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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS & HIGHWAYS

Feasibility Study
on
The Rural Road Network Development Project

FINAL REPORT (Volume 29)

MANUAL FOR FOLLOW-UP SURVEY
OF
EXPERIMENTAL PAVEMENT

OCTOBER, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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FOLLOW-UP SURVEY MANUAL

T A B L E O F C O N T E N T S

CHAPTER 1

INTRODUCTION

1.1 *OBJECTIVES OF EXPERIMENTAL PAVEMENT*

In line with the government's development policy envisaged in the Medium-Term Philippine Development Plan, increased emphasis on highway development plan was given to rehabilitation, improvement and expansion of the feeder and secondary network, particularly in the rural areas. Characteristics of rural roads projects are as follows:

* About 80% of rural roads are low traffic roads, serving for less than 500 vehicles per day.

* Pavement types for low traffic roads are generally gravel surfaces, and low-class bituminous surface pavements, however, no data for performance period, selection criteria of pavement type, etc., are available.

* Cost of pavement structure generally shares 60-70% of total civil work costs, therefore, selection of an appropriate type of pavement is quite important.

Needs of rural roads development are quite high, thus huge investments are expected. In order to implement rural road projects economically and structurally sound, a study of low-class pavement is essential.

Based on the above background, the study of low-class pavement through experimental pavement construction was planned. Objectives of experimental pavement construction are summarized as follows:

a) To analyze the functional and structural performance of various types of pavement models with time and traffic loading repetitions by conducting a follow-up survey for five (5) years, and

b) To provide basic data for appropriate structural design of pavement including selection of pavement type according to traffic and subgrade conditions.

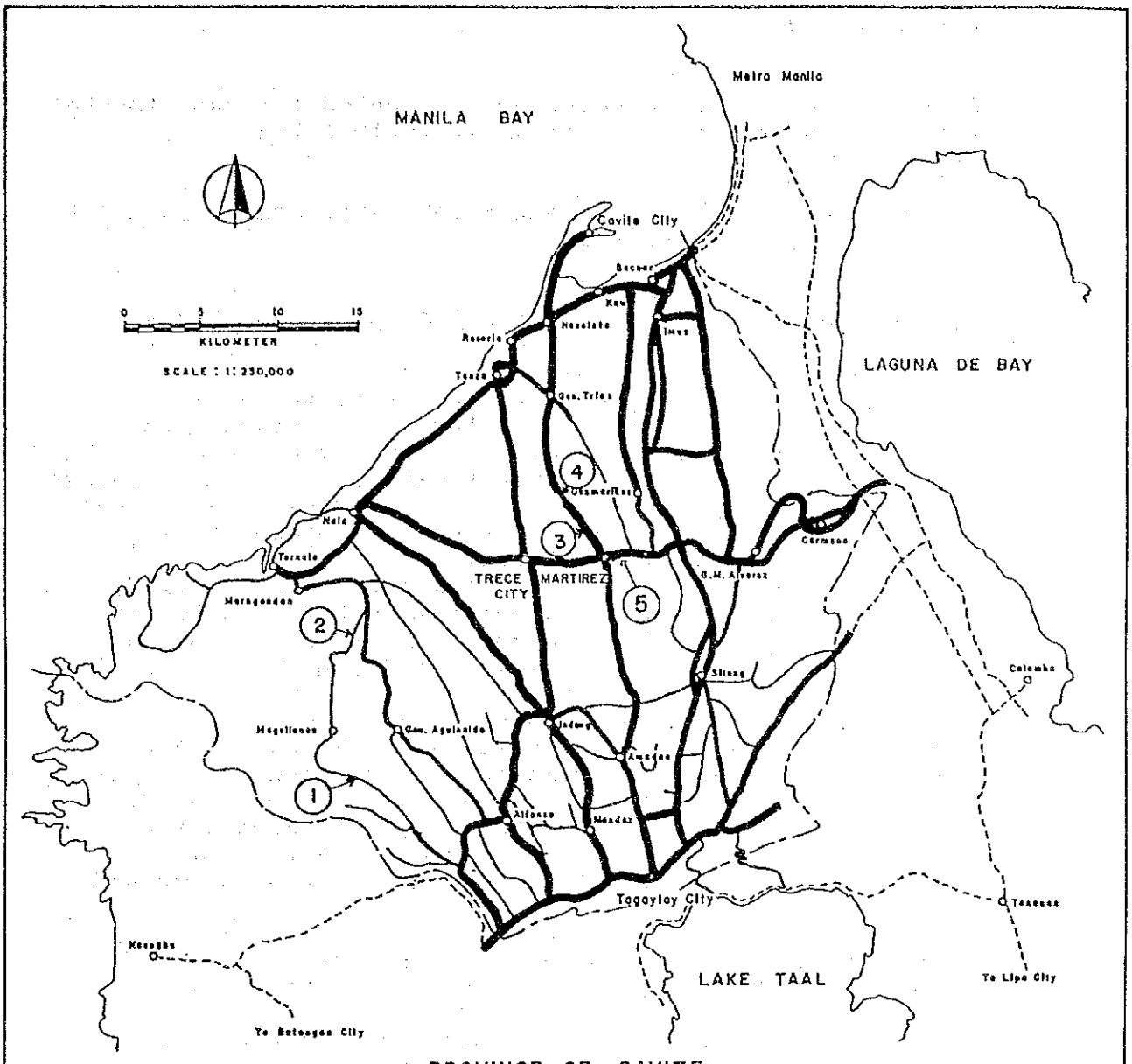
1.2 *OUTLINE OF EXPERIMENTAL PAVEMENT*

1.2.1 Location

Five (5) sections were selected in the Province of Cavite in consideration of the three (3) levels of traffic (low, medium and high) and two (2) subgrade condition (good and poor). Sections selected are summarized in Table 1.2-1 and locations are shown in Figure 1.2-1.

Table 1.2-1 Selected Sections for Experimental Pavement Construction

Section No.	Name of Road	Traffic Level	Subgrade Condition
1	Jct. Alfonso-Magallanes Road	Low	Good
2	Magallanes-Maragondon Road	Low	Poor
3	Gen. Trias-Amadeo Road	Medium	Good
4	Gen. Trias-Amadeo Road	Medium	Poor
5	Carmona-Trece Martirez Road	High	Good



LEGEND :

TRAFFIC VOLUME : AADT

- > 400
- 200 - 400
- < 200

PROPOSED EXPERIMENTAL PAVEMENT CONSTRUCTION SECTIONS

SECT. NO.	TRAFFIC VOLUME AADT *	SUBGRADE CONDITION	TYPE OF EXPERIMENTAL PAVEMENT
1	235	GOOD	GR SBST DBST BMP
2	144	POOR	GR SBST DBST BMP
3	942	GOOD	DBST BMP HAC(4cm)HAC(5cm)
4	942	POOR	DBST BMP HAC(4cm)HAC(5cm)
5	2174	GOOD	HAC(5cm) PCC(18cm)

* AS OF JUNE 1988

REMARKS:

GR : GRAVEL SURFACING
SBST: SINGLE BITUMINOUS SURFACE TREATMENT
DBST: DOUBLE BITUMINOUS SURFACE TREATMENT
BMP : BITUMINOUS PENETRATION MACADAM
HAC : HOT MIX ASPHALT CONCRETE
PCC : PORTLAND CEMENT CONCRETE

Figure 1.2-1 Experimental Pavements Construction Road Sections

1.2.2 Pavement Models

Five (5) types of pavement were selected for experimental pavement construction as shown in Table 1.2-2.

Table 1.2-2 Types of Pavement for Experimental Pavement Construction

Type of Pavement	Current Adoption and Issues
Gravel Surface	.Commonly used. .No data for performance period .No data for annual gravel loss .No data for timing of re-graveling .No historical record of maintenance
Single Bituminous Surface Treatment (SBST)	.Rarely used, thus adoptability be tested .No data for performance period, adoptability in this country in consideration of axle load characteristics, and timing of rehabilitation.
Double Bituminous Surface Treatment (DBST)	.Sometimes used by IBRD or ADB Assisted Projects and prematured deterioration are experienced. .No data for performance period, and timing of rehabilitation .No historical maintenance record
Bituminous Penetration Macadam Pavement (BMP)	.Rarely used .No data for performance period, and timing of rehabilitation
Hot-layed Asphalt Concrete (HAC), 5 cm or less in thickness	.Oftentimes used, however, prematured deterioration is frequently experienced .No data for performance period and timing of rehabilitation .No historical record of maintenance
Portland Cement Concrete Pavement (PCC), 20 cm or less in thickness	.Frequently used .No data for performance period and timing of rehabilitation .No historical record of maintenance

Eighteen (18) pavement models were selected and designed based on the engineering data, and traffic data obtained from the sites and summarized in Table 1.2-3 and location of models is illustrated in Figure 1.2-2.

Length of one (1) model is selected to be 200 meters. Joint area between models may be affected by deterioration of adjacent weak pavement, therefore, net length to be assessed shall be the middle 150-m section.

Engineering data and traffic data are attached in Appendix - A.

Table 1.2-3 PAVEMENT MODELS

TYPE OF PAVEMENT	DESIGN PERFORMANCE PERIOD	TRAFFIC VOLUME				
		LOW		MEDIUM		HIGH
		AADT 173 Truck 7 [SECTION-1]	123 7 [SECTION-2]	AADT 784 Truck, Bus 52 [SECTION-3]	[SECTION-4]	AADT 2204 Truck, Bus 392 [SECTION-5]
GRAVEL SURFACE	5 years	Model-1 Surf. C=15cm Sub. B=5cm (CBR=4%)	Model-5 Surf. C=15cm Sub. B=8cm (CBR=3%)	–	–	–
SBST	2 years	Model-2 0.5 cm Base=15cm Sub. B=8cm (CBR=4%)	Model-6 0.5 cm Base=15cm Sub. B=12cm (CBR=3%)	–	–	–
DBST	4 ~ 5 years	Model-3 1.5 cm Base=15cm Sub. B=9cm (CBR=4%)	Model-7 1.5 cm Base=15cm Sub. B=14cm (CBR=3%)	Model-9 1.5 cm Base=15cm Sub. B=30cm (CBR=3%)	Model-13 1.5 cm Base=15cm Sub. B=13cm (CBR=8%)	–
BMP	7~8 years	Model-4 5.0 cm Base=15cm Sub. B=5cm (CBR=4%)	Model-8 5.0 cm Base=15cm Sub. B=10cm (CBR=3%)	Model-10 5.0 cm Base=15cm Sub B=26cm (CBR=3%)	Model-14 5.0 cm Base=15cm Sub. B=16cm (CBR=5%)	–
AC	7 ~ 8 years	–	–	Model-11 4.0 cm Base=12cm Sub. B=8cm (CBR=8%)	Model-15 4.0 cm Base=15cm Sub. B=23cm (CBR=3%)	–
	9 ~ 10 years (3 years for Section-5)	–	–	Model-12 5.0 cm Base=12cm Sub. B=6cm (CBR=8%)	Model-16 5.0 cm Base=15cm Sub. B=21cm (CBR=3%)	Model-17 5.0 cm Base=15cm Sub. B=19cm (CBR=5%)
PCC	8 years	–	–	–	–	Model-18 Base=18cm Sub. B=20cm (CBR=5%)

Note: CBR is the design CBR of subgrade.

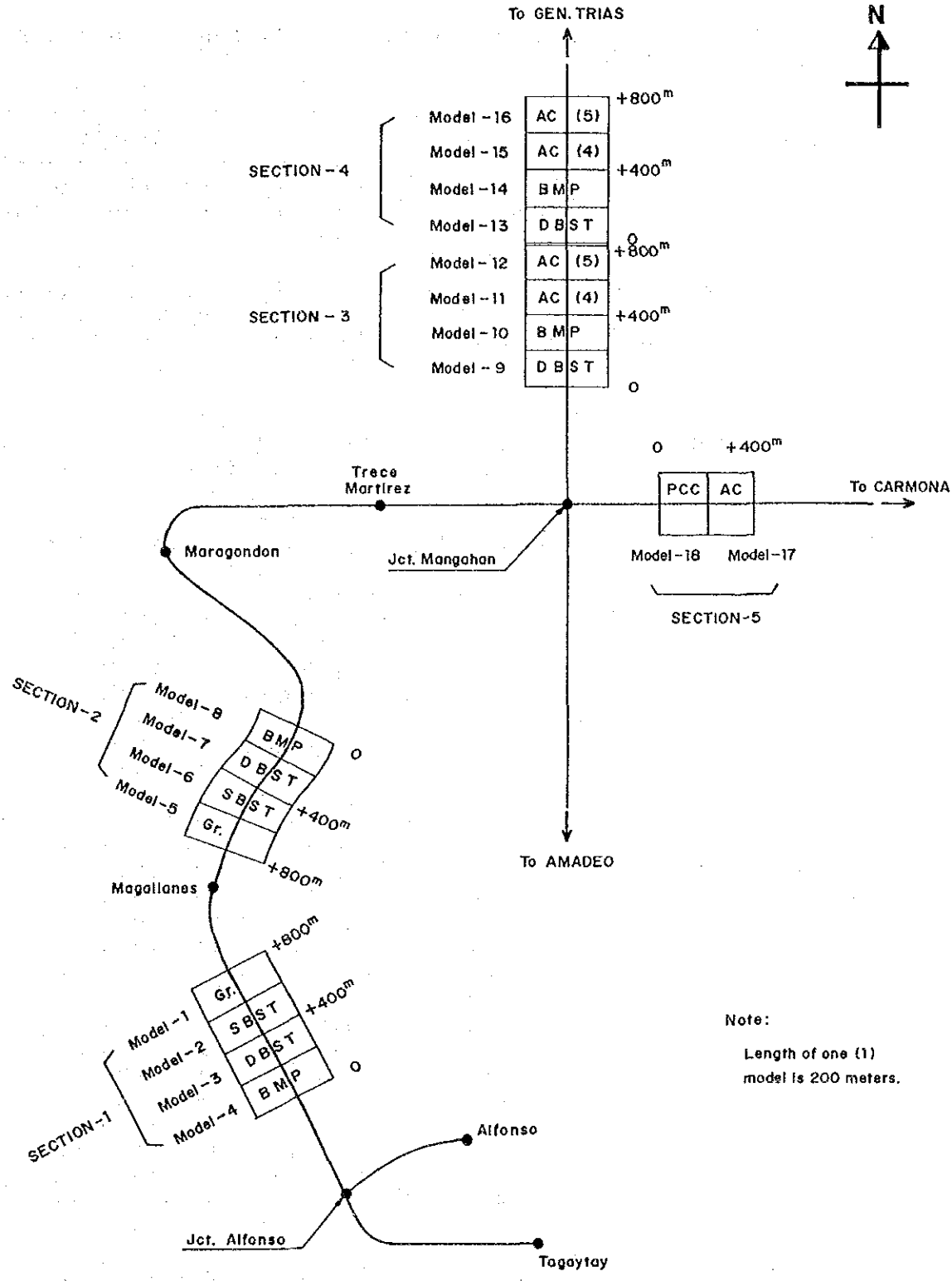


Figure 1.2-2 LOCATION OF PAVEMENT MODELS

1.2.3 Construction

Due to different sources of fund, two (2) contractors were employed as follows:

Section	Fund Source	Contractor
1, 2, 3 & 4	JICA	one (1) local contractor
5	DPWH	one (1) local contractor

Construction started early April, 1990 and originally planned to be completed in 45 days, however, due to unfavorable weather conditions, construction was delayed and completed as shown in Table 1.2-4.

Table 1.2-4 Date of Completion
(Date opened to traffic)

Section No.	Model No.	Date of Completion (Date opened to traffic)
1	1	October 26, 1990
	2	October 30, 1990
	3	October 30, 1990
	4	November 6, 1990
2	5	September 25, 1990
	6	September 5, 1990
	7	September 3, 1990
	8	August 13, 1990
3	9	August 4, 1990
	10	July 22, 1990
	11	July 15, 1990
	12	July 15, 1990
4	13	August 3, 1990
	14	July 30, 1990
	15	July 15, 1990
	16	July 15, 1990
5	17	October 6, 1990
	18	September 10, 1990 RL
		October 5, 1990 LL

Field and laboratory tests results of materials used are summarized in Appendix - B.

1.3 *OBJECTIVES OF FOLLOW-UP SURVEY*

Objectives of the follow-up survey are as follows:

1) To verify performance period of selected types of pavement.

2) To verify an appropriate timing of rehabilitation.

3) To provide basic data for an appropriate structural design.

4) To establish selection criteria of pavement types and level of rehabilitation, based on 1), 2) and 3) above.

Performance period is defined as the period that an initial pavement structure will last before it needs rehabilitation and is equivalent to the time elapsed from its initial serviceability to its terminal serviceability. The follow-up survey will be conducted for five (5) years, most of the pavement models will be verified to their performance periods under different conditions of traffic load repetitions and subgrade bearing capabilities. Those models which do not reach to terminal serviceability, performance period will be estimated by analyzing relationships between serviceability and traffic repetitions.

Another important objective is to verify timing of rehabilitation. As the low-class pavements are usually designed to have their performance period of 3 to 8 years, therefore, rehabilitation must be implemented timely. Rehabilitation level will be recommended by analyzing data obtained by the follow-up survey.

Pavement design method recommended by AASHTO Guide for Design of Pavement Structures requires design variables, performance criteria, etc. as shown in Table 1.3-1. Data obtained by the follow-up survey will provide useful information for the designer.

Based on the follow-up survey results and additional life cycle cost analysis, an appropriate pavement type and rehabilitation level will be established for different level of traffic and subgrade conditions.

TABLE 1.3-1 DESIGN REQUIREMENTS

	Pavement Type				
	AC	Surface Treatment	PCC	Gravel	Data obtained by Follow-up Survey
DESIGN VARIABLES					
Time Constraints					
Performance Period	○	○	○	○	●
Analysis Period	○	○	○	○	—
Traffic	○	○	○	○	●
Reliability	○	○	○	—	—
Environmental Impact					
Roadbed Swelling	△	△	△	—	—
PERFORMANCE CRITERIA					
Serviceability	○	○	○	○	●
Allowable Rutting	—	—	—	○	●
Aggregate Loss	—	—	—	○	●
MATERIAL PROPERTIES STRUCTURAL DESIGN					
Effective Roadbed Soil Resilient Modulus	○	○	—	○	—
Effective Modulus & Subgrade Reaction	—	—	○	—	—
Pavement Layer Materials Characteristics	△	△	○	○	—
PCC Modulus of Rupture	—	—	○	—	—
Layer Coefficients	○	○	—	—	—
PAVEMENT STRUCTURAL CHARACTERISTICS					
Drainage	○	○	○	—	●
Load Transfer	—	—	○	—	—
Loss of Support	—	—	○	—	—

NOTES: ○ *Design input variable that must be determined*
△ *Design variable that should be considered*
● *Data to be obtained by the follow-up survey*

CHAPTER 2

FOLLOW-UP SURVEY ITEMS

2.1 FOLLOW-UP SURVEY ITEMS

Follow-up survey items, their frequencies and timing are listed in Table 2.1-1.

Table 2.1-1 Follow-up Survey Items *

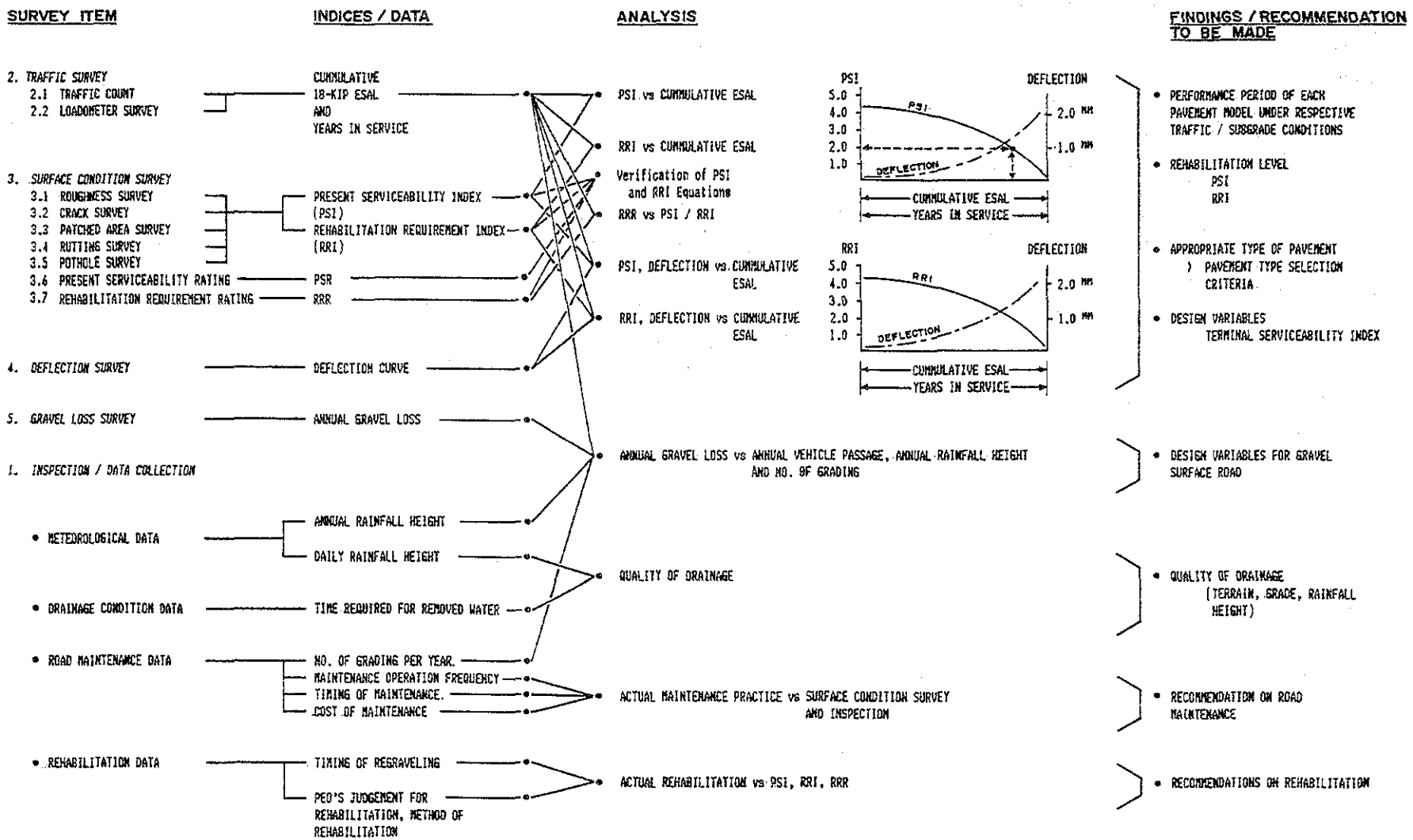
Survey Items	Frequency	Timing
1. Inspection and Data Collection which includes meteorological data, road maintenance data, drainage condition data, and rehabilitation data.	Monthly	Second week of each month
2. Traffic Survey		
2.1 Traffic Count Survey	Quarterly	January, April, July and October
2.2 Loadometer Survey	Once a Year	October
3. Surface Condition Survey	Quarterly	January, April, July and October
3.1 Roughness Survey		
3.2 Cracking Survey		
3.3 Patching Survey		
3.4 Rutting Survey		
3.5 Pothole Survey		
3.6 Present Serviceability Rating (PSR)		
3.7 Rehabilitation Requirement Rating (RRR)		
4. Deflection Survey	Twice a Year	April and October
5. Gravel Loss Survey	Quarterly	January, April, July and October
6. Photo Taking	Quarterly	January, April, July and October

* Survey items, method and frequency shall be subject to change as necessary.

2.2 *SURVEY ITEMS AND THEIR INTENDED USAGE*

Survey Items, indices to be developed based on collected data, analyses to be undertaken and recommendations to be made which are the final outputs of the follow-up survey are summarized in Table 2.2-1.

TABLE 2.2-1
SURVEY ITEMS AND THEIR INTENDED USAGE



CHAPTER 3

FOLLOW-UP SURVEY METHOD

3.1 *INSPECTION AND DATA COLLECTION*

Inspection of the experimental pavement sections and data collection shall be conducted monthly, preferably in the second week of each month. During inspection trip by the follow-up Survey Team, the following data shall be collected :

* District Engineering Office/Provincial Engineer's Office
  - Road maintenance record of the experimental pavement sections
  - Rehabilitation record of the experimental pavement sections
* PAGASA in Cavite Province
  - Meteorological data
* Nearby Residents of Experimental Pavement Section
  - Drainage condition information

3.1.1 *Inspection*

The purpose of inspection is to identify any changes in condition, defects and/or damages and record these changes in the Inspection Sheets as shown in Table 3.1-1, 2 and 3. Changes, defects and/or damages may occur in the following elements/aspects, such as:

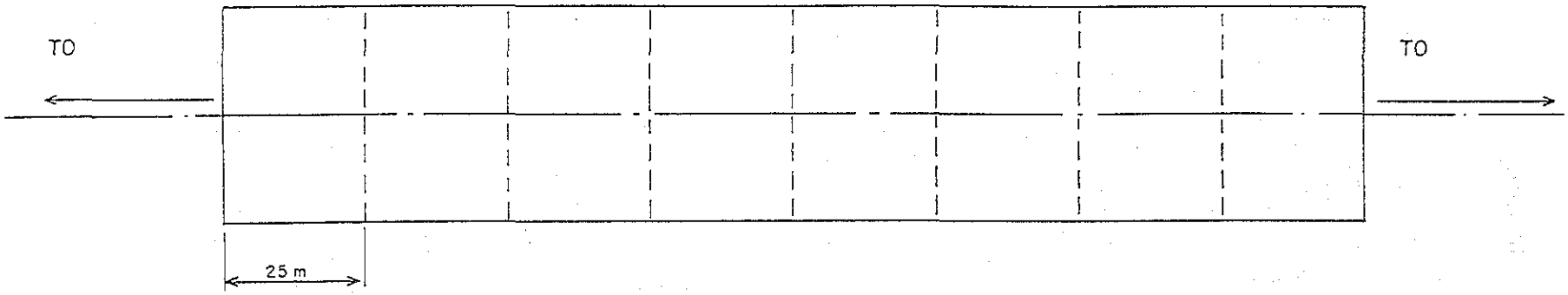
- Surface condition
- Shoulder condition
- Traffic condition
- Roadside development condition

By the inspection, any changes shall be recorded on the Inspection Sheet. Quantification of surface distresses, traffic, etc. is not required.

The follow-up Survey Team shall be required to walk all along the experimental pavement sections to record changes.

Table 3.1-1

INSPECTION SHEET - No. 1 (GRAVEL SURFACE)	SECTION No. _____ DATE: _____ WEATHER: _____
	PAVE. MODEL No.: _____ SURVEYOR: _____



1) SURFACE CONDITION

SURFACE DISTRESS	MARK
Depression	
Pothole	
Rutting	
Scouring (Surface)	
Scouring (Shoulder)	
Others	Specify

• Indicate location of distress on the plan using above mark.

2) MAINTENANCE WORK DONE

TYPE OF MAINT. WORK	YES OR NO
Pothole Filling	
Rut Filling	
Grading	
Side Ditches Clearing	
Regravelling	
Others (Specify)	

3) DRAINAGE QUALITY

DATE and RAINFALL	WATER REMOVED WITHIN

4) GENERAL CONDITION

a) Traffic

b) Roadside Development

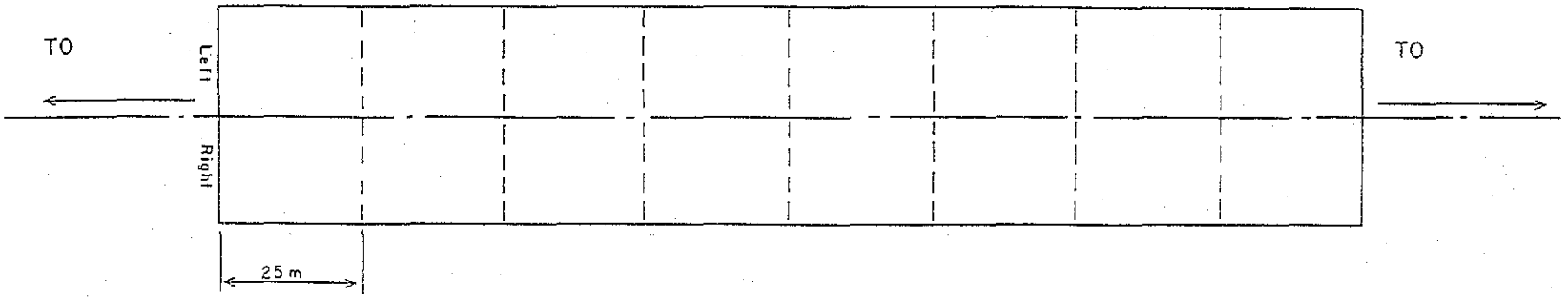
c) Harvest

d) Others

Table 3.1-2

INSPECTION SHEET - No. 2 (SBST, DBST, BMP, AC)	SECTION No.: _____ DATE: _____ WEATHER: _____
	PAVE. MODEL No: _____ SURVEYOR: _____

Sub-Section No. ① ② ③ ④ ⑤ ⑥ ⑦ ⑧



1) SURFACE CONDITION

SURFACE DISTRESS	MARK
Depression	
Potholes	
Alligator Cracks	
Block Cracks	
Longitudinal Cracks	
Transverse Cracks	
Rutting	
Patching	
Others	Specify

• Indicate location of distress on the plan using above mark.

2) MAINTENANCE WORK DONE

TYPE OF WORK	Sub. Sect No.	R or L

3) DRAINAGE QUALITY

DATE and RAINFALL	WATER REMOVED WITHIN

4) GENERAL CONDITION

a) Traffic

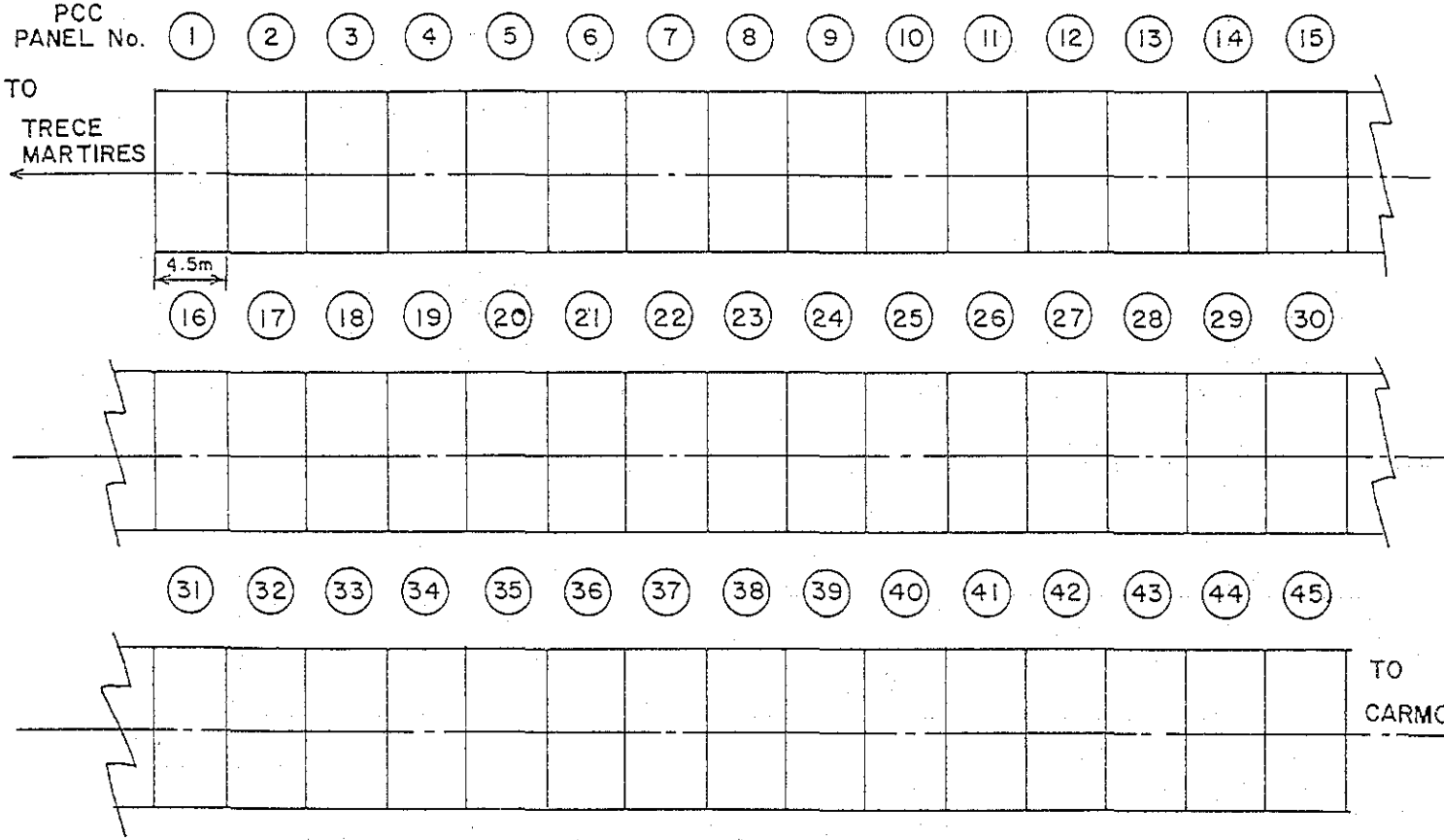
b) Roadside Development

c) Harvest

d) Others

Table 3.1-3

INSPECTION SHEET - No. 3 (PCC PAVEMENT)	SECTION No.: _____ DATE: _____ WEATHER: _____
	PAVE. MODEL No: _____ SURVEYOR: _____



1) SURFACE CONDITION

Indicate Surface Distresses on the Plan.

- Cracks
- Other Distresses
- Patching

2) MAINTENANCE WORK DONE

- Crack Sealing (Panel No.
- Joint Sealing (Panel No.
- Patching (Panel No.

3) DRAINAGE QUALITY

DATE and RAINFALL	WATER REMOVED WITHIN

4) GENERAL CONDITION

a) Traffic

b) Roadside Development

c) Harvest

d) Others

3.1.2 Road Maintenance Data Collection

Road maintenance record of the experimental pavement sections shall be collected monthly from the Cavite Provincial Engineers Office for Sections 1, 2, 3 and 4 and Cavite District Engineering Office of DPWH for Section 5. Hence, the following data shall be collected :

1) Date of maintenance work undertaken
2) Location (which shall be confirmed during the inspection trip)
3) Type of maintenance work
4) Cost of maintenance work
5) Surface condition immediately before the maintenance work

The purpose of road maintenance data collection is to assess present maintenance level and its effect on performance. It is important to note that the performance period of the pavement can be significantly affected by the type and level of maintenance applied.

The pavement models shall be tested under the normal maintenance practice or present level of maintenance in the country, therefore, the follow-up survey team shall not suggest or advise maintenance needs of the experimental pavement section. Judgement of maintenance needs and implementation of maintenance operation shall totally depend on the maintenance engineer of the District/Provincial Engineer's Office.

Delayed maintenance operation may significantly shorten the performance period. By comparing the progress of surface distresses and other defects with timing of maintenance operation, causes of short performance period will be analyzed and recommendations on maintenance operation will be prepared.

3.1.3 Meteorological Data Collection

Meteorological data on the following shall be collected monthly from PAGASA in Cavite Province :

* Daily (or 24 hr) rainfall height
* Number of rainy days
* Tropical cyclone record
* Highest, lowest and average temperature of the previous month

Rainfall data will be related to gravel loss of Gravel Surface Models and also to drainage quality of the experimental pavement section.

3.1.4 Drainage Condition Information

Information of drainage condition of the experimental pavement sections shall be collected monthly by interviewing nearby residents, and the Follow-up Survey Team's observation on the day of the inspection trip.

AASHTO Guide for Design of Pavement Structure (1986) established drainage level as follows :

Quality of Drainage	Water Removed Within
Excellent	2 hours
Good	1 day
Fair	1 day
Poor	1 month
Very Poor	(water will not drain)

For design purpose, percent of time on pavement structure is exposed to moisture levels approaching saturation is required.

Based on the rainfall data obtained from PAGASA, the Follow-up Survey Team shall ask nearby residents of the experimental pavement sections' quality of drainage of the first to third highest rainfall days in the previous month, and record information on Inspection Sheets.

3.1.5 Rehabilitation Data Collection

Rehabilitation data shall be collected at the Cavite District Engineering Office of DPWH for the experimental pavement Section No. 5 and the Cavite Provincial Engineer's Office of the experimental pavement Sections No. 1, 2, 3 and 4. The following data shall be collected:

1) Date of rehabilitation work undertaken

2) Location (which shall be confirmed during the inspection trip)

3) Type of rehabilitation work

4) Cost of rehabilitation work

5) What are the justifications of the respective offices for undertaking rehabilitation (or on what bases do the respective office determine to undertake rehabilitation work).

6) Surface condition immediately before the rehabilitation work

3.2 TRAFFIC SURVEY

3.2.1 Traffic Count Survey

The 12-hour traffic count survey by vehicle type and direction shall be undertaken quarterly (every January, April, July and October of each year) at four (4) traffic stations for three (3) days as follows :

Traffic Count Survey Station No.	Experimental Pavement Section No.	Location
Station No. 1	Section 1	Jct. Alfonso - Magallanes
Station No. 2	Section 2	Magallanes - Maragondon
Station No. 3	Section 3 & 4	Gen. Trias-Jct. Mangahan
Station No. 4	Section 5	Carmona - Jct. Mangaldan

Vehicles shall be classified as follows :

* Car/Taxi
* Jeep
* Jeepney
* Pick-up/Van
* Mini-bus
* Large-bus
* Truck - 2 Axle
* Truck - 3 Axle
* Truck/Semi-Trailer
* Motor Tricycle
* Motorcycle
* Special
* Animal Drawn

Traffic count survey results shall be summarized as shown in Table 3.2-1.

TABLE 3.2-1 TRAFFIC COUNT SUMMARY

STA. NO. _____ LOCATION _____ DATE _____

HOUR	DIR. 1 : From _____ To _____														DIR 2 : From _____ To _____												
	CAR/TAXI	JEEP	JEEPNEY	PICK-UP/VAN	MINI-BUS	LARGE-BUS	TRUCK-2 AXLE	TRUCK-3 AXLE	TRUCK SEMI-TLR.	MOTOR TRICYCLE	MOTOR CYCLE	SPECIAL	ANIMAL DRAWN	TOTAL	CAR/TAXI	JEEP	JEEPNEY	PICK-UP/VAN	MINI-BUS	LARGE-BUS	TRUCK-2 AXLE	TRUCK-3 AXLE	TRUCK SEMI-TLR.	MOTOR TRICYCLE	MOTOR CYCLE	SPECIAL	ANIMAL DRAWN	TOTAL
24 – 01																												
01 – 02																												
02 – 03																												
03 – 04																												
04 – 05																												
05 – 06																												
06 – 07																												
07 – 08																												
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23 – 24																												
≤ 24 Hrs.																												
≤ Hrs.																												
Ratio 24/																												

3.2.2 Loadometer Survey

The loadometer survey shall be undertaken once a year in October at the same survey stations as the Traffic Count Stations except Survey Station No. 2 where the loadometer survey is not required. The loadometer survey stations are summarized below :

Loadometer Survey Station No.(Refer to Traffic Count Survey Station No.)	Experimental Pavement Section No.	Location
Station No. 1	Sections 1 & 2	Jct. Alfonso-Magallanes
Station No. 3	Sections 3 & 4	Gen. Trias-Jct. Mangahan
Station No. 4	Section 5	Carmona-Jct. Mangaldan

The survey shall be conducted for 12 hours from 6:00 A.M. to 6:00 P.M. for three (3) consecutive days. Vehicles to be weighed shall be :

* Trucks, Semi-trailers, Truck-trailers
* Large-buses, Mini-buses

Sampling of vehicles to be weighed shall be random sampling. In case of sampling rate of 67%, the first and second vehicles shall be weighed and the third vehicles shall not be weighed. Sample rate shall be as follows :

Station No.	Sample Rate	
	Trucks/Semi-trailer/ Truck-trailers	Large/Mini Buses
Station No. 1	100% (All)	100% (All)
Station No. 3	80% (4 out of every 5 trucks)	50% (every other bus)
Station No. 4	67% (2 of every 3 trucks)	50% (every other bus)

Loadometer survey field sheet is presented in Table 3.2-2.

TABLE 3.2-2

DPWH / JICA TRAFFIC SURVEY

LOADOMETER SURVEY FIELD SHEET

STATION NO: _____ DATE : _____ INTERVIEWER : _____

DIRECTION : FROM: _____ TO: _____

1. IDENTIFICATION CODE				1 3 9
2. HOUR				10
3. VEHICLE TYPE				12
		3. LARGE BUS	5. TRUCK 11	
		4. MINI BUS	6. TRUCK 12	
		11. SEMITRAILER 11-1	7. TRUCK – TRAILER 11-11	
		12. SEMITRAILER 11-2	8. TRUCK – TRAILER 11-12	
		13. SEMITRAILER 12-1	9. TRUCK – TRAILER 12-11	
		14. SEMITRAILER 12-2	10. TRUCK – TRAILER 12-12	
4. VEHICLE BODY TYPE				14
5. COMMODITY TYPE				15
6. TOTAL COMMODITY WEIGHT _____ KGS.				17
(7) LICENCED CAPACITY	SEAT CAPACITY _____ SEATS			22
	LOAD CAPACITY	MOTOR VEHICLE _____ KGS.		24 28
		TRAILER _____ KGS.		29 33
	GROSS VEHICLE WEIGHT	MOTOR VEHICLE _____ KGS.		34 38
		TRAILER _____ KGS.		39 43
(8) AXLE WEIGHT	MOTOR VEHICLE	LEFT WHEEL	RIGHT WHEEL	44 48
		1st Axle _____ KGS.	1st Axle _____ KGS.	49 53
		2nd Axle _____ KGS.	2nd Axle _____ KGS.	54 58
		3rd Axle _____ KGS.	3rd Axle _____ KGS.	
	TRAILER	1st Axle _____ KGS.	1st Axle _____ KGS.	59 63
		2nd Axle _____ KGS.	2nd Axle _____ KGS.	64 68
		3rd Axle _____ KGS.	3rd Axle _____ KGS.	69 73
(9)				74 76

3.2.3 *Data Processing*

1) Traffic Count Survey Data

Traffic count survey data shall be converted to Average Annual Daily Traffic (AADT), using Hourly Factors, and Seasonal Factors which are available at the Planning Service, DPWH.

AADT shall be compiled by vehicle type and by direction.

2) Loadometer Survey Data

Measured axle loads comprising of single axle loads and tandem axle loads shall be converted to 18-kip Equivalent Single Axle Load (18-kip ESAL), using axle load equivalency factors which are presented in Appendix - C. Then, vehicle load factor (VLF) shall be computed by the following formula:

$$VLF = \frac{1}{N} \sum_{i=1}^{n} (ni \times ei)$$

where : VLF = Vehicle Load Factor
ni = number of axles for axle load group i
ei = axle load equivalency factor for axle load group i
n = total number of axles
N = total number of vehicles

VLF for trucks (inclusive 2 and 3-axle trucks, and tractors), VLF for large bus and VLF for mini-bus shall be separately computed for each direction.

VLF indicates average 18-kip ESAL of one (1) vehicle.

3.3 SURFACE CONDITION SURVEY

Measurement of surface condition shall be undertaken quarterly in January, April, July and October, thus surface condition will be checked two (2) times in the dry season and two (2) times in the rainy season.

Measurement of surface condition shall be undertaken for the items listed in Table 3.3-1.

Table 3.3-1 Items To Be Measured

Item	Gravel Surface	Bituminous Surface (SBST, DBST, BMP, and AC)	PCC
1. Roughness	o	o	o
2. Cracking	-	o	o
3. Patching	-	o	o
4. Rutting	o	o	-
5. Potholes	o	o	-
6. Present Serviceability Rating (PSR)	o	o	o
7. Rehabilitation Requirement Rating (RRR)	o	o	o

Cracking, patching, rutting, potholes and other deterioration observed during the surface condition survey shall be sketched on the field survey sheets.

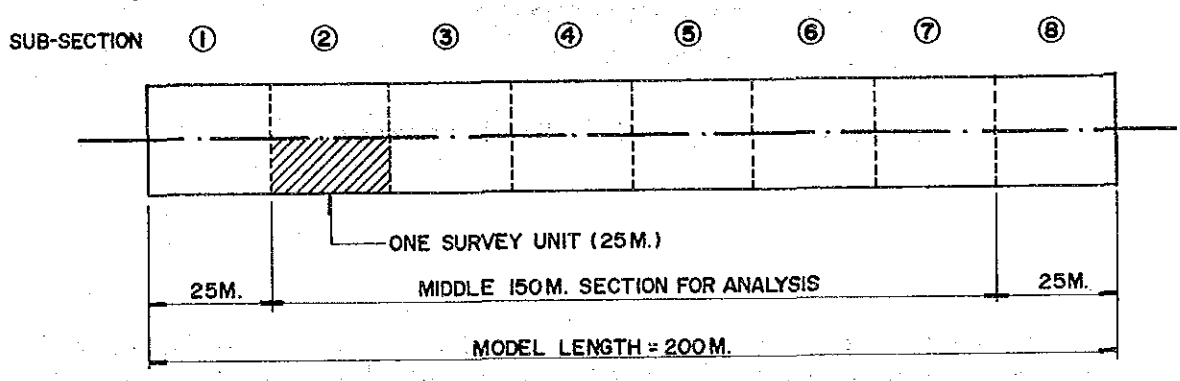
Survey unit and analysis unit shall be shown in Table 3.3-2.

Table 3.3-2 Survey Unit and Analysis Unit

Item	Gravel Surface		Bituminous Surface		P C C	
	Survey Unit	Analysis Unit	Survey Unit	Analysis Unit	Survey Unit	Analysis Unit
1. Roughness	M-150	M-150	M-150	M-150	M-150	M-150
2. Cracking	-	-	25m	M-150	4.5m	M-150
3. Patching	-	-	25m	M-150	4.5m	M-150
4. Rutting	25m	M-150	25m	M-150	-	-
5. Potholes	25m	M-150	25m	M-150	-	-
6. PSR	M-150	M-150	M-150	M-150	M-150	M-150
7. RRR	M-150	M-150	M-150	M-150	M-150	M-150

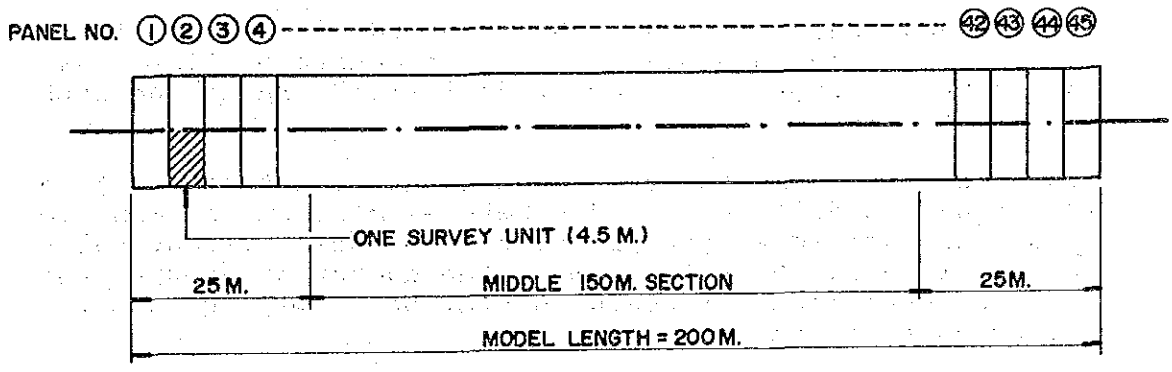
NOTE: M-150 means the middle 150-meter sections.

(GRAVEL SURFACE AND BUITUMINOUS SURFACES)



SUBSECTIONS ① AND ⑧ SHALL BE EXCLUDED FROM THE ANALYSIS.

(PCC PAVEMENT)



PANELS ① TO ⑥ AND ㊶ TO ㊺ SHALL BE EXCLUDED FROM THE ANALYSIS.

3.3.1 *Roughness Survey*

It is recommended that measurement of roughness will be undertaken by a 3-meter profilometer because of short distance of each experimental pavement model. In case a 3-meter profilometer is not available, roughness measurement shall be undertaken by a bump integrator.

1) Roughness measurement by a 3-meter profilometer

Survey Method

A 3-meter profilometer is shown in Figure 3.3-1.

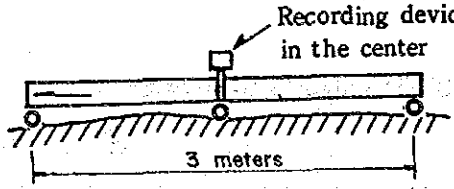


Figure 3.3-1 3-m Profilometer

Measurement shall be made for each lane along the parallel line with the road centerline and located at one (1) meter inward from the pavement edge. Surface profile is recorded automatically. From the recorded chart, elevations of waves from the datum line shall be read at 1.5 - meter interval.

Data Processing

After measuring, calculate the standard deviation of all recorded measurements over the entire course of test. Make use of the concept of "range of deviation" in making such calculation as follows :

Group the measurements by sequence into clusters of 6 to 10, find the differences (R) between maximum and minimum values of individual groups, calculate their average value ($\bar{R}$) by dividing the total sum by the number of groups, and then compute the standard deviation (σ) using the following equation.

$$\sigma = \frac{\bar{R}}{C}$$

Where : σ = standard deviation (mm)
$\bar{R}$ = average value of difference (mm)
C = a coefficient fixed in accordance with the determined number of measurements involved in the group, as shown in Table 3.3-2.

Table 3.3-2 Values of C for Computation of Standard Deviations

Number of Measurements Involved in a group	C
6	2.53
7	2.70
8	2.85
9	2.97
10	3.08

The standard deviation (σ) of every 25-m section and middle 150-m section shall be calculated.

2) Roughness measurement by a Bump Integrator

Method of Measurement

The bump integrator (See Figure 3.3-2) is a device which produces an electric impulse for a particular amount of movement of an axle relative to the frame of the test vehicles. The pulses are counted and expressed as a total amount of movement.

Each model section has a length of 200 meters, however, measurement shall be made for the middle 150-meter section. The test vehicle shall be driven at a constant speed of about 30 km per hour. The counter, having been set to zero, is switched on when the test vehicle enters the middle 150m section and switched off at the end of the middle 150m section. The reading on the counter gives the number of inches of unidirectional movement of the rear axle of the test vehicle. Three (3) runs shall be made for each pavement model and the readings shall be averaged. The same procedure shall be repeated for all pavement models.

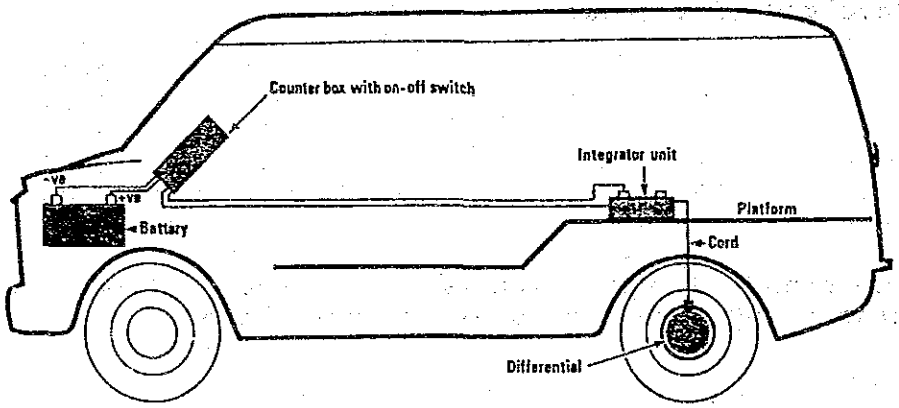


Figure 3.3-2 Bump Integrator

Data Processing

Measured value shall be converted to the standard roughness value by the following formula :

$$\text{Roughness Value (RV)} = \frac{\text{Average of Measured Value X 25.4}}{\text{Length of the section in km.}}$$

Where : Roughness value = cm/km
Average measured value = inches
Length of the section = 0.15 km

Table 3.3-3 Roughness Survey Sheet By Bump Integrator

DATE _____ WEATHER _____

SURVEYOR _____

Model No.	Direction To _____	Reading in the Counter			Average
		First Run	Second Run	Third Run	

3.3.2 Cracking Survey

1) Bituminous Surface Pavement Models

Survey Unit

Survey unit shall be 25 meters. Measurement shall be recorded every 25 meters by lane.

Cracks To Be Measured

Cracking classes are classified into the following three (3) classes and classes 2 and 3 shall be measured as:

Class 1 cracking:	The earliest type of cracking consisting of fine disconnected hairline cracks. (Measurement of this class cracking is not required.)
Class 2 cracking:	Class 1 cracks are lengthened and widened until the cells are formed on what is commonly called alligator cracking. A small amount of surface spalling at the crack is usually evident.
Class 3 cracking:	The segment of class 2 cracks spalled more severely at the edges and loosened to the cells rock under traffic.

Method of Measurement

Cracked area is measured in square meters of surface area. The road surface with classes 2 and 3 cracking shall be divided into grids with 0.5m x 0.5m and marked with white chalks on the surface, then a number of grids shall be counted as classified into the following :

Grid-A:	One (1) crack, which crosses a grid, exists in a grid. Cracking is measured to be 0.125 square meters.
Grid-B:	Two (2) or more cracks, exist in a grid. Cracking is measured to be 0.25 square meters.

Total cracking in the survey unit (25 meter section) will be computed as follows :

Cracked Area (sq.m) = number of Grid-A x 0.125
+ number of Grid-B x 0.25

Data Processing

Cracked area shall be converted to "Cracking Index", which is expressed as follows :

$$\text{Cracking Index} = \frac{\text{Cracked Area}}{\text{Total Surface Area}} \times 100$$

Where : Cracking Index in %
Cracked Area in square meters

For survey unit : sum of cracked areas in 25-meter section
For analysis unit : sum of cracked areas in the middle 150-meter section

Total Surface Area in square meter (in case of width of 3.0m)

For survey unit : 3.0m x 25m = 75 sq. m

For analysis unit : 3.0m x 150m = 450 sq. m

2) PCC Pavement Model

Survey Unit

Survey unit shall be one (1) PCC panel (= 4.5 meters). Measurement shall be recorded at every PCC panel by lane.

Cracks To Be Measured

Cracking classes are classified into the following four (4) classes and classes 3 and 4 shall be measured:

Class 1 : Fine cracks not visible under day surface condition for a man with good vision standing at a distance of 15 ft.

Class 2 : Cracks that can be seen at a distance of 15 ft. but exhibited only minor spalling such that the opening at the surface is less than $^1/_4$ inch.

Class 3 : Any crack spalled at the surface to a width of $^1/_4$ inch or more for at least one-half its length.

Class 4 : Any crack which has been sealed.

Method of Measurement

Class 3 and Class 4 cracks are measured in linear meters. All class 3 and class 4 cracks shall be sketched on the survey sheet and crack length shall be measured by a measuring tape. Total crack length in a survey unit (one panel = 4.5 meters) will be recorded.

Data Processing

Crack length shall be converted to "Cracking Index" which is defined as the total length in (linear meters) of all cracks under class 3 and 4 per 1,000 square meter of surface area.

For a survey unit (4.5-m) :

$$\text{Cracking Index} = \frac{\text{Total Crack Length in Survey Unit} \times 1{,}000}{3.35 \times 4.5}$$

For an analysis unit (150-m) :

$$\text{Cracking Index} = \frac{\text{Total Crack Length in Survey Unit} \times 1{,}000}{3.35 \times 150}$$

3.3.3 *Patching Survey*

1) Bituminous Surface Pavement Models

Survey Unit

Survey unit shall be 25 meters. Measurement shall be recorded every 25 meters by lane.

Method of Measurement

Area of pavement surface repaired by skin patching or deep patching shall be measured in square meters of surface area. All existing patched areas shall be measured on the pavement surface by a measuring tape and area in square meter shall be computed.

Data Processing

Patched area shall be converted to "Patching Index" which is expressed as follows:

$$\text{Patching Index} = \frac{\text{Total Patched Area}}{\text{Total Surface Area}} \times 100$$

where: Patching Index in %

Total Patched Area: in square meter

For survey unit : Sum of patched areas in 25-m section

For analysis unit: Sum of patched areas in the middle 150-m section

Total Surface Area: in square meter

For survey unit : 3.0m x 25 = 75 sq. m.

For analysis unit: 3.0m x 150 = 450 sq. m.

2) PCC Pavement Model

Survey Unit

Survey unit shall be one (1) panel (4.5 meters). Measurement shall be recorded every one (1) panel by lane.

Method of Measurement

Method of measurement shall be undertaken exactly in the same manner as the case for bituminous surface pavement model:

Data Processing

Patched area shall be converted to "Patching Index" which is defined as patched area (sq. m.) per 1,000 sq. m and expressed as follows:

$$\text{Patching Index} = \frac{\text{Total Patched Area}}{\text{Total Surface Area}} \times 1{,}000$$

where: Patching Index in sq. m./1,000 sq. m.

Total Patched Area: in square meter

For survey unit : Sum of patched areas in one (1) panel

For analysis unit: Sum of patched areas in the middle 150-m section

Total Surface Area: in square meter

For survey unit : 3.25 x 4.5 = 15.08 sq.m

For analysis unit: 3.35 x 150 = 502.5 sq.m

3.3.4 *Rutting Survey*

Rutting shall be measured for gravel surface and bituminous surface pavement models in the same manner explained hereunder.

Rutting area shall be recorded on the Field Survey Sheet. Rut depths in mm shall be measured in each survey unit (25 meter). A 1.2-meter straight edge shall be laid across the rut and maximum depth is measured. Measurement shall be made for both wheelpaths of a lane and at taken every five (5) meters along the length of the rut.

Data Processing

Rutting is expressed by the mean depth of rut in both wheelpaths.

3.3.5 *Pothole Survey*

Potholes shall be measured in number and square meter for gravel surface and bituminous surface pavement models in the same manner explained hereunder.

Approximate locations of potholes and their diameters shall be sketched for each survey unit on the Field Survey Sheets. Number of potholes and total areas in square meter for each survey unit shall be recorded in the Field Survey Sheets.

Data Processing

Pothole areas shall be converted to "Pothole Index" which is expressed as follows:

$$\text{Pothole Index} = \frac{\text{Total Patched Area}}{\text{Total Surface Area}} \times 100$$

where: Pothole Index in %

Pothole Area: in square meter

For survey unit : Sum of pothole areas in 25-m section

For analysis unit: Sum of pothole areas in the middle 150-m section

Total Surface Area: in square meter

For survey unit : 3.0m x 25 = 75 sq. m.

For analysis unit: 3.0m x 150 = 450 sq. m.

3.3.6 *Present Serviceability Rating (PSR)*

Present serviceability is defined as the ability of a specific section of pavement to serve high-speed, high volume, mixed (truck and automobile) traffic in the existing condition.

Method of rating shall be as follows:

Rating Panel

8 - Filipino road users (preferably 2 engineers, 2 economists, 2 administrative staff and 2 drivers)

Rating Method

Each member of the rating panel is required to rate the serviceability/comfort/rideability using their own judgement on the middle 150-meter section of each pavement model and record it in the form as shown in Table 3.3-4, while the survey vehicles are travelling at 60 kph.

The rating states range 0 to 5, as follows:

5-4 Very Good
4-3 Good
3-2 Fair
2-1 Poor
1-0 Very Poor

Present Serviceability Rating (PSR)

PSR, defined as the mean of the individual ratings, shall be calculated for the middle 150-m section of each pavement model.

Acceptability

Each member of the rating panel is further required to indicate whether or not the pavement being rated is acceptable.

Table 3.3-4 Individual Present Serviceability Rating Form

Name of Rater _____ Date _____

Vehicle _____

Model No.	Direction To_____	Surface Condition Rating 5	4	3	2	1	0	Acceptable ? Yes	No	Undecided

Rating		Condition		
5-4	:	Very Good	---	Very Comfortable
4-3	:	Good	---	Comfortable
3-2	:	Fair	---	Acceptable
2-1	:	Poor	---	Uncomfortable
1-0	:	Very Poor	---	Very Uncomfortable

3.3.7 Rehabilitation Requirement Rating (RRR)

Since the present serviceability rating is a subjective assessment by the road users, using their own guideline and judgement, the rating does not necessarily identify the sections where the rehabilitation works are needed, when judged from the engineering point of view.

To assess the rehabilitation needs, a rating panel shall be organized only by experienced engineers and conduct the rating based on the ocular survey on the pavement condition, paying their attentions to pavement distress such as cracking and pothole.

Rating Panel

4 - Filipino highway engineers in charge of design, construction and maintenance.

Rating Method

Each engineer shall be required to rate his engineering judgement on the middle 150-m section of each pavement model and record it in the form shown in Table 3.3-5, while the survey vehicle is running at 20 kph.

The criteria of the rating are as follows:

5-4	:	No deficiencies
4-3	:	Little deficiencies
3-2	:	Considerable deficiencies
2-1	:	Severe deficiencies needing immediate treatment
1-0	:	Immediate reconstruction required

Rehabilitation Requirement Rating (RRR)

RRR, defined as the mean of the individual ratings, shall be calculated for the middle 150-m section of each pavement model.

Table 3.3 - 5 Individual Rehabilitation Requirement Rating Form

Name of Rater _____ Date _____

Vehicle _____

Model No.	Direction To_____	Surface Condition 5	4	3	2	1	0	Acceptable ? Yes	No	Undecided

POINTS		SURFACE CONDITION
5 - 4	:	No Deficiencies
4 - 3	:	Little Deficiencies
3 - 2	:	Considerable Deficiencies but immediate treatment is not required.
2 - 1	:	Considerable severe deficiencies, immediate treatment is required.
1 - 0	:	Reconstruction is immediately required.

3.3.8 Surface Condition Survey Field Sheet

The field survey sheets for surface deterioration, i.e., cracking, patching, rutting and potholes are shown on the following pages.

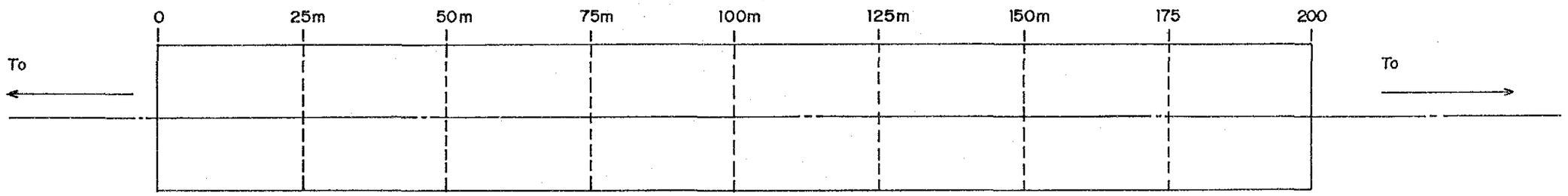
Type of Pavement	Sketch	Measurement
Gravel Surface	Field Survey Sheet No. 2	Field Survey Sheet No. 1
Bituminous Surface	Field Survey Sheet No. 4	Field Survey Sheet No. 3
PCC Pavement	Field Survey Sheet No. 6	Field Survey Sheet No. 5

FIELD SURVEY SHEET - No. 1
(GRAVEL SURFACE MODEL)

SURVEY ITEMS
Rotting / Potholes

SECTION NO. _____ DATE _____ WEATHER _____
PAV'T. MODEL NO. _____ SURVEYOR _____

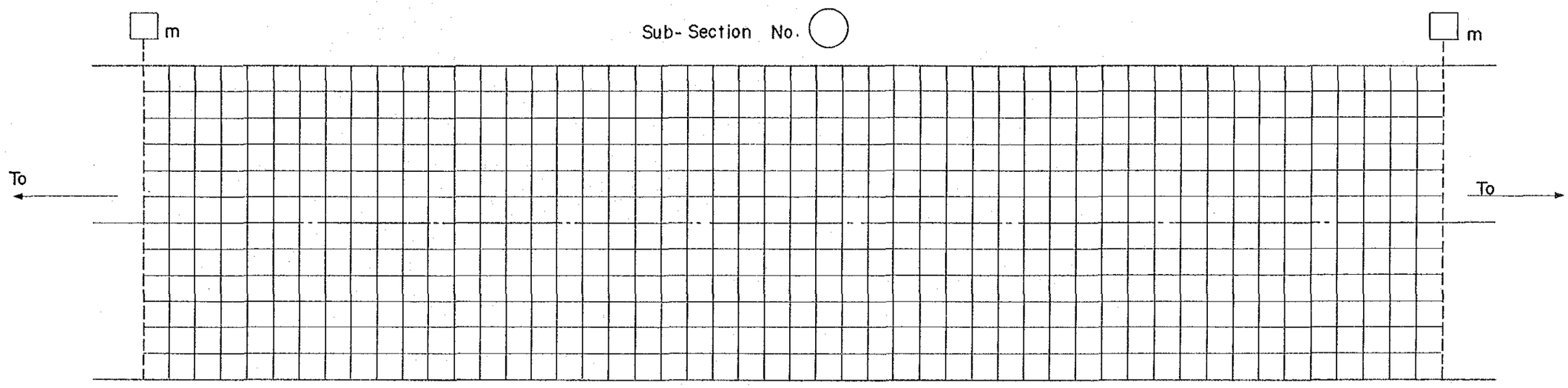
Potholes (Record diameter of Pothole)									
Rut Depth	Outer								
	Inner								



Rut Depth	Inner								
	Outer								
Potholes (Record diameter of Pothole)									

Notes : Indicate approximate location of ruts and potholes on the plan.
Also indicate other distresses observed on the plan.

FIELD SURVEY SHEET - No. 2 (GRAVEL SURFACE MODEL)	SKETCH OF RUTTING / POTHOLES	SECTION No. _____ PAVEMENT MODEL No. _____ SUB-SECTION No. _____	DATE _____ SURVEYOR _____	WEATHER _____



Sketch Rutting ( ), Potholes ( ) and Other Deterioration

Photograph

Photograph

FIELD SURVEY SHEET - No. 3
(SBST, DBST, BMP, AC MODELS)

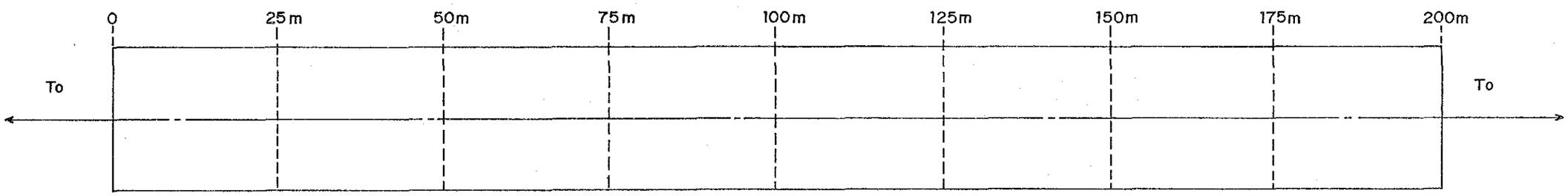
SURVEY ITEMS

Cracking / Patching / Rutting / Pothole

SECTION NO. _____ DATE _____ WEATHER _____

PAV'T. MODEL NO. _____ SURVEYOR _____

Potholes (Record Diameter)								
Rut Depth	Outer							
	Inner							
Patching (sq. m.)								
Cracking	No. of Grid-A							
	No. of Grid-B							



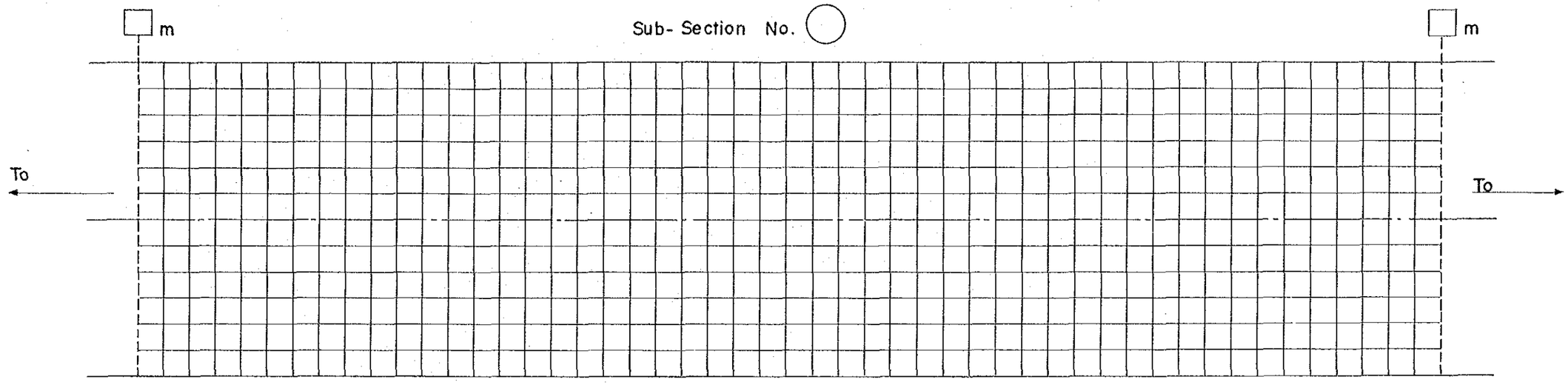
Cracking	No. of Grid-A							
	No. of Grid-B							
Patching (sq. m.)								
Rut Depth	Inner							
	Outer							
Potholes (Record Potholes)								

Notes: Indicate approximate location of Cracks (Grid-A: [A], Grid-B: [B]), Patching (■), Rutting (≡), Potholes (○) and other distresses on the plan.

FIELD SURVEY SHEET - No. 4
(SBST, DBST, BMP, AC MODELS)

SKETCH oF
CRACKING/PATCHING/RUTTING/POTHOLE

SECTION No. _____ DATE _____ WEATHER _____
PAVEMENT MODEL No. _____
SUB-SECTION No. _____ SURVEYOR _____



Sketch Cracking (2 or 3 Depending on Class), Patching ( ), Rutting ( ), Potholes ( ) and Other Deterioration.

Photograph

Photograph

FIELD SURVEY SHEET – No. 5
(PCC PAVEMENT MODEL)

SURVEY ITEMS
CRACKING / PATCHING

SECTION NO. _____ DATE _____ WEATHER _____
PAV'T. MODEL NO. _____ SURVEYOR _____

Patching (sq. m.)																						
Crack Length (m)																						

Panel №	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓

Crack Length (m)																						
Patching (sq. m.)																						

Patching (sq. m.)																						
Crack Length (m)																						

Panel №	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜	㉝	㉞	㉟	㊱	㊲	㊳	㊴	㊵	㊶	㊷	㊸	㊹	㊺

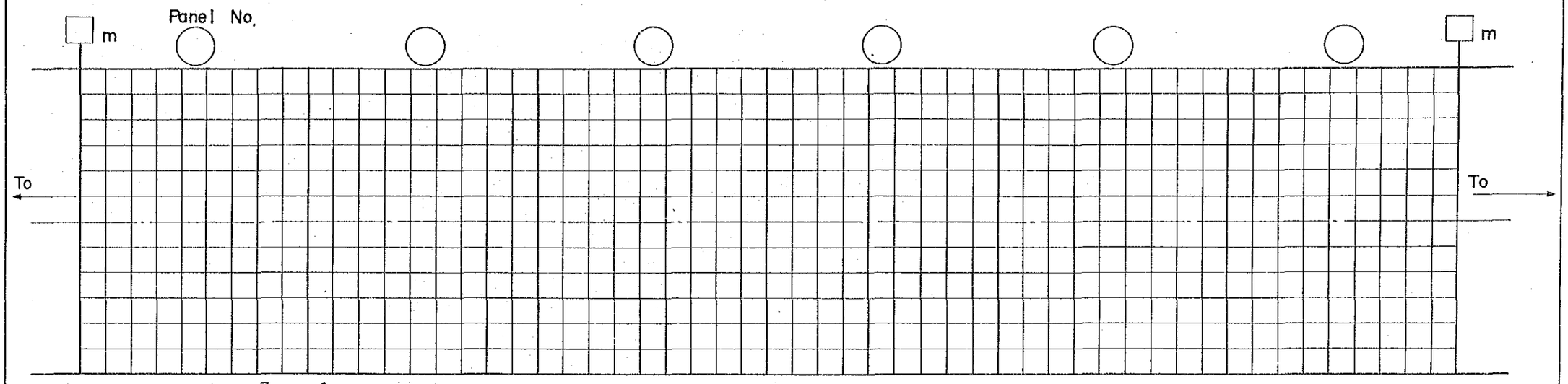
Crack Length (m)																						
Patching (sq.m.)																						

Note: Indicate location of Cracks and Patching (■) of each panel on the plan.
Also indicate other distress observed on the plan.

FIELD SURVEY SHEET - No. 6
(PCC PAVEMENT MODEL)

SKETCH OF
CRACKS / PATCHING

SECTION No. _____ DATE _____ WEATHER _____
PAVEMENT MODEL No. _____
PANEL Nos _____ to _____ SURVEYOR _____



Sketch Cracks (3 or 4 Depending on Class), Patcking (●) and Other Deterioration

Photograph

Photograph

3.3.9 *Data Compilation of Surface Condition Survey*

Data collected/processed shall be compiled as shown in Tables 3.3-9, 3.3-10 and 3.3-11. These data shall also be stored in the diskette.

Table 3.3-9

DATA COMPILATION SHEET – No. 1 (GRAVEL SURFACE)	SECTION NO. _____ PAV'T. MODEL NO. _____	Month / Year _____

DIRECTION		SUB-SECTION NO.	①	Middle 150 m. Section ②	③	④	⑤	⑥	⑦	Sub-Total ② ~ ⑦	⑧
	To ____	ROUGHNESS	—	—	—	—	—	—	—		—
		RUTTING (Mean Depth (mm))									
		POTHOLE Area (sq.m.)									
		POTHOLE Index (%)									
		P S R	—	—	—	—	—	—	—		—
		R R R	—	—	—	—	—	—	—		—
	To ____	ROUGHNESS	—	—	—	—	—	—	—		—
		RUTTING (Mean Depth (mm))									
		POTHOLE Area (sq.m.)									
		POTHOLE Index (%)									
		P S R	—	—	—	—	—	—	—		—
		R R R	—	—	—	—	—	—	—		—

Table 3.3-10

DATA COMPILATION SHEET – No. 2
(SBST, DBST, BMP, A.C)

SECTION NO. _____
PAV'T. MODEL NO. _____

Month / Year _____

DIRECTION		ITEM		SUB-SECTION NO. ①	Middle 150 m. Section ②	③	④	⑤	⑥	⑦	Sub-Total ② ~ ⑦	⑧
	To _____	ROUGHNESS		–	–	–	–	–	–	–		–
		CRACKING	Area (sq.m.)									
			Index (%)									
		PATCHING	Area (sq.m.)									
			Index (%)									
		RUTTING (Mean Depth in mm.)										
		POTHOLE	Area (sq.m.)									
			Index (%)									
		P S R		–	–	–	–	–	–	–		–
		R R R		–	–	–	–	–	–	–		–
	To _____	ROUGHNESS		–	–	–	–	–	–	–		–
		CRACKING	Area (sq.m.)									
			Index (%)									
		PATCHING	Area (sq.m.)									
			Index (%)									
		RUTTING (Mean Depth in mm.)										
		POTHOLE	Area (sq.m.)									
			Index (%)									
		P S R		–	–	–	–	–	–	–		–
		R R R		–	–	–	–	–	–	–		–

TABLE 3.3 - 11

DATA COMPILATION SHEET - No. 3 (PCC PAVEMENT MODEL)	SECTION NO. _____ PAV'T. MODEL NO. _____	MONTH / YEAR _____

	Panel Nº	DIRECTION													
		TO CARMONA							TO TRECE MARTERES						
		Rough-ness	Cracking		Patching		PSR	RRR	Rough-ness	Cracking		Patching		PSR	RRR
			Length (m.)	Index	Area (sq.m.)	Index				Length (m.)	Index	Area (sq.m.)	Index		
	①	–					–	–	–					–	–
	②	–					–	–	–					–	–
	③	–					–	–	–					–	–
	④	–					–	–	–					–	–
	⑤	–					–	–	–					–	–
	⑥	–					–	–	–					–	–
MIDDLE 150 - M. SECTION	⑦	–					–	–	–					–	–
	⑧	–					–	–	–					–	–
	⑨	–					–	–	–					–	–
	⑩	–					–	–	–					–	–
	⑪	–					–	–	–					–	–
	⑦~⑪	–					–	–	–					–	–
	⑫	–					–	–	–					–	–
	⑬	–					–	–	–					–	–
	⑭	–					–	–	–					–	–
	⑮	–					–	–	–					–	–
	⑯	–					–	–	–					–	–
	⑰	–					–	–	–					–	–
	⑫~⑰	–					–	–	–					–	–
	⑱	–					–	–	–					–	–
	⑲	–					–	–	–					–	–
	⑳	–					–	–	–					–	–
	㉑	–					–	–	–					–	–
	㉒	–					–	–	–					–	–
	⑱~㉒	–					–	–	–					–	–
	㉓	–					–	–	–					–	–
	㉔	–					–	–	–					–	–
	㉕	–					–	–	–					–	–
	㉖	–					–	–	–					–	–
	㉗	–					–	–	–					–	–
	㉘	–					–	–	–					–	–
	㉓~㉘	–					–	–	–					–	–
	㉙	–					–	–	–					–	–
	㉚	–					–	–	–					–	–
	㉛	–					–	–	–					–	–
	㉜	–					–	–	–					–	–
	㉝	–					–	–	–					–	–
	㉙~㉝	–					–	–	–					–	–
	㉞	–					–	–	–					–	–
	㉟	–					–	–	–					–	–
	㊱	–					–	–	–					–	–
	㊲	–					–	–	–					–	–
	㊳	–					–	–	–					–	–
	㊴	–					–	–	–					–	–
	㉞~㊴	–					–	–	–					–	–
	TOTAL														
	㊵	–					–	–	–					–	–
	㊶	–					–	–	–					–	–
	㊷	–					–	–	–					–	–
	㊸	–					–	–	–					–	–
	㊹	–					–	–	–					–	–
	㊺	–					–	–	–					–	–

3.4 *DEFLECTION SURVEY*

Deflection survey by Benkelman Beam shall be conducted twice a year in April and October, one time each during dry and rainy seasons.

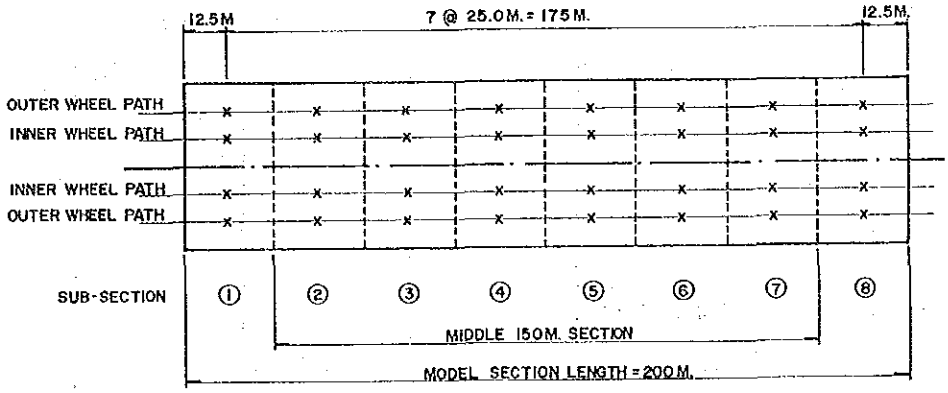
1) Method of Measurement

Loading

Two (2) axle dump truck having an 8.16-ton rear axle load and inflated tire pressure of 80 psi.

Location

Every 25-meter interval, or at the center of sub-section as shown below :



NOTE : x shows location of deflection measurement

In case of PCC pavement model, deflection near the transverse joint between the following panels shall be measured :

Panels (2) and (3), (8) and (9), (13) and (14), (19) and (20), (25) and (26), (30) and (31), (36) and (37), (41) and (42)

Field survey sheet is shown in Table 3.5-1.

2) Data Processing

For the middle 150-m section, following shall be computed by lane (direction) :

$\bar{X}$: Mean value of individual rebound deflection (x 0.01 mm)

σ : Standard deviation

V : Variation coefficient

$$\text{Where } V = \frac{\sigma}{\bar{X}} \times 100$$

Table 3.4-1
DEFLECTION SURVEY FIELD SHEET

SECTION NO. _____ DATE _____

PAV'T. MODEL NO. _____ WEATHER _____

SURVEYOR _____

SUB-SECTION NO. (PANEL NO.)	DIRECTION			
	TO		TO	
	OWP	IWP	IWP	OWP
① (②/③)				
② (⑧/⑨)				
③ (⑬/⑭)				
④ (⑲/⑳)				
⑤ (㉕/㉖)				
⑥ (㉚/㉛)				
⑦ (㊱/㊲)				
⑧ (㊶/㊷)				

Note: Sub-section no. for Gravel and Bituminous Surface Models.
Panel No. for PCC Pavement Model.
OWP is outer wheelpath.
IWP is inner wheelpath.

3.5 *GRAVEL LOSS SURVEY*

Gravel loss survey shall be undertaken quarterly in January, April, July, and October.

1) Method of Survey

Changes in elevation of gravel surface shall be measured by Cross-section Survey.

Bench mark shall be established at Informatory Sign which is constructed at the beginning portion of gravel pavement model. Reference bench mark shall also be established at nearby permanent structure/object outside the roadway.

Cross-section Survey shall be conducted at 12.5-meter interval. Cross Sections to be surveyed shall always be determined and measured from the end of Single Bituminous Surface Treatment Model. Elevation of every 1.0 meter point and any uneven portions shall be surveyed (See Figure 3.6-1).

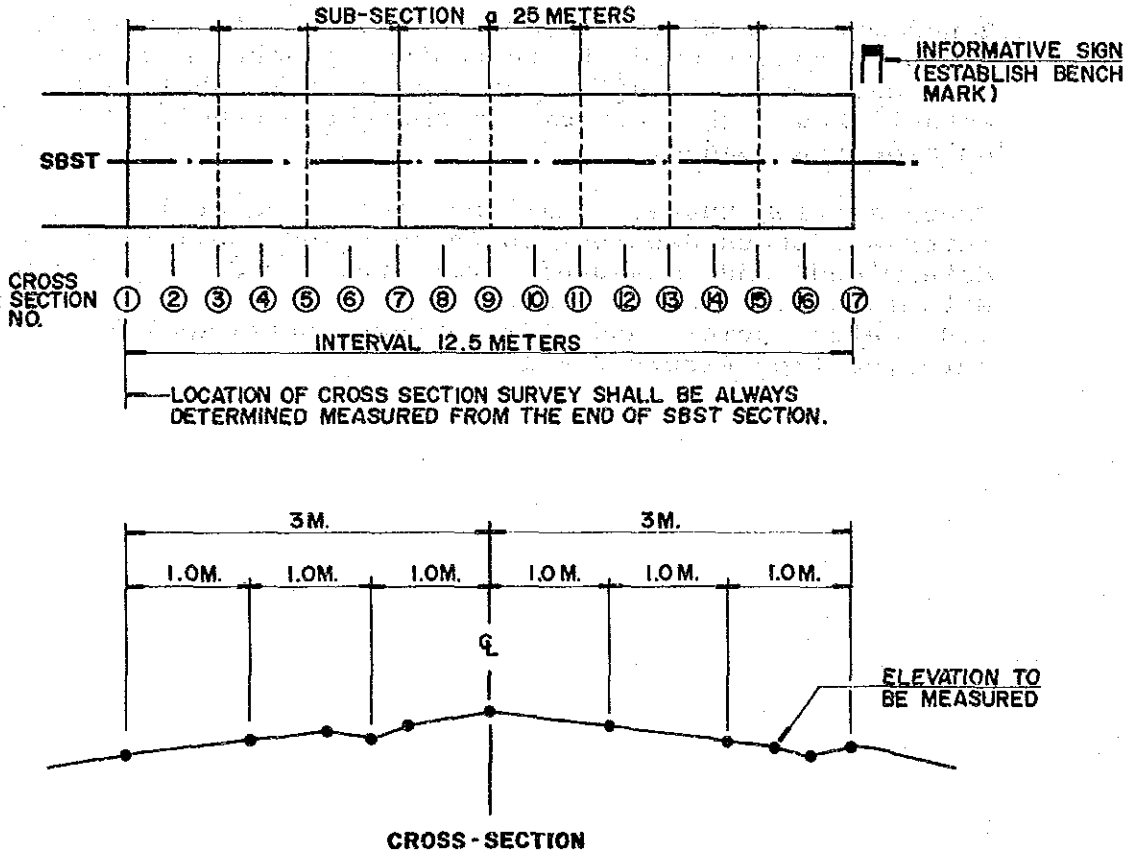


FIGURE 3.6-1
LOCATION OF CROSS SECTION SURVEY AND ELEVATION TO BE MEASURED

2) Data Processing

After the field survey, cross sections shall be drawn at the scale of 1:50 and shall be compared with the initially surveyed cross-sections (cross-sections taken just after the completion of the surface course work). Differences in cross sectioned area between the initial cross section and the cross section taken by the follow-up survey shall be computed for each direction (or lane). Differences in cross sectional area shall be converted to gravel loss in thickness by the following formula :

$$\text{Gravel Loss} = \frac{\text{Differences in cross sectional area of one (1) direction}}{W}$$

Where:

Gravel Loss : in cm
Difference in cross sectional area of one (1) direction : square cm.
W : width of one-direction = 300 cm.

3.6 PHOTO TAKING

Photos shall be taken quarterly at 25-m interval all along the experimental pavement sections. Location of photo taking shall be fixed and photos shall always be taken at the same location.

Photos shall be attached on the field survey sheet for the surface condition survey.

CHAPTER 4

ANALYSIS AND EVALUATION OF FOLLOW-UP SURVEY DATA

4.1 ANALYSIS AND EVALUATION

4.1.1 *Verification of Equation For PSI and RRI*

Feasibility Study on the Rural Road Network Development Project (the Study) developed equations to compute PSI and RRI for gravel and bituminous surface pavements as follows :

PSI :	Gravel	: $PSI=7.49-2.06 \log R$	(r=0.542)
	DBST	: $PSI=7.76-1.96 \log R-0.11 \sqrt{P}$	(r=0.739)
	BMP	: $PSI=9.80-2.46 \log R-0.25 \sqrt{P}$	(r=0.917)
	AC	: $PSI=7.32-1.68 \log R-0.14 \sqrt{P}$	(r=0.817)
RRI :	DBST	: $RRI=6.22-1.29 \log R-0.51 \sqrt{P}$	(r=0.874)
	BMP	: $RRI=5.80-0.89 \log R-0.42 \sqrt{P}$	(r=0.917)
	AC	: $RRI=6.04-1.12 \log R-0.39 \sqrt{P}$	(r=0.859)

Where, PSI = Present Serviceability Index
RRI = Rehabilitation Requirement Index
R = Roughness (cm/km)
P = Patching plus pothole (%)
r = Correlation coefficient

Feasibility Study of the Road Improvement Project on the Pan-Philippine Highway (Philippine-Japan Friendship Highway) developed equations to compute PSI and RRI for PCC pavement as follows :

PCC Pavement : $PSI = 5.75-2.0 \log R-0.06 \sqrt{C+P}$
$RRI = 7.53-1.5 \log R-0.11 \sqrt{C+P}$

Where, R : Roughness in cm/km
C : Cracking (total of class 3 and class 4 cracks in meter per 1,000 sq. m.)
P : Patching in sq.m. per 1,000 sq.m.

Utilizing such data obtained by the following survey, as PSR, RRR, and indices of surface distresses, PSI and RRI equations developed by the said two (2) studies shall be verified.

4.1.2 *Analysis of Performance Period*

1) Relationship Between PSI and Cumulative 18-kip ESAL

PSI computed by the equation, PSR rated by the Follow-up Survey Team and cumulative 18-kip ESAL with corresponding years shall be plotted on the graph. Terminal serviceability of low-class pavement is recommended to be 2.0 for PCC and bituminous Pavement and 1.5 for gravel surfaces by the study as well as AASHTO Guide for Design of Pavement Structures.

Read cumulative 18-kip ESAL at PSI=2.0 for each PCC or bituminous pavement model and at PSI=1.5 for each gravel surface model.

For these models of which PSI is still above 2.0 even after five (5) years, cumulative 18-kip ESAL shall be estimated from the graph.

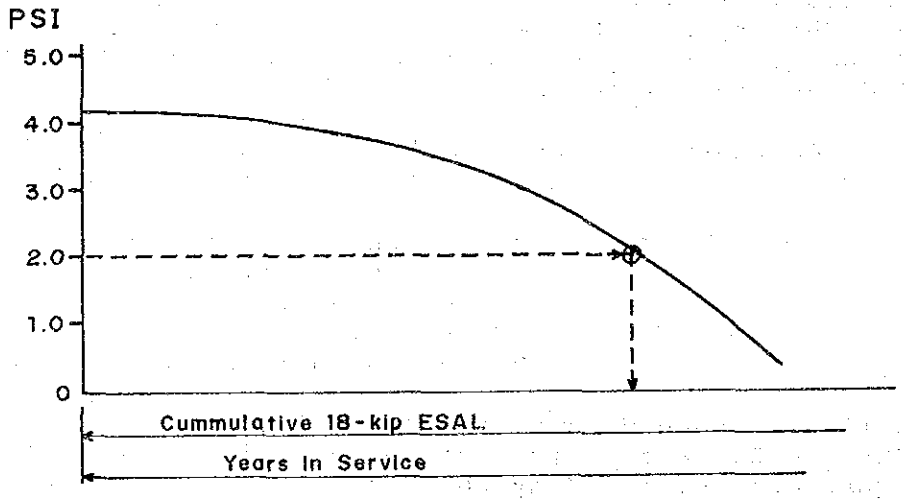


Figure 4.1-1 PSI VS. Cumulative 18-kip ESAL

2) Relationship Between RRI and Cumulative 18-kip ESAL

Analysis as the same manner mentioned in 1) above shall be conducted to obtain the relationship between RRI and cumulative 18-kip ESAL.

For the models which is rehabilitated within the follow-up survey period, compute PSI, RRI and cumulative 18-kip ESAL at the time of start of rehabilitation and also compare with Rehabilitation Requirement Rating made by the follow-up team.

3) Relationship Between Deflection and PSI/RRI/Cumulative 18-kip ESAL

Relationship between deflection and PSI (or RRI)/Cumulative 18-kip ESAL shall be drawn as illustrated in Figure 4.1-2.

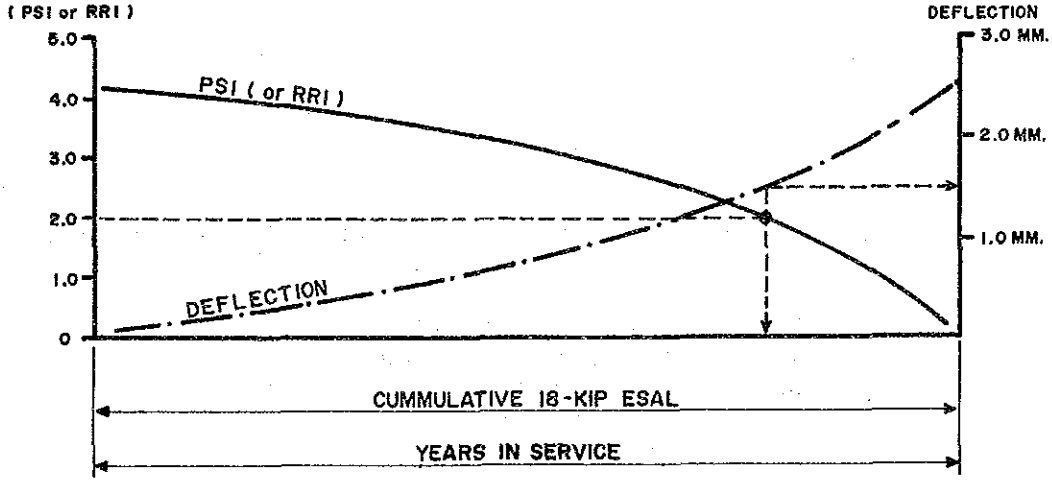


Figure 4.1-2 Deflection VS. PSI (or RRI)

The principal purpose of deflection analysis is to find relationship between deflection measured at a given time and the future performance of the pavement. The deflection is expected to reflect the strength of the subgrade soil and pavement structure as they were actually constructed regardless of how they may have been specified, and might serve as a satisfactory substitute for both design and load, so that the future performance of a pavement under a given load might be predicted from deflection of the pavement measured.

Rehabilitation level and/or timing might be specified by the level of deflection.

Analysis shall be made in due consideration of the above expectations.

4) Evaluation of Performance Period

Based on the above analysis, performance period of each type of pavement shall be evaluated, and summarized in consideration of the following factors :

a) Traffic Level (cumulative 18-kip ESAL and AADT)
b) Subgrade Condition (subgrade CBR)
c) Pavement structural thickness

Terminal Serviceability shall also be expressed by the following indices :

a) PSI
b) RRI
c) Deflection

4.1.3 Annual Gravel Loss Analysis

Annual gravel loss obtained by the Follow-up Survey shall be related to the following :

* Annual rainfall height
* Number of vehicle passage
* Grade of the section
* Surface materials
* Number of grading

4.1.4 Quality of Drainage

Based on information on quality of drainage obtained during Inspection Trip and Meteorological data, "percent of time pavement structure is exposed to moisture levels approaching saturation" shall be estimated for each Experimental Pavement Sections. Results shall be related to the following factors :

* Terrain
* Grade
* Drainage facilities provided
* Number of rainy days and rainfall height

4.1.5 *Actual Maintenance Practice*

Road maintenance record collected from the District Engineering Office and Provincial Engineer's Office shall be compared with surface condition survey results obtained by the follow-up survey, and analyze the following :

* Maintenance works have been undertaken timely or not.
* Type of maintenance work implemented by respective office was appropriate or not.
* Maintenance cost spent.
* What kind of maintenance works should have been undertaken to prolong the life of pavement?

4.1.6 Actual Rehabilitation

If there are some pavement models which are rehabilitated within the period of the follow-up survey (5 years), analyze the following :

* PSI, RRI and RRR at the time start of rehabilitation
* Rehabilitation has been implemented timely, compared with PSI, RRI and RRR which are the judgements of road users and experienced engineers.
* Selection of rehabilitation method were appropriate or not.

4.2 *RECOMMENDATIONS TO BE MADE*

Based on the analysis as well as experiences obtained through the follow-up survey, recommendations on the following shall be prepared :

1) Performance period of each pavement model under respective traffic and subgrade conditions

2) Rehabilitation level by PSI, RRI and Deflection

3) Pavement type selection criteria

4) Design Requirement
   - Terminal Serviceability
   - Annual gravel loss
   - Quality of drainage

5) Recommendations on road maintenance

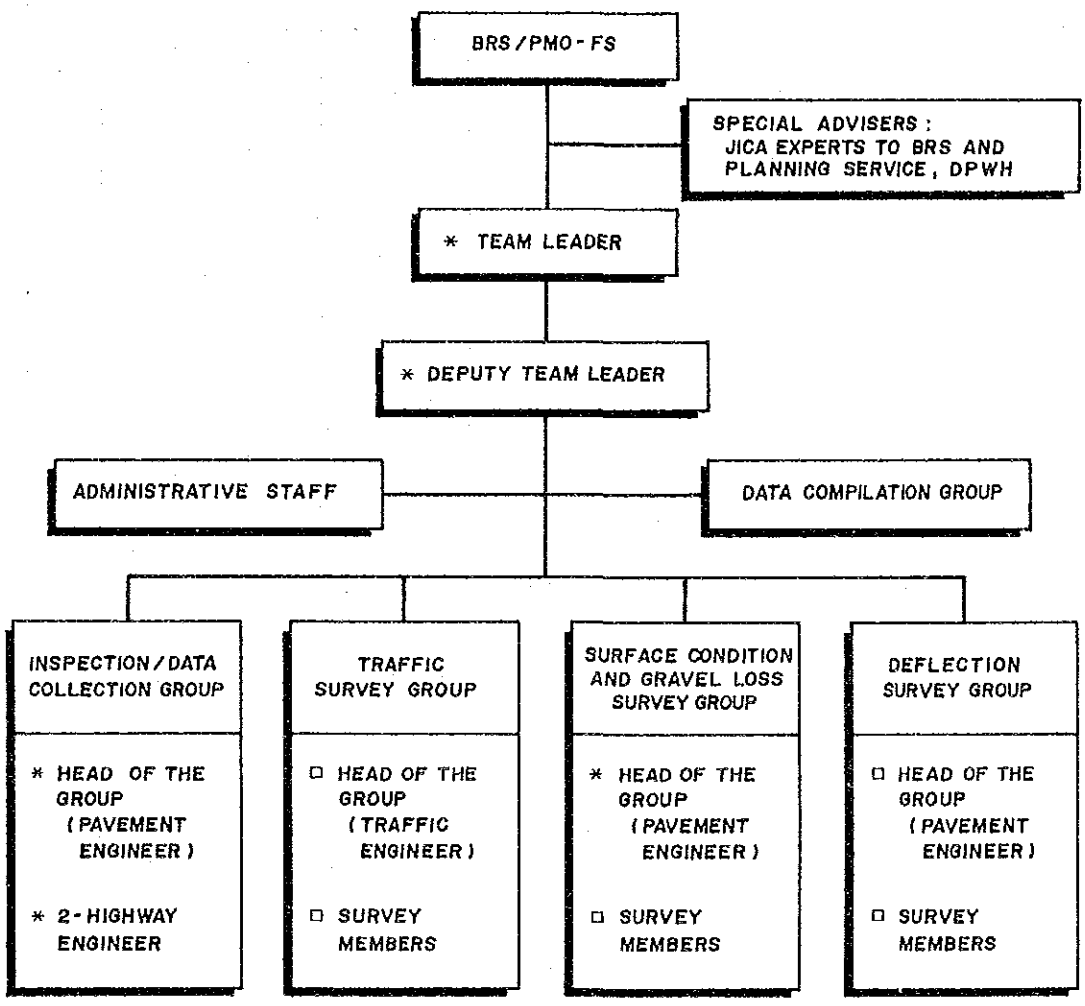
6) Recommendations on rehabilitation

CHAPTER 5

PROPOSED ORGANIZATION FOR FOLLOW-UP SURVEY

5.1 *PROPOSED ORGANIZATION*

It is recommended that the Bureau of Research and Standards (BRS) and the Project Management Office-Feasibility Study (PMO-FS) jointly organize the Follow-up Survey Team. Proposed organization of the Follow-up Survey Team is shown in Figure 5.1-1.



NOTE : * Permanently Assigned.

□ Mobilized when the respective survey is undertaken.

- Head of Inspection/Data Collection Group can be concurrently assigned to Head of Surface Condition/Gravel Loss Survey Group.
- Existing PMO-FS organization can be utilized for Administrative Staff and Data Compilation Group

Figure 5.1-1 PROPOSED ORGANIZATION

5.2 *SURVEY SCHEDULE*

Annual survey schedule is shown in Table 5.2-1.

TABLE 5.2-1 ANNUAL SURVEY SCHEDULE

Survey Items	MONTH											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1. Inspection and Data Collection	X	X	X	X	X	X	X	X	X	X	X	X
2. Traffic Survey												
2.1 Traffic Count Survey	X			X			X			X		
2.2 Loadometer Survey										X		
3. Surface Condition Survey	X			X			X			X		
4. Deflection Survey				X						X		
5. Gravel Loss Survey	X			X			X			X		
6. Photo Taking	X			X			X			X		

NOTE: Inspection in the months of January, April, July and October is not required, however, data collection shall be undertaken.