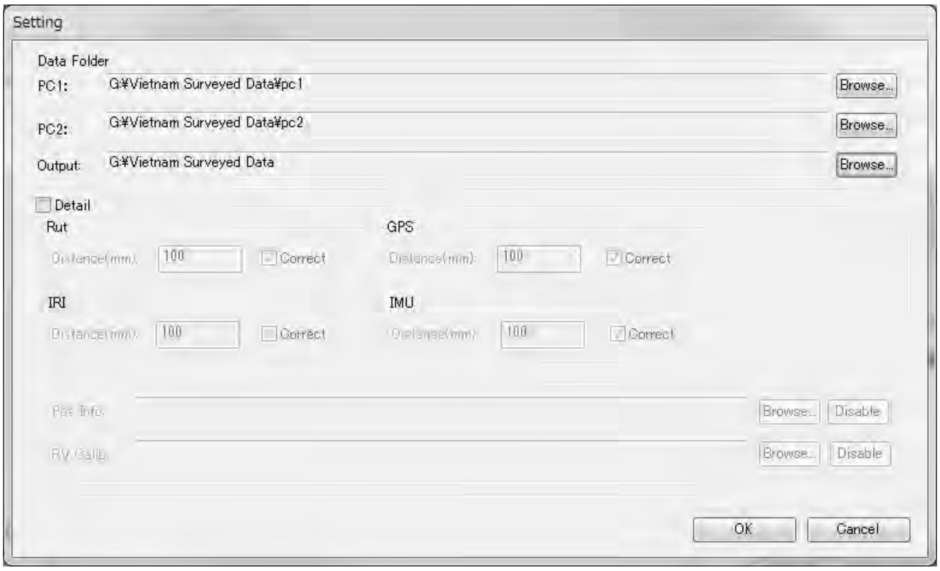



Figure 8.2 Setting Menu Interface

Table 8.4 Features of the Setting Menu

| Feature | Description | Notes |
|---|---|---|
| Data Folder | Settings for the Input and Output data folders | |
| Browser | Specifies the destinations for saving the input data and output data. | |
| OK | Accept | |
| Cancel | Cancel | |

### 8.5 Procedures

(1) Work Flow

The work flow for setting up the origin-destination application is as described in Figure 8.3.

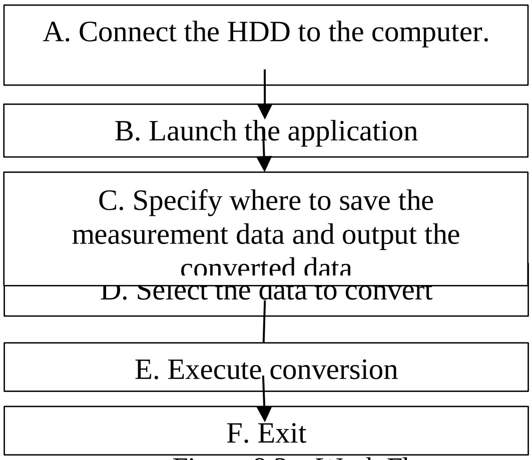



Figure 8.3 Work Flow

A. Connect the HDD to the computer.

Connect the HDD containing data (PC1 and PC2) to the computer.

B. Launch the application

Double click the application within PC-01 of the connected the HDD to launch the application. The icon of the application is a shown in Figure 8.4.

Figure 8.4 Icon of the Application

C. Specify save locations of the measurement data

Click the “Setting” button on the Main menu to display the Setting menu. Click the “Browse…” button for the items “PC1”, “PC2” and “Output” under the Data Folder pane of the Setting menu and specify the save location for each data.


Figure 8.5 Specifying the Save Locations of Measurement Data

D. Select the data to convert

Select the data to convert from the list of measurement data under the Measure Data pane. To select an item, check the checkbox under the “No.” column.

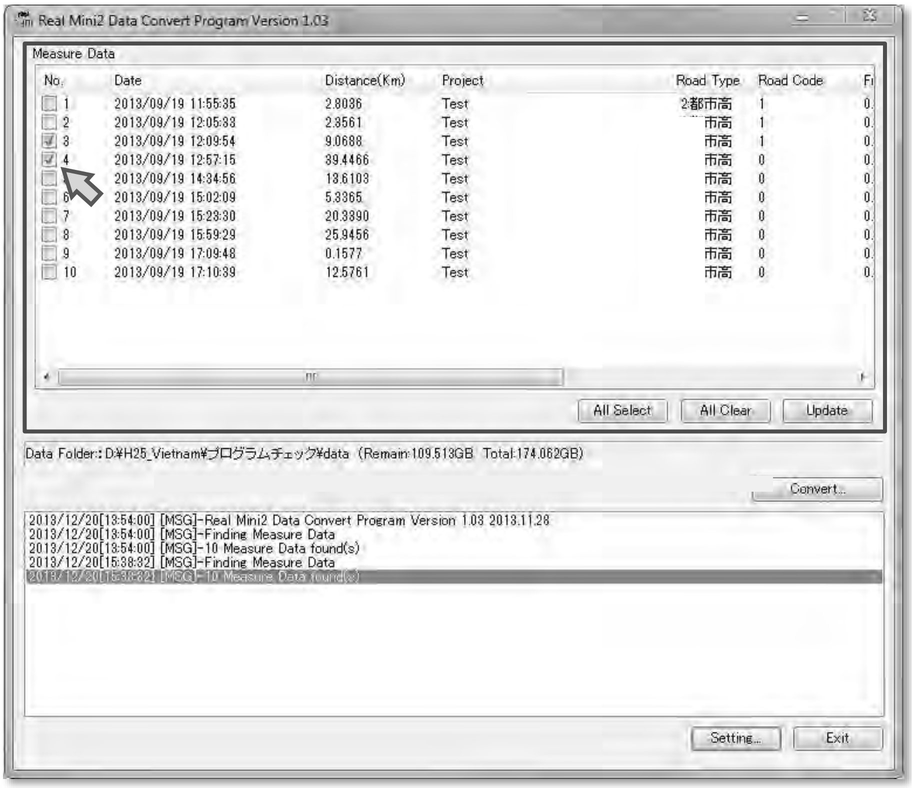



Figure 8.6　Data Selection

E. Execute the conversion

Click the “Convert…” button to execute the conversion.

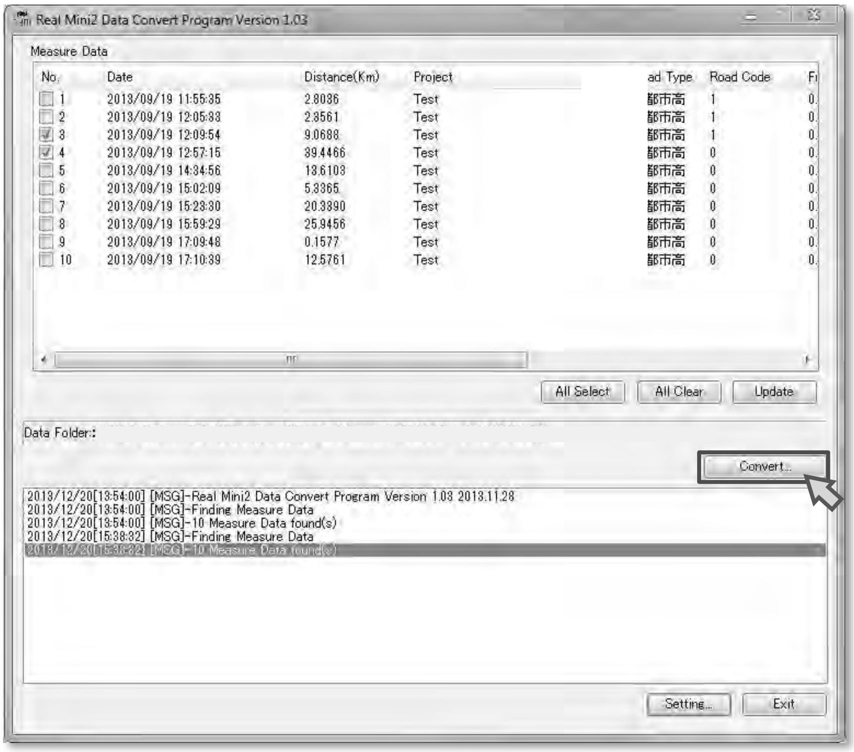



Figure 8.7　Execute Conversion


Figure 8.8 Conversion in Progress

F. Exit

Confirm that the log window at the bottom of the Main menu displays the message, “[MSG[-<<<Finish **m**s>>>”.

Click “Exit” to exit the application.

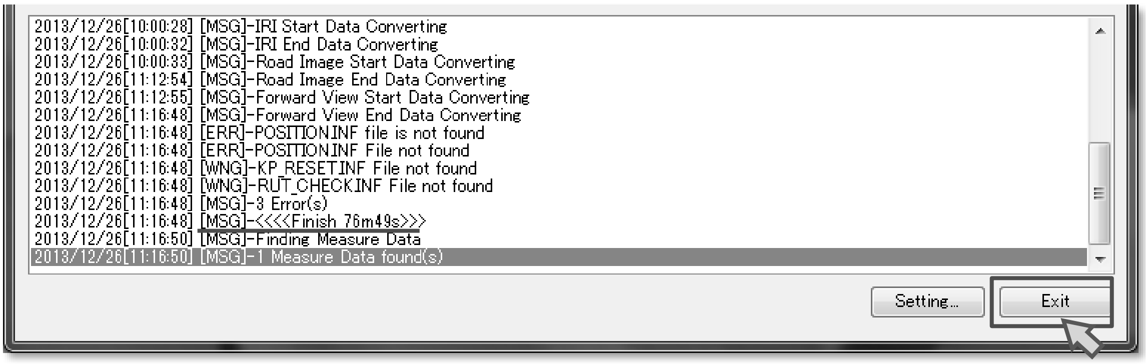



Figure 8.9 Log Window

## 8.6 Re-execute

If it is necessary to re-execute the data conversion, delete the “DATACNV.INF” folder created under the PC measurement folder that was created to the HDD and also delete the “RMD_XXXXXX_XXX_XXXXXXXX_XXXXXX” folder containing the converted data in the output folder.

## 8.7 Event Log

While the data conversion is in progress, logs are displayed at the bottom of the Main menu. A log consists of a timestamp, a log type and a message.

Table 8.5 List of Displayed Events

<table>
<tr><th>Log</th><th>Description</th></tr>
<tr><td>YYYY/MM/DD-HH:MM-SS.MSS [KKK]-message</td><td>KKK: log type<br><table><tr><td>MSG</td><td>WNG</td><td>ERR</td></tr><tr><td>Event</td><td>Warning</td><td>Error</td></tr></table>A message is displayed.</td></tr>
<tr><td>YYYY/MM/DD-HH:MM:SS.MSS year, month, date, hour minute, second, millisecond</td><td>Indicates the time of occurrence.</td></tr>
</table>

Table 8.6　List of Events

| Log | Description |
|---|---|
| REAL Mini2 Data Convert Application Version X.XX XXXX.XX.XX | The version information displayed when the application is launched. |
| Finding measure data | The application is searching for measurement data. |
| N Measure data found(s) | N record[s] of measurement data was found. |
| Convert data : XXXXXXXX_XXXXXX (NNN/NNN) | Converting data XXXXXXXX_XXXXXX. |
| Start processing | Pre-processing the data to prepare for conversion. |
| This data is converted to previous[XXXX] | XXXX has already been converted. |
| End processing[N] | Pre-processing is complete. |
| XXX Start data converting | Starting data conversion of “XXX”. |
| XXX Data donverting error | An error occurred while converting data “XXX”. |
| XXX End data converting | Data conversion of “XXX” is complete. |
| Cancel data converting | The data conversion has been cancelled. |
| <<<<Finish XXmXXs>>> | Data conversion of the entire data is complete. |

Table 8.7　List of Errors

| Log | Description |
|---|---|
| XXX Fail to create output folder | Failed to create the folder for “XXX”. |
| Fail to write measure info[N] | Failed to write the measurement information. |
| POSITION.INF File is not found | POSITION.INF could not be found. |
| PC1_MEASURE.INF File not found | PC1_MEASURE.INF could not be found. |
| KP_LIST.CSV File not found | KP_LIST.CSV could not be found. |
| MARK_LIST.CSV File not found | MARK_LIST.CSV could not be found. |
| KP_RESET.INF File not found | KP_RESET.INF could not be found. |
| RUT_CHECK.INF File not found | RUT_CHECK.INF could not be found. |
| DATACNV.INF File not found | DATACNV.INF could not be found. |
| PC2_MEASURE.INF File not found | PC2_MEASURE.INF could not be found. |
| ROAD_CAL.INF File not found | ROAD_CAL.INF could not be found. |
| Memory is not enough[Size:XXXX] | Failed to allocate the required amount of memory. |

# 9. Instruction Manual of Data Analysis Application

## 9.1 Purpose

This application is responsible for creating data regarding cracking, rutting, and IRI data and GPS coordinates using the road surface data collected by REAL Mini.

## 9.2 Input and Output Data

Data used for this application and the data output are as described in Table 9.1.

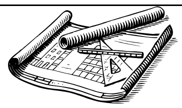
Table 9.1 Input and Output Data of the Analysis Application

| Name | Type | Notes |
|---|---|---|
| RMD_999999_999_99999999_999999 | Input | Converted data |
| C3_*****.csv | Output | Cracking analysis |
| R3_*****.csv | Output | Rutting analysis |
| S3_*****.csv | Output | IRI analysis |
| FA_*****.csv | Output | GPS coordinates |

## 9.3 Equipment

Table 9.2 describes the equipment required for this application.

Table 9.2 List of Equipment

| Equipment Name | Image | Notes |
|---|---|---|
| Computer |  | |
| HDD |  | HDD where data is stored. |
| This application (RM2_RISA.exe) |   | |
| Road information resources |  | Field surveys, field Notes , drawings, official documents, etc. |

## 9.4 Interface and Contents

<Launch Menu>

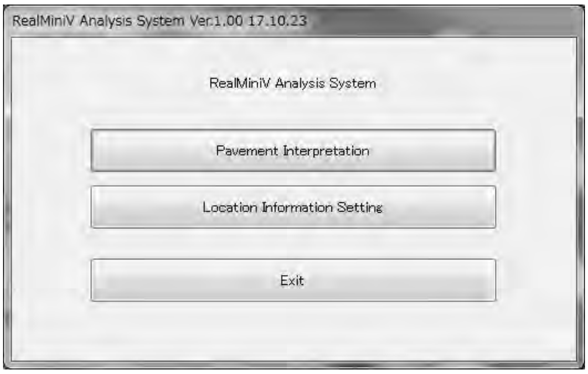



Figure 9.1　Launch Menu

Table 9.3　Features of the Launch Menu

| Item | Description | Notes |
|---|---|---|
| Pavement Interpretation | Launches the analysis application. | |
| Location information Setting | Launches the Location setting application. | This feature will not be discussed in this section. |
| Exit | Exits from the application. | |

<Data Selection Menu>

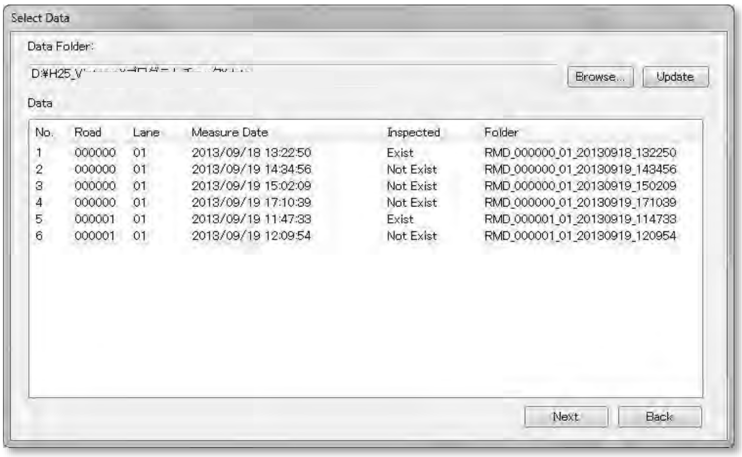



Figure 9.2　Data Selection Menu Interface

Table 9.4　Features of the Data Selection Menu

| Item | Description | Notes |
|---|---|---|
| Data Folder | Displays the folder path of the current file location. | |
| Browse… | Opens the Data Folder Selection window. | |
| Update | Updates the Data pane. | |
| Data | Displays a list of analysis data present in the specified folder. | |
| No. | List number. | |
| Road | Road number configured at the time of measurement. | |
| Lane | Lane number configured at the time of measurement. | |
| Measure Date | Time stamp of when the measurement was taken.(Year, month, date, hour and minutes) | yyyy/mm/dd hh:mm:ss |
| Inspect | Presence of the analysis data | Exist/Notesxist |
| Folder | Folder path of the analysis data | |
| Next | Go forward to the Information menu | Enabled when a data is selected from the list. |
| Back | Go back to the Launch menu. | |

<Information Menu>

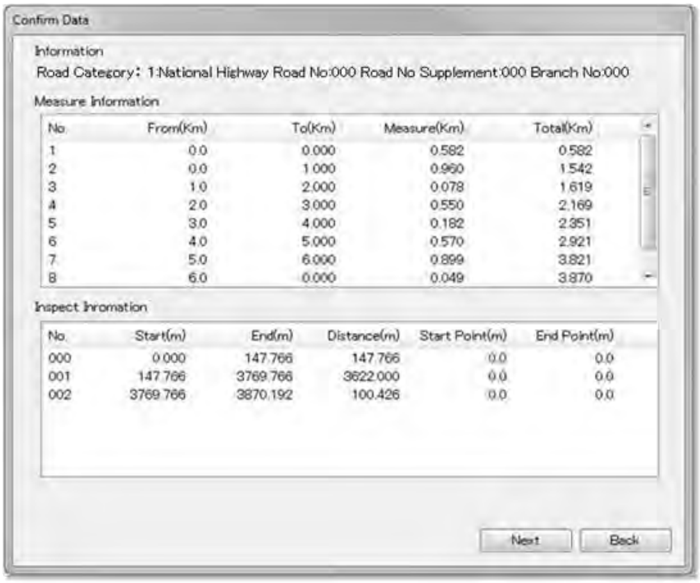



Figure 9.3 Information Menu Interface

Table 9.5 Features of the Information Menu

| Item | Description | Notes |
|---|---|---|
| Information | Displays the measurement timestamp of the selected data. | |
| Road category | Describes the road type category. | 1 degit |
| Road Number | Displays the road number. | 3 degits |
| Road Number Supplement | Displays the road number supplement. | 3 degits |
| Branch number | Displays the brunch number. | 3 degits |
| Measure Information | Information of the events interval in measurement | |
| Inspect Information | Information of an analysis section | |
| Next | Go forward to the Analysis menu. | |
| Back | Go back to the Data Selection menu. | |

<Analysis Screen>

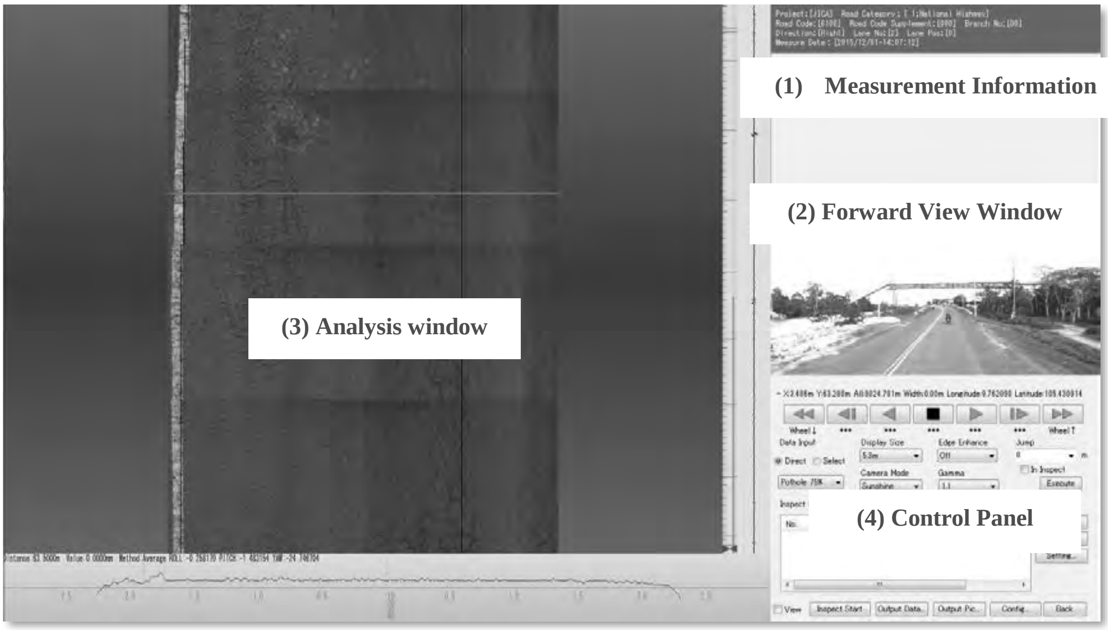



Figure 9.4 Analysis Screen

Table 9.6 Features of the Analysis Screen

| Item | Description | Notes |
|---|---|---|
| (1) Measurement Information | Displays the measurement information, such as the road, measurement timestamp and others. | Information entered at the time of measurement. |
| (2) Forward View Window | Displays the forward view image. | |
| (3) Analysis Window | Displays the road surface image, cross and longitudinal sections. | |
| (4) Control Panel | Used for operations such as playing back images, jumping from point to point and other operations. | |

(1) Measurement Information

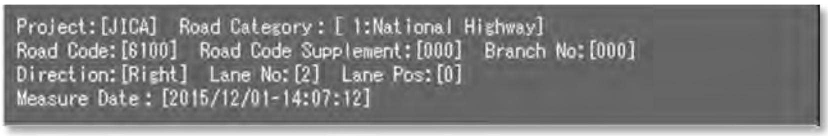



Figure 9.5 Measurement Information

Table 9.7 Features of the Information Pane

| Item | Description | Notes |
|---|---|---|
| Project | Name of the project | |
| Road Category | Road category of the target road | 1 degit |
| Road Code | Displays the road and branch numbers. | 3 degits |
| Road Code Supplement | Supplement number of the road code | 3 degits |
| Branch No. | Branch number of the road code | 3 degits |
| Direction | Left bound or Right bound | |
| Lane No. | Traffic lane | |
| Lane Pos | Lane position of the measurement | |
| Measure Data | Time stamp of the time of measurement (year, month, date, hour and minutes) | |

(2) Forward View Image

Figure 9.6 Forward View Image

Table 9.8 Features of the Forward View Footage

| Item | Description | Notes |
|---|---|---|
| Forward view Image | Displays the forward view image. | |

(3) Analysis Window

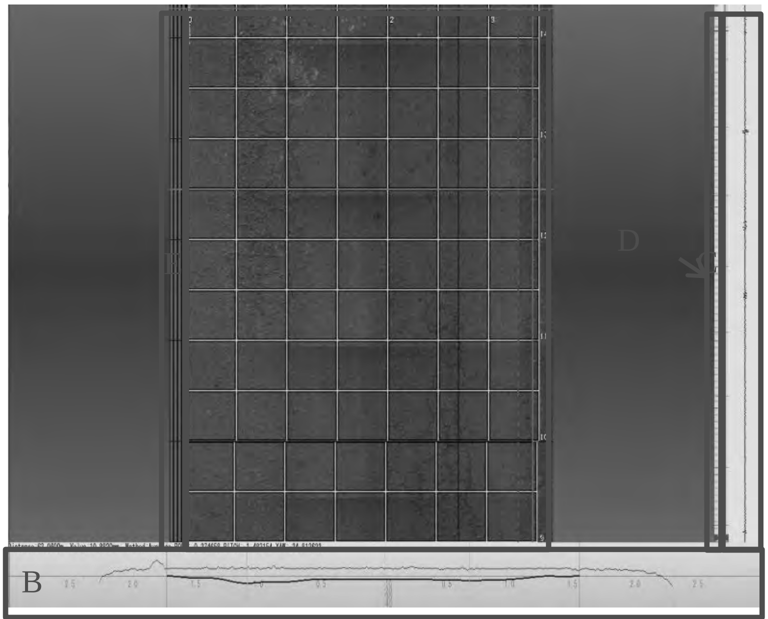



Figure 9.7 Analysis Window

Table 9.9 Features of the Analysis Window

| Feature | Description | Notes |
|---|---|---|
| A: Road surface image | Displays the image of the road surface. Interprets road cracks. | |
| B: Cross section | Displays the cross section of the road surface | |
| C: Longitudinal section | Displays the longitudinal section of the road surface. | |
| D: Position information bar | Displays information regarding the current position, event positions and such. | |
| E: Management Data bar | Configurations for managing data, such as specifying the road type category and others. | |

(4) Control Panel

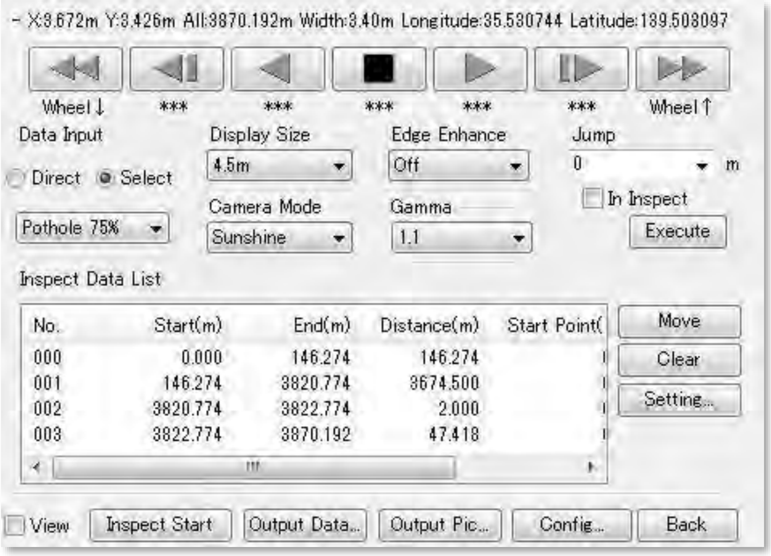



Figure 9.8 Control Panel Interface (full view)


Figure 9.9 Operation Panel Interface

Table 9.10 Features of the Operation Panel

| Item | Description | Notes |
|---|---|---|
| X, Y, All, Width, Longitude, Latitude | Coordinates of the cursor placed on the road surface image | Displays the distance and longitude and latitude information retained by the data. |
|  | Frame backward | |
|  | Mesh backward | Go back one mesh at a time |
|  | Continuous backward | |
|  | Stop | |
|  | Continuous forward | |
|  | Mesh forward | Go forward one mesh at a time |
|  | Frame forward | |


Figure 9.10 Road Surface Image Operation Interface

Table 9.11 Features of the Road Surface Image Operation Interface

| Item | Description | Notes |
|---|---|---|
| Data Input | Configure the input setting for interpreting road cracks | |
| Direct | Input directly from a keyboard | |
| Select | Input by selecting from the list | |
| Display Size | Configure the display size of the road surface image | |
| Camera Mode | Switch the lighting mode of the road surface image | |

| | | |
|---|---|---|
| | sunshine, shadow or synthetic. | |
| Edge Enhance | Configure the level of edge enhancement | |
| Gamma | Configure the gamma correction value. | |


Figure 9.11 Jump Operation Interface

Table 9.12 Features of the Jump Operation

| Item | Description | Notes |
|---|---|---|
| Jump | Jump to the position specified | |
| Specify distance | Select a event positions from the list, or, enter a specific distance manually | Dropdown list (input is also allowed) |
| In Inspect | Configure the movement range. | ON: Movement within the current range<br>OFF: Movement within the entire data |
| Execute | Execute movement | |

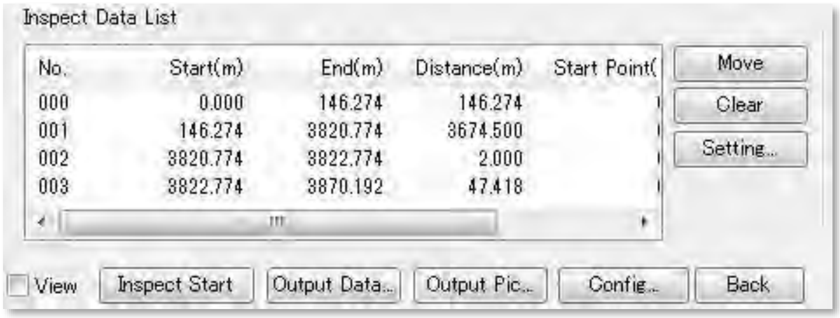



Figure 9.12 Configuration Panel Interface

Table 9.13 Features of the Configuration Panel

| Feature | Description | Notes |
|---|---|---|
| Inspect Data List | Displays the data list | Displays a list by sections |
| Move | Moves to the starting point of the data selected from the list. | |
| Clear | Deletes the selected data from the list. | Integrates the selected data with the previous section data. |
| Setting | Determines the analysis interval | |
| View | Turns on/off the HUD on the road surface image | |
| Inspect Start | Begin the configuration of the analysis section. | |
| Output Data | Opens the Data Output menu. | |
| Output Picture | Opens the Road Surface Image Output menu. | |
| Configuration | Opens the Configuration menu | |
| Back | Go back to the Data Selection menu. | |

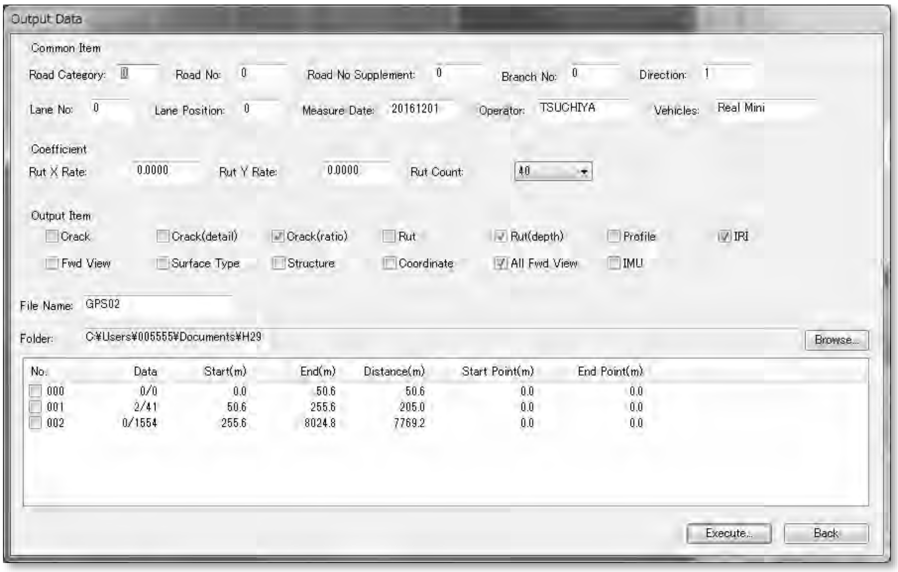



Figure 9.13 Data Output Menu Interface

Table 9.14 Features of the Data Output Menu

| Feature | Description | Notes |
|---|---|---|
| Common Item | Settings of common items | Specified at the time of measurement. |
| Road Category | Grade of the road | 1: National Highway<br>2: Expressway<br>3: Provincial Road<br>4: Others Road |
| Road No. | Road number. | |
| Road No Supplement | Supplement No. of road No. | |
| Branch No. | Branch number | |
| Direction | Left-bound, Right-bound, Single-bound | Left: 1, Right: 2, Single: 3 |
| Lane No. | Traffic lane number | |
| Lane Position | Position of the traffic lane number | |
| Measure Date | Timestamp of the measurement | YYYYMMDD |
| Operator | Name of the operator | |
| Vehicles | Name of the measuring vehicle | |
| Coefficient | Rut coefficient | |
| Rut X Rate | X coefficient | |
| Rut Y Rate | Y coefficient | |
| Rut Count | The number of output points of a rutting profile. | |
| Output Item | Selection of output data | |
| Crack | Number of meshes with cracks | |

| | | |
|---|---|---|
| Crack(detail) | Details of crack interpretation | |
| Crack(ratio) | Crack ratio | |
| Rut | Rut profile | |
| Rut(depth) | Rut depth | |
| Profile | Longitudinal section/ profile | |
| IRI | IRI | |
| Fwd View | Forward view footage (target data only) | |
| Surface Type | Surface type | |
| Structure | Structures | |
| Coordinate | Coordinates | |
| All Fwd View | Forward view footage (entire data) | |
| IMU | IMU data | |
| File Name | Input the file name of the output data | |
| Brows | Specify the folder path to output the data | |
| Data list | Select the data to output | |
| Execute | Execute output | |
| Back | Go back to the Analysis menu | |

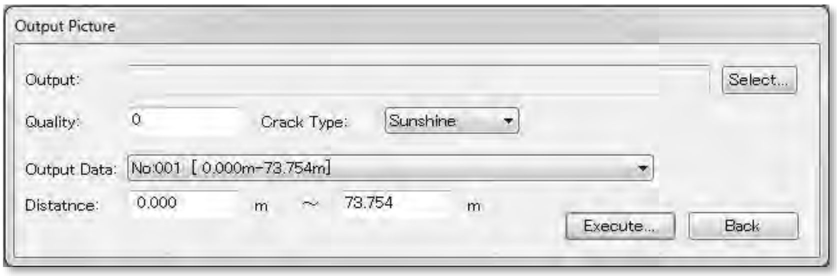



Figure 9.14 Road Surface Image Output Menu Interface

Table 9.15 Features of the Road Surface Image Output Menu

| item | Description | Notes |
|---|---|---|
| Select | Select the folder path to output data. | |
| Quality | Specify the compression level of the image. | |
| Crack Type | Select the road surface camera. | |
| Output Data | Select the output range. | |
| Distance | Enter the distance (origin/destination) | |
| Execute | Execute output | |
| Back | Go back to the Analysis menu | |

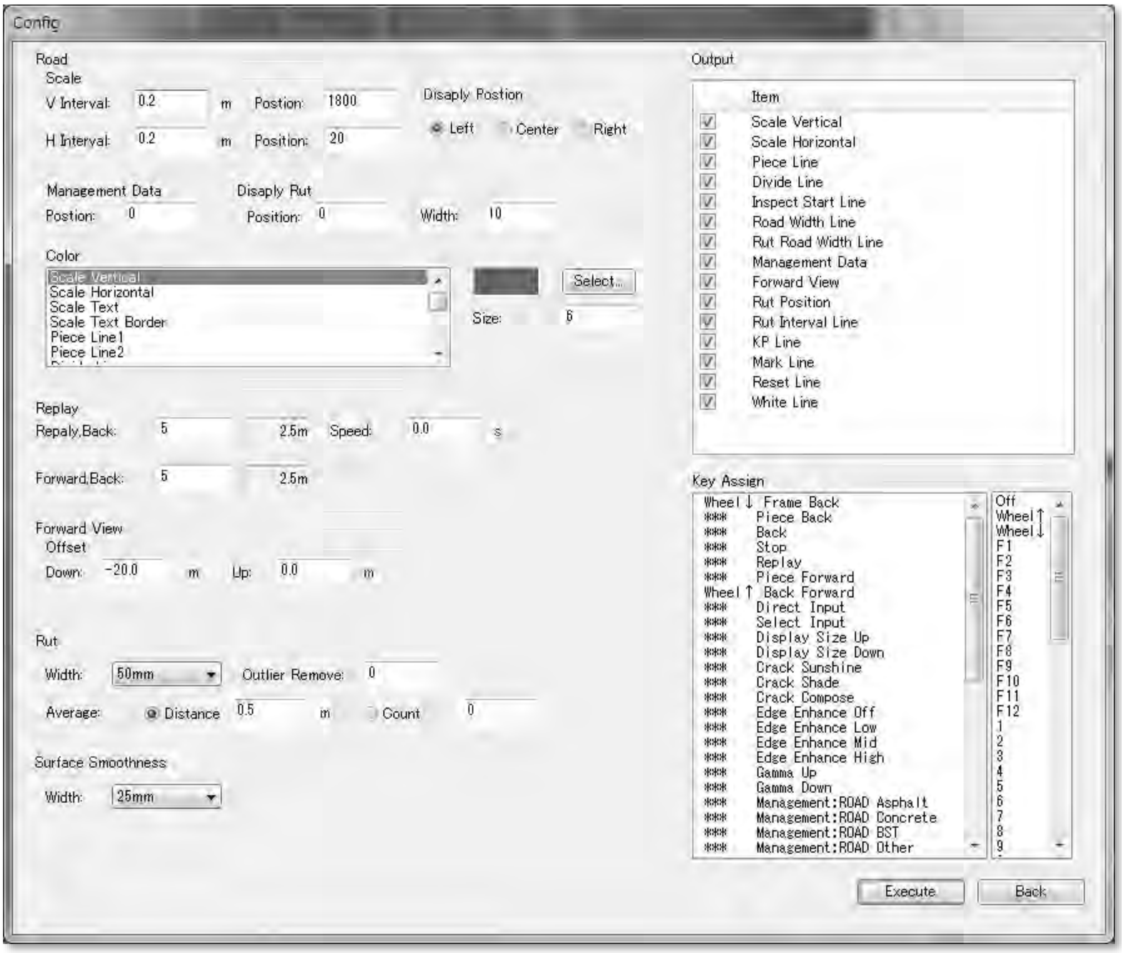



Figure 9.15 Configuration Menu Interface

Table 9.16 Features of the Configuration Menu

| Item | Description | Notes |
|---|---|---|
| Road | Configure the scale displayed to the road surface image | |
| V interval | Graduation of the vertical scale | |
| Position | Position of the vertical scale | |
| H interval | Graduation of the horizontal scale | |
| Position | Positioning of the horizontal scale | |
| Display Position | Select the base position. | |
| Management Data | Display position of the Management Data Configuration bar. | |
| Color | Specify the color of each configuration item. | |
| Replay | Playback configuration. | |
| Replay Back | Configure the movement when Replay Back is executed. | Specify in crack mesh counts |
| Forward Back | Configure the movement for playing forwards and backwards. | Specify in crack mesh counts |
| Speed | Specify the playback speed. | |
| Forward View | Offset configuration for the forward view. | |
| Right | Offset for the Right-bound data. | |
| Left | Offset for the Left-bound data. | |
| Rut | Configuration for the cross section display. | |
| Width | Width of the display range. | |
| Outlier Remove | Threshold for abnormal value. | |

| | | |
|---|---|---|
| Average | Select how to process the moving average.<br>Distance: moving average based on the specified length<br>Count: moving average based on the specified data count | |
| Surface Smoothness | Configuration for the longitudinal section display. | |
| Width | Width of the display range. | |
| Output | Configuration of displayed items. | Check the check box to display an item |
| Key Assign | Assign shortcut keys | |
| Execute | Accept the configurations made. | |
| Back | Go back to the Analysis menu. | |

## 9.5 Operation Procedure

(1) Work Flow

The workflow of the Data Analysis Application is as described in Figure 9.16.

A. Launch the application

↓

B. Configure the starting and ending points for the analysis

↓

C. Define the road width

↓

D. Cracking Interpretation

↓

E. Analysis rutting

↓

F. Road surface type classification

↓

G. Data output

Figure 9.16 Work Flow

(2) Data Analysis

**A. <u>Launch the Application</u>**

Double click on [RM2_RISA.exe] found on the computer and launch the application.

Figure 9.17 Icon of the Application

Select [Pavement Interpretation].

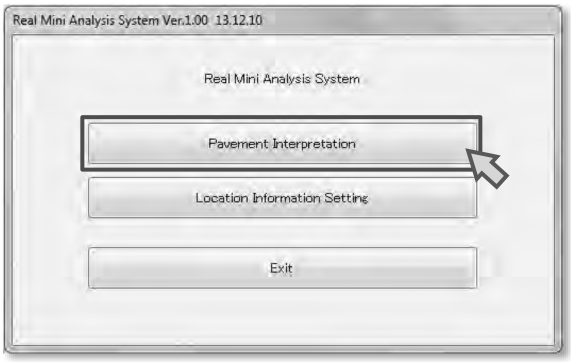



Figure 9.18　Application Selection

Click on [Browse] and specify the folder path of the analysis data.

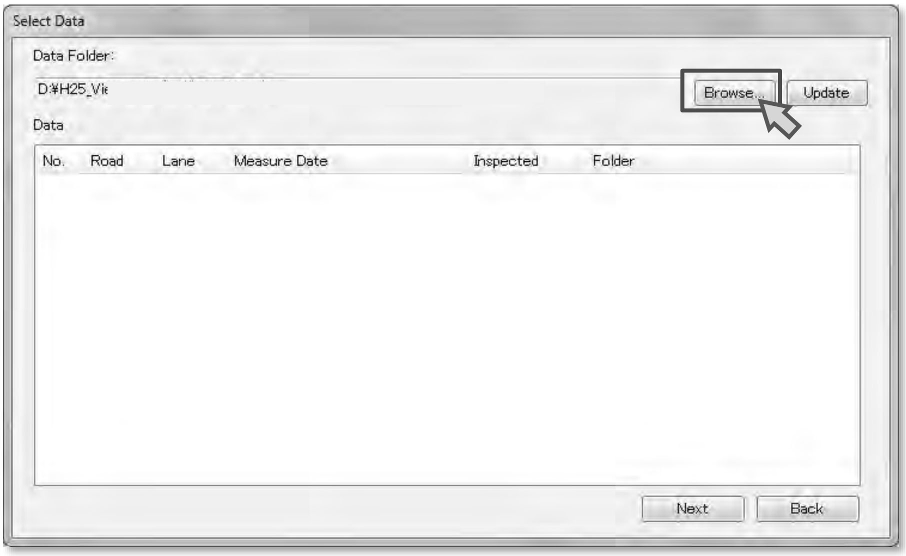



Figure 9.19　Selection of Data Available for Analysis

Specify the folder storing the data output by the data conversion application and click on [OK].

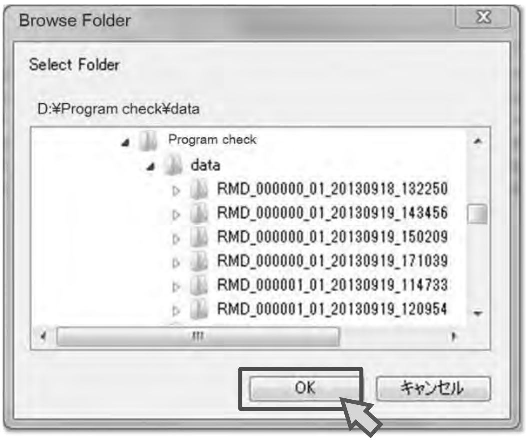



Figure 9.20　Folder Selection

From the list, select the data to analyze and click [Next].

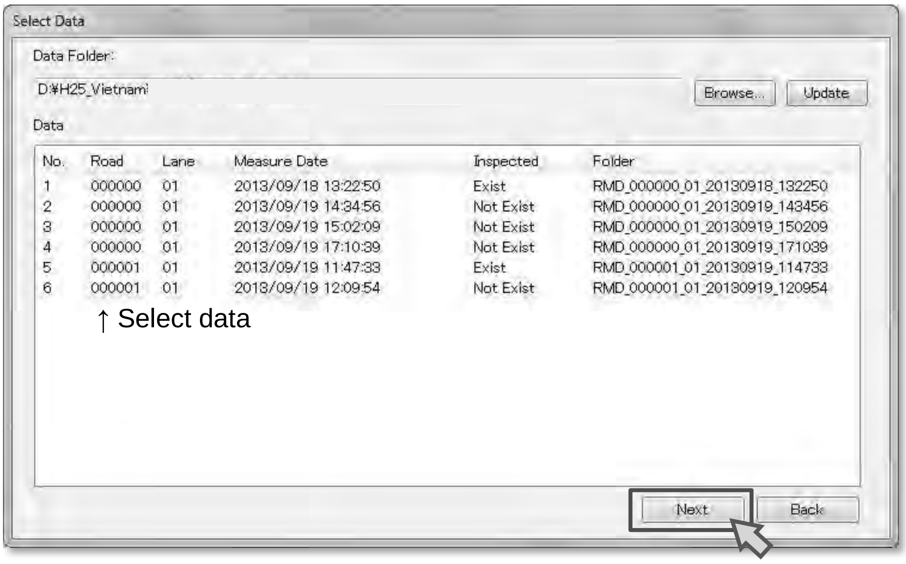



Figure 9.21 Data Selection

Click [Next].

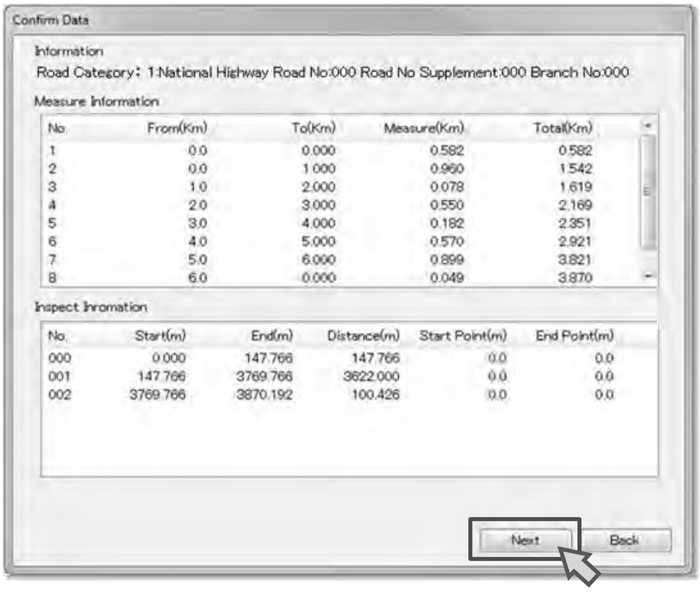



Figure 9.22 Data Confirmation

This will launch the Analysis menu.

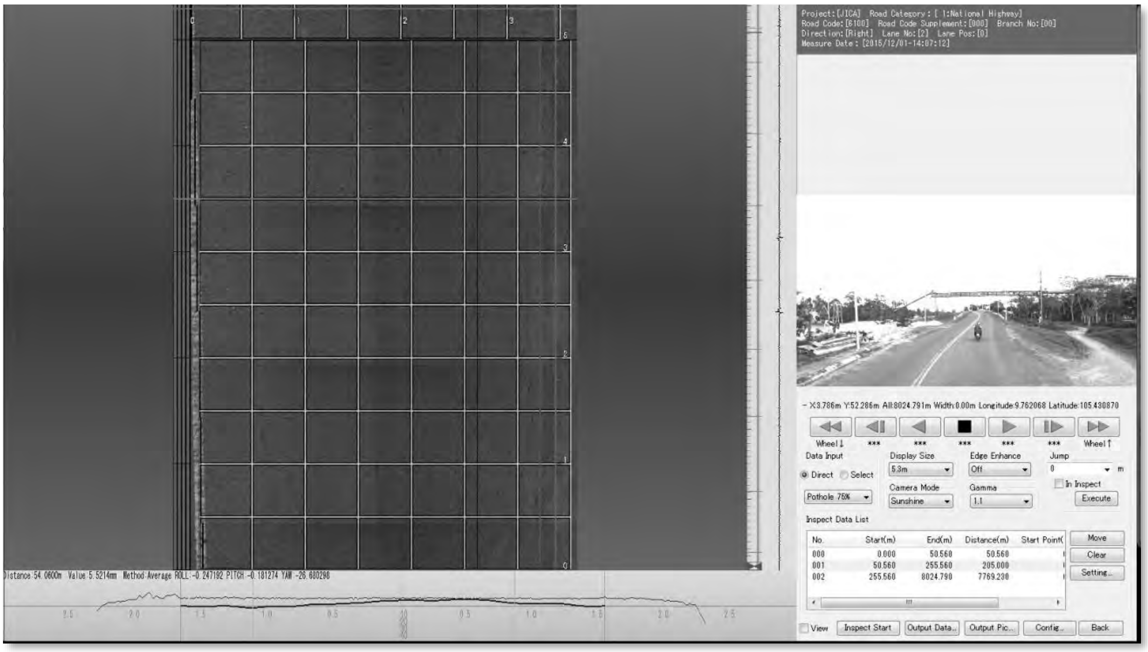


Figure 9.23 Analysis Menu

**B. <u>Configure the Starting and Ending Points of the Analysis</u>**

Click [Inspect Start].

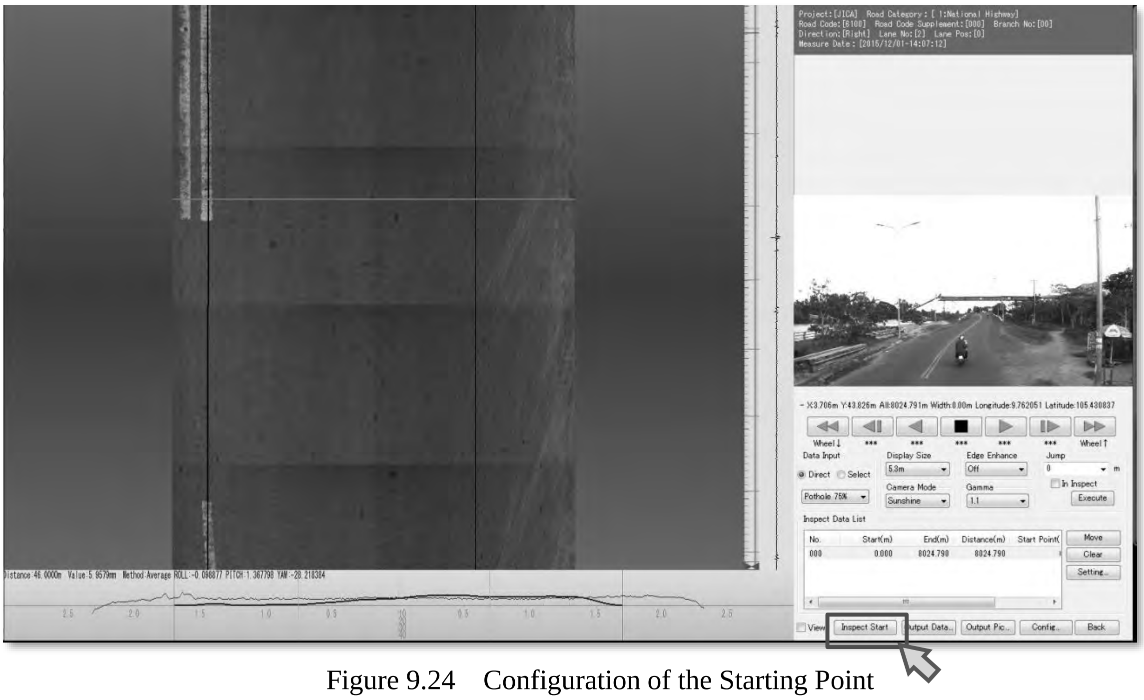


Figure 9.24 Configuration of the Starting Point

Placing the cursor on the road surface image will cause a red line to appear. Move the cursor to the starting point and click.

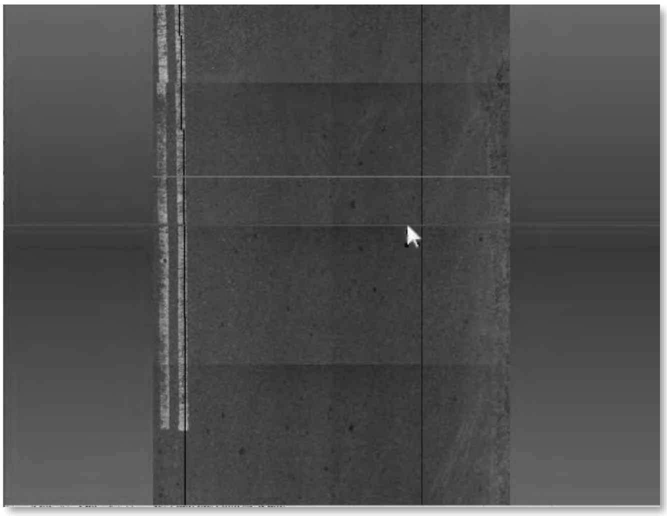


Figure 9.25　Align the Red Line to the Starting Position

Click [Yes].

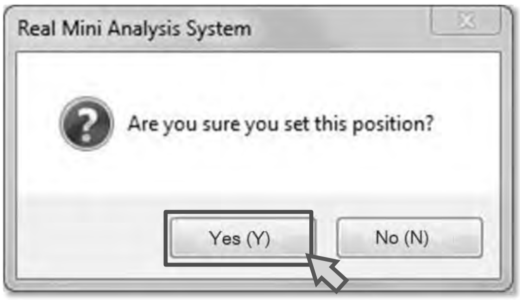



Figure 9.26　Configuration Confirmation Message

Specify the [Size] under the [Crack]-[Mesh] section and the [Unit Of Interval] under the [Rut] section, and click [OK]. The base values for these fields are shown in Table 9.17　.

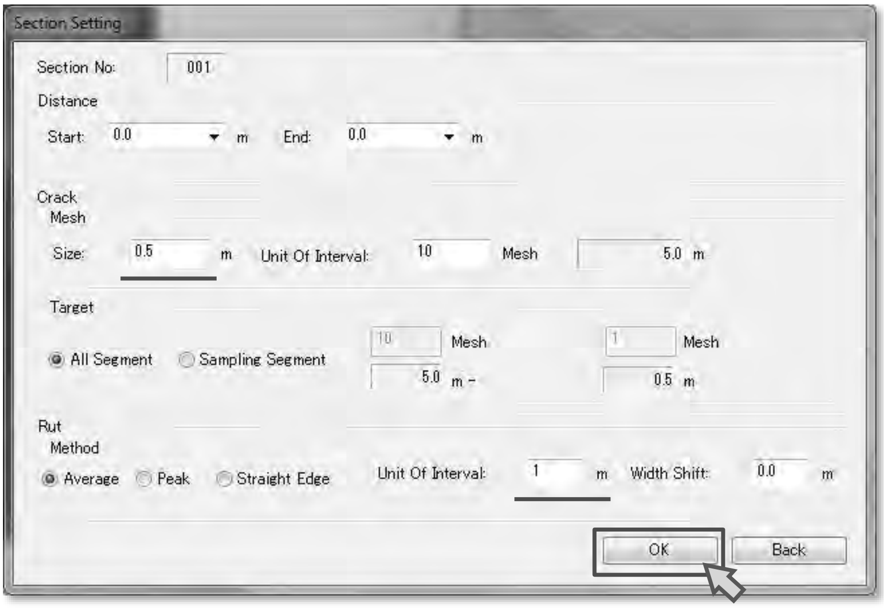



Figure 9.27　Section Setting

Table 9.17 Analysis Preset Value

| Item | Preset Value |
|---|---|
| Size | 0.5 |
| Unit Of Interval | 1 |

Repeat the same steps to configure the ending point.
Confirm that the configured section is displayed to the [Inspect Data List] pane of the Analysis menu.

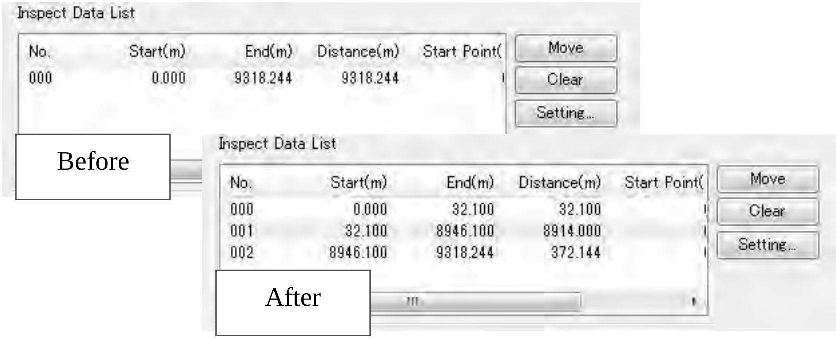



Figure 9.28 Confirm the Configuration Change

The analysis target section will now show that the road surface distress interpretation is made available, and meshes and scales are displayed, as shown in Figure 9.29.

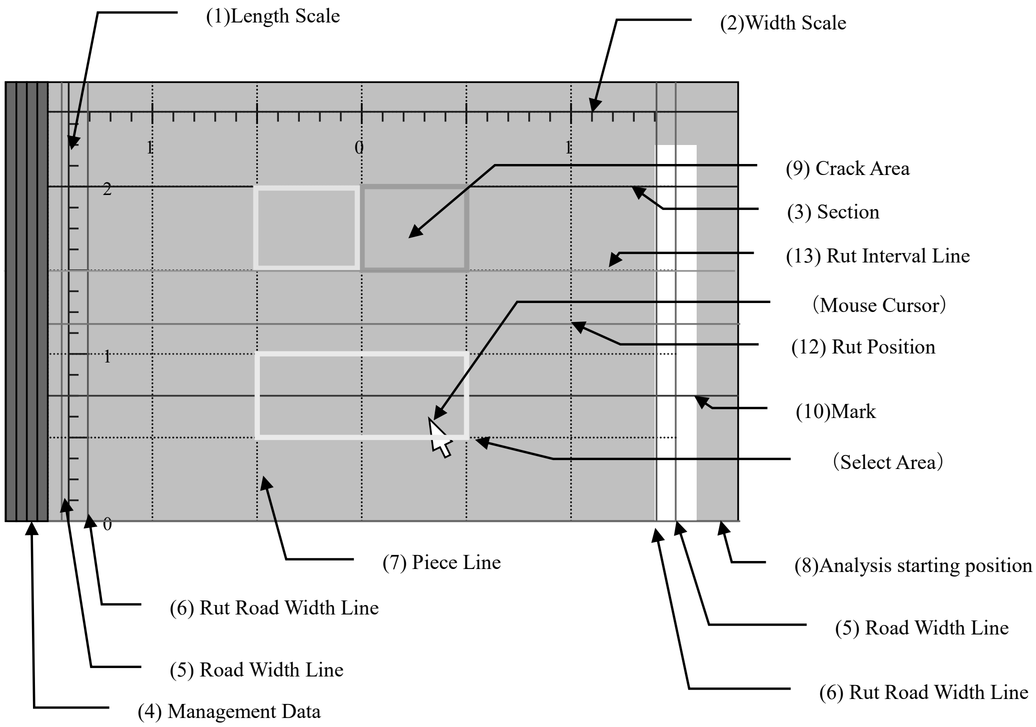



Figure 9.29 Road Distress Interpretation Menu Details

**Tips-1 Reference for Configuring the Road Width**

On the road surface image and position information bar, the starting and ending points configured from the [Starting and End Point Configuration Application] will appear as green lines. Use these lines as a guide to determine the starting and ending points.

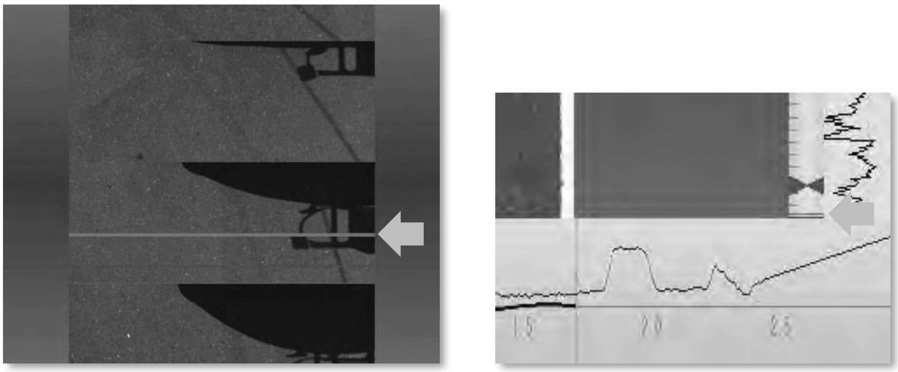


Figure 9.30 Flags Displayed by the Application to set the starting and ending points

**Tips-2 How to Correct Configurations**

If the configuration should be changed or corrected, select the data to delete from [Inspect Data List] and click on the [Clear] button.

Make sure that you carefully execute this step as clicking on [Clear] will also delete the road surface interpretation data if it is already present.

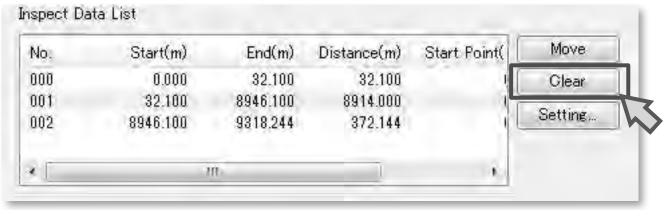



Figure 9.31 Deleting a Section

**C. <u>Define the Road Width</u>**

1) Example of Defining the Road Width

Both the cracking analysis and rutting analysis require the road width to be defined. Generally, both cracking analysis and rutting analysis should use the same road width definition.

**Case1 Two Lane Marks are visible**

If lane marks are present on both sides of the road, the distance between the inner edge of the lane mark to the inner edge of the opposite lane mark defines the road width.

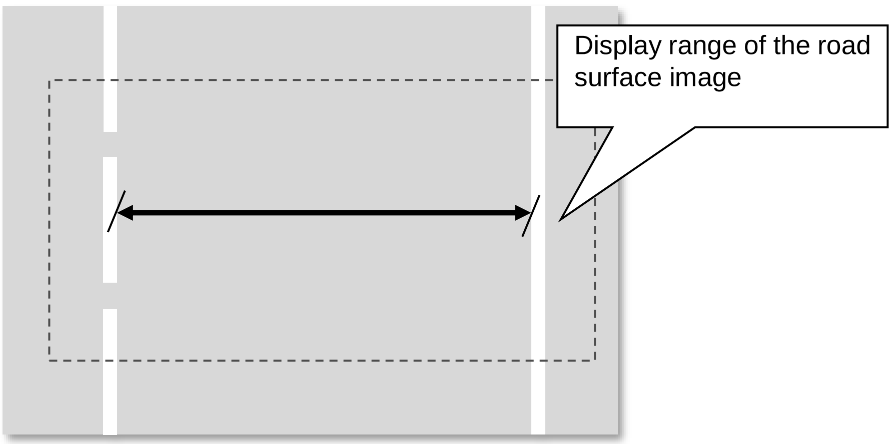



Figure 9.32 Two Lane Marks on Both Sides

In the case of a broken line, assume that the lane mark extends on both sides and do not modify the road width.

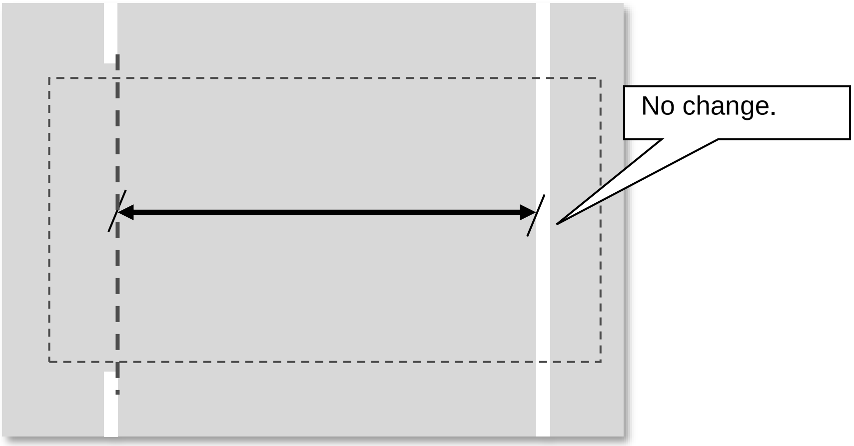



Figure 9.33 For Broken Lines

**Case 2 One Lane Mark is visible**

If only a centerline is present, the road width should be measured by starting from the inner edge of the centerline to the farthest edge on the opposite side so that the width is set as wide as possible.

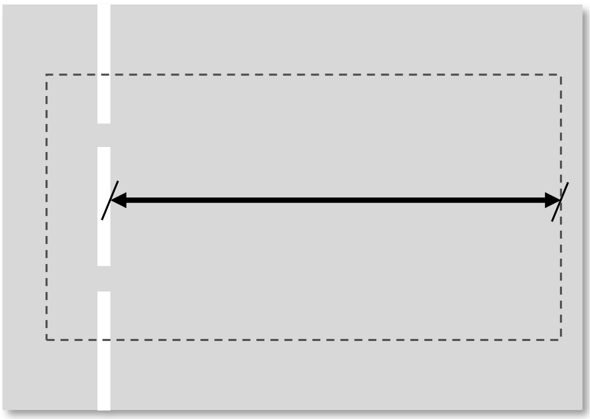


Figure 9.34 When Only a Center Line is Visible

Additionally, if the lane mark is present only on the opposite side, the road width should be measured by starting from the inner edge of the lane mark to the farthest edge of the opposite side so that the width is set to as wide as possible.

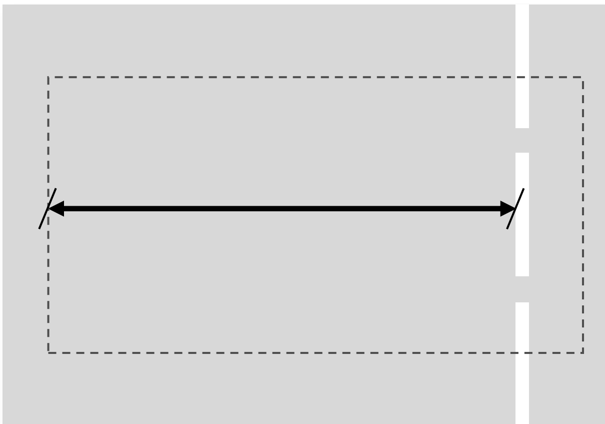


Figure 9.35 Only Lane Mark of Shoulder is Visible

If the opposite lane is still unpaved, the road width should be defined at the boundary between the paved lane and the unpaved lane.

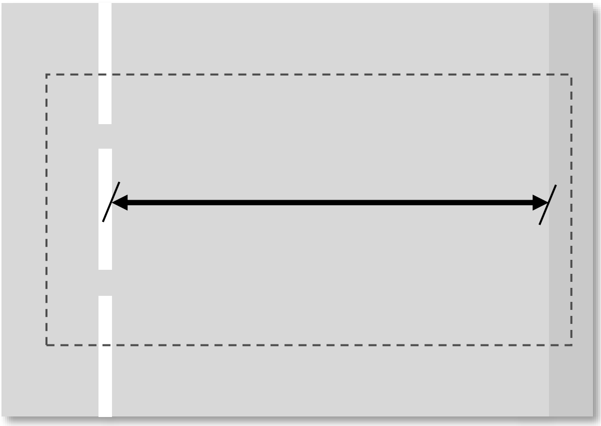


Figure 9.36 One Lane is Unpaved (Example 1)

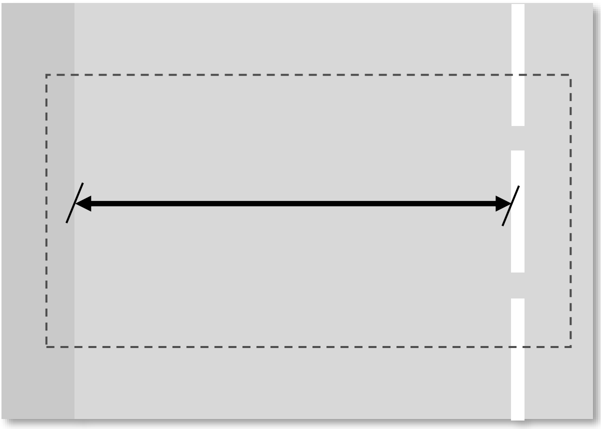


Figure 9.37 One Lane is Unpaved (Example 2)

**Case 3 No Lane Marks**

When there are no lane marks present, set the road width to the maximum.

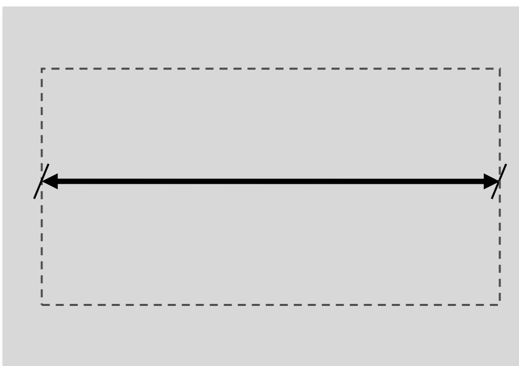


Figure 9.38 No Lane Marks 1

If both edges are unpaved, define the entire paved plane as the road width for analysis.

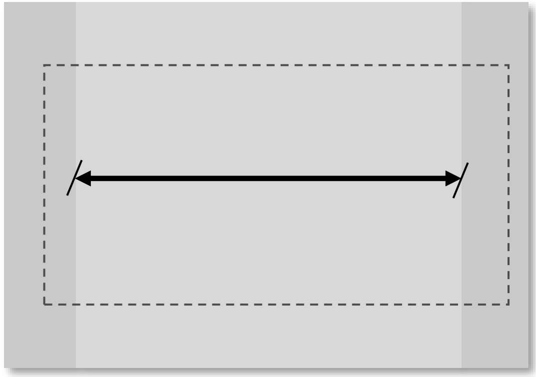


Figure 9.39 No Lane Marks 2

**Case 4 Increase/Decrease in Number of Lanes**

When the number of lanes of the road increases or decreases, the connecting section should not change the road width. However, if the connecting section includes an unpaved section, the road width should be defined by using the widest road width of the paved section.

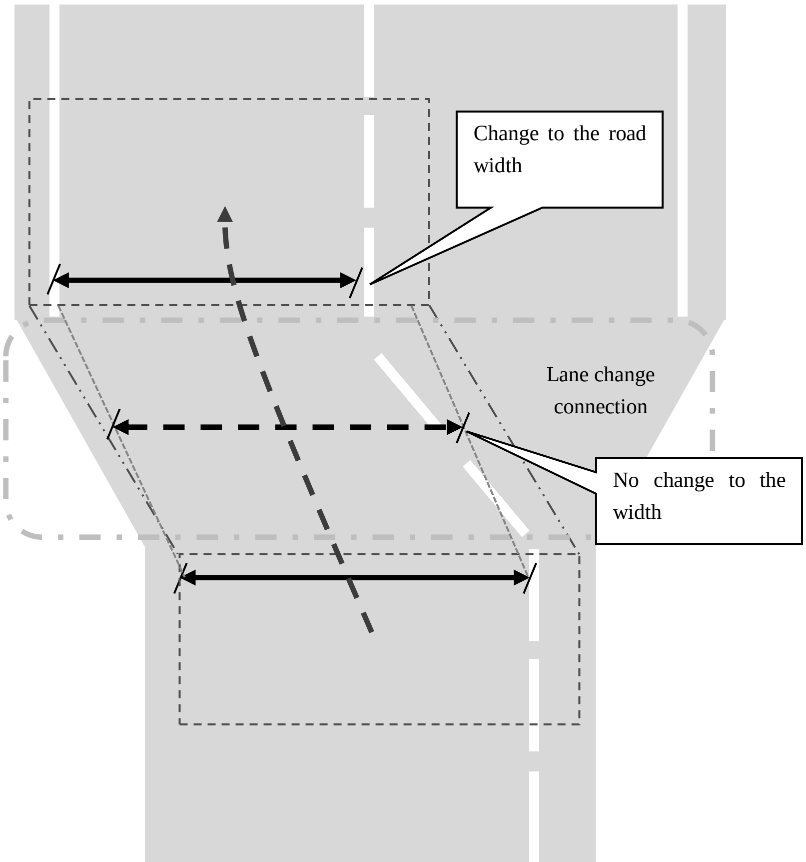



Figure 9.40 Example of Change in Number of Lanes

**Case 5 Overtake**

When the survey vehicle had over taken another vehicle or passed over an obstacle to avoid it during the course of its travel, the road width should not change but maintain the width from the immediate section. However, t if another vehicle or an obstacle is captured together within the analysis range, only change the rutting width so that the range capturing the vehicle is avoided.

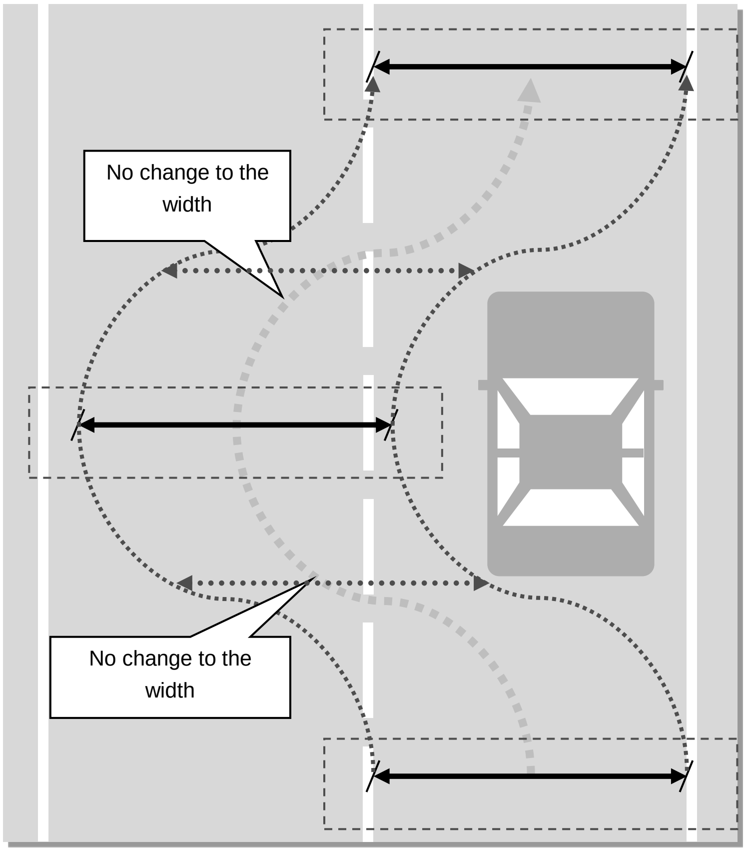



Figure 9.41　Example of an Overtake

2) How to Define the Road Width

The pink lines running along the sides of the road surface image indicate the width for cracks, and the purple lines indicate the width for rutting. Place the cursor on the line and perform the operation described in Table 9.18　to define the widths.

<u>***The line pair for both cracks and rutting is displayed overlapping by default.**</u>

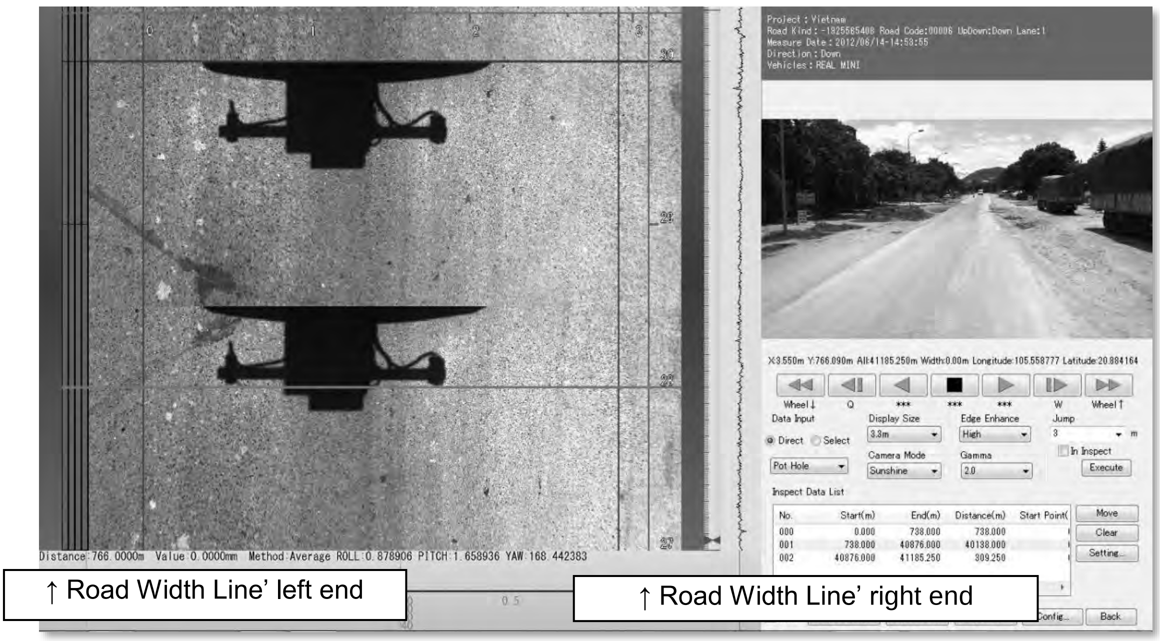
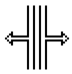
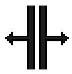
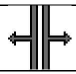
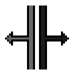
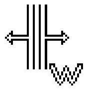
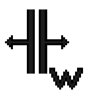



Figure 9.42　Defining the Width

Table 9.18 Operation for Defining the Width

| | | |
|---|---|---|
| Crack |  | The width of both sides can be changed once the cursor changes its form to the symbol as seen on the left. |
| |  | Holding down the “Ctrl” key will change the cursor to the symbol as seen on the left, allowing the width of one section to be changed. |
| |  | When the mouse cursor pushing the Shift key looks like this, the road width moved by parallel translation. |
| |  | When the mouse cursor pushing Ctrl＋Shift key looks like this, the road width of 1 sector moved by parallel translation. |
| Rut |  | Holding down the “Alt” key will change the cursor to the symbol as seen on the left, allowing the rutting analysis width to be changed. |
| |  | Holding down the “Alt” and “Ctrl” keys together will change the cursor to the symbol as seen on the left, allowing the rutting analysis width of a single section to be changed. |

**D. Cracking Interpretation**

1) Example of Cracking Interpretation Pattern

Cracks, patches and potholes are interpreted and classified into thirteen categories. To each category, one key is assigned.

Table 9.19 Classification of Cracking Interpretation

| No. | Classification | Description |
|---|---|---|
| 1 | Two or More Crack | There are two or more cracks in the mesh |
| 2 | Single cracking | There is one crack in the mesh |
| 3 | Patching 75% | Patching occupies an area of more than 75% of the mesh |
| 4 | Patching 25% | Patching occupies an area of more than 25% to less than 75% of the mesh |
| 5 | Pothole 75% | Pothole occupies an area of more than 75% of the mesh |
| 6 | Pothole 25% | Pothole occupies an area of more than 25% to less than 75% of the mesh |
| 7 | Pothole | Pothole occupies an area of greater than 0% to less than 25% of the mesh |
| 8 | Concrete cracking 25cm | Total length of crack in the mesh are more than 25cm to less than 50cm |
| 9 | Concrete cracking 50cm | Total length of crack in the mesh are more than 50cm to less than 75cm |
| 10 | Concrete cracking 75cm | Total length of crack in the mesh are more than 75cm to less than 100cm |
| 11 | Concrete crack 100cm | Total length of crack in the mesh are more than 100cm to less than 125cm |
| 12 | Concrete cracking 125cm | Total length of crack in the mesh are more than 125cm to less than 150cm |
| 13 | Concrete cracking 150cm | Total length of crack in the mesh are more than 150cm |

1~2: Asphalt concrete and BST pavement

3~7: Asphalt, BST and cement concrete pavement

8~13: Cement concrete pavement

The below describes patterns of cracking interpretations.

**Case 1 Asphalt Pavement: Crack**

The below are examples of asphalt pavement with Two or More Crack and One Crack.

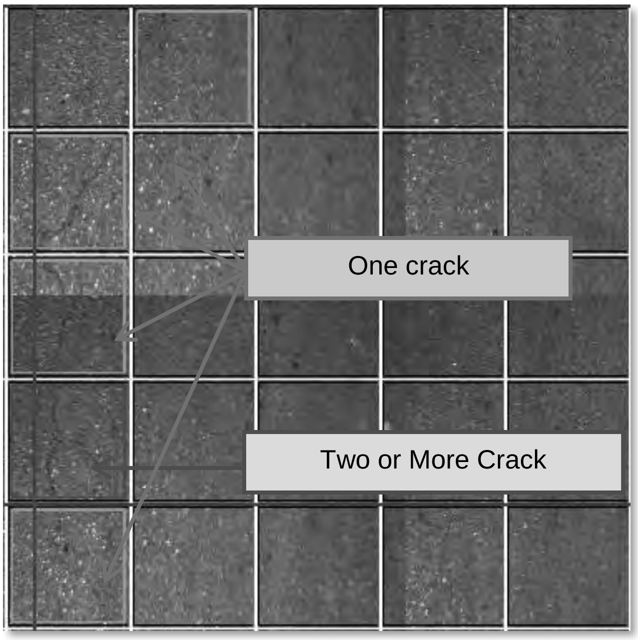



Figure 9.43 Crack Observation (Asphalt Pavement)

Here is an example of a one crack.

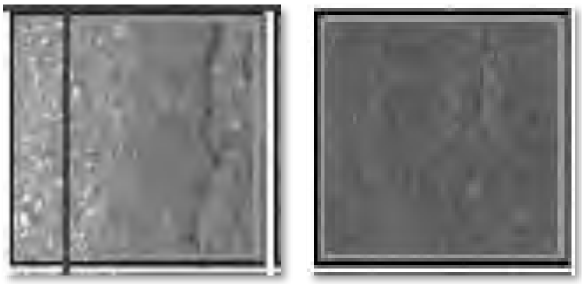


Figure 9.44 One Crack

Here is an example of two or more crack.

Figure 9.45 Two or More Crack

**Case 2 Asphalt Pavement: Patching + Crack**

The below example is an asphalt pavement with patching and cracking.

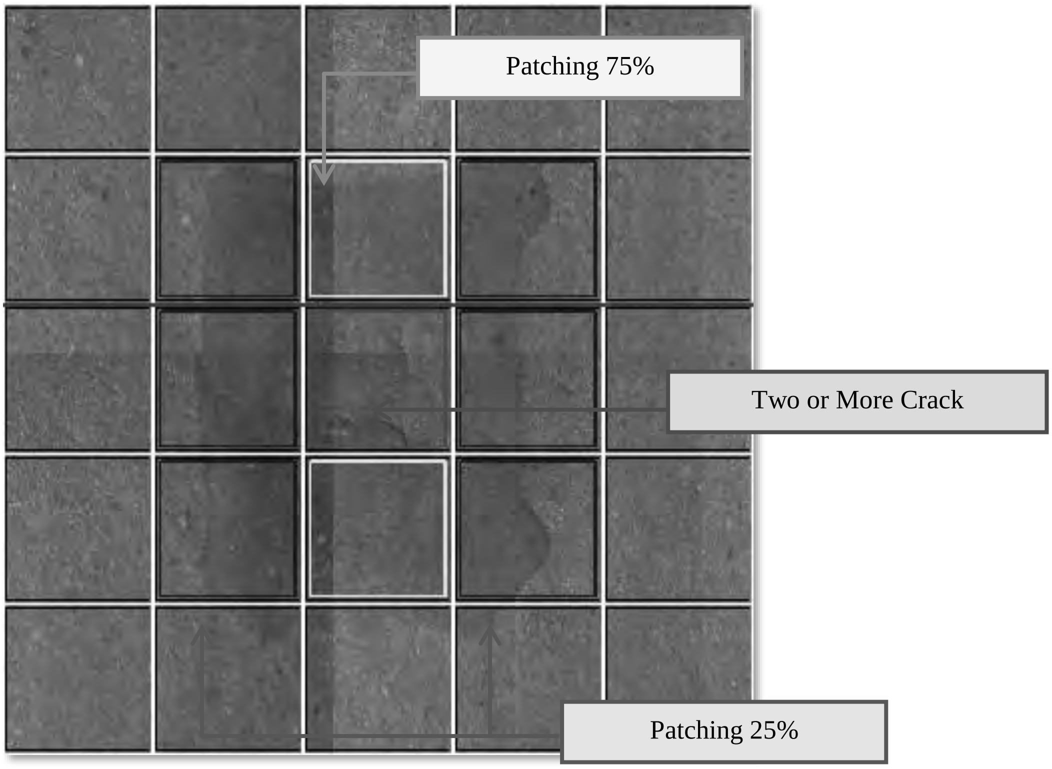



Figure 9.46 Patching 75%, Two or More Crack, Patching 25% (Example)

**Case 3 Asphalt Pavement: Pothole**

The below is an example of an asphalt pavement with a pothole.

Figure 9.47 Pothole – Forward View

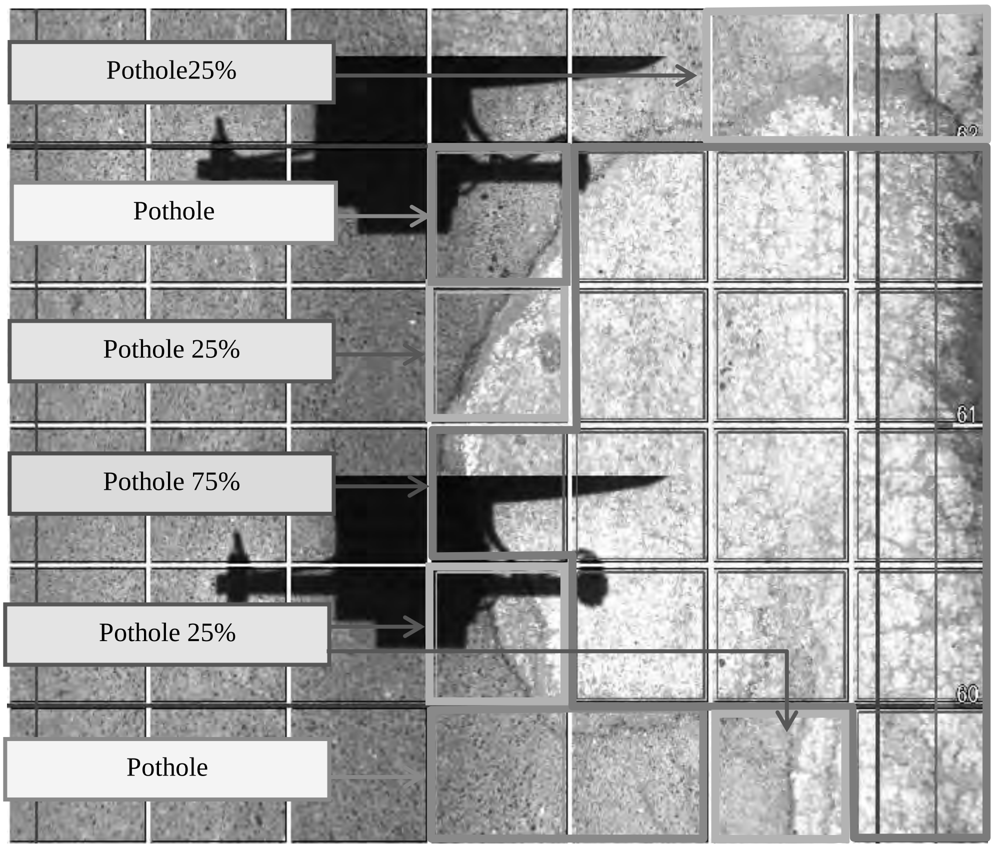



Figure 9.48 Pothole Interpretation (Asphalt Pavement)

**Case 4 Cement Concrete Pavement: Crack**

The below is an example of cracking in a cement concrete pavement. Cracking in cement concrete pavement are interpreted by their lengths.

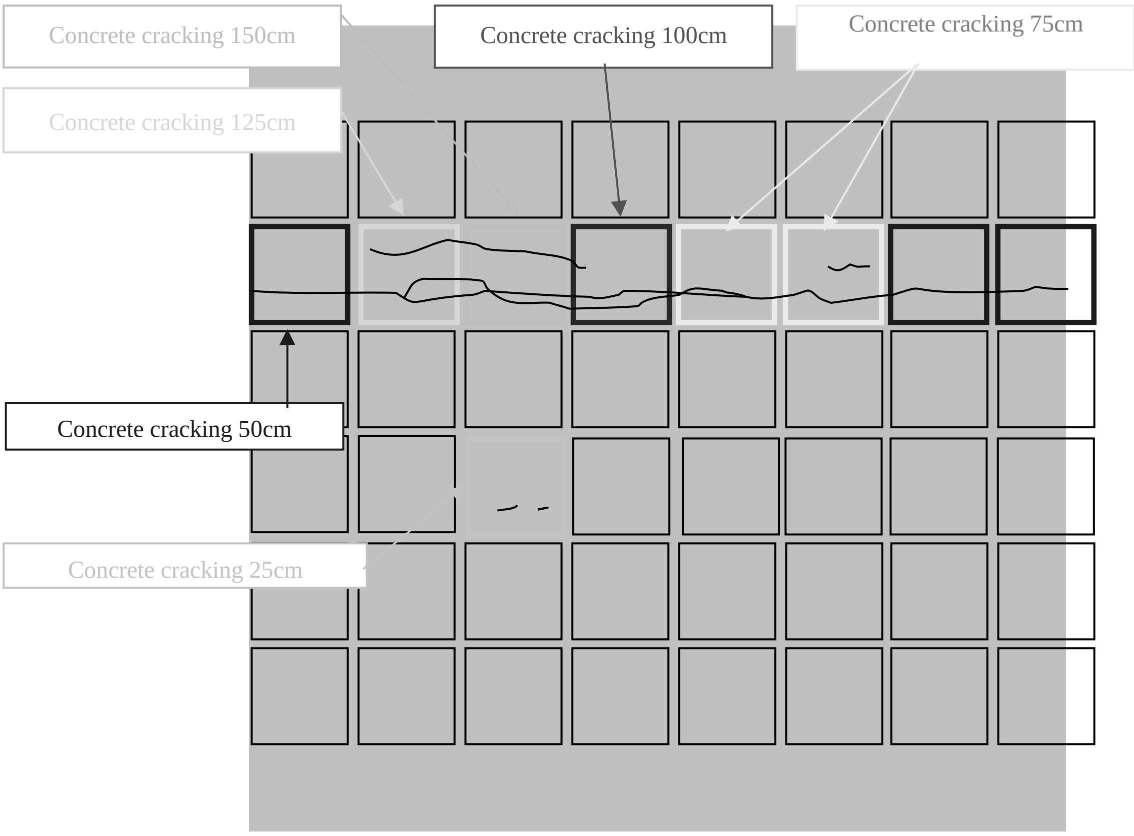



Figure 9.49 Schematic Presentation of Pavement Damage Interpretation (Cement Concrete Pavement)

2) How to Interprete Crack

Place the cursor to the cracking displayed in the road surface image, and opreate the keys described in Table 9.20 and Figure 9.50 to enter the classification of the cracking.

Figure 9.50 Example of Crack Recording Operation

Table 9.20 Key Assignments

| No. | Key | Classification | No. | Key | Classification |
|---|---|---|---|---|---|
| 1 | A | Two or More Crack | 8 | Q | Concrete cracking of 25cm |
| 2 | S | one crack | 9 | W | Concrete cracking of 50cm |
| 3 | D | Patching 75% | 10 | E | Concrete cracking of 75cm |
| 4 | F | Patching 25% | 11 | R | Concrete cracking of 100cm |
| 5 | Z | Pothole 75% | 10 | E | Concrete cracking of 75cm |
| 6 | X | Pothole 25% | 11 | R | Concrete cracking of 100cm |
| 7 | C | Pothole | 12 | T | Concrete cracking of 125cm |
| | | | 13 | Y | Concrete cracking of 150cm |

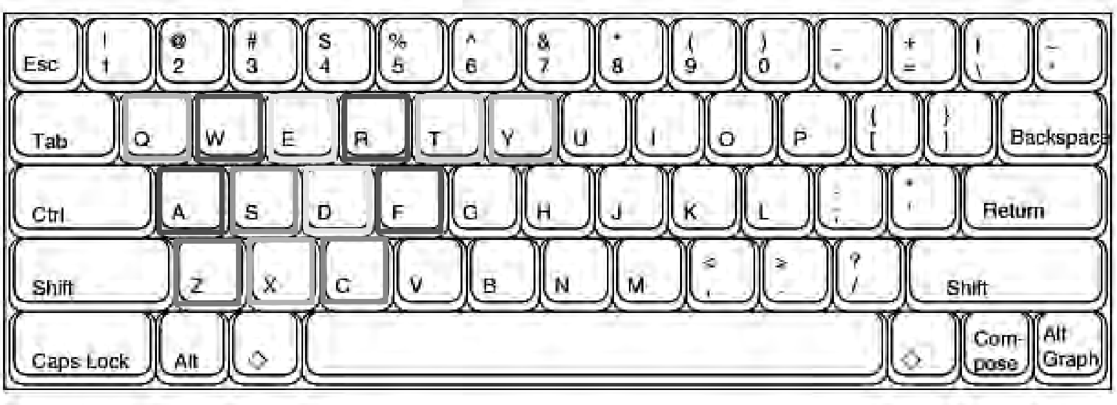



Figure 9.51 Key Assignments

**E. Rut Analysis**

1) Examples/Cases of Rut Analysis

Generally, a rutting is automatically processed when the road width is configured. However, when dealing with a wet road surface and/or an image obscured by another vehicle, calibration such as moving the data capture point or minimizing the road width will become necessary.

**Case 1 Normal Rut**

The below is an example of the display of a normal rut.

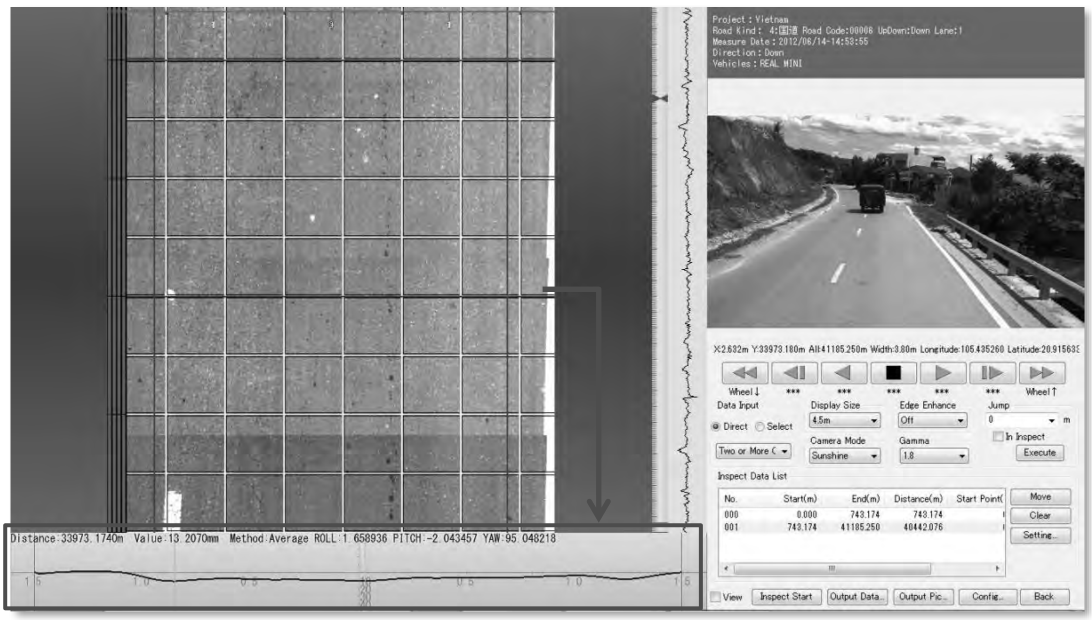


Figure 9.52 Example of Rut (Normal Case)

**Case 2 Abnormal Rut 1**

The below example describes a case where the rut properties are not properly captured due to obstacles (such as a puddle). Obstacles can also include traveling vehicles as well as objects fallen to the road. To avoid these noises, either move the data capture point or, minimize the road width of the rutting analysis for the target section.

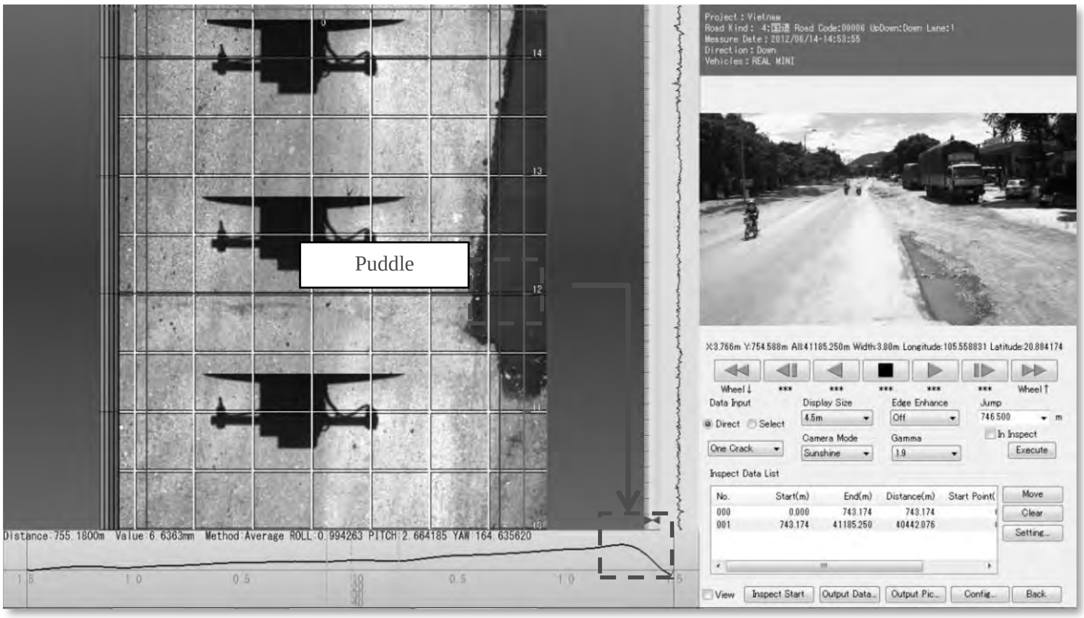



Figure 9.53 Rut (Abnormal Case 1)

**Case 3 Abnormal Rut 2**

The below example describes a case where the measuring vehicle suffered a temporary data anomaly. As far as the forward view image shows, there seem to be no distress on the road surface. It is possible that the other anomalies of the captured data are due to the result of metals, such as metal joints of a bridge. To deal with situations like this, shift the data capture point to solve the problem.

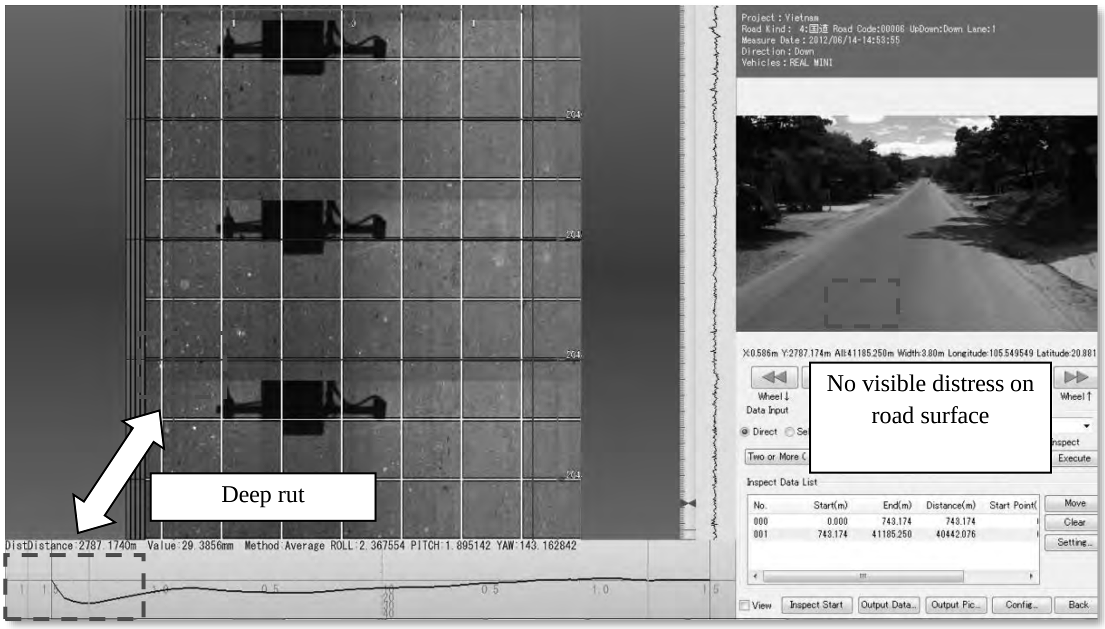



Figure 9.54 Deep Rut

2) How to Rut Interpretation

Placing the cursor on the road surface image will display a green line. In the cross section view, the rut shape is displayed exactly at the position where the green line appears. The red horizontal line indicates the output point of the rut data.


Figure 9.55 Display of the Rut

**Tips-1 Handling Abnormal Data 1**

When the rutting profile at the position of the red line indicates an aabnormality similar to that of cases 2and 3, place the cursor to the red line and click and drag the line once the cursor symbol changes to the form shown in Figure 9.56.

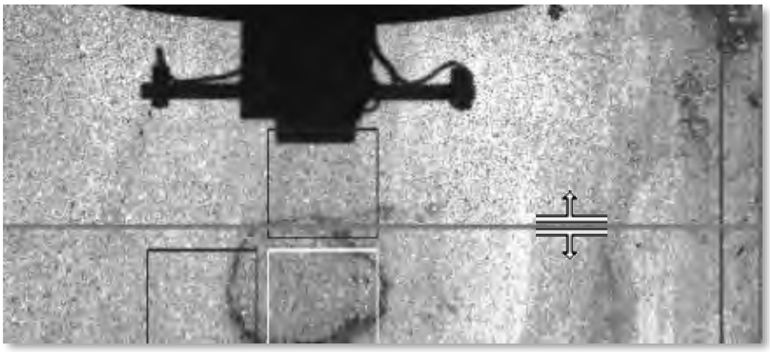


Figure 9.56 Navigating the Rutting Position

**Tips-2 Handling Abnormal Data 2**

When the rut shape of the red line indicates an abnormality similar to that of cases 2 or 3 due to somesort of an obstacle, change the position of the road width so the obstacle can be evaded.

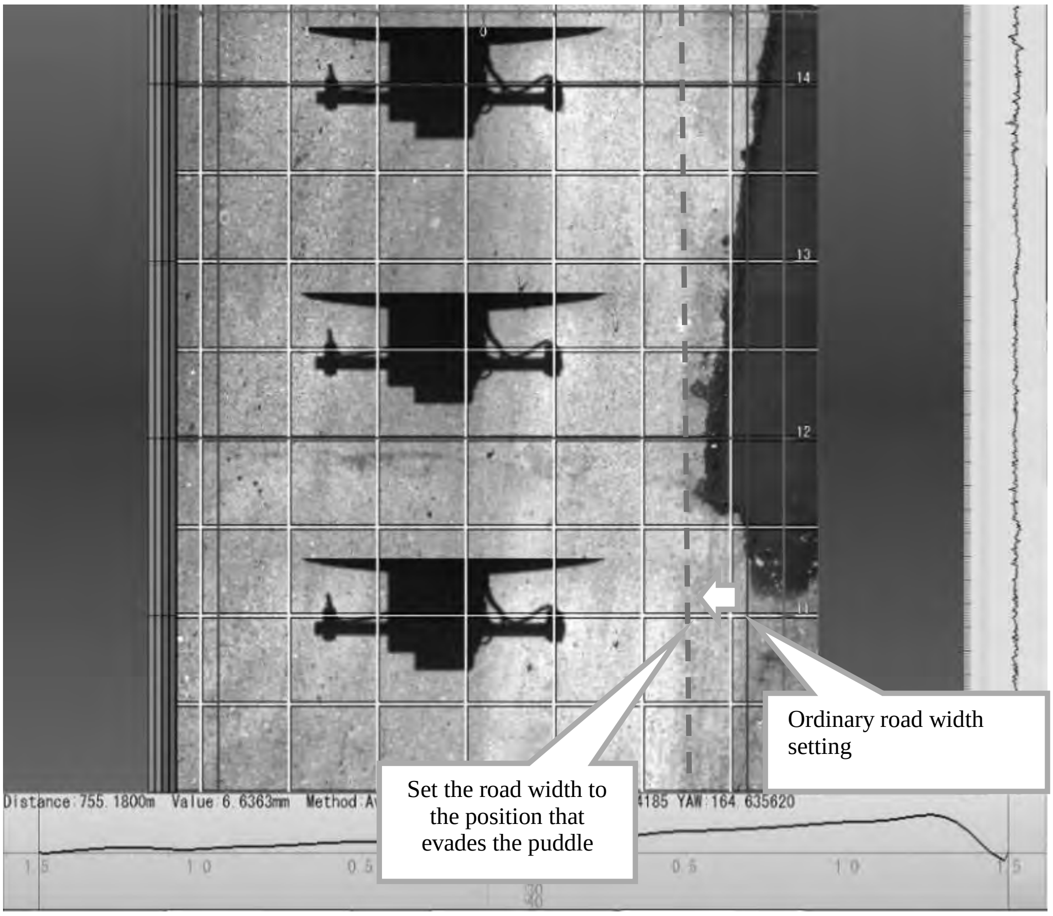



Figure 9.57 Handling by Changing the Road Width Setting

F. Pavement Type Classification

1) Pavement Types

Road surfaces are categorized to any of the three types listed in Table 9.21 .

Table 9.21 Road Surface Types

| No. | Type | Abbreviation |
|---|---|---|
| 1 | Asphalt Concrete | AC |
| 2 | BST | B |
| 3 | Cement Concrete | CC |
| 4 | Other | Other |
| 5 | N/A | * |

2) How to Categorize Road Surfaces

Place the cursor to the Management Data Bar to display “1”, and then right click to select the road surface type. In the example shown in Figure 9.58, the road is an asphalt pavement, so [ROAD: Asphalt] is selected.

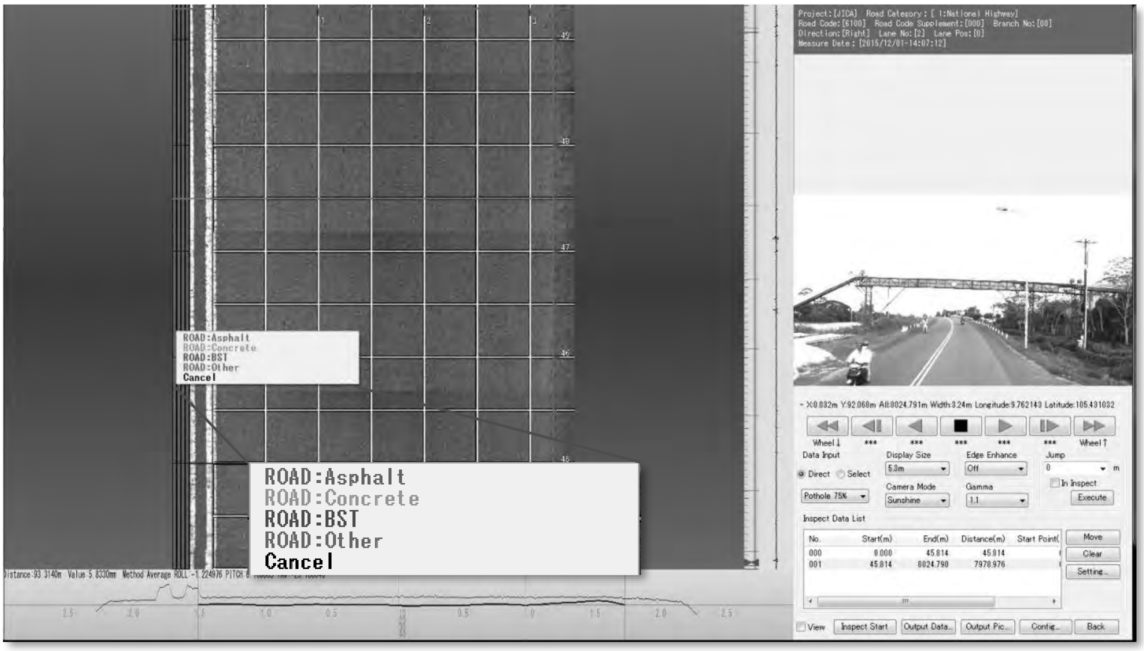



Figure 9.58 Road Surface Classification Images

3) Data Output

Click [Output Data] on the Config menu.

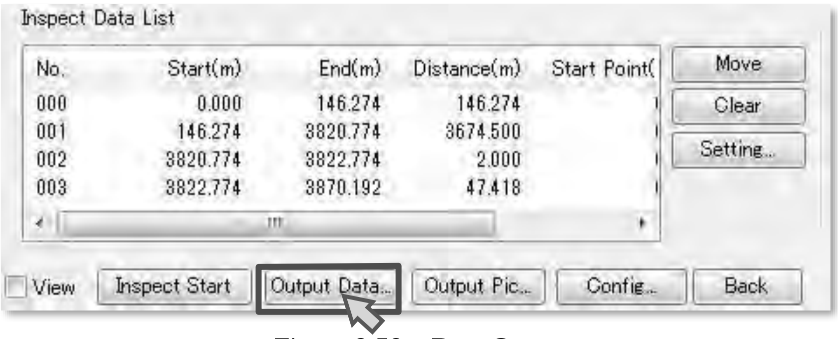



Figure 9.59 Data Output

Fill in the fields displayed in the [Common Item] section.

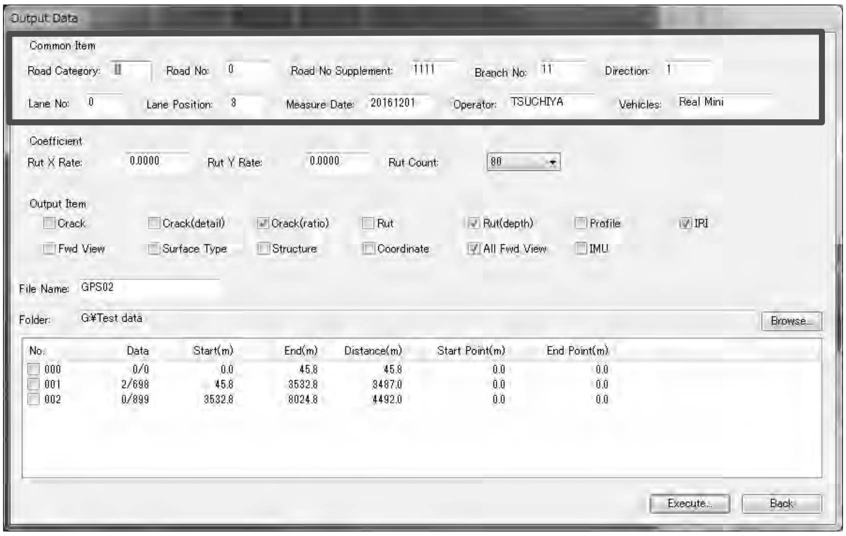



Figure 9.60 Output Configuration 1

From the [Output Item] section, check the items to output.
Required items are the following four items: Crack(ratio), Rut(depth), IRI and All Fwd View.

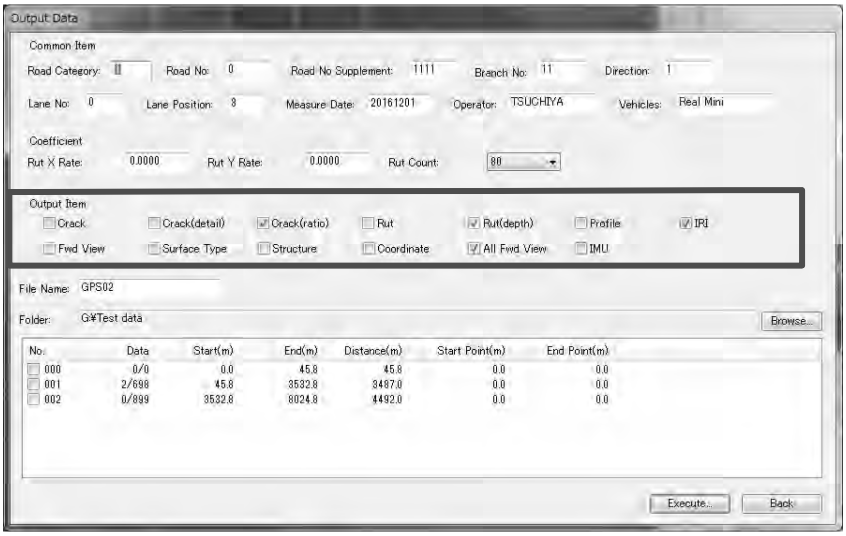


Figure 9.61 Output Configuration 2

Enter the output file name to the [File Name] field. Typically, the file name should be named in a [Road code+Left/Right+Lane_Origin_Destination] format.
Example: NH1001000000R1_000k00000_023k00250 (National Highway 1, Right, Lane 1, From:0k0 To 23k250)

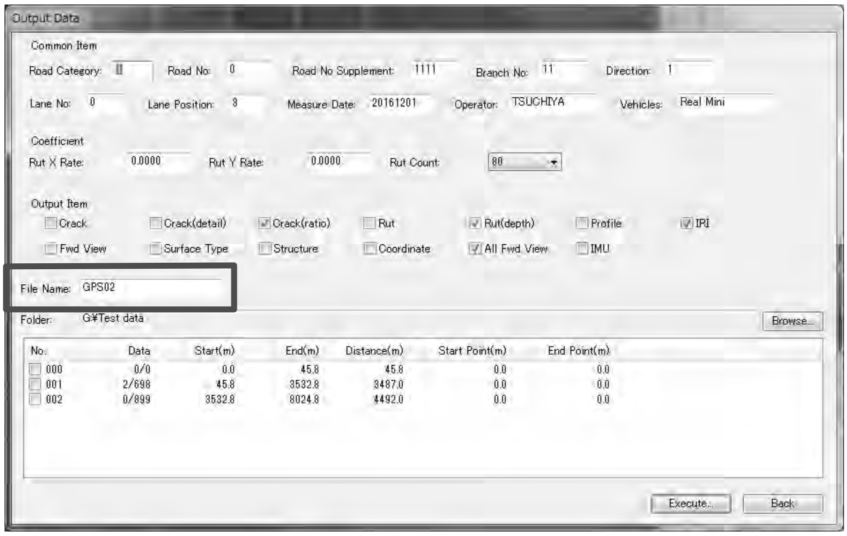


Figure 9.62 Output Configuration 3

Click on the [Browse] button and specify the folder path for the output data.
where to output the data.

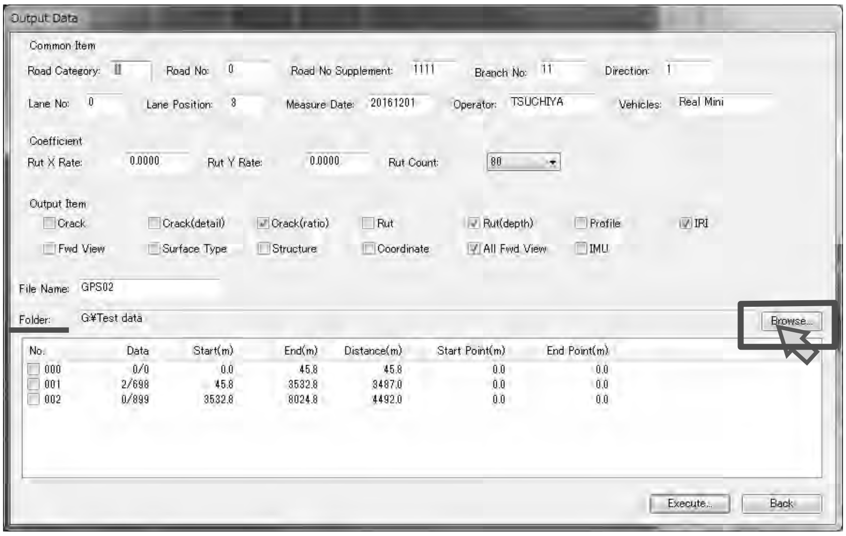



Figure 9.63　Output Configuration 4

Click on the [Execute] button to output the data.
The output data is created to the speficied path as a CSV file.

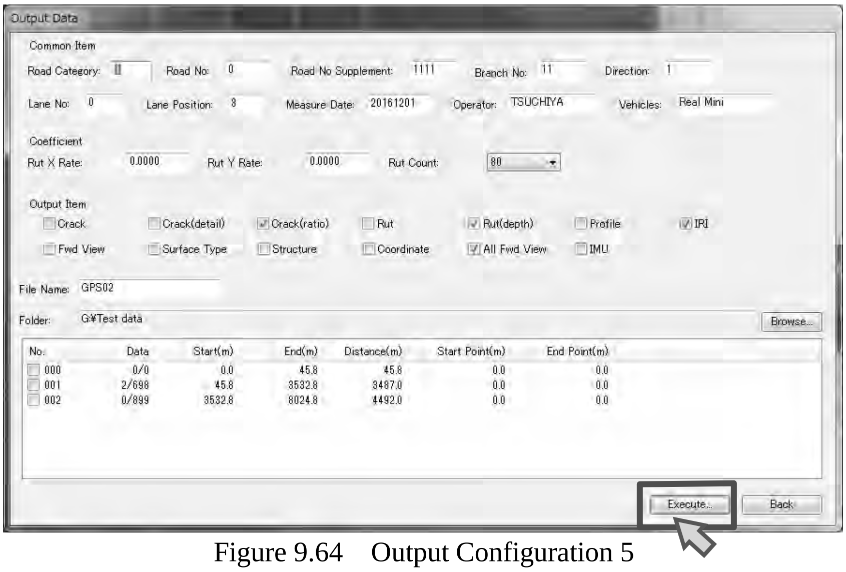



Figure 9.64　Output Configuration 5

(3)　Data Check

The Data Analysis application has a function of judging a value exceeding a certain range at the timing of data output as an abnormal value and outputting a list of abnormal data records as “ERROR.txt”. The operator shall check whether the data judged to be an abnormal value is due to a mistake in analysis work as the following way;

・Open the file of abnormal value list (ERROR.txt) and find the location information
・Check the road condition on the Data Analysis application
・In case of a mistake in analysis, it shall be analyzed again

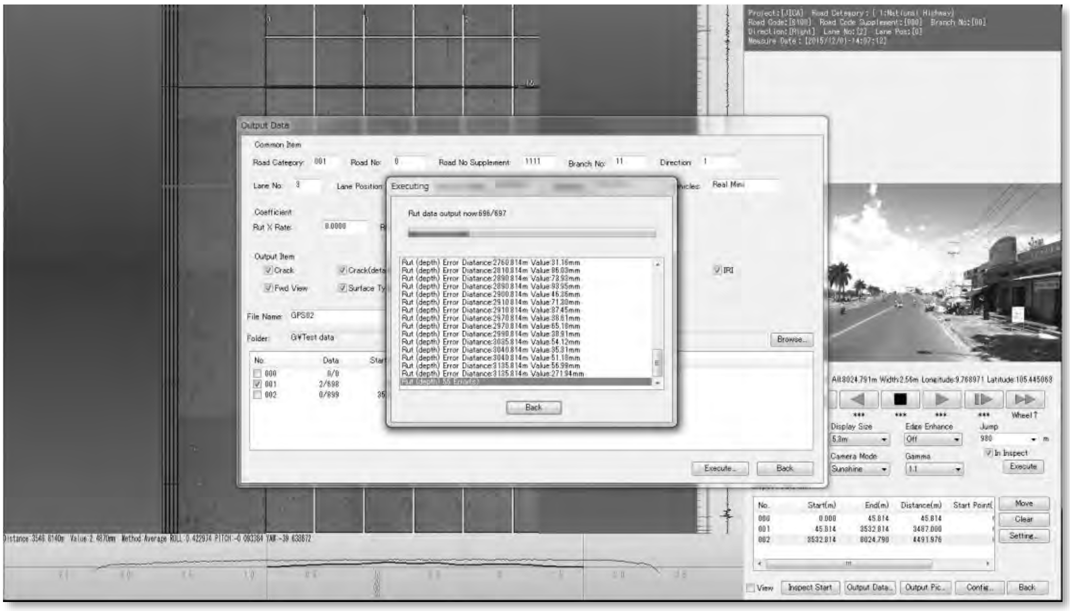


Figure 9.65 Data check in the analysis application

1) Data Check Method

Data check shall be done following contents

- Crack Ratio (%)
- Rut Depth (mm)
- IRI (mm/m)

When output the data from the data analysis application, data check would start automatically. The progress of the data check can confirm in the progress bar. When complete the data check, “Done” would be indicated in the window.

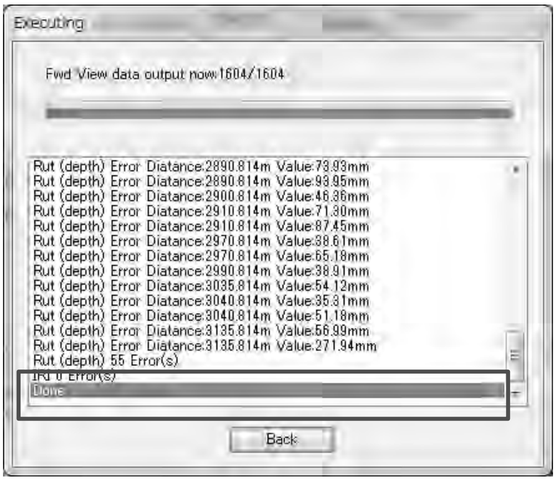



Figure 9.66 Data check window

The result of the data check would save the same folder of the other output files.

In the “ERROR.TXT”, the value exceeding of the threshold and position information are recorded in the order of Crack Ratio, Rut Depth, and IRI.


Figure 9.67 Sample of "ERROR.TXT"

Operator would open "ERROR.TXT" and confirm the judged as abnormal value using the data analysis application. If the interpretation of data analysis have mistaken, operator should re-analysis the mistaken part and re-output the data.
When rutting or IRI value is 0, data convert shall be done again. If the data still cannot be corrected, there is a possibility of device failure. So operator must contact to provider.

Table 9.22 Possible reasons of analysis errors

| Data Item | Criteria | Mistaken |
|---|---|---|
| Crack Ratio | More than 70% | Interpretation mistaken |
| Rut Depth (Max.) | More than 50mm | Setting mistaken of road width |
| Rut Depth (Ave.) | More than 30mm | Setting position mistaken |
| Rut Depth (Max.) | 0mm | Data conversion error |
| Rut Depth (Ave.) | 0mm | Device failure |
| IRI | 0mm/m | Device failure |

2) Setting the Threshold

The threshold to extract the abnormal value would be set in "System.ini". "System.ini" is saved at the same folder with data analysis application. Below table shows the contents of "System.ini". Further, if threshold is set "-1", the threshold would not use in the data check.

Table 9.23 'System.ini' content

| Content | Description | Note |
|---|---|---|
| LANGUAGE | Display language in the system | 1: English, 0: Japanese |
| CR_RATE_TH_LOW | Smaller threshold | Crack ratio |
| CR_RATE_TH_HI | Larger thershold | Crack ratio |
| RUT_TH_LOW | Smaller threshold | Rut depth |
| RUT_TH_HI | Larger threshold | Rut depth |
| IRI_TH_LOW | Smaller threshold | IRI |
| IRI_TH_HI | Larger threshold | IRI |

"System.ini" is normally set as shown in **Figure 9.68**, data check is performed as follows.

・" CR_RATE_TH_LOW=-1" : Invalidate the smaller threshold of crack ratio
・" CR_RATE_TH_HI=70" : Error the section of crack ratio more than 70%
・" RUT_TH_LOW=0" : Error the section of rut depth is 0mm
・" RUT_TH_HI=30" : Error the section of rut depth more than 30mm
・" IRI_TH_LOW=0" : Error the section of IRI is 0mm/m
・" IRI_TH_HI=15" : Error the section of IRI more than 15mm/m

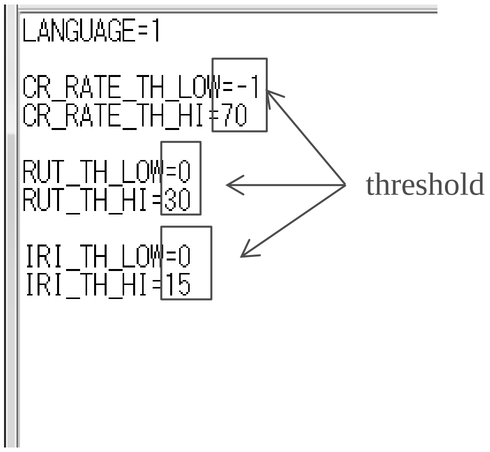



Figure 9.68 Threshold in "System.ini"

(4) Data Delivery

The data output by this analysis application is used for the data processing. Table 9.24 describes the list of data required for the Data Processing.

Table 9.24 Delivery Data

| No. | Data | Notes |
|---|---|---|
| 1 | C3_******.csv | Cracking analysis |
| 2 | R3_******.csv | Rutting analysis |
| 3 | S3_******.csv | IRI analysis |
| 4 | FA_******.csv | GPS coordinates |

# 10. Instruction Manual of Location Setting Application

## 10.1 Purpose

This application is responsible for creating the positional data of road managing information, such as road structures, intersections, and number of traffic lanes, by using forward view images and road surface images captured by REAL Mini.

## 10.2 Input and Output Data

The data used for and output by this application are as described in Table 9.1.

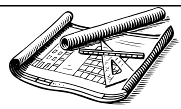
Table 10.1 Input and Output Data of the Location Setting Application

| Name | Type | Notes |
|---|---|---|
| RMD_999999_99_99999999_999999 | Input | Converted data |
| P_*****.csv | Output | Positional information data |

## 10.3 Equipment

The equipment required for this application is described in Table 10.2.

Table 10.2 List of Equipment

| Equipment Name | Image | Notes |
|---|---|---|
| Computer |  | |
| HDD |  | HDD containing data. |
| This application<br>(RM2_RISA.exe) |  | |
| Road information resources |  | Field survey, field notes, drawings, official documents and others. |

## 10.4 Interface and Contents

<Launch Menu>

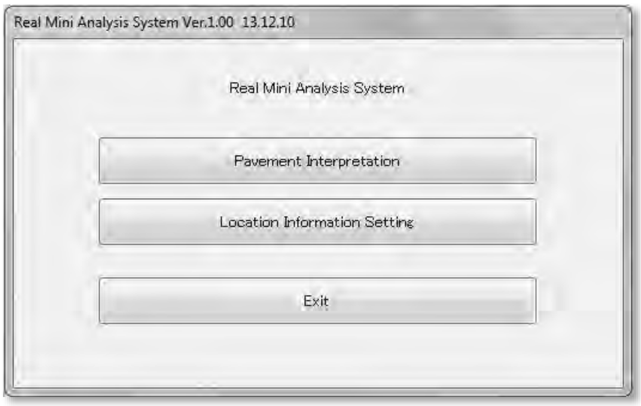



Figure 10.1 Launch Menu

Table 10.3 Features of the Launch Menu

| Item | Description | Notes |
|---|---|---|
| Pavement Interpretation | Launch the analysis application. | This feature will not be discussed in this section. |
| Location-based information Interpretation | Launch the Positional Information application. | |
| Exit | Exit the application. | |

<Data Selection Menu>

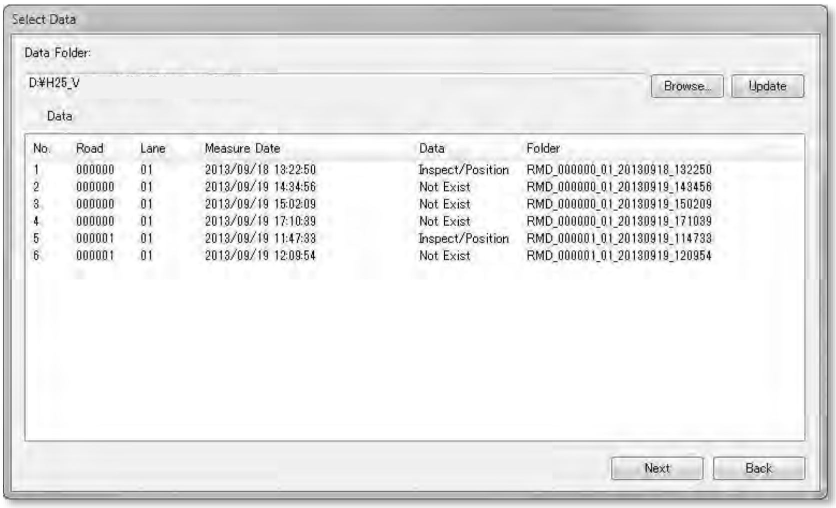



Figure 10.2 Data Selection Menu Interface

Table 10.4 Features of the Data Selection Menu

| Item | Description | Notes |
|---|---|---|
| Data Folder | Displays the current folder path. | |
| Browse… | Opens the data folder path selection window. | |
| Update | Refreshes the display of data. | |
| Data | Displays the list of analysis data within the selected folder. | |
| No. | List number | |
| Road | Road number configured at the time of measurement. | |
| Lane | Lane number configured at the time of measurement. | |
| Measure Date | Timestamp of when the measurement was taken(year, month, date, hour and minutes). | yyyy/mm/dd hh:mm:ss |
| Inspect | Checks for the presence of analysis data. | |
| Folder | Folder name of the analysis data. | |
| Next | Go to the Information menu. | Made available when a data is selected from the list. |
| Back | Go back to the Launch menu. | |

<Identify the Location Window>

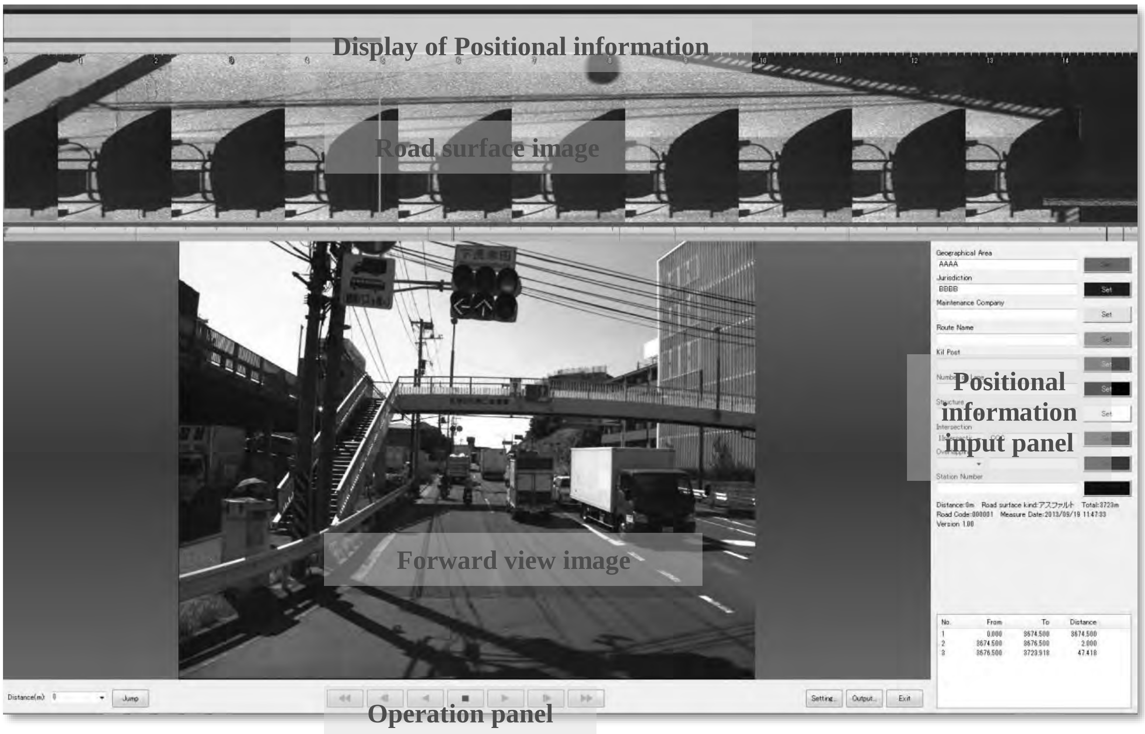



Figure 10.3 Identify Window

Table 10.5 Features of the Identify Window

| Item | Description | Notes |
|---|---|---|
| Display of positional information | Display of the configured positional information. | |
| Road surface image | Display of the road surface image. | |
| Forward view image | Display of the forward view image | |
| Operation panel | Allows operations including playback of images and skipping from point to point. | |
| Positional information input panel | Input positional information. | |

Positional Information Input Panel

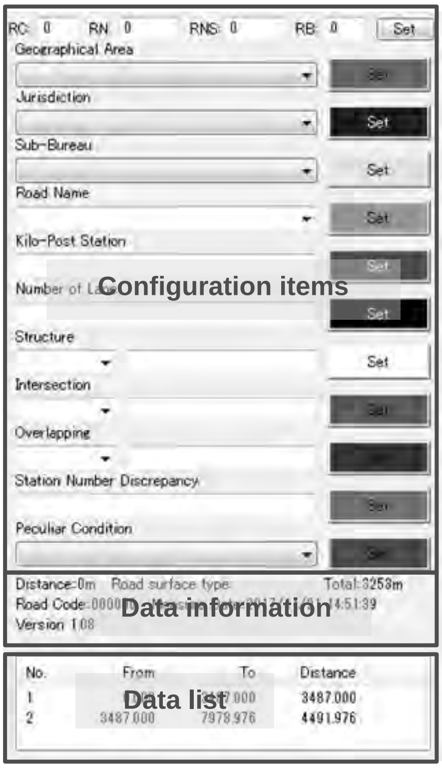



Figure 10.4 Positional information Input Panel

Table 10.6 Features of the Positional information Input Panel

| Item | Description | Notes |
|---|---|---|
| Configuration items | Items to configure the positional information. | |
| Data information | Display of data information regarding the analysis currently in progress. | |
| Distance | Distance of the current screen. | |
| Road surface type | The road surface type category. | |
| Total | The total length of the entire data. | |
| Road Code | Road category, Road number, Road number Supplement and buranch number | |
| Measure Date | Timestamp of when the measurement was taken (in year, month, date, hour and minutes). | |
| Version | The current application version. | |
| Data list | Display of the list of analysis target data. | |

Operation Panel


Figure 10.5 Operation Panel


Figure 10.6 Jump Operation

Table 10.7 Features of the Jump Operation

| Item | Description | Notes |
|---|---|---|
| Distance field | Enter the distance by selecting a reset information from the list, or, manually input the distance. | Pull down list (accepts direct input) |
| Jump | Jump (skip) to the position specified to the Distance field. | |

Figure 10.7 Image Operation Interface

Table 10.8 Features of the Image Operation

| Item | Description | Notes |
|---|---|---|
|  | Frame backward. | |
|  | Mesh backward. | |
|  | Continuous backward. | |
|  | Stop | |
|  | Continuous forward. | |
|  | Mesh forward. | |
|  | Frame forward. | |


Figure 10.8 Interface of Other Options

Table 10.9 Features of Other Options

| Item | Description | Notes |
|---|---|---|
| Setting | Open the Environment Configuration menu. | |
| Output | Open the Data Output menu. | |
| Exit | Exit from the application. | |


Figure 10.9 Data Output Menu Interface

Table 10.10 Features of the Data Output Menu

| Item | Description | Notes |
|---|---|---|
| Common Item | Configuration of common items. | Configured at the time of measurement. |
| Road Category | Grade of the road | 1: National Highway<br>2: Expressway<br>3: Provincial Road<br>4: Others Road |
| Road No. | Road number. | |
| Road No. Supplement | Supplement No. of road No. | |
| Branch No. | Branch number | |
| Left Right | Left-bound, Right-bound, Single-bound | Left: 1, Right: 2, Single: 3 |
| Lane No. | Number of Lane | |
| Lane Position | Lane position | |
| Measure Date | Timestamp of when the measurement was taken. | YYYYMMDD |
| Operator | Name of the operator. | |
| Vehicles | Name of the measuring vehicle. | |
| File Name | Enter the file name of the output data. | |
| Brows… | Specify the output folder path. | |
| Data list | Select the output target data | |
| Execute | Execute output. | |
| Back | Go back to the Analysis menu. | |

## 10.5 Operation Procedure

(1) Work Flow

The work flow of the Location setting application is as described in Figure 10.10.

A. Launch the application.

↓

B. Configure the positional information.

↓

C. Output data

Figure 10.10 Work Flow

(2) Identify the Location Position

A. Launch the Application

Double click on [RM2_RISA.exe] (this application) found on the computer to launch the application.

Figure 10.11 Icon of the Application

Click on [Location Information Setting].

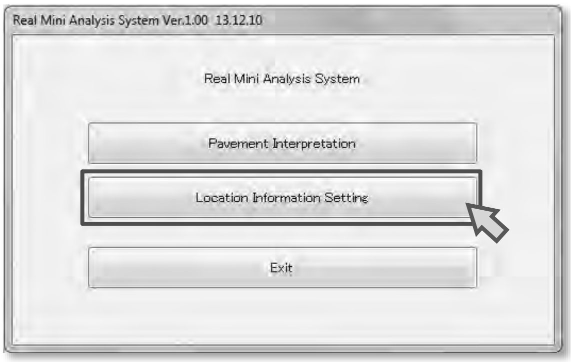



Figure 10.12 Selecting the Application

Click on [Browse] and specify the folder path of the identify the data.

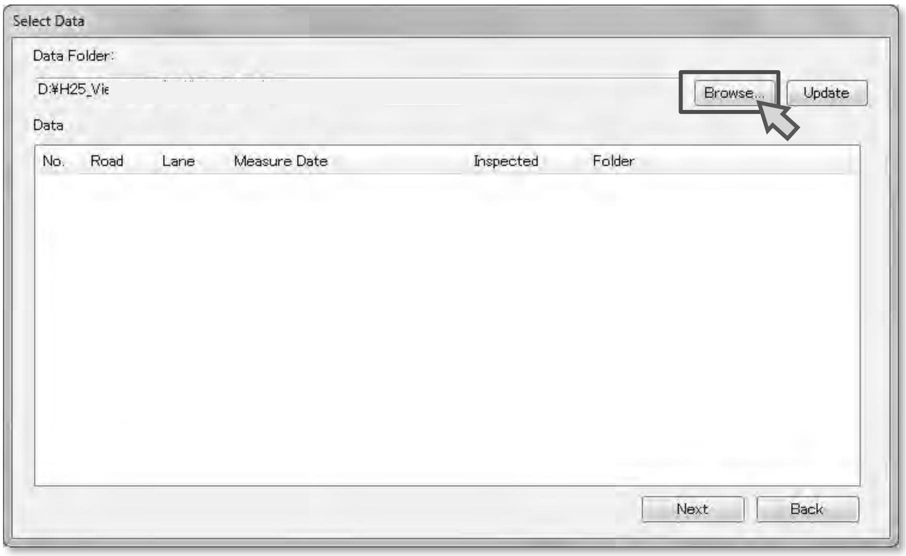



Figure 10.13 Selecting the Data Available for identify

Specify the folder containing the data converted using the data converter application and click [OK].

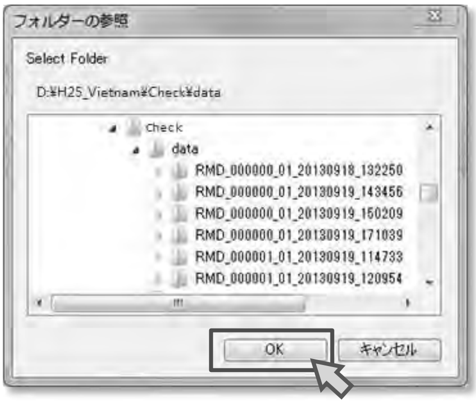



Figure 10.14 Folder Selection

From the list, select the data to identify the location and click [Next].

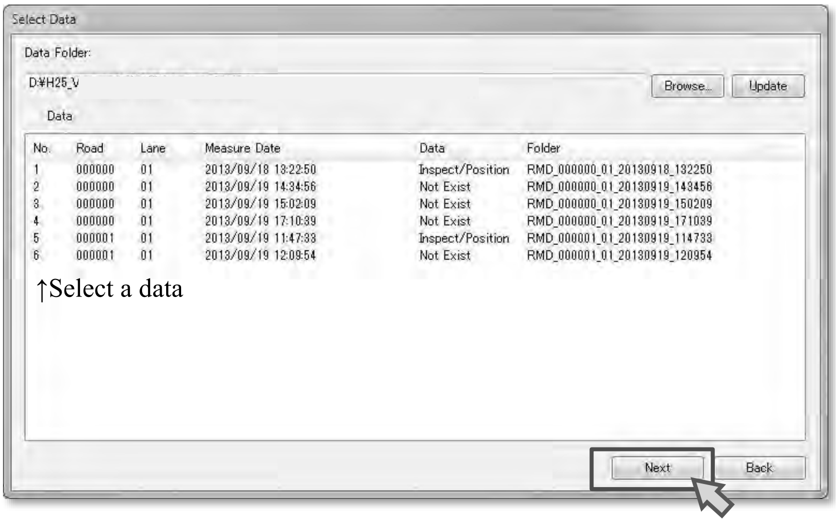



Figure 10.15 Data Selection

This will launch the Analysis menu.

Figure 10.16 Identify the Location Window

B. Configuring the Positional information

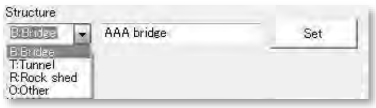
Positional information is configured for the 11 items as listed in Table 10.11 . The minimal unit accepted by this application is 5 meters. Configuration of the positional information is made by performing the operations described in Table 10.12 .

Table 10.11 Items for Positional information

| No. | Classification | Description | Data Type |
|---|---|---|---|
| 1 | Geographical Area | Area of the target segment. | Segment |
| 2 | Jurisdiction | Administrative authority of the target | Segment |

| | | | |
|---|---|---|---|
| | | segment. | |
| 3 | Management Agency | Sub Bureau of the target segment. | Segment |
| 4 | Road Name | Road name of the target segment. | Segment |
| 5 | Kilo-post station | Kilo-post station number | Point |
| 6 | Number of Lane | Number of traffic lanes for the target segment. | Segment |
| 7 | Structure | Bridges, tunnels, and rock sheds and their specific names. | Segment |
| 8 | Intersection | Intersections, railway crossings, tollgates and their specific names. | Point |
| 9 | Overlapping | Reasons for an overlap and the name of the overlapping road. | Segment |
| 10 | Station Number Discrepancy | The administrative Station Number when a discrepancy is present between the measurement station number and administrative station number. | Point |
| 11 | Peculiar Condition | | Segment |

Table 10.12 Operations for Positional information

| | | |
|---|---|---|
| Input method |  | Configure information to the specified position. .<br>Click the button. |
| |  | Configure information from the specified position.<br>Hold down [Shift] and click the button. |
| |  | Delete the information of the specified position.<br>Hold down [Ctrl] and click the button. |
| |  | Delete information from the specified position.<br>Hold down [Shift] + [Ctrl] and click the button. |
| Input type |  | Enter names and numbers directly.<br>● Road Name<br>● Kilo-post station number<br>● Number of Lane<br>● Station Number Discrepancy |
| |  | Select an item from the pull down list.<br>● Geographical Area<br>● Jurisdiction<br>● Maintenance Company<br>● Peculiar condition |
| |  | Select a code from the pull down list and enter the specific name of the item.<br>● Structure<br>● Intersection<br>● Overlapping |

Play back the image and navigate the forward view image and the road surface image to the boarder of a segment. identify the configuration starting (ending) position with the left edge of the road surface image.


Figure 10.17  Example of Identify Position for a Bridge

**Tips-1  Point and Segment Data**

Table 10.11  shows that there are different kinds of data: point data and segment data. Item numbers 1 to 4, 6, 7, 9, and 11 are segment data, and because a segment is a type of data that retains lengths, the starting and ending positions must be configured.

1) Configuring the Geographical Area, Jurisdiction, Management Agency and Road Name

Configuring the Geographical Area, Jurisdiction, Management Agency and Road Name are set their information from start to end position. The set procedure is follow.

a) To move to the start position marking guide.
b) For Geographical Area, to record from selecting the pull-down list of Geographical Area and to push “Shift” key and click “Shift from”.
c) For Jurisdiction, to record from selecting the pull-down list of Jurisdiction and to push “Shift” key and click “Shift from”.
d) For Management Agency, to record from selecting the pull-down list of Sub bureau to push “Shift” key and click “Shift from”.
e) Road Name is automatically indicated. If the indicated name and the target road name are same, to push “Shift” key and click “Shift from.
f) If the indicated name and the target road name are different, operator select the road name from pull-down list and record the road name.


Figure 10.18 Example of Identify the Boundary Position

Select the relevant information from the pull down list, or enter the information directly. Hold down the [Shift] key and click to configure the information to the succeeding segments.

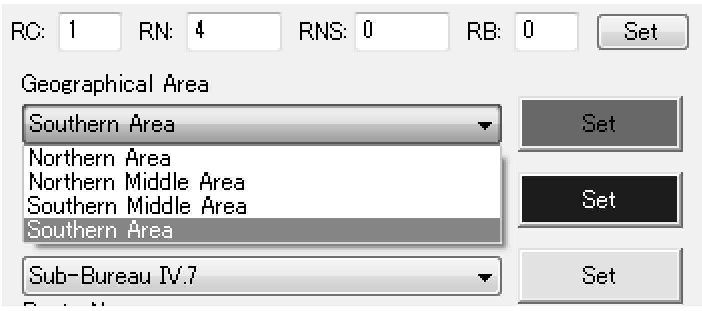



Figure 10.19 Example of Selecting and Entering Information

There are many roads in Vietnam managed by DRVN, PDOT, Expressway or etc...
This application loads the road name from "Road_Name.csv". If new road is surveyed, it should add the road code and road name into the lowest line in the csv file.


Figure 10.20 Example of Selecting the road name

The file structure of the data analysis exist the csv file as below figure. The csv file also indicated in the below figure. This file consist of “Road category”, “Road Number”, “Road Number Supplement”, “Branch Number” and “Road Name” separated by comma.

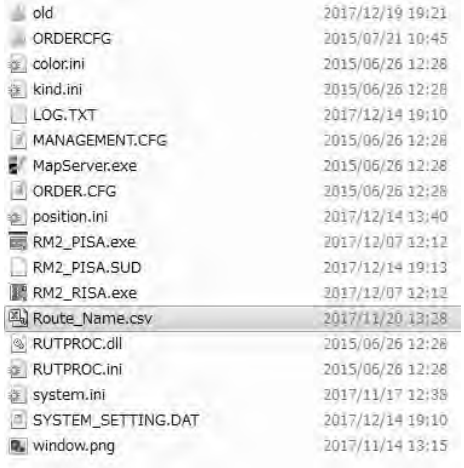



Figure 10.21 Folder structure

```
1,502,0,1,Ho Chi Minh Route_Don Chuong to Soc Ha
1,503,0,0,Ho Chi Minh Route West
1,503,0,1,Mission Route HCM
1,504,0,0,Ho Chi Minh Route East
1,505,0,0,Truong Son Dong
1,506,0,0,N1 Route
1,507,0,0,N2 Route
1,508,0,0,Nam Song Hau Route
1,509,0,0,Quan Lo - Phung Hiep Route
1,509,0,1,Quan Lo - Phung Hiep Route_Branch
1,510,0,0,Nghi Son - Bai Tranh Route
1,511,0,0,Hai Van Tunnel
1,511,0,1,Connecting road HV Tunnel Ta Quang Buu Route
1,511,0,2,Connecting road between Hai Van Tunnel - Tuy Loan with National Highway 1
2,3,0,1,Southern Ring Road 3 To Cau Dau
0,1,0,1,Phap Van - Cau Gie Expressway
0,1,0,2,Cau Gie - Ninh Binh Expressway
0,1,0,13,Dau Giay - Long Thanh Expressway
0,1,0,15,HCM - Trung Luong Expressway
0,4,0,0,Ha Noi - Hai Phong Expressway
0,5,0,0,Ha Noi - Viet Tri - Lao Cai Expressway
0,7,0,0,Ha Noi - Thai Nguyen - Cho Moi Expressway(NH3)
0,8,0,0,Lang - Hoa Lac Expressway
0,14,0,0,Lien Khuong - Da Lat Expressway
0,20,0,0,Ring Road No.03 Hanoi City Expressway
0,99,0,1,Approach Cho Dem Inter.
0,99,0,2,Approach Ben Luc Inter.
0,99,0,3,Approach Tan An Inter.
0,99,0,4,My Thuan Bridge & Parallel road
0,99,0,5,Can Tho Bridge & Parallel road
0,99,0,6,Exp. Dong Tam
0,99,0,7,Exp. Luong Phu
0,99,0,8,Ca Mau coastal passage way
```

Figure 10.22 Road_Name.csv

2) Configuring the Structure, Intersection and Overlapping

Structure, Intersection and Overlapping are record only the position onto the data.

<Structure>

To records the type, name, and section of structure. Following table shows the recording structure.

Table 10.13 Setting item of Structure

| Type |
|---|
| Bridge |
| Tunnel |
| Rock shed |
| Others |

Recording procedure as below;

a) To move to the start position of the structure

The start position of the structure set on the left edge area of the road image in upper of the application.

b) To select the type of structure

c) To input the name of structure

d) To push "Shift" key and click "Shift from" and record the structure information from the position.

e) To move to the end position of the structure
The end position of the structure set on the left edge area of the road image in upper of the application.

f) To push "Shift" and "Ctrl" and click "Delete from", and delete the structure information from the indicated image.

Figure 10.23 Example of Identify the Position for a Road Infrastructure

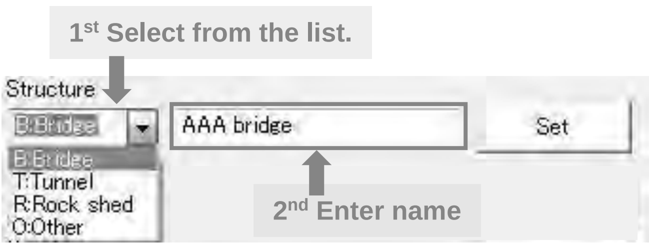



Figure 10.24 Example of Entering Infrastructure Details

<Intersection>
To records the type, name of intersection. Following table shows the recording intersection.

Table 10.14 Setting item of Intersection

| Type |
|---|
| Intersection |
| Roundabout |

| |
|---|
| Viaduct |
| Railway Crossing |
| Toll Gate |
| Others |

Recording procedure as below;

a) To move to the center of intersection
Move to the center position of the intersection on the left edge of the road image of the application.

b) To select the type of intersection

c) To input the name of intersection

d) To click “Set” and record the information of the intersection

If there are some kinds of intersection as roundabout, railway cross, viaduct, or intersection with traffic light at the same position. Please select in the following order. roundabout→ intersection (with traffic light) →railway cross → viaduct

<Overlapping>

To records the type, name, and section of overlapping. Following table shows the recording overlapping

Table 10.15 Setting item of Overlapping

| Type |
|---|
| Route overlap |
| Left and Right bound overlap |

Recording procedure as below;

a) To move to the start position of overlapping
Move to the start position of the overlapping on the left edge of the road image of the application

b) To select the type of overlapping

c) To input the name of overlapping road

d) To push “Shift” key and click “Shift from” and record the overlappng information from the position.

e) To move to the end position of the overlapping section
Move to the end position of the overlapping on the left edge of the road image of the application

f) To push “Shift” and “Ctrl” key and click “Delete from”, and delete the overlapping information from the indicated image.

3) Configuring the Kilo-post Station and Station Number Discrepancy
To records the position of Kilo-post Station and Number of Lane.

< Kilo-post Station >

To record the number of Kilo-post Station. The recording procedure as follows;

a) To move to Kilo-post Station
Move to the KP position on the left edge of the road image of the application

b) To input the number of Kilo-post Station

c) To push “Set” and record the information of Kilo-post Station

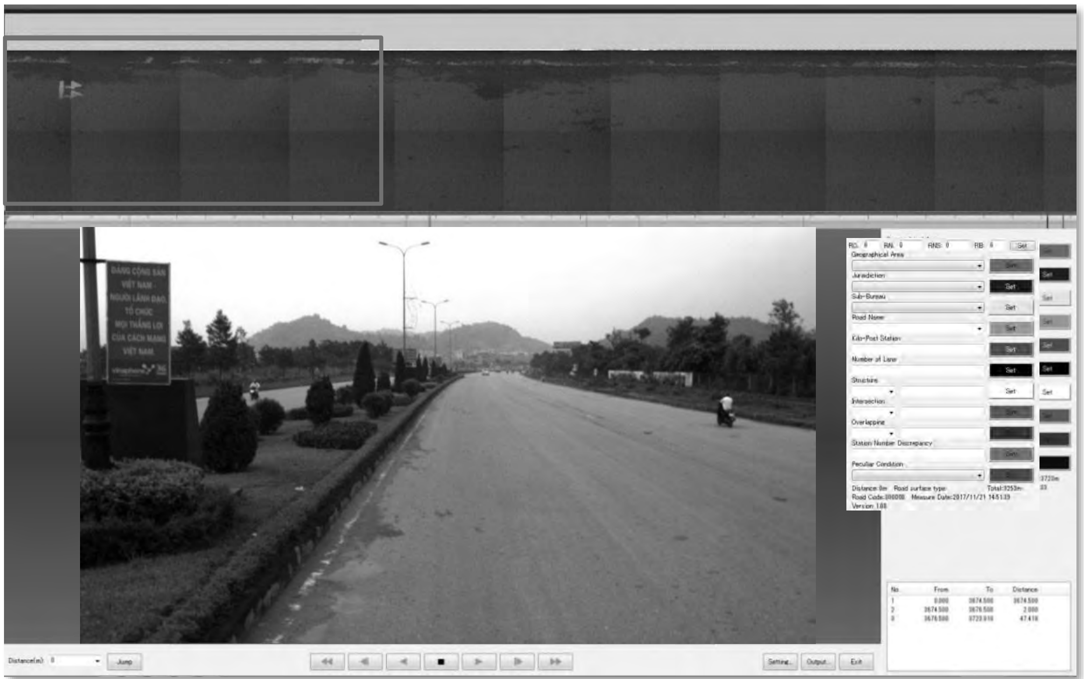


Figure 10.25 Example of Identify the Kilo-post Position


Figure 10.26 Kilo-post station (3 kilo-post station)


Figure 10.27 Example of Input of Details

< Number of Lane >
To records the number of lane. The recording procedure as follows;

a) To move to the position change number of lane
The position change number of lane check at the forward view image. From the forward view image and road image, operator identifies the position change number of lane.

b) To input the number of lane

c) To push “Shift” key and click “Shift from” and record the number of lane

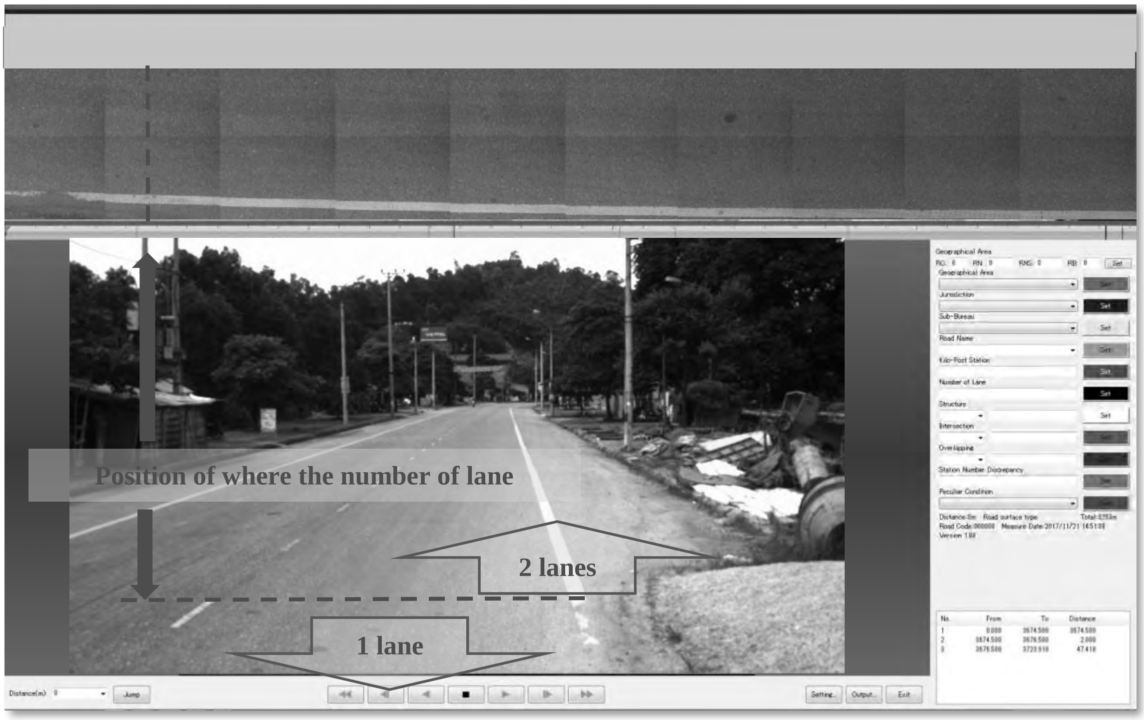



Figure 10.28 Example of Change in Number of Traffic Lanes

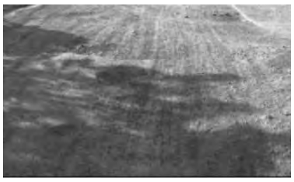
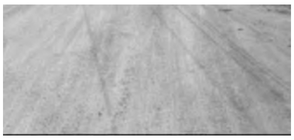

Figure 10.29 Example of an Input for Number of Lanes

4) Peculiar Condition

Operator records the type, name and section of peculiar condition. Peculiar condition such as broken, wet condition and other condition could not be evaluated by Crack. The pavement condition data file should make clarify the position of such condition. The peculiar condition which operator record as follow table.

Table 10.16 Definition of peculiar condition

| Item | Discription | Image |
|---|---|---|
| 1.Broken | It was once paved. There is serious damaged section due to which damage cannot be quantified. |  |
| 2.Unpaved or unidentified Pav. Type | Unpaved : It has never been paved.<br>Unidentified Pav. Type : Pavement type other than AC, CC and BST. (Gravel, Rock…) |  |

| | | |
|---|---|---|
| 3.Wet Condition | The lane is covered with water and the whole is wet. |  |
| 4.Other damage | Other type damage that can not be judged as cracking.(such as Raveling, Scratch… ) |  |
| 5.Invisible | Can not see the surface due to coverage of pavement surface by other object such as sand, soil, construction material, etc. |  |
| 6.Under construction | There is ongoing construction work on the survey lane. |  |

The recording procedure as follow;

a) To move to the start position of peculiar condition
The start position of the peculiar condition set on the left edge of the road image in upper of the application.

b) To select the type of peculiar condition

c) To push "Shift" and click "Shift from" and record the information of peculiar condition from the indicated image.

d) To move to the end position of peculiar condition
The end position of the peculiar condition set on the left edge of the road image in upper of the application.

e) To push "Shift" and "Ctrl" keys and click "Delete from" to delete the information of peculiar condition from indicated image


Figure 10.30 Example of an Input for Peculiar Condition

C. Data Output

Click on [Output].


Figure 10.31 Data Output

Enter the details under the [Common Item] section.

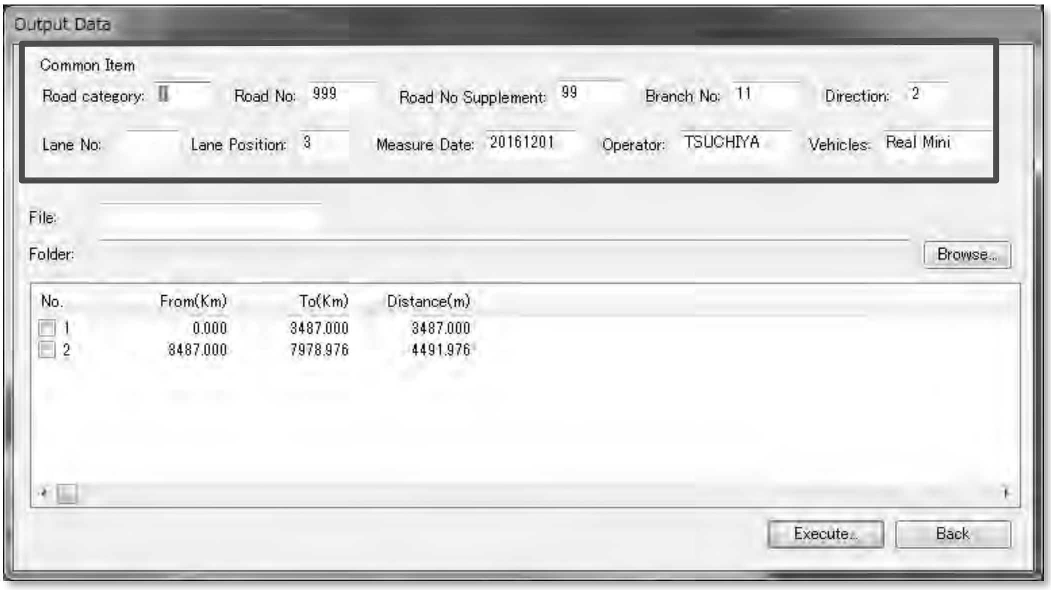



Figure 10.32 Output Configuration 1

To the [File] field, enter the output file name. Normally, the format should be in [road code+R/L+lane_origin distance_desitnation distance] format.
Example) NH100100000R1_000k00000_023k00250 (National Highway 1, Right, Lane 1, From:0k0 To 23k250)


Figure 10.33 Output Configuration 2

Click on [Browse] and specify the output folder path.


Figure 10.34 Output Configuration 3

Click on [Execute] to execute the data output.


Figure 10.35 Output Configuration 4

The data is output in a CSV format to the specified folder path.

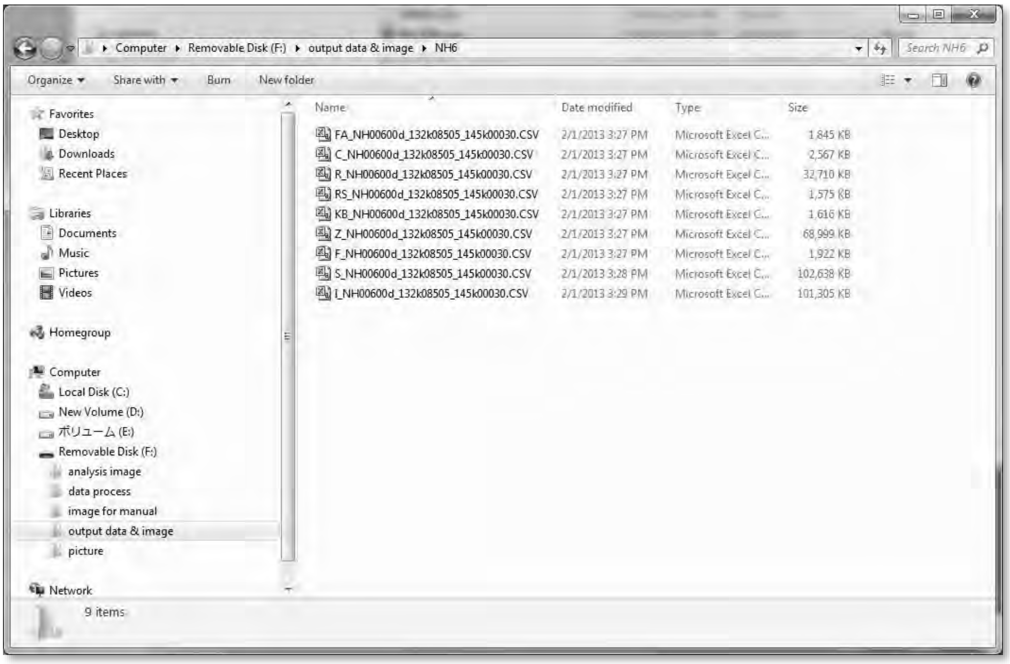



Figure 10.36 Confirmation of Output

(3) Data check

The Location setting application check the data about KP number and direction. If same KP number input, Error messege is displayed in window when output the data. And if the order of KP don’t matches the road direction, Error messege is displayed in window when output the data. These error information record in “Error2.txt”.

(4) Delivery Flow

“P_******.csv “ output by this application is used for the data processing. Other data file is used for the confirmination of the setting information. Operator is confirmed whether the set information is the same for the right direction and the left direction.

Table 10.17 Delivery Data

| No. | Data | Notes |
|---|---|---|
| 1 | P_******.csv | Positional information data |
| 2 | 0001-0.CSV | List of Jurisdiction |
| 3 | 0001-1.CSV | List of Sub-Bureau |
| 4 | 0005.CSV | List of KP |
| 5 | 0101.CSV | List of Number of Lane |
| 6 | 0104.CSV | List of Structure |
| 7 | 0105.CSV | List of Intersection |
| 8 | 9998.CSV | List of Peculiar Condition |