NCDD SEACAP

វគ្គបណ្តុះបណ្តាលស្តីពី
ការថែទាំផ្លូវលំដ្ឋានបន្ទាប

TRAINING COURSE ON MAINTENANCE OF LOW VOLUME RURAL ROAD

ឧបត្ថម្ភធនដោយ — SUPPORTED BY

SEACAP & NCDD

រៀបចំដោយ ORGANIZED BY

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ភ្នំពេញ, ថ្ងៃទី ២៥-២៩ ឧសភា ឆ្នាំ២០០៩

PHNOM PENH, MAY 25-29, 2009

Course Content Module 2

	Session	Session Content
May 25th	0730-0800 0800-0830 0830-0930	Registration Formal Opening Course Introduction: Fieldwork Introduction Coffee break
	1000-1200	**Session 1** • Concepts of LVRR maintenance • LVRR defects and causes • Survey of road defects
	1200-1400	**Lunch and informal discussion**
	1400-1530	**Session 2** • Routine maintenance activities • Materials for LVRR Maintenance Coffee break
	1600-1730	**Group Discussion :** Maintenance procedures in practice
May 26th	0800-1030	**Session 3** • Norms for RR Maintenance • Cost estimating • Maintenance funding & implementation
	1030-1100	Coffee break
	1100-1200	Description of Fieldwork Activities • DCP • MERLIN • Data Collection
	1200-1400	**Lunch and informal discussion**
	1400-1530	**Session 4** • RR maintenance planning • RR Maintenance works Quality assessment • Community Supervision and Audit Coffee break
	1600-1715	**Group Discussion :** Community involvement in maintenance –implementation, supervision, audit
	1715-1730	**Fieldwork arrangements**
May 27th	0730-1730	**Session 5 Fieldwork:** LVRR maintenance survey exercise

May 28th	All Day (Includes lunch and coffee breaks)	**Session 6: Maintenance Exercise** • Fieldwork objectives discussion • Exercise data discussion • Exercise completion by groups • Presentation preparation
May 29th[d]	0800-0930	**Session 7: Assessment** • Exercise: group presentations Coffee Break
	1000-1200	• Examination
	1200-1400	**Lunch and informal discussion**
	Afternoon 1400-1430 1430-1500 1500-1530 1530	**Closing Activities** • Examination review • Certificate award • Course Assessment • Closure Coffee
	1600	**Admin and Departure**

Notes:

1. Starting with the initial course introduction the Module will be oriented towards the field exercise.
2. For each **lecture session** there will be 1 Moderator and 1 lecturer plus support lecturers. The Moderators will vary throughout the course.
3. Lecturing per session should be **limited to a maximum of 1 hour** to be followed by a **class discussion** which must involve as many participants as possible presenting **their** views. Lecturers/moderators should avoid speaking in this discussion as much as possible.
4. The **Group Discussion**s will involve splitting the trainees into groups for separate discussion. Each group will present a 5 minute summary of their conclusions at the end.
5. The **fieldwork** exercise will involve groups assessing a length of unsealed road (about 500m) for routine maintenance. The groups should collection sufficient site information to be able to produce a maintenance plan and BoQ for the next year for that road. This work will then be formally presented by a minimum of 3 spokespersons per group.
6. During the fieldwork there will be **demonstrations** of both DCP and MERLIN procedures. Data from this work will be required to be analysed and presented as part of the group presentations.

1.1 CONCEPTS OF RURAL ROAD MAINTENANCE

◆SUMMARY

After completing Session 1.1 participants should be able to understand concepts of Rural Road Maintenance and distinguish between Routine Maintenance 1 and Routine Maintenance 2..

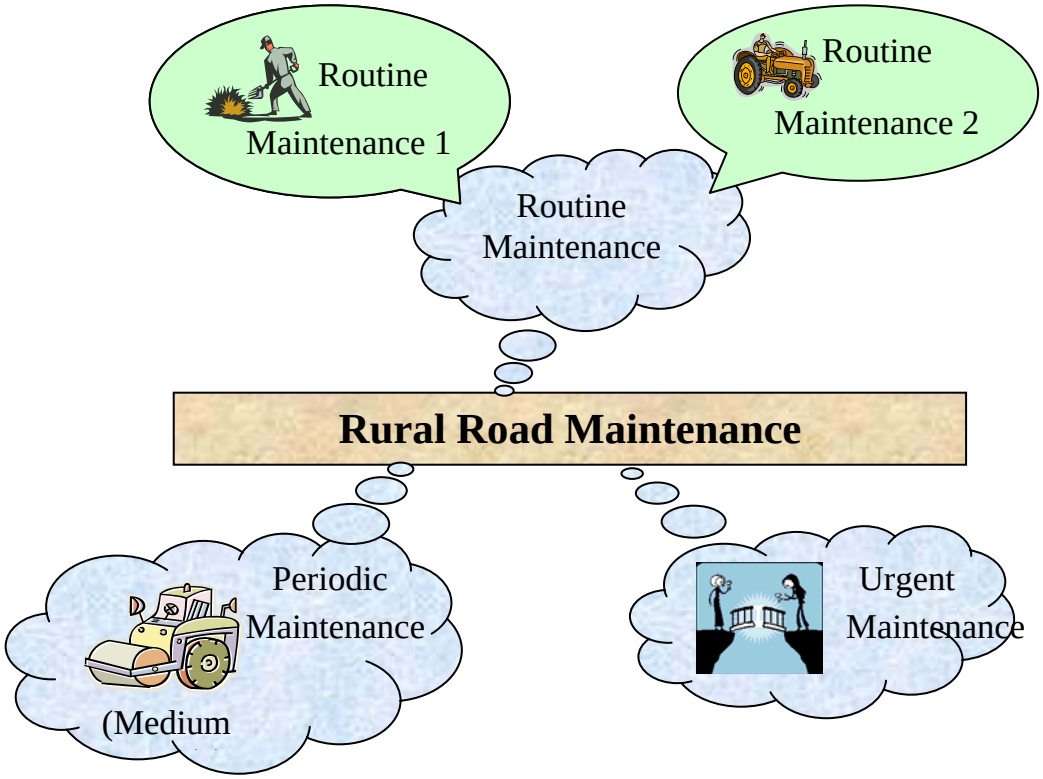
The participants will be introduced the concepts and methods of road maintenance, the concept of Routine Maintenance 1 and Routine Maintenance 2 and will distinguish between these maintenance activities.

ACTIVITIES:

a) Understand methods of road maintenance & distinguish between maintenance activities.
b) Understand the activities of road Routine Maintenance 1
c) Understand the activities of road Routine Maintenance 2
d) Self - assessment

Types of Rural Road Maintenance.

☞ *Look at* the below drawing and memorize ***types of Rural Road Maintenance***



NOTES

There are two types of Routine Maintenance: Routine Maintenance 1 & Routine Maintenance 2
Undertaking Routine Maintenance does not require high cost and yields extensive benefits, maintains the road quality and extends road service life.

There are some maintenance items that require only unskilled labour and simple hand tools for example grass cutting, bush clearing, and ditch cleaning etc. These items can be carried out everywhere using compulsory or voluntary labour. These maintenance items are called **Routine 1**. Some other items require material, equipment and specialized skills such as pothole patching, or mechanical grading. They require certain additional resources and specialized skills. These maintenance items are called **Routine 2.**

Routine Maintenance 1

☞ Look at following pictures and memorize ***Routine Maintenance 1*** for the Rural Road Network.

Routine maintenance 1 activities

Vegetation

Bush/tree cleaning, grass cutting

Drainage System

Clean ditches/drains

Clean culverts

Lining & repair drains, culverts

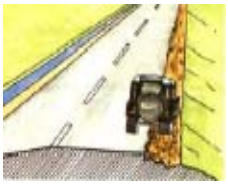
Pile gravel, stone preventing waterway scour

Road - bed

Remove small landslides

Refill slope gully

Reshape shoulder



Refill embankment slip

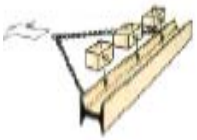
Road Surface

Fill Potholes

Treat soft spots (earth, gravel road)

Grade corrugations

Reshape camber (primitive)



Other work

Clean pavement or bridge surface

Remove debris from culverts or bridges

Spray water to reduce dusting

Clean road signs

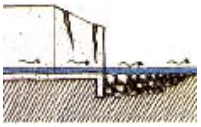
Routine Maintenance 2

☞ Look at following pictures and memorize ***Routine Maintenance 2*** for the Rural Road Network.

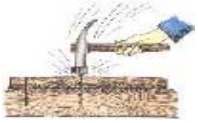
Routine maintenance 2 activities

Drainage System

- Repair & stabilize culverts



- Drive nails on wooden bridge



- Replace bridge wooden planks

- Repair bridge quarter cones

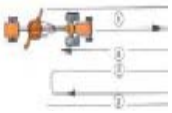
Road Surface

- Fill potholes

- Treat soft spots or rutting (bituminous pavement)

- Seal cracking (bituminous pavement)

- Reshape road camber (by use of equipment)



- Repair concrete slab

Road - bed

- Remove large landslides

- Treat large soft spots

- Stabilize embankment slope

Other work

- Repair retaining walls

- Paint & repair traffic signs

- Repair concrete or steel guard rails

Differentiating between types of Rural Road Maintenance

1. Tick (✔) in the appropriate boxes to indicate your choice.

Routine maintenance 1

Work is carried out in a frequent and timely manner	Correct	
	Incorrect	
 ***Simple labour is required***	Correct	
	Incorrect	
 ***Use hand tools (knife, hoes, shovel,…)***	Correct	
	Incorrect	
 ***Possibly use compulsory labor***	Correct	
	Incorrect	
 ***Use roller***	Correct	
	Incorrect	

2. Fill in the lines below with three names of Routine Maintenance 1 Activities for Rural Road Network

   – .....
   .....

   – .....
   .....

   – .....
   .....

3. Tick (✔) in the appropriate boxes to indicate your choice

Routine maintenance 2

Work is carried out in a regular and timely manner.

Correct	
Incorrect	

Need materials (soil, sand, stone…

Correct	
Incorrect	

Labourers should have skills and expertise

Correct	
Incorrect	

Need equipment, facilities and machines…

Correct	
Incorrect	

4. Fill in the lines below with three names of Rural Road Routine Maintenance 2 activities

   – .....
   .....
   – .....
   .....
   – .....
   .....

5. Tick (✔) in the appropriate boxes to indicate your choice

Periodic maintenance

Work is carried out infrequently

Correct	
Incorrect	

Require more effort, higher costs and more planning

Correct	
Incorrect	

Require materials (soil, sand, stone, plastic…)

Correct	
Incorrect	

Labourers should have skills and expertise

Correct	
Incorrect	

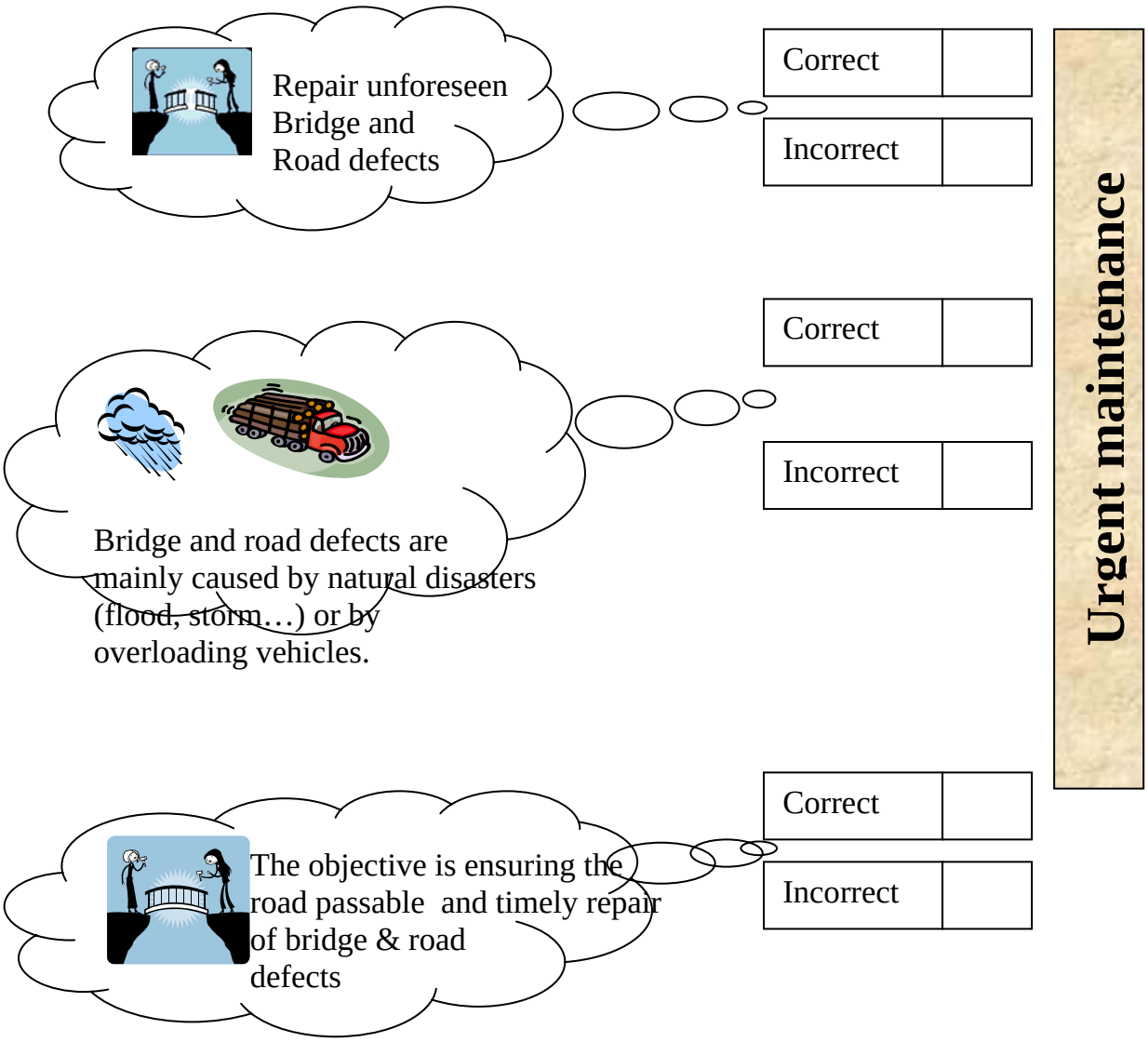
Need specialized equipment and machines…

Correct	
Incorrect	

6. Complete the following conclusion:

"Routine maintenance means restoring the road's surface quality. Therefore, it requires high expenditures. However, if ..... is carried out in a satisfactory manner, the periodic maintenance will be simpler with lower cost."

7. Tick (✔) in the appropriate boxes to indicate your choice



8. Fill in the following table with three names of urgent maintenance activities for the Rural Road Network

No.	Urgent maintenance activities	Causes
1	Remove soil slide	Landslide of cutting slope by long-lasting rain
2	.....	.....
3	.....	.....

SELF ASSESSMENT

1. Fill in the following table with ***features in each type of road maintenance.***

Types of maintenance	Features
Routine Maintenance 1	- Work is carried out in a frequent and timely manner. -..... -..... -..... -.....
Routine Maintenance 2	-..... -..... -..... -..... -.....
Periodic Maintenance	-..... -..... -..... -..... -.....
Urgent Maintenance	-..... -..... -..... -..... -.....

Good | Not good

2. Fill in the following table with some of your local road maintenance activities. Determine the type of maintenance that these activities belong to?

No.	Maintenance Activities	Types of maintenance		Causes
		Routine Maintenance 1	Routine Maintenance 2	
1	Clean drains	✔		Rubbish and silt deposition
2	……. …….	……. …….	……. …….	……. …….
3	……. …….	……. …….	……. …….	……. …….
…	……. …….	……. …….	……. …….	……. …….
…	……. …….	……. …….	……. …….	……. …….
…	……. …….	……. …….	……. …….	……. …….

Good | Not good

1.2 RURAL ROAD DEFECTS AND THEIR CAUSES

◆SUMMARY

After session 1.2 participants should be able to:

- Understand the common defects of rural roads and in related structures
- Understand main causes of defects.
- Apply this knowledge to a local road network

The participants are introduced to some typical rural road, bridge, and culvert defects. The main causes of the described defects are identified and discussed.

ACTIVITIES:

a) Understand the defects of road, bridges, and culverts in the rural road environment.
b) Define the causes of road defects
c) Apply this knowledge to a Self - assessment

Defects in road structures, bridges, and culverts in the rural environment

☞ Look at the picture of main ***defects*** of road structures, bridges and culverts... below, fill in the boxes with names of defects and appropriate maintenance activities.

Excessive vegetation growth on road shoulders.....

1

Routine Maintenance 1

.....
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2

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15

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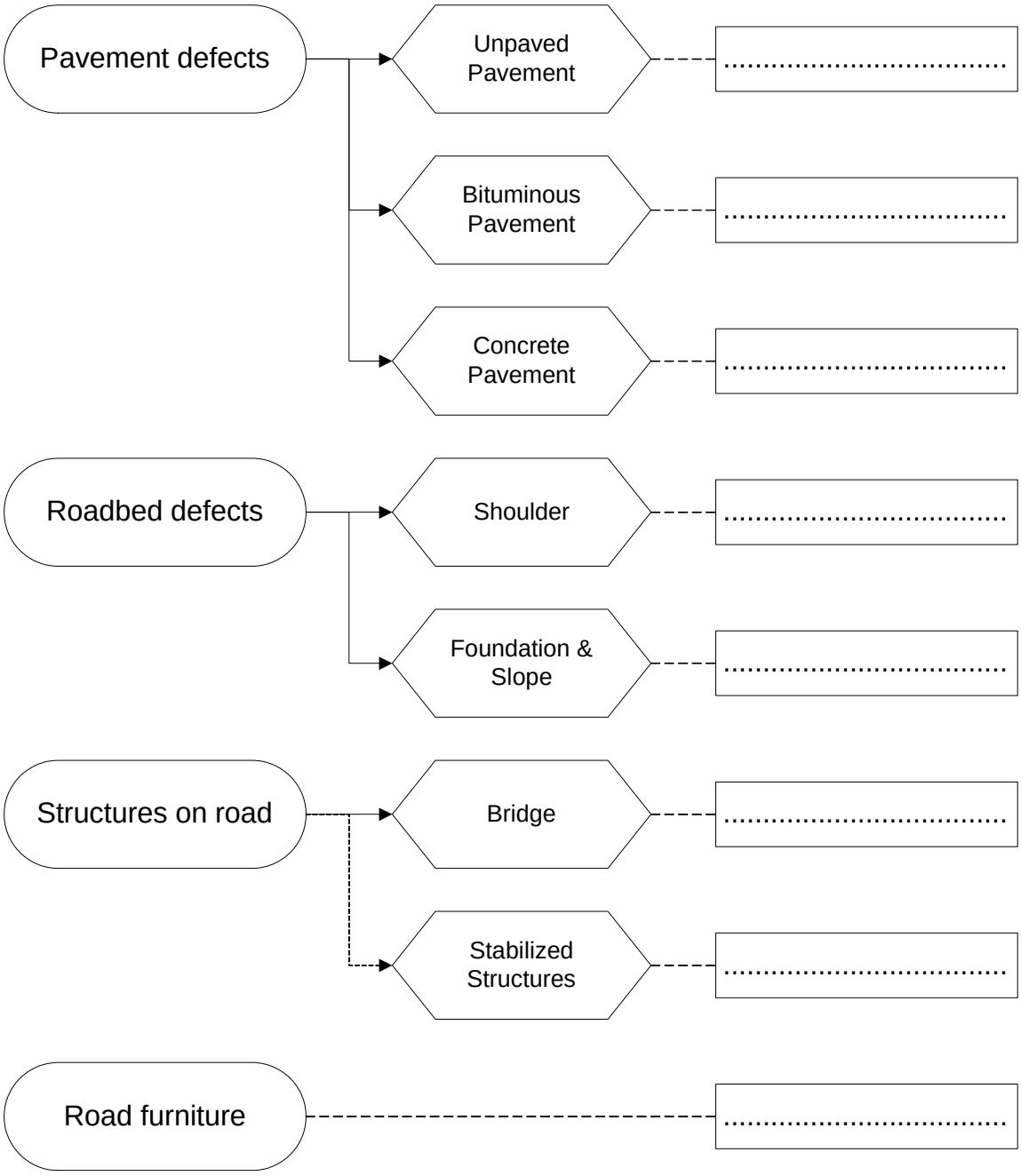
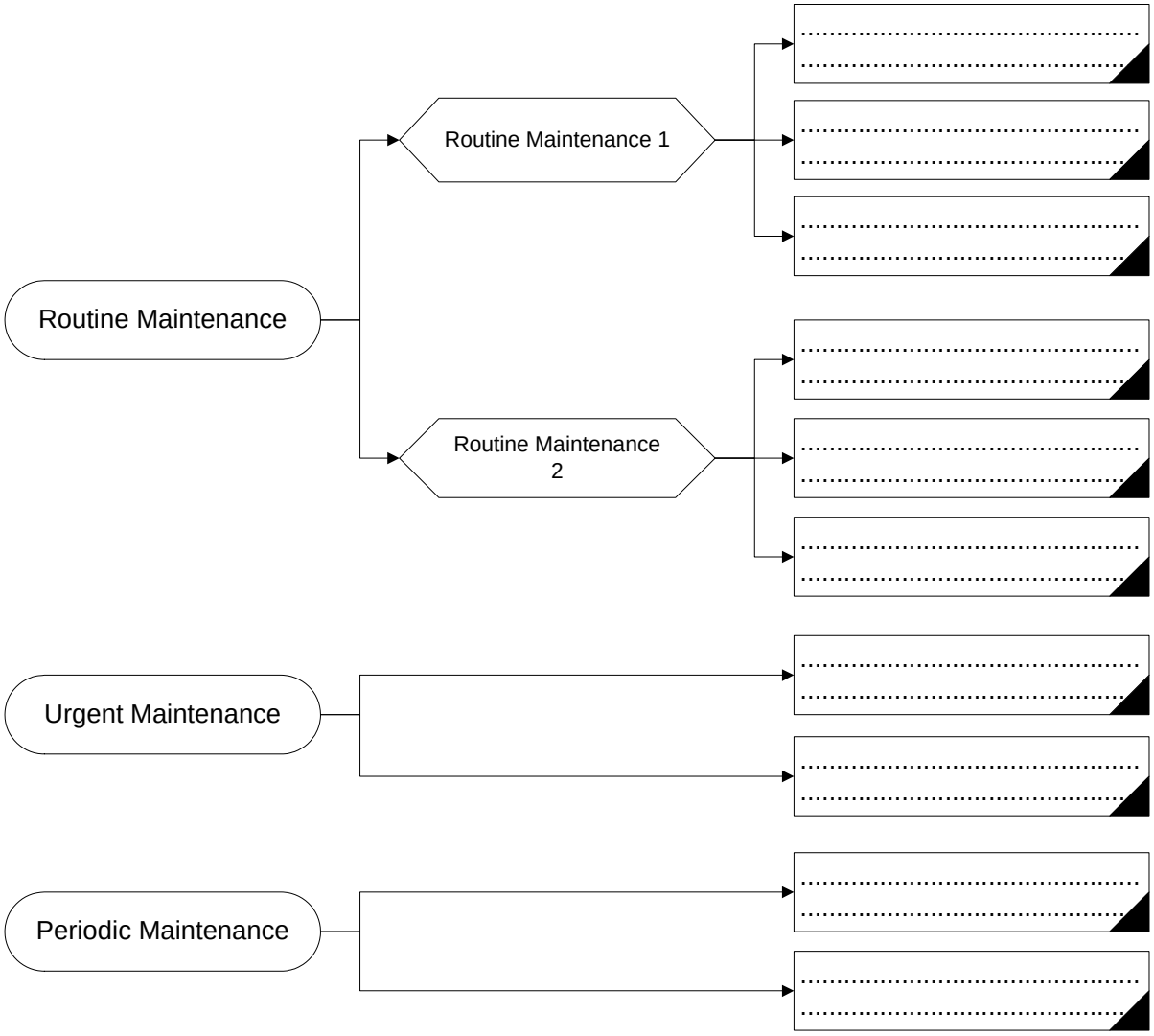
Put the number of defects stated in the above pictures in the appropriate boxes of following frames.

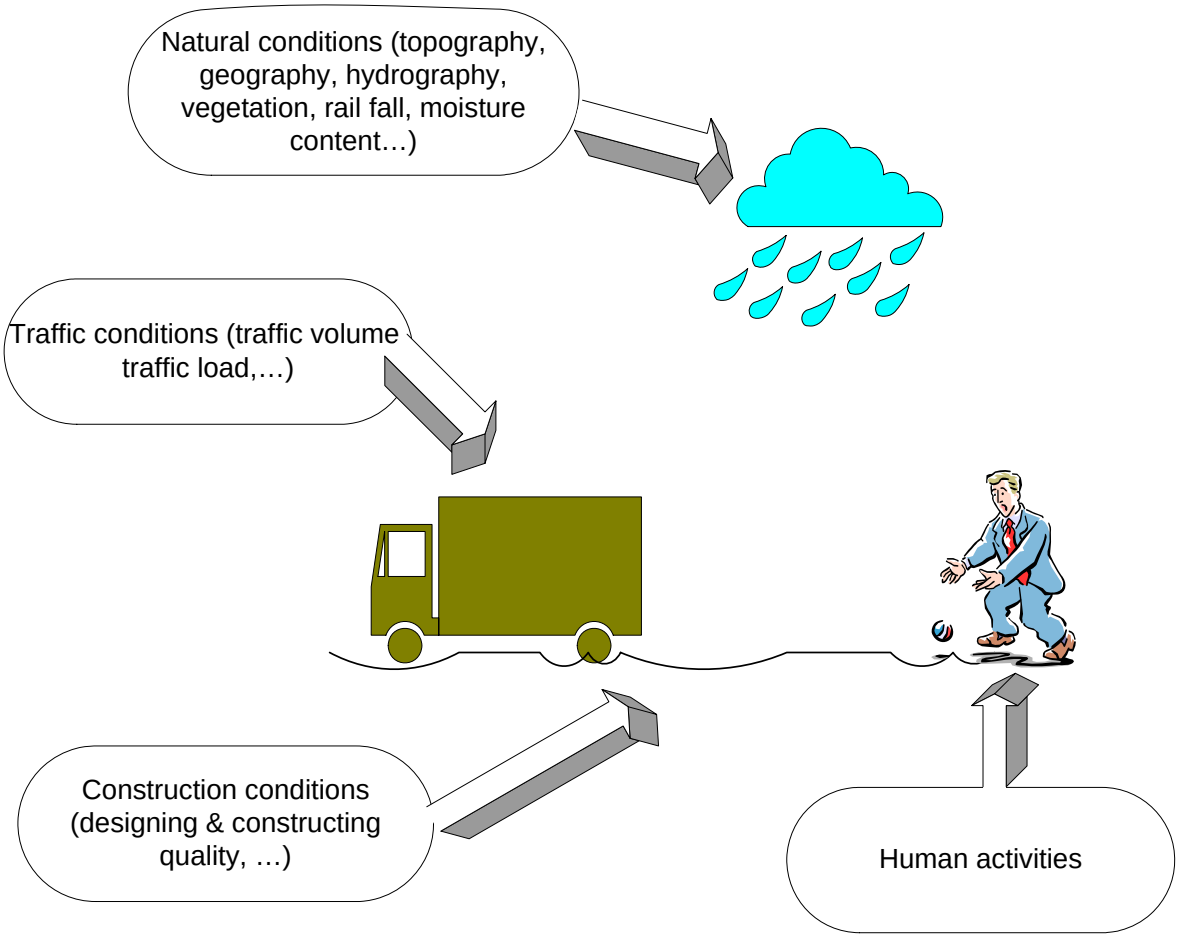

Pavement defects
Unpaved Pavement
.....
Bituminous Pavement
.....
Concrete Pavement
.....
Roadbed defects
Shoulder
.....
Foundation & Slope
.....
Structures on road
Bridge
.....
Stabilized Structures
.....
Road furniture
.....

List names of 10 defects of your local Road Network and put them in appropriate boxes corresponding to maintenance types.



Causes of rural road defects

Look at the figures below concerned with rural road *physical conditions* and the ***main causes*** of road defects.



Possible causes of defects outlined in pictures above

1	…… ……
2	…… ……
3	…… ……
4	…… ……

5	....
6	....
7	....
8	....
9	....
10	....
11	....
12	....
13	....
14	....
15	....

NOTES

Water is an enemy of road -
Don't let water stagnate on the road surface or road shoulders.

SELF ASSESSMENT

1. Tick the boxes to indicate Routine Maintenance 1 and Routine Maintenance 2 corresponding to appropriate defects.

Defects	*Routine Maintenance 1*	*Routine Maintenance 2*
- Soft spots on the earth road		
- Edge damage of bituminous pavement		
- Culvert slide down		
- Side ditch erosion		
- Side drain deposition		

Good | Not good

2. Fill in the following boxes with possible causes of defects as shown in the below pictures:

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Good | Not good

1.3 DEFECTS SURVEY AND MAINTENANCE ASSESSMENT

◆SUMMARY

After session 1.3 participants should be able to:

- Comprehend road defect and related structure survey methods.
- Be able to understand all road defect survey procedures.
- Understand and be able to use the field survey forms
- Understand and be able to use the road condition evaluation form and draft a bill of quantities for maintenance.

The participants are introduced maintenance assessment procedures and are given a thorough explanation of the structure and the use of investigation forms.

The participants are introduced to methods that measure road defects and practice filling in relevant forms and draft maintenance Bill of Quantities

ACTIVITIES:

a) Learn about assessing standards of road condition
b) Understand simple surveying tools & learn about their use to establish a road defect survey
c) Learn about pavement defect surveys, surveying forms & preparation of bill of quantities
d) Learn about the other road & structure defects, surveying form & preparation of bill of quantity
e) Self - assessment

Indicators for assessment of rural road conditions and indicators for quantifying road defects

Two types of Rural Road Maintenance assessment criteria:

- **Qualitative criteria** used for quality assessment of RR condition (Descriptions; eg good, poor, very poor etc)

- **Quantitative criteria:** used for defining number, size, weight (m,m2, m3, kg…) needed for identifying volume of maintenance works and/or estimating maintenance cost

☞ ***Read*** *Table 1, Table 2, Table 3, Table to appreciate road condition assessment parameters.*

Fill *in the blank below with road condition assessment parameters for each type of road.*

Table 1: quality assessment criteria for an unsealed road

Criteria	Unit	Good	Fair	Bad	Very bad
1. Crossfall	percent	4 - 6	2 - 4	1 - 2	<1
2. Pothole area	% of surface area	0	≤ 3.5	> 3.5 and ≤10	>10
3. Corrugation	Height of corrugation (cm)	None	≤ 3 cm	>3 cm & ≤5cm and total length of corrugation greater than 20% of road length	>5 cm and total length of corrugation greater than 20% of road length

Table 2: quality assessment criteria for bitumen or brick surfaced road.

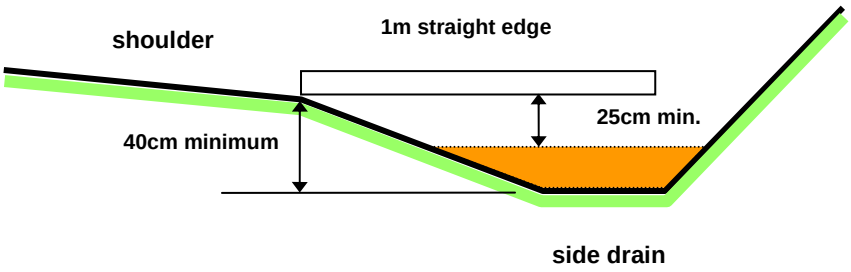
Criteria	Unit	Good	Fair	Bad	Very bad
1. Cracking of surface or settlement	% Area of surface affected	0	≤5.0	>5.0 and ≤20	>20
2. Pothole or surface wear > 1cm	% Area of surface affected	0	≤ 3.5	> 3.5 and ≤10	>10

Table 3: quality assessment criteria for concrete road.

Criteria	Unit	Good	Fair	Bad	Very bad
1. Panel with corner breaks	% of panels	< 1	1 ~ 10	> 10 ≤ 20	> 20
2. Cracked panel	% of panels	0	1 ~ 10	> 10 ≤ 20	>20

Table 4: Condition Assessment of ditches & shoulders.

Criteria	Unit	Good	Bad
1. Side Drains	Road shoulders cannot drain, or side drain is silted to less than 25cm below road shoulder level*	0	Any - record the total length of road affected (metres)
2. Vegetation	Grass on shoulders or in drains more than 5cm high, bushes or trees growing or overhanging shoulders or drains	None	Any - record the total length of road affected (metres)



☞ ***Look carefully*** at pavement defect surveying form below to understand its structure

DF090.02

ROAD DEFECT SURVEYING FORM

Form1: Pavement Defects

Province:.....	District:.....	Commune:.....	Starting Time:.....	Finishing time:.....	Page:
Road Code:.....	Road name:.....	From:..... To.....	Surveyor Name:.....	Date:.....	.....

			0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
Chainage		Km																					
		m																					
Summary		Pavement/Shoulder width (m):.....																					
		Pavement type:.....																					
pavement	1	Pavement clearing (length/area) -m/m2-																					
	2	Corrugation (depth/area) -cm/m2-																					
	3	Rutting (depth/area) - cm/m2-																					
	4	Pothole (average depth/area) - cm/m2-																					
	5	Soft spot (volume/area) - m3/m2-																					
	6	Cracking, raveling, fretting (area) - m2																					
	7	Numbers of concrete slab need to be replaced - slab -																					
	8	Concrete pavement cracking (area) - m2 -																					
	9	Crack, joint damage (length) - m -																					

☞ ***Read carefully*** this surveying form for defects of shoulder, side drain, other structures & road furniture... to understand the forı

RT2 Project

ROAD DEFECTS SURVEYING FORM

Form 2: For shoulder, side drain & embankment defects

Province:.....	District:.....	Commune:.....	Starting Time:.....	Finishing time:.....	Page:
Road Code:.....	Road name:.....	From:..... To.....	Surveyor Name:.....	Date:.....	.....

			0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
	Location	Km																					
		m																					
Summary	Pavement/Shoulder width (m):.....																						
	Pavement type:.....																						
shoulder - road bed - side drain	1	Shoulder reshaping (m/m^2)																					
	2	Grass cutting on shoulder (m/m^2)																					
	3	Brush clearing on road side (m^2)																					
	4	Side drain clearing (m)																					
	5	Additional excavation of side drain (m)																					
	6	Minor landslide removing (m^3)																					
	7	Embankment/ slope refilling (m^3)																					
	8	Side post/ traffic sign clearing (unit)																					

☞ ***Read carefully*** this surveying form for defects of bridge, culvert, retaining wall ... to understand the form structure

RT2 Project

ROAD DEFECTS SURVEYING FORM

Form 3: For bridge, culvert , retaining wall... defects

Province:.....	District:.....	Commune:.....	Starting Time:.....	Finishing time:.....	Page: .....
Road Code:.....	Road name:.....	From:..... To.....	Surveyor Name:.....	Date:.....	

Location	Km																														
	m	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000									
Summary	Pavement/Shoulder width (m):.....																														
	Pavement type:.....																														
bridge - culvert - other structures	1 Clean debris on bridge surface (m^2)																														
	2 Replace bridge wooden plank (m^3)																														
	3 Replace bridge wooden nails (unit)																														
	4 Repair abutment(c¸i)																														
	5 Remove concrete, masonry (m^3)																														
	6 Soil excavation (m^3)																														
	7 Replace concrete (m^3)																														
	8 Replace masonry (m^3)																														

☞ ***Look at*** complex table of field survey results below & ***study*** relation between it and field surveying forms above

Table 6 - defect quantity - field survey result form								
Commune:.....						*Road : .....*		
Lenght: ..... km			*Road code: .....*			*Date: .....*		
Pavement: Macadam - Pavement width/Road width:3.5m/5m						***condition assessment ****		***defect quantity*****
Type and location of defects								
Location (km) or landmark	*K0 - K0+500*	*K0+ 500 - K1*				*Assessment parameter*	*Rating*	
road bed - shoulder - side drain								
Side drain clearing (m)	*130*	*80*				*210 (m)*	*Bad*	*210 m*
Side drain excavation (m/m3)	*20/6.4*	*0*				*20 (m2)*	*Bad*	*6.4 m^3*
Vegetation clearing (m2)	*30*	*42*				*72 (m2)*	*Bad*	*72 m^2*
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
pavement								
Cross fall (%)/(m)	*2/120*	*1.5/300*				1.5-2 *(%)*	*Bad*	
Corrugation (5cm>h>3cm) (m)/(m^2)	*0*	*0*						
Corrugation (h>5cm) (m)/(m^2)	*200/700*	*140/490*				*34%****	*Very bad*	*1190 m^2*
Pothole (Htb=12 cm) (m^2)	*80*	*60*				*5.4%*****	*Bad*	*140 m^2*
Soft spots (m^2)/(m^3)	*20/14*	*30/18*						*50m^2/ 32 m^3*
.....	.....	.....	.....	.....	.....	.....	.....	.....
bridge, culvert and other structures								
Dirt/debris on bridge surface(m2)	*0*	*5*						*5 m^2*
Replace bridge nails (unit)		*30*						*30 c,i*
Soil excavation for culvert outlet (m3)	*3*							*1.9*
Soil refilling for culvert outlet (m3)	*3*							*3 m^3*
Culvert outlet masonry (m3)	*4*							*4 m^3*
.....	.....	.....						.....
.....	.....	.....						.....

**Pavement/drainage system condition..... is rated in assessment parameters.*

*** Column of defect quantity expresses quantitative parameter. This is input data of road maintenance estimating.*

**** Assessment parameter of corrugation is calculated in % of road length: (200+140)/1000 = 0.34 (34%)*

***** Assessment parameter of pothole is calculated in % total pavement area (for both pothole and soft spots): (80+60+20+30)/(1000x3.5) = 0.054 (5.4%)*

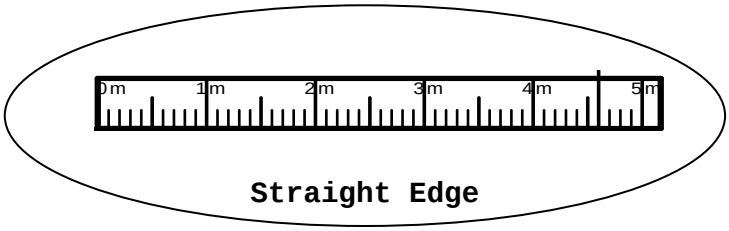
Common tools for rural road defect surveying

Measurement tools: consist of following main tools:

1. *Length measurement*
2. *Angle measurement*
3. *Cross slope (fall) template*

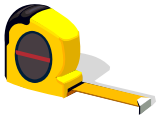
Length measurement tool

- used for measuring the length in:
  - milimetre, - ***mm***
  - centimetre, - ***cm*** (1cm = 10mm)
  - decimetre, - ***dm*** (1dm = 10cm = 100mm)
  - metre, - ***m*** (1m = 10dm =100cm =1000mm)
- Tools:
  - Straight edge : plastic (up to 1m long); wooden (up to 3 m long); aluminum (up to more than 5 m long)
  - Locked steel measurement tape: maximum length of 2 or 5m
  - Steel measurement tape: maximum length up to 20, 30 or 50m
  - Measurement tape: maximum length up to 10, 20, 30 or 50m



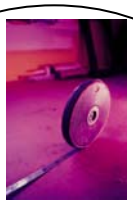
Straight Edge

Measurement Tape



Locked steel measurement tape

Steel measurement tape



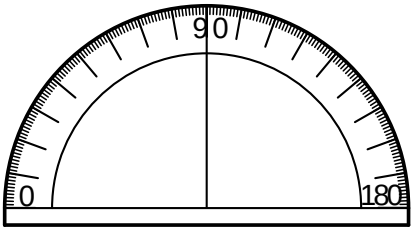
Cloth measurement tape

Note

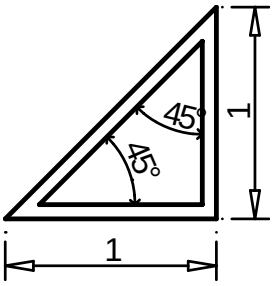
Use straight edge or locked steel tape for measuring short distance &measurement tape for long distance to ensure accuracy

Angle measuring tool

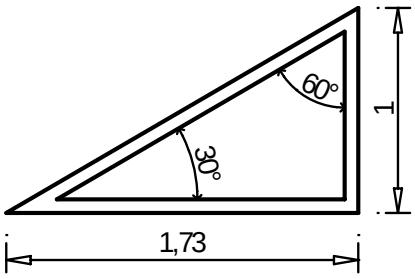
- used to measure angle value:
    - degree, - ^{o}
    - minute, - ' (1^{o} = 60')
    - second, - " (1' = 60")
- angle measuring tools:
    - Quadrant: made from plastic to measure different angle value.
    - Angle measuring template made from wood, is used to check fixed angles (30^{o}, 45^{o}, 60^{o}, 90^{o} angle).



Quadrant



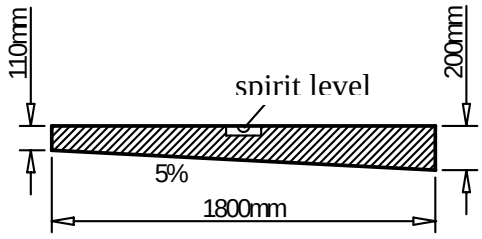
Template for 45^{o} angle



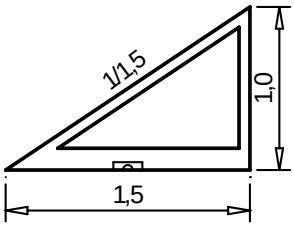
Template for 30^{o} vµ 60^{o} angle

Slope measuring template

- Slope measuring template is used to check cross fall, embankment slope, side drain slope....
- There are two types of slope measuring template:
    - Template with spirit level is used to check low slope such as cross fall, that is usually expressed in %.
    - Template for high slope is usually in right triangle shape. It is used to check embankment and/or side drain slope. The expressed value is 1: m (or 1/m), means 1 unit of length changing in height corresponding to m unit of length in horizontal distance (for example m metres)



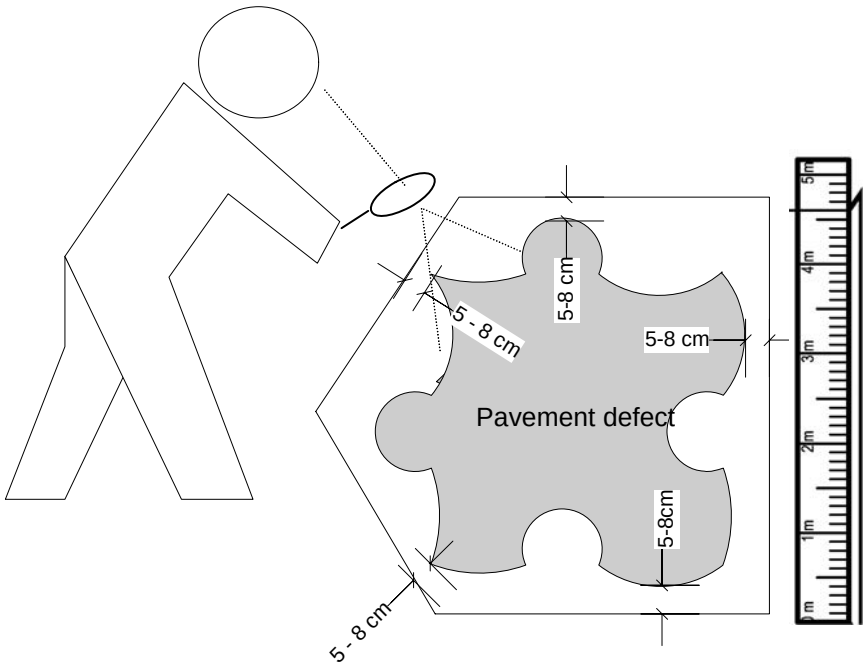
Template for low slope



Template for checking slope of

Defects surveying so as to make qualitative & quantitative assessment

Measure area of pavement damage



Measure damage area (corrugation, rutting, soft spot, raveling, cracking …) l

Measuring tools:

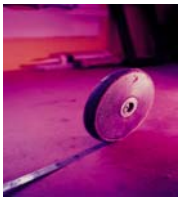
Wood/ Plastic straight edge 3 - 5 m long

Steel measurement tape

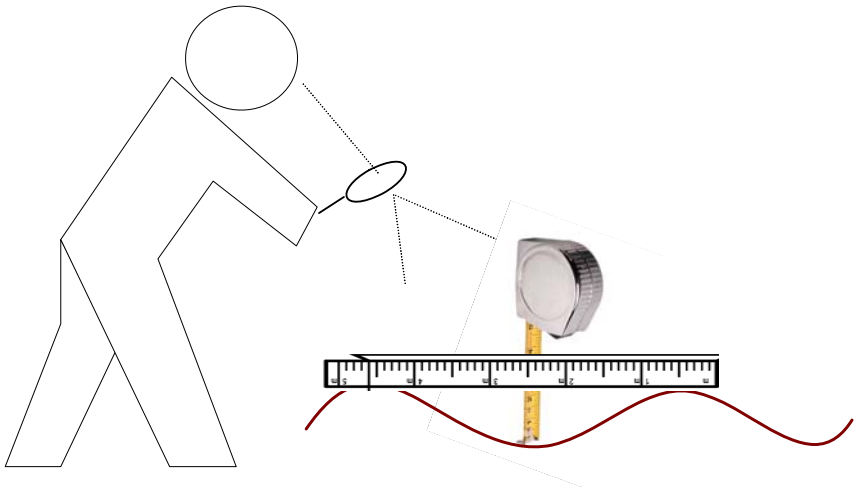
Measuring steps:

- *Define damage area (figure above).*
- *Measure dimensions of damage area*
- *Calculate the area*

Cloth measurement tape



Measure the depth of corrugation, rutting and pothole



Defining depth of rutting, corrugation, or pothole
using straight edge & tape measure

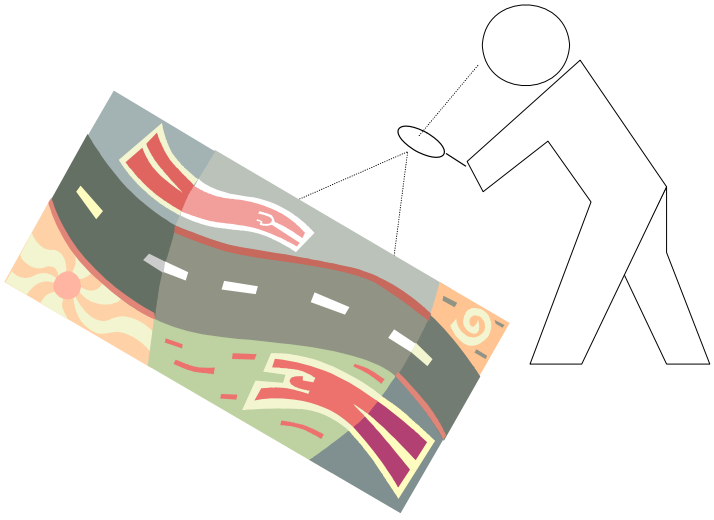
Implementing steps:

- *Placing the straight edge horizontally on pavement surface (on top of corrugation or on surface level)*
- *Placing the steel tape square with the straight edge until reaching the bottom of rutting/ corrugation/ pothole.*
- *Take readings at the crossing with the straight edge. The taken reading is the depth*

Measure pavement area need to be cleaned

Implementing steps:

- *Length measuring*
- *Width measuring*
- *Area Calculating*



Qualitative & quantitative assessment for shoulder, side drain, embankment & other structures defects.

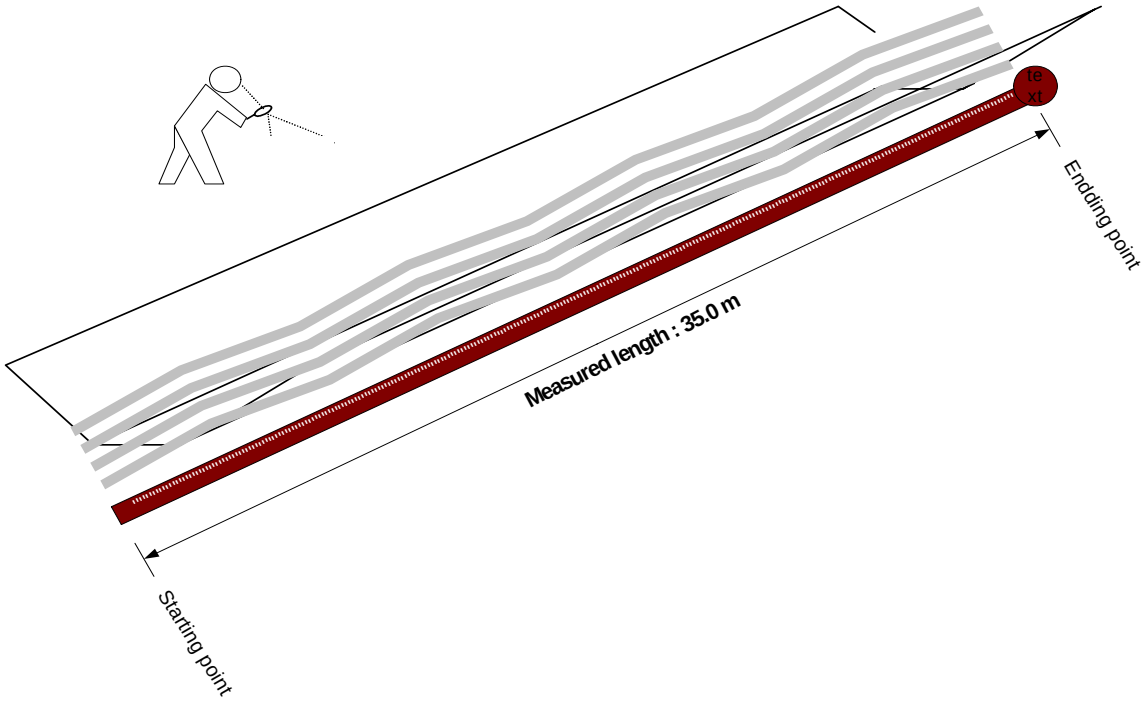
Length measuring (length of side drain needs to be clear; length of shoulder needs to be reshaped...)

Used tools:

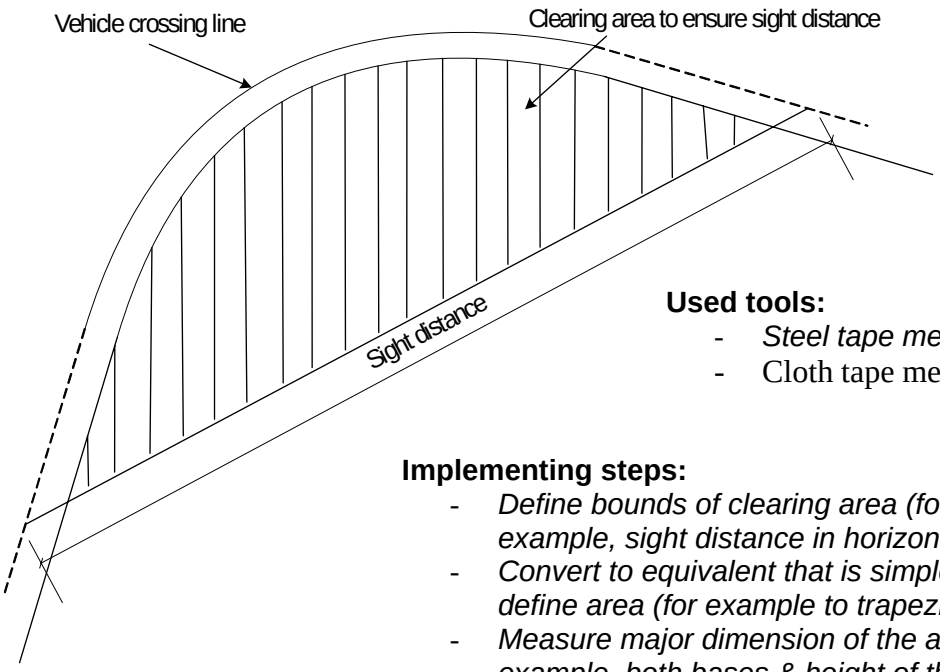
- *Steel measurement tape*
  Cloth measurement tape

Implementing steps:

- *Put the tip of measure at beginning of shoulder/drain... that need to be reshaped/ cleared...*
- *Pull out the tape till maximum rang, then continue to the end of defect.*
- *Note the reading at the end, then accumulate to measured length*



Measure area (Vegetation area need be cleared....)

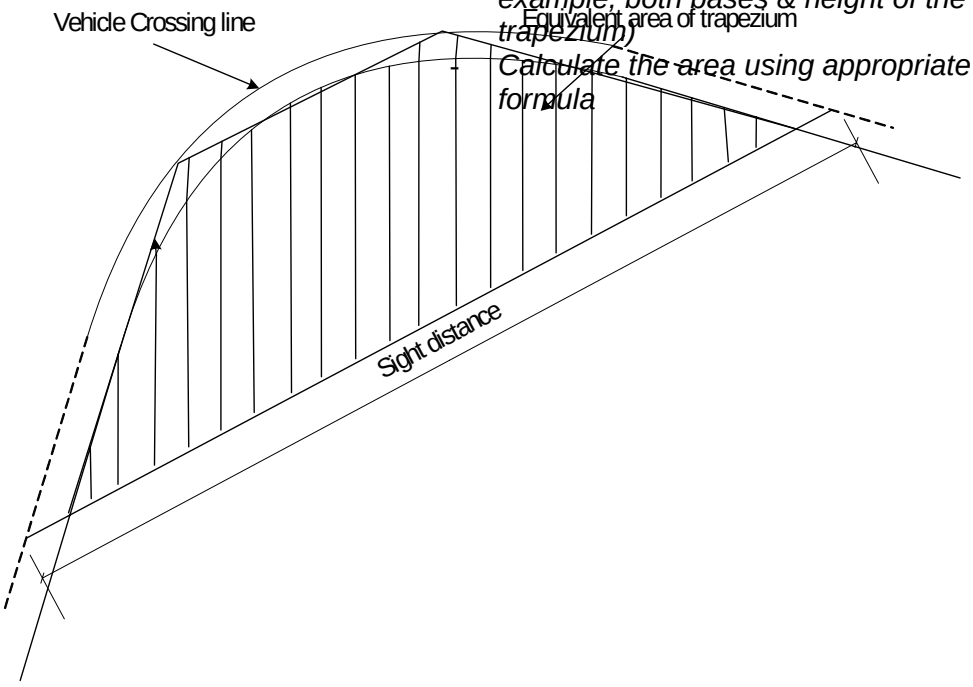


Used tools:

- *Steel tape measure*
- Cloth tape measure

Implementing steps:

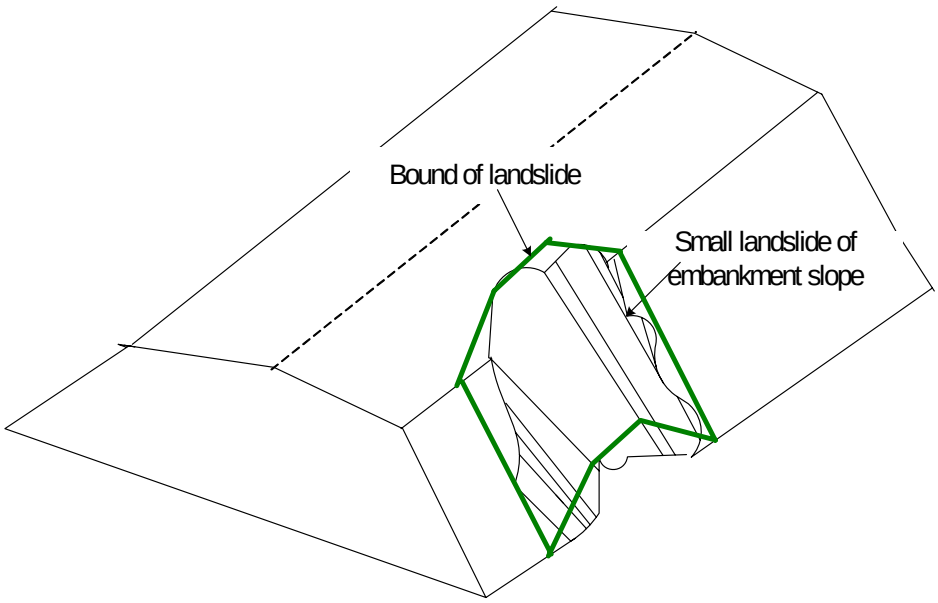
- *Define bounds of clearing area (for example, sight distance in horizontal curve.*
- *Convert to equivalent that is simple to define area (for example to trapezium).*
- *Measure major dimension of the area (for example, both bases & height of the trapezium)*
- *Calculate the area using appropriate formula*



Measure volume (small landslide, soil refilling of embankment slope ....)

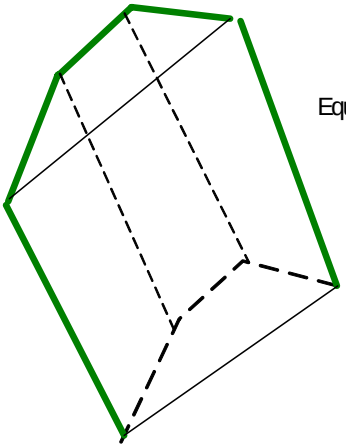
Used tools:

- *Steel tape measure*
- *Cloth tape measure*

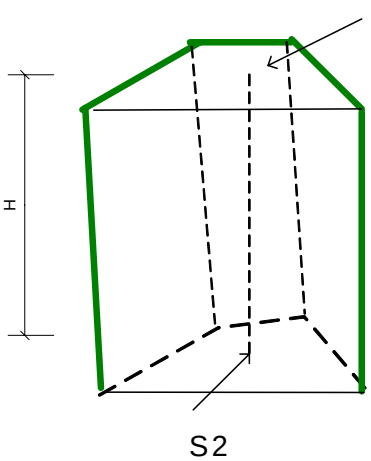


Implementing steps:

- *Define bound of defect*
- *Convert to simple shape to calculate the volume (for example prism shape as figure beside)*
- *Measure major dimensions (both bases & height)*



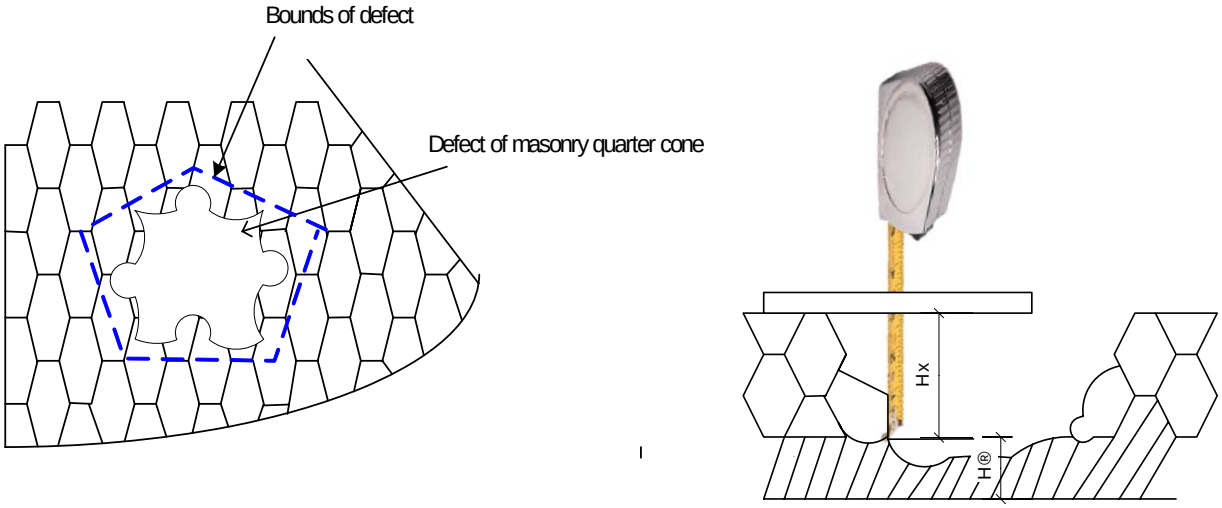
Equivalent shape to calculate volume



Equivalent shape to calculate volume

V= (S1+S2)/2 x h
where:
- S1 & S2 is area base
- H is height of the

Measure volume of structure defect (quarter cone of bridge, retaining wall ....)



Implementing steps:

- Define bound of defect
- Convert ot equivalent shape
- Measure major dimensions to calculate the area (S)
- Measure depth of masonry (H_x) - estimate depth of damp soil need to be excavated Soil excavation ($V_{®\mu o} = S. H_®$) = soil refilling
- Renewed masonry ($V_x = S .H_x$)

NOTES

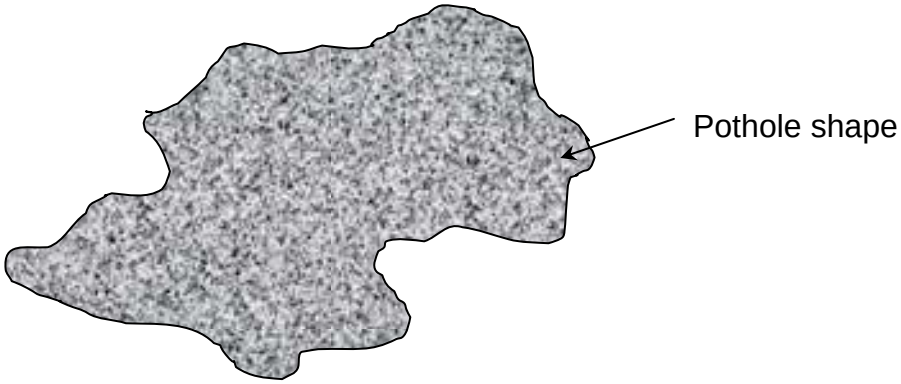
Defect zone should be converted to an equivalent simple shape to define maintenance demand

Keep in mind following procedure:

- ***Measure & quantify defect by qualitative and quantitative parameters***
- ***Record in field survey form (form 1, form 2, form 3)***
- ***Make calculation & put data in complex table***

SELF ASSESSMENT

1. ***Define bounds*** of pothole in figure below, ***convert*** to equivalent simple shape, ***write formula*** to calculate equivalent area, then ***fill in blank line*** with measuring procedures to calculate pothole area



Measuring procedure to calculate pothole area:

.....
.....
.....
.....
.....
.....

Formula to calculate pothole area :

. . . . . .

Good | Not good

2.1 TECHNIQUES FOR ROUTINE MAINTENANCE 1

◆SUMMARY

After session 2.1 participants should be able to understand procedures and techniques for implementing Routine Maintenance 1 and be aware of the wrong or right steps in each maintenance technique

Participants should be able to complete the self- assessment

ACTIVITIES

a) Learn about procedures and techniques to carry out road Routine Maintenance 1 activities
b) Understand the right/wrong steps in procedure of some activities of Rural Road Maintenance - the Routine Maintenance 1
c) Self - assessment

Procedures and techniques for Routine Maintenance 1

ROUTINE MAINTENANCE 1

Defect 1 – Vegetation growth excessive on road shoulders, structures or affecting drainage system, visibility and safety for traffic and people.

Maintenance Activity 1 – Control vegetation: bush/tree clearing & grass cutting and disposal:

- Cut trees and bushes if they affect drainage of shoulder or visibility.
- Cut grass on shoulders and in drains to 2 – 3 cm high (do not remove the roots as these prevent erosion of shoulder surface).
- Dispose of cuttings safely so that they do not obstruct the road, shoulder or drainage or affect other roadside structures. Do not burn them on the roadside and in areas that can affect other structures. It is not allowed to burn near any forest. There must be a person to watch over the burning and to water the ash afterwards.

•

Tick (✔) in blank to make right selection.

Brush/tree clearing, grass cutting and disposal

To ensure appropriate sight distance for traffic safety and good drainage.

Yes	
No	

Not necessary to clear brush of more than 7cm in height

Yes	
No	

Manual.

Do not uproot, cut grass to 2 cm height to prevent erosion

Yes	
No	

Disposal in authorized place.

Do not burn near forest !

Yes	
No	

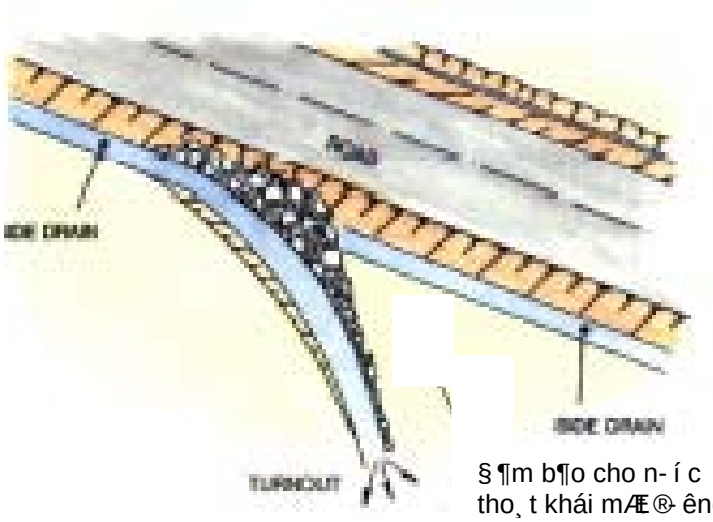
It is not routine work. It is carried out every 3 years.

Yes	
No	

Defect 2 – Side or turn-out drains silted or blocked by debris.

Maintenance Activity 2 – Clean debris/silt from side ditch & turnout drain

- Ensure that the silt and debris are removed so that they do not wash back into the drains.

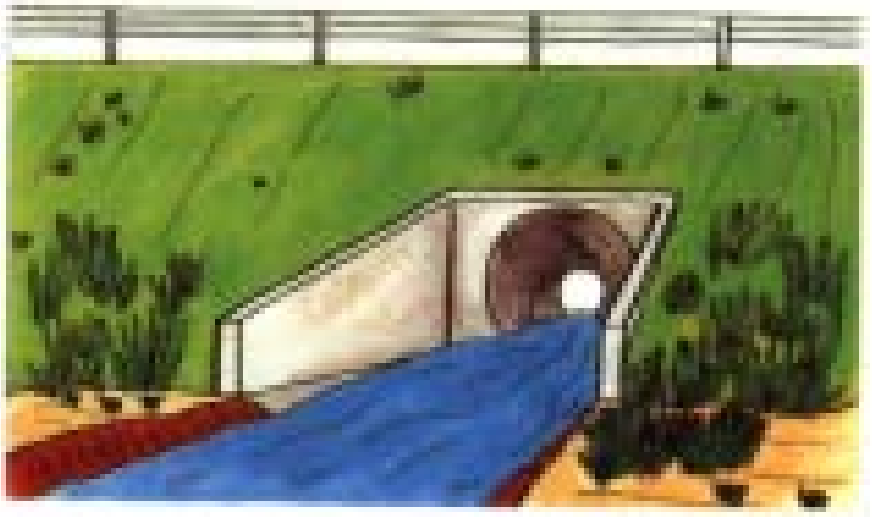


§ ¶m b¶o cho n- í c tho¸ t khái mÆ®- êng

This important activity should be carried out before the rains and after each storm or flood.

Defect 5 – Debris or silt in or close to culvert outlet

Maintenance activity 5 – Clean debris/silt from culverts.



Dispose of the debris clear of the structure so that it does not cause a repeat of the problem. Try to find out where the debris comes from so that the problem can be prevented in future.

Read following descriptions for to know about *routine maintenance 1 - activities* ***2 and 5 - culvert, side drain clearing***. Tick (✔) into blanks to make selection.

Clearing culverts, side drain

For good drainage, avoid water collecting on surface or water penetration to sub-grade resulting in road damage

Yes	
No	

Remove debris/silt from side ditch

Yes	
No	

Clearing debris/silt inside culvert, at inlet and outlet

Put trash-rake at inlet

Yes	
No	

Disposel in appropriate place.

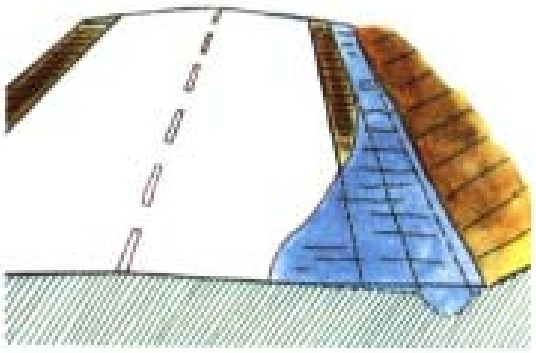
Do not let debris be washed back into culverts, drains.

Yes	
No	

It is carried out only before and after rainy season.

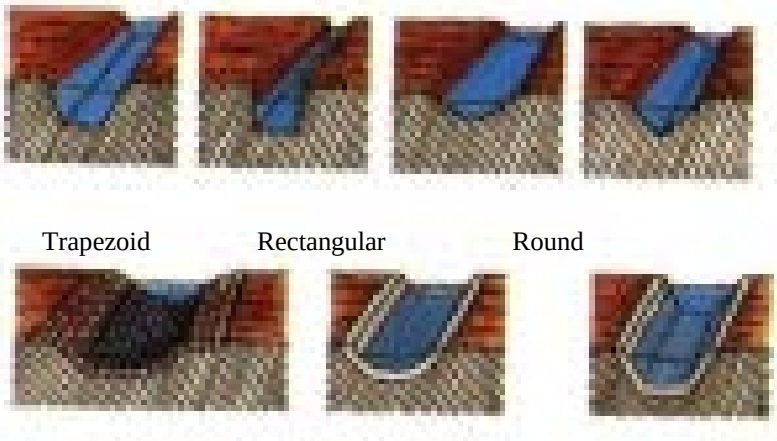
Yes	
No	

Defect 3 – Water ponds on road or side of road because side or turn-out drains have not been provided or side or turn-out drains are damaged.



Maintenance activity 3 – Construct new drains or reconstruct side & turn-out drains

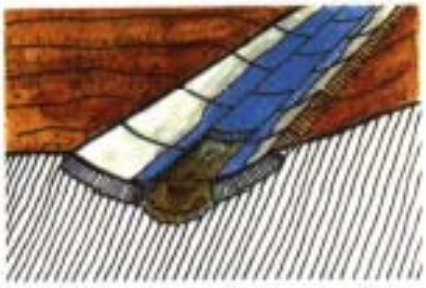
Different shapes of side and turn-out drains



Construct new drains to dispose of the water. Line the drain with stone, brick or concrete if erosion problems are expected. In some cases the road may have to be built up to achieve good drainage (major repair).

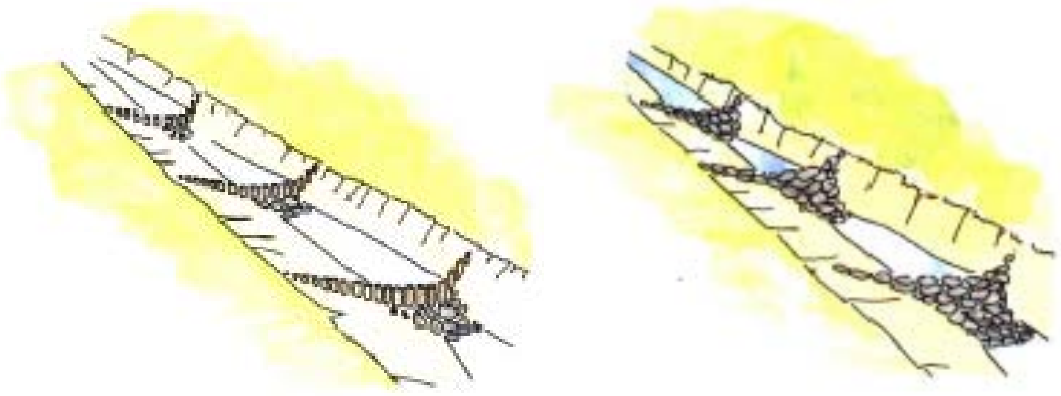
Defect 4 – Drains damaged or eroded

Maintenance activity 4 – Repair damaged drains.



Local defect in side drain

Use suitable local materials for the repairs.

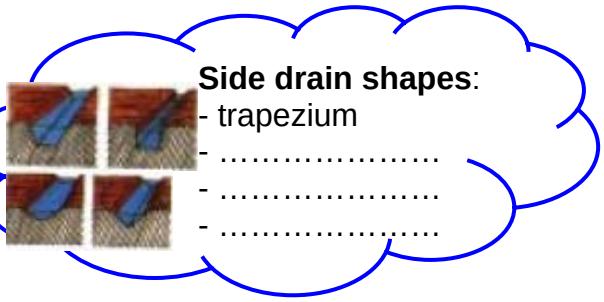


Scour checks reduce water velocity on steep drains to prevent erosion.

Erosion from side ditch will cause silting at ditch end, affecting water drainage. Clean silt from ditch end and rebuild scour checks from bamboo, wood, stone, brick or masonry on steep section to prevent further erosion.

Read above maintenance activity 4 for to know about maintenance activities of drains repairing. *Add more information* in blanks (.....) and *tick* (✔) to *make selection*.

Renew & repair side drain



Side drain shapes:
- trapezium
- ……
- ……
- ……

Types of drain paving:
- Rip rap
- ……
- ……
- ……

Yes	
No	

The works should be checked and carried out regularly.

Note

Water is the main enemy of a road. Water must be shed from the road as soon as possible by any means. Sufficient drainage should be checked, provided.
Costly anti-erosion building and lining to side drain should be carefully considered to apply only to appropriate drain sections.

Read activity 4 to know about routine maintenance 1 - repair damaged drain. Tick (✔) in the blank to make selection.

Drain stabilization, anti-erosion

Reduce water velocity and avoid erosion, especially in steep drain in mountain area.

Yes	
No	

Anti-erosion types:
- Scour check by wooden stake.
- Scour check by stone pile.
- Drain, building & lining

Yes	
No	

Scour check by wooden stake:

Drive wooden stakes on drain surface in long section

Yes	
No	

Scour check by stone pile:

Pave rock/stone on drain surface in long section

Yes	
No	

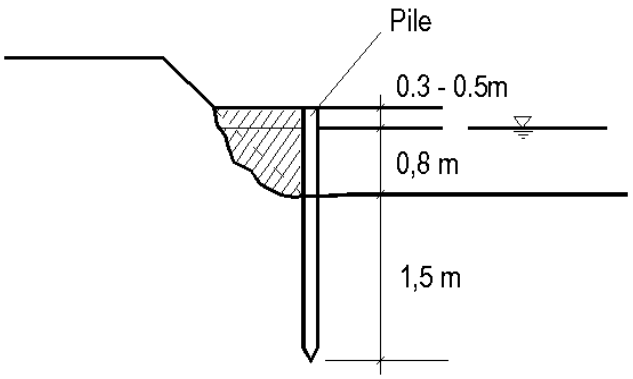
It is carried out only when deep erosion has happened.

Yes	
No	

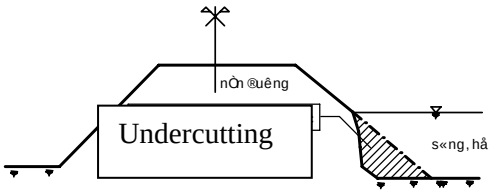
Defect 8 – Embankment toe scoured by waterway or water traffic. This defect is a common occurrence in Lower Mekong area..

Maintenance activity 8 – Repair waterway scour

- Firstly check the depth of erosion at embankment toe to prepare soil for filling. Fill is soft clay or sand-clay mix. That means it can be cut into pieces by spades.
- Prepare bamboo piles. In Mekong delta, piles should be of cazeput of thickness greater than the wrist (i.e. the diameter is 7 to 10cm) and the pile length is 2 –3 m.
- Piles should be driven into place side by side if river waves are strong. Piles can be driven 20cm away from each other if the waves are not strong. Pile tops should be 30 to 50cm above normal water level to reduce river traffic action.
- Place fill material behind the driven piles



Erosion usually occurs when embankment toe along river and/or lake is undercut by waves.
Read above paragraph for to know maintenance activities. Fill missing information into following figure:



Repair erosion at embankment toe

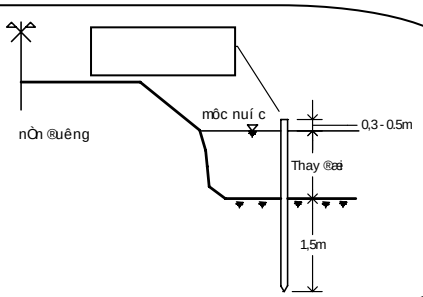
1). **Prepare fill materials:** use ……. or …… (cut into pieces by spade).

Sand must be packed in plastic sack if used

2). **Prepare piles:** use bamboo or cajuput piles with 7-10cm diameters

- The length of piles will be appropriate to drive to ….. metres depth.
- Pile interval is ….. cm, and it is smaller with strong flow
- Neohouzeaua/bamboo wattle should be prepared to place behind piles

3). **Drive piles:** Piles are driven into appropriate depth and pile tops should be at from..… cm to ……..cm above normal water level.
Piles are driven firmly in straight line by hand using wooden rammer.



4). **Backfill soil:** Prepared soil is backfill behind driven piles after placing neohouzeanua/ bamboo wattle to level of pile top that is above normal water level from ..… cm to ……..cm.

Defect 16 - Potholes (earth/gravel/stone macadam /brick road)

Maintenance activity 16 – Fill potholes (earth or gravel or stone macadam road)

- Potholes can take any shape. Dig the pothole into multi-sided shape as shown in the sketch and the bottom of the new shape must be 3cm deeper than bottom of pothole. Cut sides of pothole into vertical edges. For stone macadam surfaces the pothole repair should extend down to the base of the layer.
- Use material of the same type with existing material to fill in pothole in layers of not more than 10cm. Compact each layer before placing the next. Use hand rammer, vibrating plate or jumping compactor to compact. Filled material must have suitable moisture content.
- Final layer should be filled loose 1 to 2cm higher than surrounding level and then well compacted and trimmed level with the existing surface .

When repairing deep potholes, the finished repair may be left a little above the surrounding surface to allow for slight settlement under traffic.

Overfill recommendations

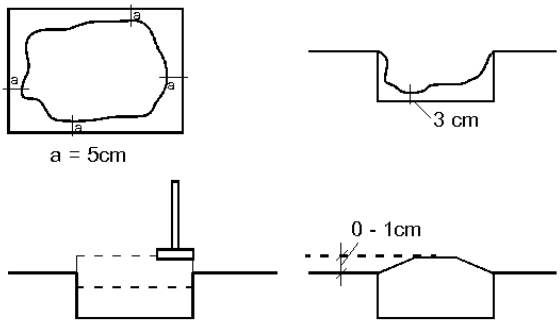


Figure 45 Pothole filling on earth and gravel road

For stone block or brick paving,

- Cut out the damaged area with hammers and chisels or crowbars. Use goggles to protect the eyes. Trim the size of the pothole suitable to fit the replacement paving materials.
- Excavate and replace any weak or wet material under the pothole.

- If the base of the excavation is wet, dig a channel and fill with stone chippings to drain the excavation to the side of the road.
- Compact the base of the excavation with a hand rammer.

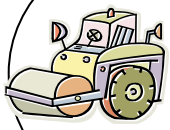
Fill the pothole and compact each layer as necessary to match the existing pavement construction.

☞ Read above paragraph for to know procedure of pothole filling - activity 16. ***Fill into blank in following figure*** to complete the procedure.

Pothole on pavement

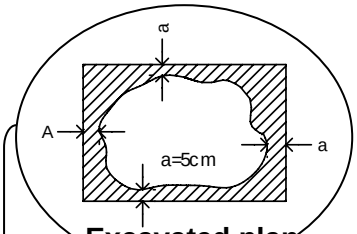
Bituminous pavement

Unpaved pavement

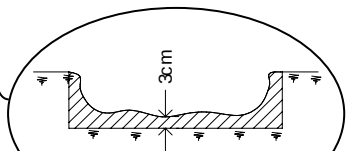


Routine Maintenance 2

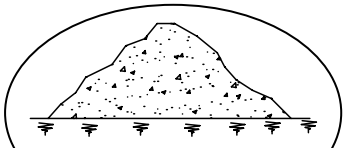
Routine Maintenance 1



Excavated plan



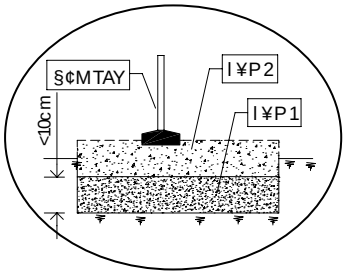
Excavated cross section



Material for pothole filling

Step 1:
Localize and excavate.
……
……
……
……

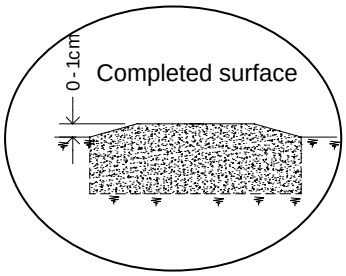
Step 2:
Prepare material for pothole filling
Use the same material with existing pavement



See Session 2.3

Step 3:
Layer & compact
- The thickness of a layer is not more than ……cm
- Compact using

Step 4:
Finish surface
- To ensure even surface.
- Level of completed surface should be 1cm higher than existing pavement (to allow for secondary compaction)



Defect 17 – Soft spots or local depression on gravel or stone macadam road.

Maintenance activity 17 – Repair ponding or soft spot

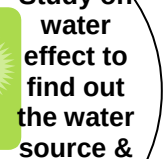
- This is caused by waterlogged foundation. Therefore, the area should be checked to see how water can penetrate (rain water, ponding water or spring). Drain off any standing water by providing drains, providing sand layer, re-excavating side ditch etc. If the problem is caused by ponding water or spring then it should be reported to the district for advice.
- Remove the surface and all soft material, dispose of unsuitable material safely so that it does not wash back into drains.
- Build up the roadway with suitable material with appropriate moisture content. Build up in 10cm layers, compact each layer before laying the next.
- Resurface the road and compact.

Read above paragraphs, maintenance activity 17 for to know procedure of soft spot repairing - activity 17. ***Fill into blank in following figure*** to complete the procedure.

Soft spot and local settlement

Common reason is water affects to make road subgrade weaker

Treatment procedure



Study on water effect to find out the water source & solution

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……

Step 1:
Localize and excavate all soft soil to hard soil layer.
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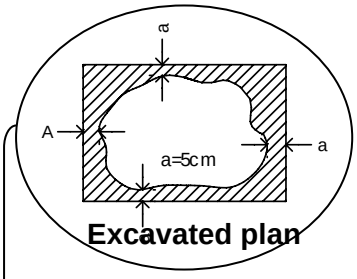
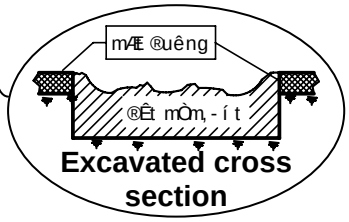
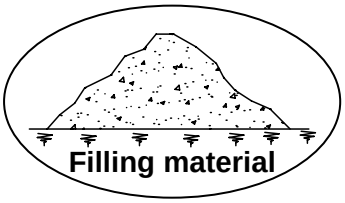
……

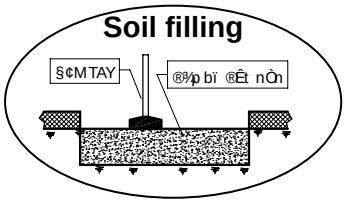




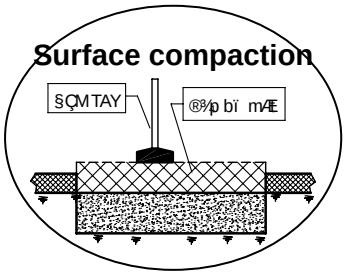
Step 2:
Prepare material for backfilling
- Soil: use the same soil with existing material
- Stone: ……..



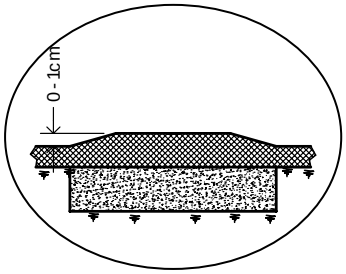
Step 3:
Layer and compact soil
- Layer thickness is not excess than ……..cm
- Compact each layer using



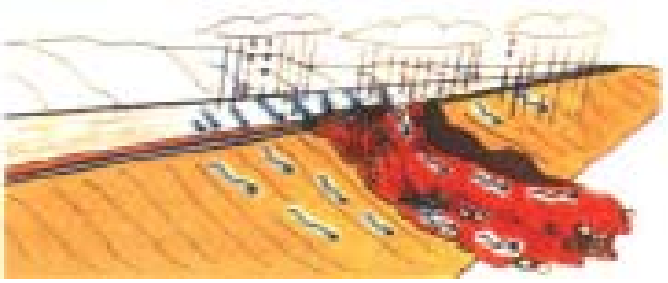
Step 4:
Layer and compact pavement using gravel/crushed stone
- Layer thickness is not excess than ……..cm
- Compact each layer using



Step 5:
Finish surface
- To ensure even surface.
- Level of completed surface should be 1cm higher than existing pavement (to prevent second compaction)



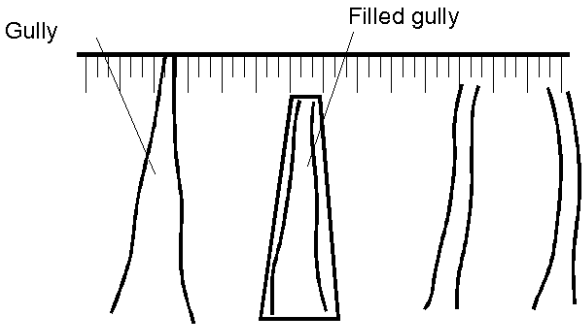
Defect 6 – Slip on embankment



Maintenance activity 6 – Refill embankment Slip

- Use hoes and spades to carefully remove the slip and take the waste material to a safe place.
- Clean out wet or loose material. Drain away any standing water. If the foundation is soft, lay a 10 - 20cm layer of sand to help drainage.
- If a spring is discovered, lay a pipe(s) to drain the water away.
- Use soil of the same type as the embankment to fill by layers of not more than 30 cm loose thickness. Compact each before placing the next. If the slip material already has suitable moisture content it can be used for filling (see Terminology Item 4 on Appropriate Moisture Content).
- Trim the embankment to the correct slope. Plant or turf the area of repaired embankment; watering as necessary to re-establish the vegetation. Trees may be planted at the bottom of the embankment to help to stabilise the new earthworks.

Defect 7 – Erosion on fill or cut slope



Maintenance activity 7 – Refill slope gully

- Fill slope erosion due to rain water
  - Firstly, cut the gully into a shape which is easy for working on (see the sketch), cut the gully edges to straight lines and make gully bottom flat.

- Fill the gully with good soil and compact with a hand rammer and then plant or turf the area.
- If there are many gullies next to each other, combine all of them into the repair

- Erosion on cut slope.
  - If the cut slope is gentle and it is possible to fill gullies and plant or turf then repair it as mentioned above.
  - If the slope is steep and erosion is serious affecting stability of the slope then it must be reported to the District personnel for advice on permanent repair.

Defect 9 – Minor landslide on to the road

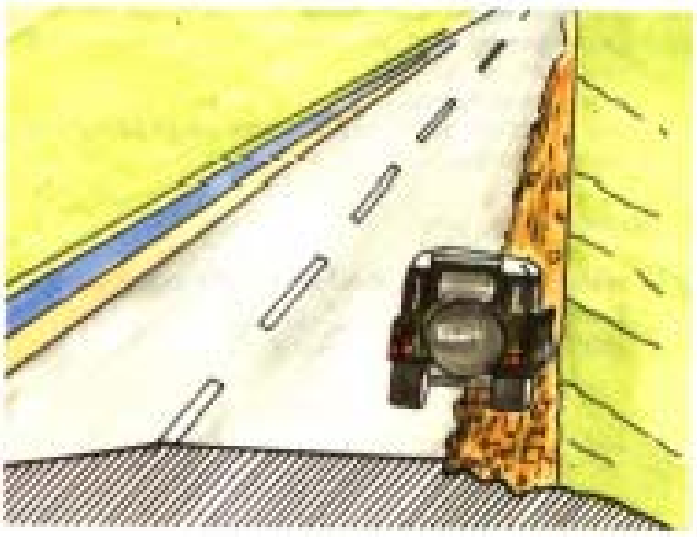
Maintenance activity 9 – Remove small landslide

Extreme care must be taken to avoid further slips and injury to workers.

- Carefully remove the slip material and dispose of safely so that it does not wash into drains or farm fields.

Consult the district authorities about major landslides, or if advice is required on dealing with small landslides.

Defect 10 – Shoulder does not drain water away from road surface, or is eroded



Maintenance activity 10 - Reshape/replenish shoulder surface material

Reshape the shoulder so that it slopes away from the road at about 5% (1:20), allowing water to drain off the road surface. Use cross fall template to check the slope.

Shoulder erosion: cut back to a sound, dry foundation. Clean out loose material. Repair shoulders with laterite or other good material in 10cm (maximum) layers. Water and compact the new material to the final crossfall slope (5%).

Note that the inner edge of shoulder must be level with outer edge of road surface.

Defect 11 – Debris or waste on road surface.

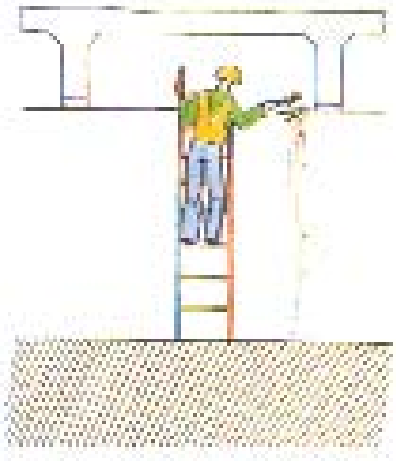
Maintenance activity 11 – Clean road surface

Remove debris and waste from road surface. Dispose of safely so that it does not wash back to road surface.

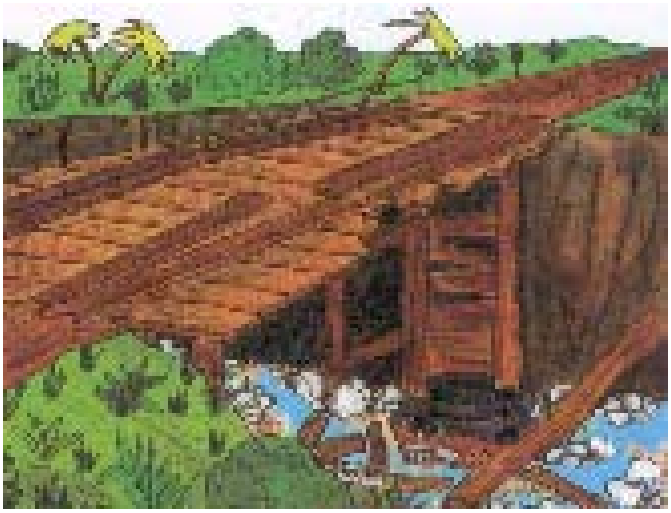
Defect 12 – Dirt or debris on bridge surface, bridge drains are blocked.

Maintenance activity 12 – Clean channel & bridge surfaces

Clean bridge surfaces, clear all bridge drains.

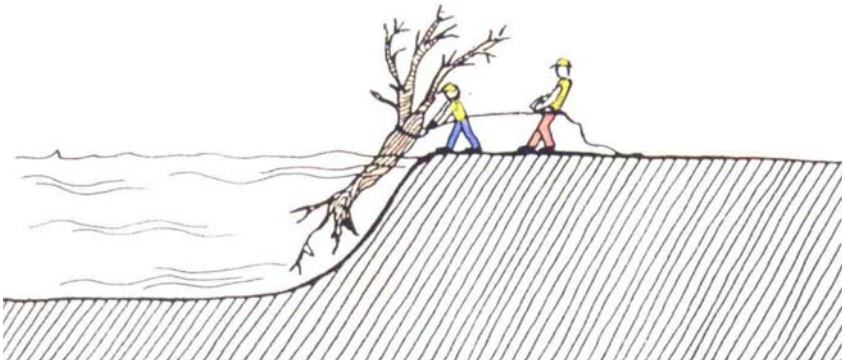


Defect 13 – Debris, logs or timbers blocked the channel under bridge or on causeway.



Maintenance activity 13 – Clear bridge or causeway opening

Remove logs and other obstructions from channel.



Defect 14 – Dry and dusty surface

Dust is traffic hazard. It is also a nuisance to road users and people living nearby particularly on sections going through settlements.

Maintenance activity 14 – Spray water

Spray water to dampen the road surface.

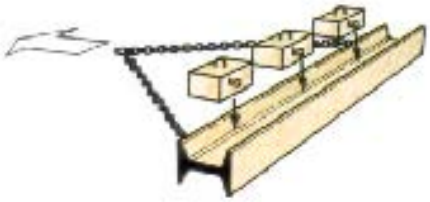
Defect 15 – Road furniture: Traffic signs are dirty or covered by vegetation

Maintenance activity 15 – Clean signs, cut trees or plants that cover the signs

Defect 18 - Road surface corrugated – unpaved road

Maintenance activity 18 – Remove corrugations

- Corrugations are caused by traffic action and often occur on the surface of unbound material.
- Repair corrugations: According to international experience, drags can be made from old tyres or steel beams, e.g. an “I” steel beam (see Figure 45) . The drag is towed along the road with a vehicle e.g. tractor or bulldozer.



Steel I beam (400mm depth section) drag. Can be surcharged to increase weight if necessary

Figure 49 Surface before and after dragging by steel I beam

A 400 mm steel I beam, 2m long, of approximately 180kg weight has been successfully used in Vietnam.

In dry weather it may be advisable to dampen the road surface before dragging to avoid dust.

Dragging does not alter the camber or crossfall of the surface. If reshaping is required this should be carried out as a separate activity

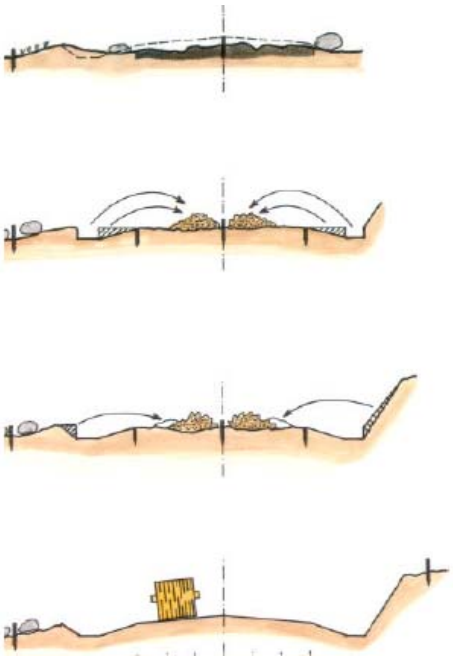
Defect 19 – Road surface does not drain to the edge of the road

If the water does not drain off the road surface, it will quickly become damaged, and require expensive repairs.

Maintenance activity 19 – Reshape road camber (by labour):

Use picks, hoes, rakes or shovels to redistribute the surface material to create a camber so that it slopes and drains away from the centre of the road at about 5%. Use wooden or bamboo pegs to set out the correct surface levels and cross

fall with the aid of a camber template, or straight edge, spirit level and measuring tape. If additional material is required to fill depressions, low areas or ruts, then use material of the same type. Loosen the low areas with picks before filling to create a rough surface to increase cohesion between filling material and the repaired surface. Material should be at an appropriate moisture content (Terminology Item 3) before compacting. The first compaction should be done from road edge to road centre. Rut fill material should be well compacted in layers. Compaction may be carried out by using hand rammers, jumping compactor, vibrating plate compactor or roller.

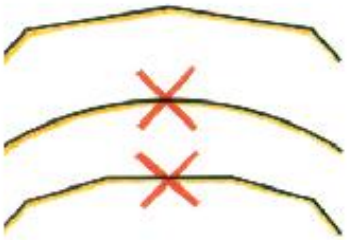


This activity may also be carried out by mechanized methods (towed or motorized grader) in areas of low population or where funds and resources are available – see Maintenance activity 20.

Correct camber

Incorrect camber

Incorrect camber



Restore camber

☞ ***Read*** the remaining contents of above paragraphs (from page 17 to 24)" for to know procedure of other activities of routine maintenance 1. *Summary* the procedure in following boxes.

Eroded embankment refilling

1.....
2..... .....
3..... .....
4..... .....
5..... .....

7 Repair erosion on fill or cut slope

1..... .....
2..... .....
3..... .....
4..... .....

10 Reshape and refill shoulder

1..... .....
2..... .....
3..... .....

11 Clean pavement surface

1..... .....
2..... .....

12 Clean bridge surface and clear bridge drain

1..... .....
2..... .....

13
Clear the flow under bridge (opening)

1.....
2.....

14
Spray water on pavement

1.....
2.....

15
Clean traffic signs

1.....
2.....

18
Remove corrugation

1.....
2.....

19
Reshape road camber

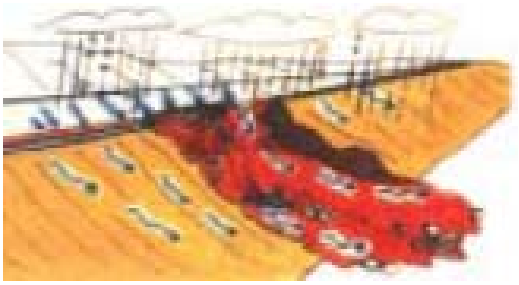
1.....
2.....
3.....

note

Maintenance activities should be carried out in accordance with known methods and procedures to ensure work quality

Understand right/wrong steps in working procedure of some main activities of Routine Maintenance

Bad compaction could result in embankment slip in rainy reason.
Read maintenance activity 6 - Refill embankment Slip, page 17" for to know procedures of refilling embankment slip



Mark *(X)* beside wrong techniques in the left column and *connect* remaining correct techniques to the right pictures in the right column

a). Trim embankment to correct slope, plant grass on slope surface.

b). It is the best to use slide soil for refilling.

c). Remove the slip using spades and dispose the waste materials to permitted place.

d). Reshape slope surface using grader

e). Clean out wet or loose materials. Drain away any standing water.

f). Water refilling soil to wet before compaction

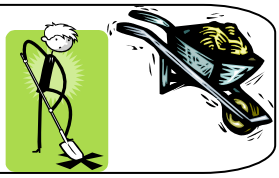
g). Drain away underground water (if any).

h). Refilling embankment slip in submerged area should not be carried out until dry season

i). Refill and compact soil by layers from embankment toe with a 30 cm thickness

Refill erosion on embankment slope

1



2

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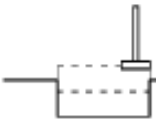


5

Fill or cut slope erosion due to rain

Mark *(X)* beside wrong techniques in the left column and *connect* remaining correct techniques to the orders in the right column

a). Plant or turf grass on repaired surface.

b). It is the best to use sand for refilling

c). Cut the gully into a wedge shape with straight edges and flat bottom which is easy for working on. If there are many gullies next to each other, combine all them into one repair.

d). Refill by layer from bottom using the same soil of embankment, compact by the refilled layers using hand hammer.

e). Compact using heavy roller.

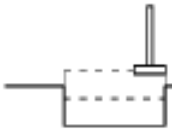
f). Trim slope surface by spades.

g). Should let erosion be continuously developed until partial embankment slip, then start repairing

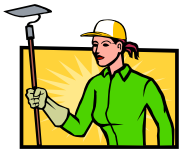
Refill slope gully

1

2



3



4

SELF ASSESSMENT

1. Fill in following lines the procedure of repairing embankment toe erosion along river due to crushing wave

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………………………………………………………………………….
………………………………………………………………………..

Good | Not good

2. Fill in following lines the procedure and requirements of pothole filling on gravel pavement.

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Good | Not good

2.2 TECHNIQUES FOR ROUTINE MAINTENANCE 2

◆SUMMARY

After Session 2.2 Participants should be able to comprehend procedures and techniques in implementing Routine Maintenance 2 and distinguish the wrong/right steps in each maintenance technique. They should then be able to complete the self – assessment.

The participants will be introduced procedures and techniques for implementing Routine Maintenance 2 and be asked to view some maintenance techniques and differentiate the right and wrong steps in these procedures

ACTIVITIES:

a) Learn about procedures & techniques to carry out activities of Routine Maintenance 2
b) Scrutinize & realize wrong/right steps in the procedure to implement some activities of Routine Maintenance 2.
c) Self - assessment

Procedures and techniques to implement some activities of Routine Maintenance 2 may require skills, materials or equipment to be brought in.

☞ ***Learn about*** common features of Routine Maintenance 2 based on the comparison with Routine Maintenance 1 - ***fill in following blanks***

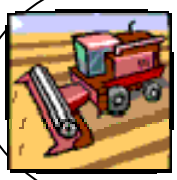
Similarity:
Activities should be carried out
……
during a year

activities of routine maintenance 1

activities of routine maintenance 2

Using hand tools (knife, hoe, shovel,…)

Difference



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Skill:
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Material:
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2

Defect 20 - Road surface corrugated or poor camber – unpaved road

Maintenance activity 20 – Reshape road camber (by equipment):

This activity must be carefully carried out on an earth gravel, laterite or stone macadam surface as more damage then good may be caused if incorrectly carried out. Large motor graders are not suitable for this activity on narrow commune roads as they and their blades are too large. The work should be carried out by a small motor grader (< 100hp or 75kW), or by tractor towed grader.

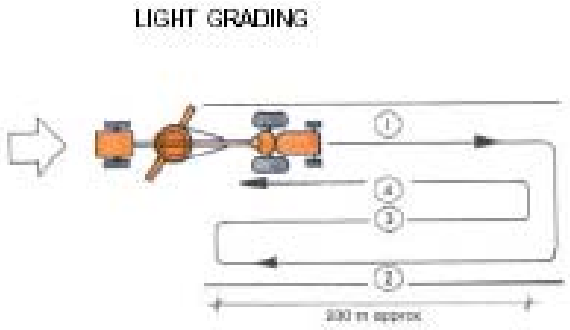
The objective of grading is to remove corrugations and restore the camber by returning material from the sides of the road to the centre of the road to form a cross fall of about 5%.

Work is best scheduled to follow a period of rain, as the moisture in the material will greatly assist compaction by rollers or traffic.

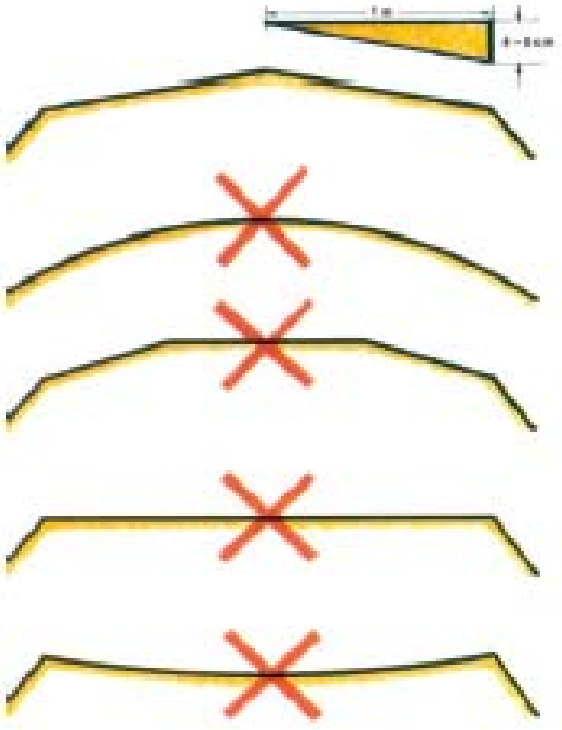
Patching of large potholes or depressions should be carried out as a separate activity prior to grading. Areas of standing water should be drained. It may be necessary to scarify the existing surface to cut to the bottom of any defects and loosen the material for reshaping.

- The grader will work on one side of the road at a time, making passes to cut and move material across the road surface. Each pass should be about 200metres or to a convenient turning point.
- Normally initial cutting passes are required to bring material from the edges of the road surface. Spreading passes redistribute the material away from the centre of the road. An even number of passes should be used to avoid a flat crown to the road.

- Light grading will require about 4 passes to bring material to the centre and spread it out to the correct camber.

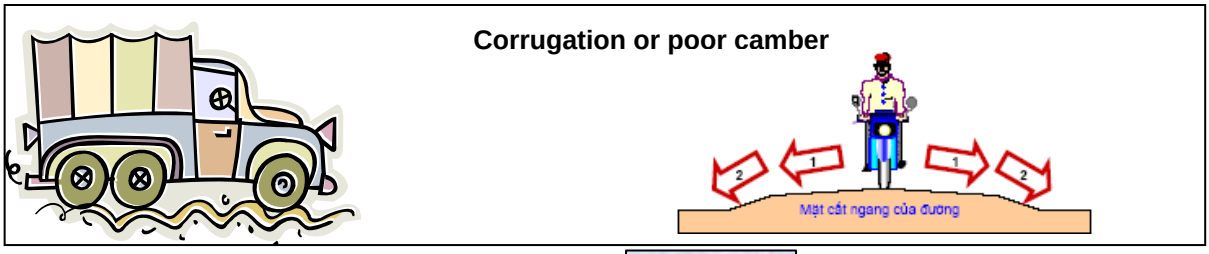


- Heavy grading will be required on a poor, uneven surface. Additional passes will be required to reshape the camber.
- The finished camber should be 5%, checked with a camber board every 100metres.
- Compaction after grading at an appropriate moisture content will make the surface more durable, reduce gravel loss and extend the period of time until the next grading.



4

Read above paragraph (page 3, 4) for to know about routine maintenance activity 20 - Reshape road camber by grader. ***Fill following blanks to complete*** the procedure.



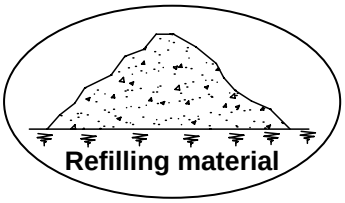
Reshape camber using
……
……

Purpose of camber reshaping is
……
……
……

Treatment procedure

Step 1:

Prepare refilling materials while pavement surface is corrugated seriously.



Step 2:

Local treatment & pavement scarification using
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Step 3:

Cut & move pavement material from protruding to sunken place by
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Step 4:

Compact pavement
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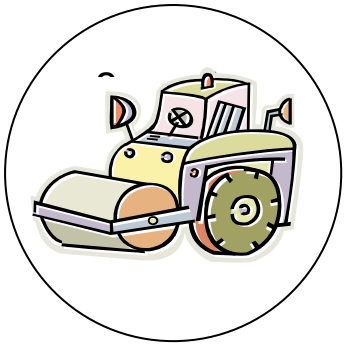
……
……



Bleeding of bituminous pavement reduces skid resistance

Bleeding

Bleeding results in adhesion of tyre in sunshine and slipperiness in the rain

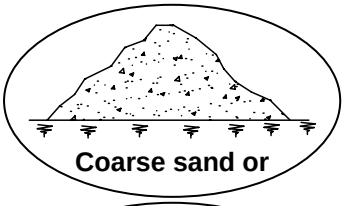
Purpose of anti-bleeding is to ensure traffic safety

Treatment Procedure

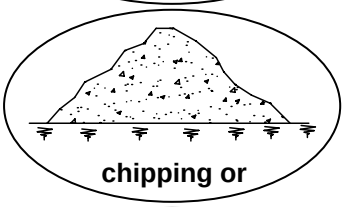
Step 1:

Prepare material to spread on bleeding area.
Usable materials:

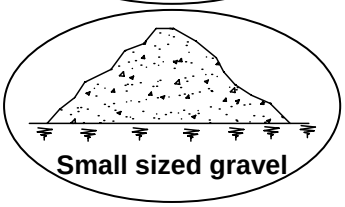
- **Coarse sand**
- **Chipping or**
- **0.5 -1.0mm sized gravel**



Coarse sand or



chipping or



Small sized gravel

Step 2:

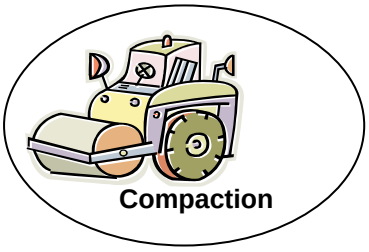
Spread (coarse sand, chipping of gravel) evenly on pavement at bleeding area.

Note:
It should be carried out at noon in hot weather to facilitate adhesion between bitumen and aggregate

Spread chipping evenly

Step 3:

Compact using light roller to make aggregate fastened into bituminous pavement



Compaction

Should:

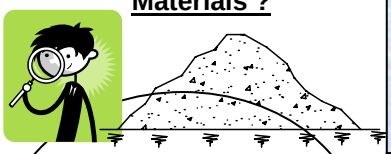
Sweep chippings, coarse sand from shoulders up into bleeding pavement

Sweep chipping up

Fill in the blanks to complete pothole filling procedure (in large area) on bitumen sealing surface.

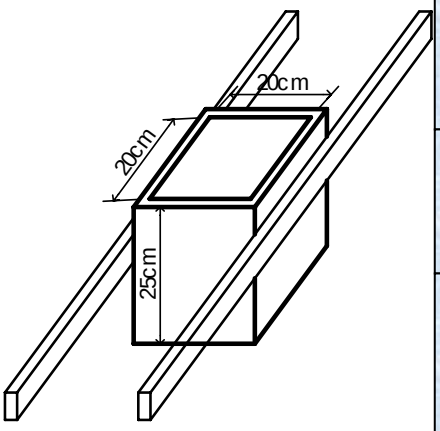
Tools ?

1. Mandrel
2. Crowbar
3. Hand-compactor or roller
4. Bitumen tank heater
5. Bitumen sprayer



Materials ?

1. Bitumen
2. Crushed stone 4x6
3. Crushed stone 2x4
4. Crushed stone 1.6x2
5. Crushed stone 1x1.6
6. Crushed stone 0.5 x 1



10 litre wooden bin

Step 1:
Localize & excavate pothole to minimum depth of 10 cm, clear excavated hole.
.....:.....

Step 2: Spread standard crushed stone
Spread crushed stone 4x6 or 2 x 4 by hand and compact by pedestrian compactor or roller.
Compacted ratio is 1.3

Step 3: The 1st bitumen spraying
Hot bitumen spraying at the rate of 1.9kg/m2

Step 4: The ..... stone spreading
Spread crushed stone 1.6x2 by hand and compact by hand-held compactor or roller.
18 - 20 litre/m2

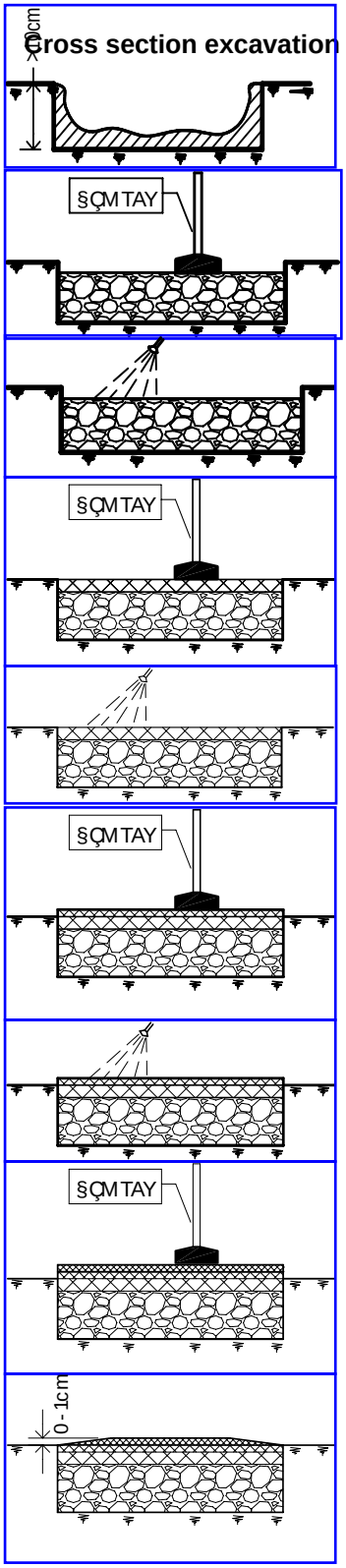
Step 5: The ..... bitumen spraying
Spray hot bitumen at the rate of 1.5kg/m2

Step 6: The ..... stone spreading
Spread crushed stone 1 x 1.6 by hand and compact by hand-held compactor or roller.
Crushed stone ratio is 14 - 16 litre/m2

Step 7: The ..... bitumen spraying . Spray hot bitumen at the rate of 1.1kg/m2

Step 8: The ..... stone spreading
Spread crushed stone 0.5 x 1 by hand and compact by hand-held compactor or roller.
Crushed stone ratio is 9 - 11 liter/m2

Step 9: Finish pothole filling surface.
Finishing surface is even and higher 1 cm than existing pavement (for secondary compaction)

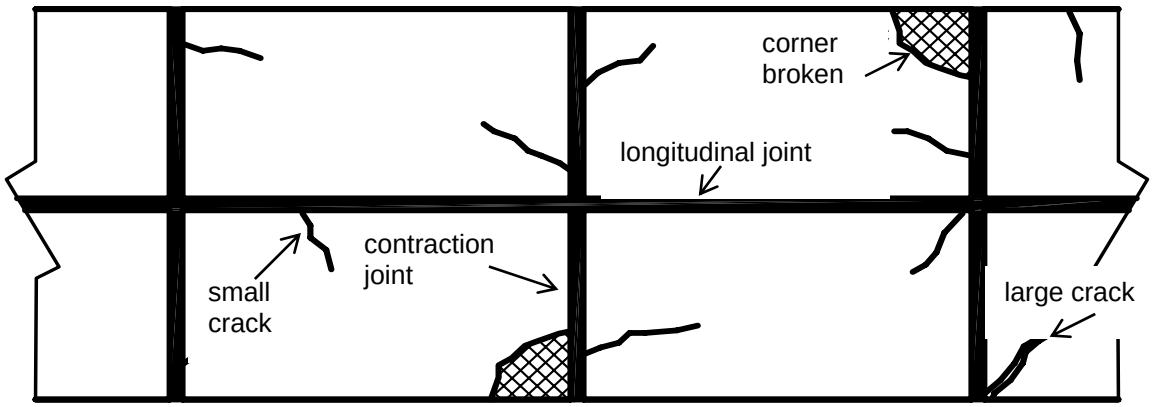


Read again Module 12 - "Repair soft spot on unpaved pavement" section and Module 13 - "Pothole filling on bitumen sealing surface" and ***make by yourself*** the procedure to repair soft spot on bitumen sealing pavement .

Soft spot/ settlement on bituminous pavement include damages of both pavement and sub-grade. The completed treatment is excavating soft spot to end of wet sub-grade, then replacing new material for both sub-grade and pavement that are suitable to existing pavement structure.

No.	Description	Material	Tools/Machine	Note
1	Prepare material for soft spot repair	....	....	....
2	Localize and excavate soft sport................	....	Pick axe, crowbar, shovel, hoe	Excavate in square and straight edge shape to solid soil
	....	....	....	....

Damage to concrete pavement usually takes the form of cracking and broken slab edge and/or corner.

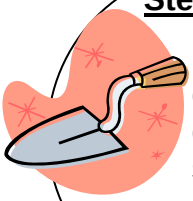


Small crack treatment: cracking width less than 5mm

Step1:

Use heated hard bitumen or cutback to seal crack

Step 2:



Fill the crack with coarse sand/ chippings using trowel

Small broken on concrete slab

Step 1:

Clean broken area using brush/ blowing cleaner. Do not wash !

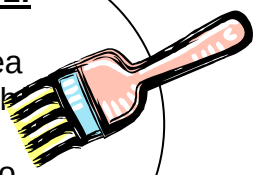
Step 2:

Fill broken area with bitumen mastic

Large crack treatment: cracking width more than 5mm

Step 1:

Clean broken area using brush blasting cleaner. Do not wash !



Step 2:

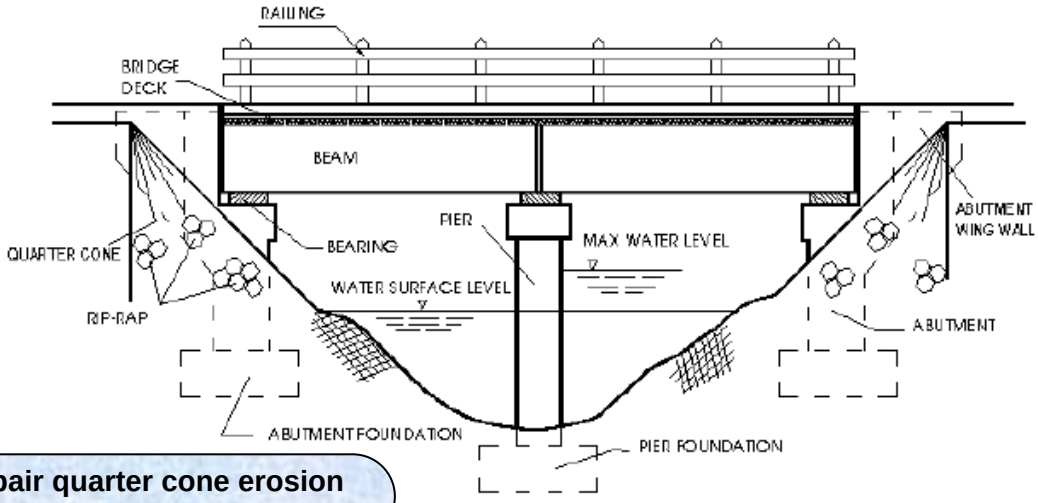
Fill the crack with bitumen mastic

Step 3:

Fill crack by coarse sand/ chippings using trowel

Serious cracking & broken concrete slab should be removed and replaced by the new one.
Corner with large crack (> 50 cm), should

☞ Drainage structures such as bridges, culverts... are often eroded due to water flow.



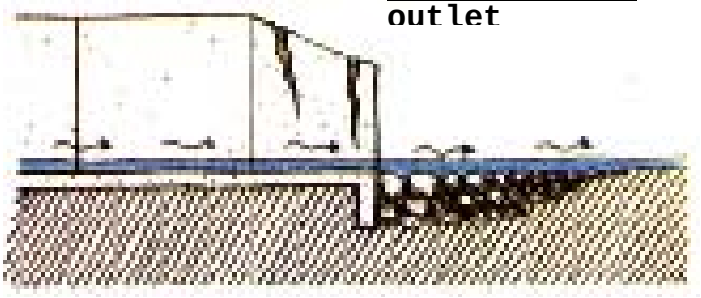
Repair quarter cone erosion

Step 1:
Clear erosion area: remove rocks & excavate all soft soil.

Step 2:
Refill using suitable soil and compact.

Step 3:
Rebuild quarter cone using masonry with 100# cement mortar

Repair eroded outlet



Step 1:
Work should be done in dry season. Prepare construction site, hold back the stream to repair culvert inlet

Step 2:
Excavate damaged inlet

Step 3:
Refill aggregate with high depth of excavation. Compact to required density

Step 4:
Rebuild culvert inlet using masonry with 150# cement mortar
Note: Extend inlet area using masonry or rock paving in case of erosion extension outside culvert inlet.

Practice to appreciate wrong/right steps of maintenance activities procedure

☞ Strike through (~~kkkkkkk~~) the wrong sentences in the following procedure to reshape road camber

1. Rural Road Maintenance - activity 20 to reshape road camber using grader should be carried out when road surface is corrugated or poor in cross fall.
2. It is not necessary to drain away water pond on road surface because water spray is required anyways for optimum moisture content to compact.
3. It could be necessary to scarify existing pavement to bottom of the damages and to turn up pavement material.
4. Light grader is operated to make passes from pavement center to edges.
5. Refilling materials are not required. It is only necessary to cut pavement in the place and move to another.
6. It is only necessary to make pavement surface even. No need to recompact.
7. Completed cross fall is about 5%. It is checked every 100 meter using a cross fall template.

Good	Not good

☞ Fill the correct orders in the right column for pothole filling on bitumen sealing surface.

1.	*Clear excavation material in pothole*	
2.	*Layer 4 x 6 crushed stone at level that is included compaction rate of 1.3*	
3.	*Localize pothole, excavate in square shape to 10 cm depth.*	
4.	*Layer 16x20 crushed stone at the rate of 18 - 20 liter/ m2,*	
5.	*The first bitumen spraying at the rate of 1.9 kg/m2*	
6.	*The second bitumen spraying at the rate of 1.5 kg/m2*	
7.	*The third bitumen spraying at the rate of 1.1 kg/m2*	
8.	Spread 10 x 16 crushed stone at the rate of 14 - 16 litre/m2, then compact	
9.	*Spread 5 x 10 crushed stone at the rate of 9 - 11 litre/m2, then compact*	

Good	Not good

2.3 ROUTINE MAINTENANCE MATERIALs

SUMMARY
After completing Session 2.3 participants should be able to understand issues relating to the materials to be used for Rural Road Maintenance and in particular appreciate the quality of materials required.
.
The participants will introduced the principal materials used in Rural Road Maintenance and the activities in which they should be used and their required quality.

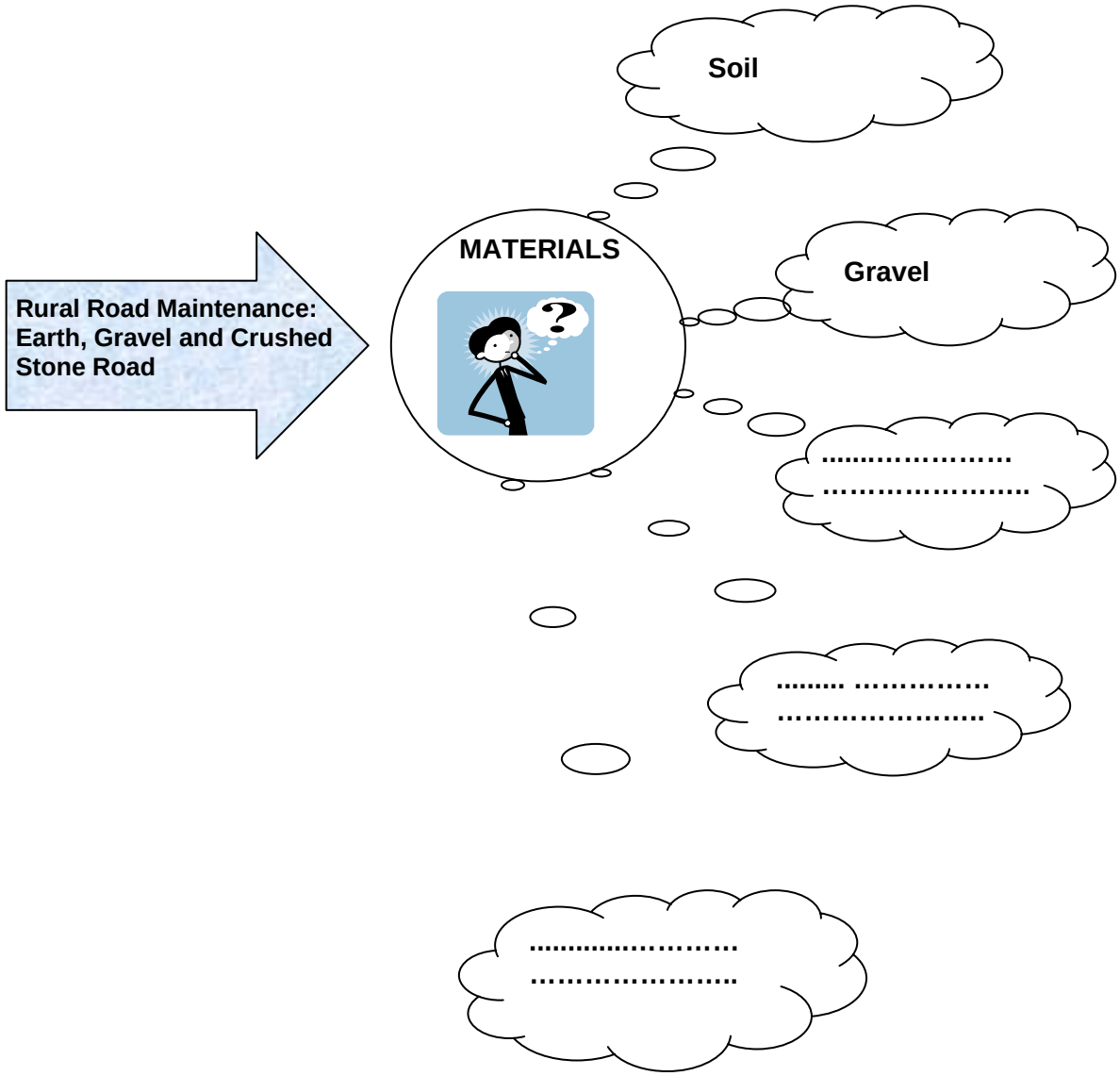
Participants should be able to complete the Self-Assessment

ACTIVITIES:

a) Learn about materials for sealed pavement maintenance (appreciate the materials & their quality)
b) Learn about materials for bituminous pavement maintenance (appreciate the materials & their quality)
c) Learn about the main materials for -road structures maintenance (appreciate the materials & their quality)
d) Self - assessment

Learn about materials for maintaining earth, gravel and crushed stone road – definitions and requirements

Think of materials that are necessary for maintaining the above road?
Look at and complete the following diagram:



***Learn** about* soil for Rural Road Maintenance

In maintenance works, soil is used to repair subgrade and earth surface. However not all kinds of natural soil can be used for construction of subgrade and maintenance because some soil is hard when dry but soft when wet. Soil used for

subgrade repair should be of the same kind as the existing subgrade soil and of appropriate moisture content. Appropriate moisture can be quickly identified at site by squeezing a sample of the soil in the hand. If moisture is too high then water will leak through the fingers, if moisture is too low (soil is too dry) then soil will fall apart when opening the hand. Some commonly used soil for subgrade filling:

- Soil mixed with colluviums, laterite.
- Sandy soil.
- Clayey soil.
- Soil mixed with sand.

The following soils can be used for filling if the above soils are not available or need to be transported rom long distance:

- Clay
- Sand (coarse sand, fine sand)
- Soil dust, sand dust
- Organic clay
- Rubble mixed with soil

The following soils are not allowed to be used:

- Salty soil
- Soil with high percentage of salt and plaster (over 5%)
- Muddy soil.
- Humus (with many grass roots)

1. Add more information in the following table:

- Mark (++) for the commonly used soil for Rural Road Maintenance
- Mark (+) for the usable soil for Rural Road Maintenance
- Mark (-) for soils that are not allowed to use for Rural Road Maintenance

No.	Types of soil	For refilling earth road bed and road surface		
		The commonly used soil (++)	The usable soil (+)	Soils that are not allowed to use (-)
1	Sandy clay (more clay, less sand)	++		
2	Clayey sand (more sand, less clay)			
3	Sandy clay mixed with laterit			
4	Clayey sand mixed with laterit			
5	Clay		+	
6	Sand			
7	Soil dust, sand dust			

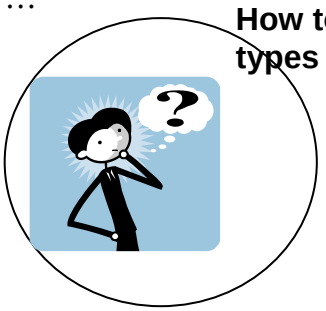
8	Borrow damp soil			
9	Rubble mixed with soil			
10	Salty soil			-
11	Soil with high percentage of salt and crystal			
12	Muddy soil			
13	Humus (with many grass roots and wastes)			

For Rural Road Maintenance, it is the best to use.....
……
……
……
.....
.....

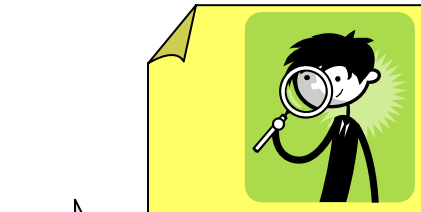
NOTES

Soil is an indispensable material in constructing and maintaining rural road. It is used to refill earth road bed and earth pavement. There are many types of soil, *however, not all of them can be used for road maintenance.*

2. …



How to assess types of soil?



Read Table 1- below to know how to assess major soil characteristics

Table 1: simple identification of soil classes at site

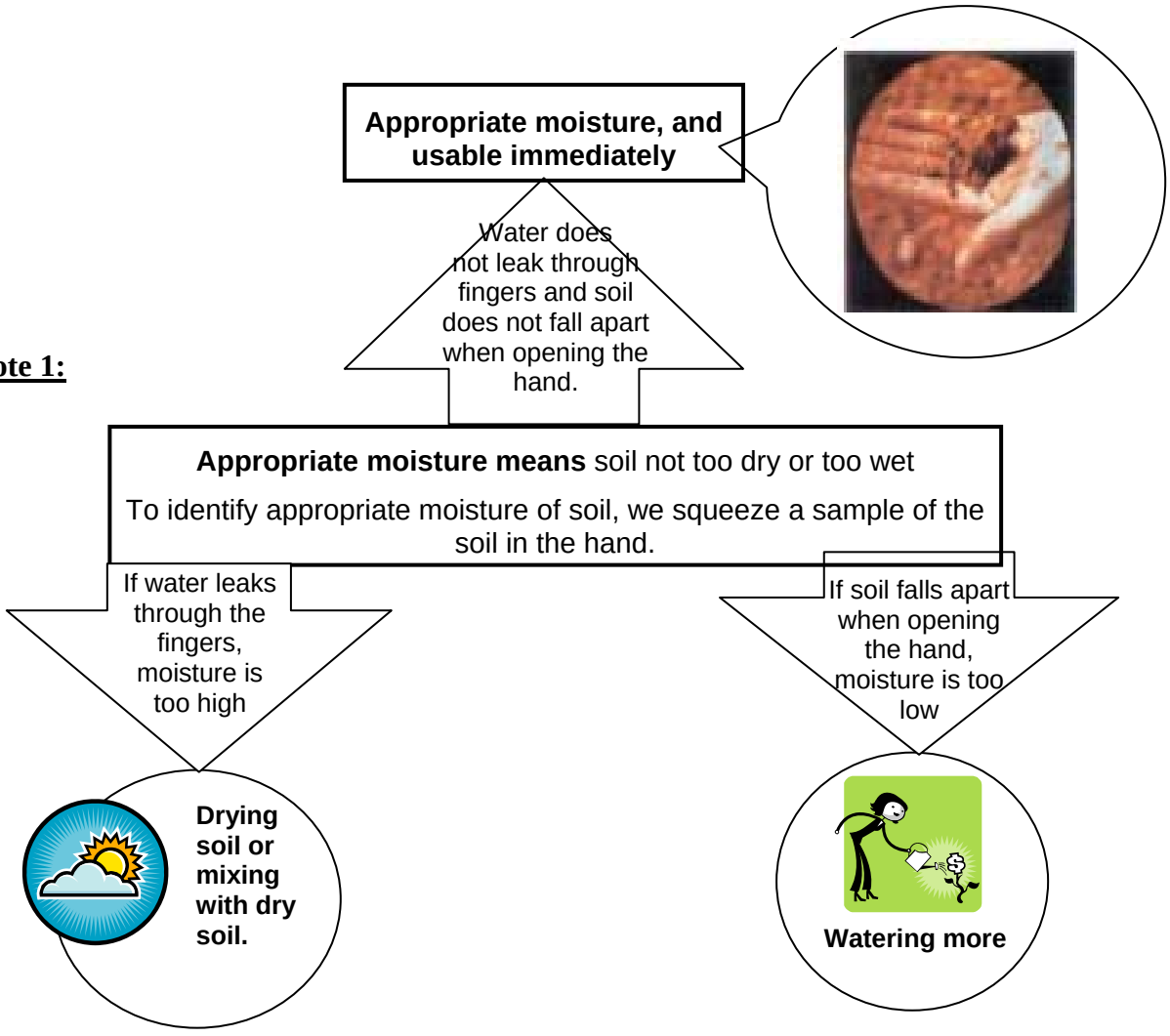
Soil class	Feeling when rolled in hand	Appearance of soil piece after rolling in hand?	Squeeze when dry?	Condition when wet?	Can it be rolled into stick shape?	Other features
Clay	Fine particles of same shape	Only fine and smooth particles are seen	Difficult to break into small particles	Plastic and sticky	Easy to roll into sticky shape with diameter (<3mm)	Smooth and polished section
Clay soil (or heavy soil	Fine particles of different types	Particle size over 0.25mm are seen	Easy to crush	Plastic but not so sticky	Difficult to roll into stick shape with diameter of 3mm	Smooth but not polished section
Sandy soil	More coarse particles than fine particles	Majority of particles are over 0.25mm	Very easy to crush	Less sticky Less plastic	Difficult to roll into stick	Rough section

How to use the soil?

I***t is necessary for chosen soil to be used effectively and appropriately to ensure road maintenance quality***

Read the following notes carefully when using soil:

Note 1:



Note 2:

If sand is used for filling then sand must be laid in ……. and watered.

Note 3:

If rubble mixed with soil is used then it must be added with……

Note 4:

In low land areas where only damp clay is available for filling sub-grade then:

- Spades or shovels should be used to cut the clay into ……..
- Size of soil cuttings……..

- Clay cuttings should be dropped from high distance for them ……..each other.
- While placing, we should trample on clay cuttings to increase their density.

☞ Learn about **natural gravel** for Rural Road Maintenance

Gravel material is ***a mix of different particle sizes following particular grading principles.*** Air voids between coarse particles are filled by finer and air void will be decreased during compaction.
The better gradation (particle size contents are conformed to standard gradation), the higher density will be reached after compaction.
Read carefully contents in following table ***to know*** characteristics of three types of natural gravel commonly used for road construction:

Types of gravel	Place where gravel is available	Features	Construction Requirements
Alluvial gravel	Rivers or streams in mountainous areas	- Mix of pebble and sand - Without plastic clays.	- Remove over sized pebble. - Add more clays to increase plasticity and make it easy to compact
Laterite	Hills in midland region	- Red - brown color. - Formed by dark brown laterites in different sizes. - Include a lot of clays.	- Reduce clays. - Used at appropriate moisture
Colluvial gravel	Rolling terrain in mountainous and midland areas	- Yellow or bright brown color - Include a lot of pebbles and clays.	- Reduce clays (if clay content is high). - Used at appropriate moisture

Referring to your local circumstances and present in summary types of available soil and gravel materials in your locality:
……..
……..
……..
……..
……..
……..
……..
……..
……
……..……..

☞ Learn about **crushed stone as a material** for Rural Road Maintenance

Stone is mostly used in construction and maintenance of roads under the form of crushed stone. Stones are crushed and sieved from natural stone (coarse stone) with different size from 0.5x1cm to 6x8cm. Basic requirements for crushed stones are as follow:

1. **Sufficient strength:**
   - Strength of stones to be crushed must be 600kg/cm2 or higher.
   - Stone strength is identified by compressing a stone of pipe shape with its diameter equal to its height and equal to 5cm.

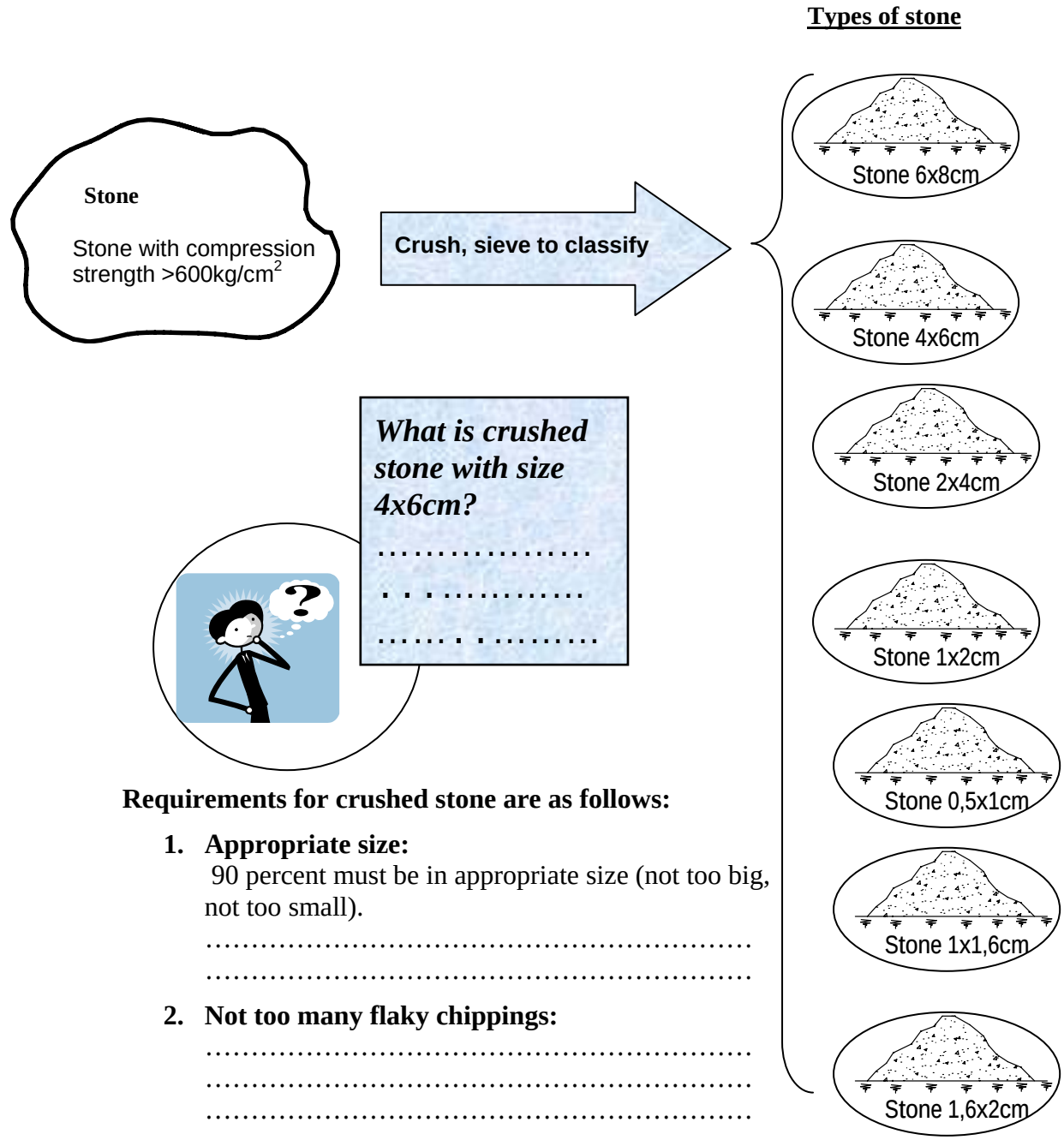
2. **Appropriate size:**
   Stone size is defined by small sieve with diameter (d) and large sieve with diameter (D). For example: chippings of 4 x 6 cm are the chippings which pass 6cm sieve and stay on 4cm sieve. It is required that:
   - Chippings >D and < d should not exceed 10% of total weight.
   - Chippings bigger than D + 30mm should not exceed 3% of total weight.
   - Chippings smaller than 0.63d should not exceed 3% of total weight.

3. **No too many flaky chippings:**
   Flaky chippings are not used for surfacing because they are easy to be broken when rolled. Flaky chippings are those with a thickness (smallest dimension) is less than 6 times of their length plus width. It is required that the percentage of flaky chippings should not exceed 10% (as per weight of chippings).

4. **Clean chippings**
   - Chippings must not be contaminated. Soil percentage should not exceed 3% of chipping weight
   - Grass, straw and leaves are not allowed in chippings

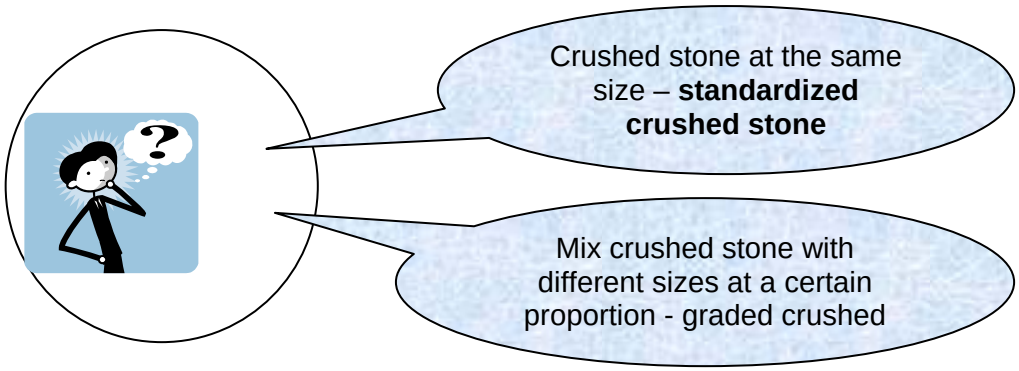
5. **Abrasion value should not be too high:**
   During compaction progress as well as under traffic action, there is abrasion between aggregates and they will become round in shape. Therefore the abrasion value should be from 5% to 10%.

Read above descriptions on **crushed stone** to know the features of and requirements for crushed stone. Then add more information in the following figure



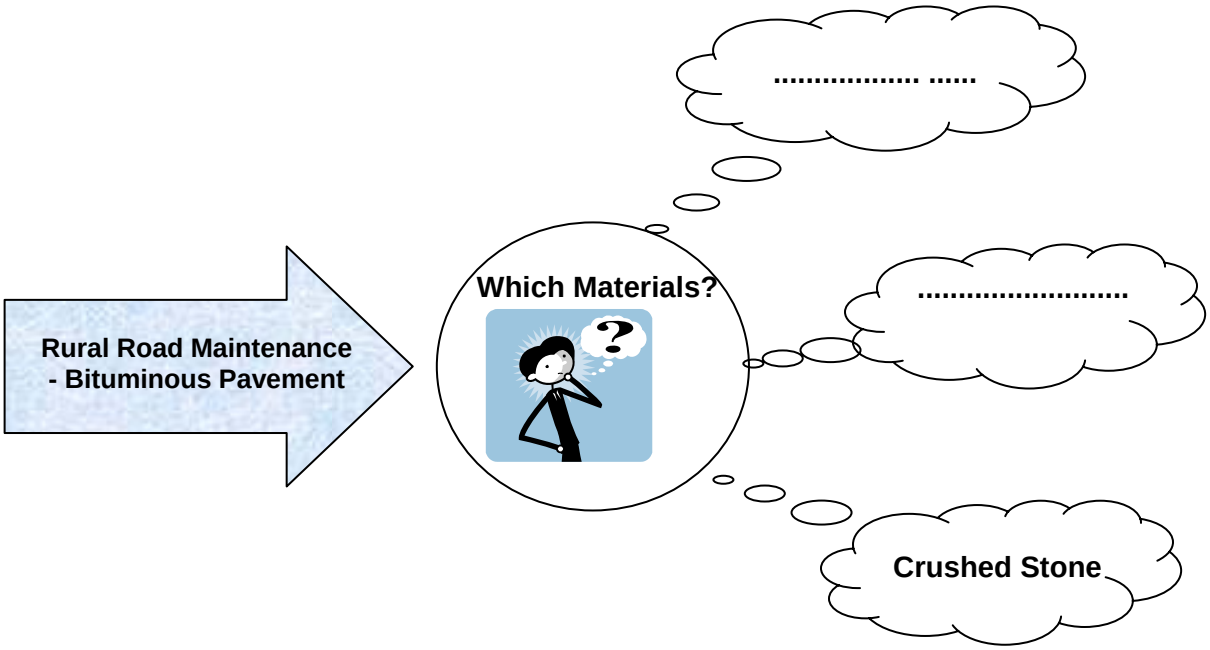
Requirements for crushed stone are as follows:

1. **Appropriate size:**
   90 percent must be in appropriate size (not too big, not too small).
   ……
   ……
2. **Not too many flaky chippings:**
   ……
   ……
   ……
3. **Clean chippings:**
   ……
   ……
4. **Abrasion value should not be too high:**
   ……
   ……
   ……



Learn about materials for bituminous pavement maintenance - definition and requirements

☞ Which materials do you think necessary for bituminous pavement maintenance? Fill in the blanks to complete the following figure:

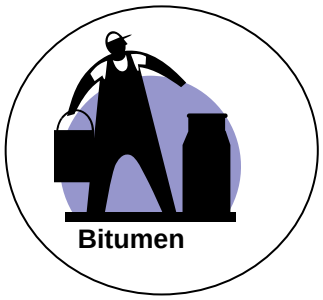


Where:

- Characteristics
- Definition
- Classification
- Using Requirements of all types of materials Binder (bitumen) is presented in following paragraph.

Learn about **bitumen material** for Road Construction and Maintenance

Bitumen is a product extracted from the oil refinery process. It is black, stone-binding and waterproof.
Bitumen is commonly used in surface layer of pavement construction. Types of bituminous pavement called asphalt concrete, bitumen sealing, bitumen penetration depending on using materials, material manufacturing methods and construction procedures.
Bitumen emulsion; Bitumen sealing and bitumen penetration are most popular in Rural Road Network.
Hard bitumen with penetration 60/70 is commonly used in constructing ***bitumen sealing and bitumen penetration***



Bitumen requirements:

1. Good adhesion to stone
2. Penetration at 25^{o}C is 60 – 70^{o} (0.1mm)
3. Elongation at 25^{o}C is 100cm (minimum)
4. Soften point is 46 - 55^{o}C
5. Flash point is 230^{o}C (minimum)

Put in **160^{o}C** heating containers **(**till white smoke rises)

Pour hot bitumen in spraying can and hand-spray evenly on pavement surface

Good Bitumen?

- Right type (brand name on the packing)
- Have quality certificate from supplier

Are not allowed to heat again (heating to use once)

Learn about materials for road structures maintenance - definition and requirements

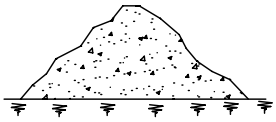
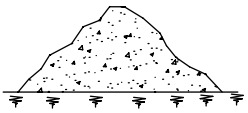
Learn about **cement** for road structures maintenance.

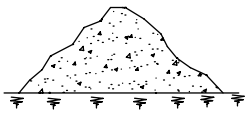
Types of cement for road & road structures repair and maintenance

- Cement-grade 200 (PC20)
- Cement-grade 300 (PC30)
- Cement-grade 400 (PC40)

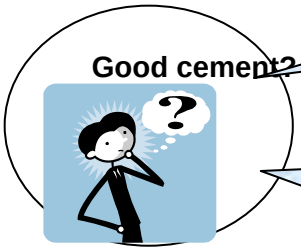
Cement Usage

Write down names of products containing cement in the suitable blanks:


Cement + 
Crushed stone + 
Coarse sand + **Water = –** .....


Cement + 
Coarse sand + **Water =** .....


Cement + 
Fine sand + 
Lime + **Water =** .....



- Having recognized brand name

- In bags
- Cement particles are soft, fine and do not curdle
- Not in store for a long time

☞ Learn about **mortar as a material** for road structures maintenance.

Cement mortar is commonly used for Rural Road Maintenance, specifically as follows:

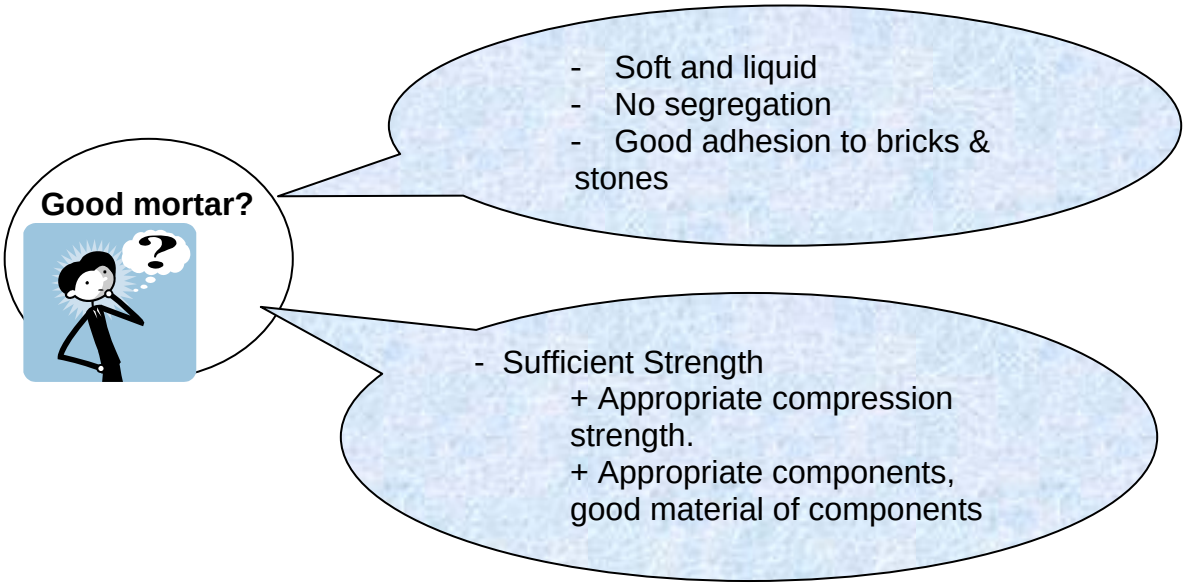
- To repair drain system such as building and lining.
- To repair culverts such as building and plastering apron, head wall, wing wall or crack sealing.
- Repair bridges such as building, jointing, lining and plastering the quarter cone…
- Repair/reinforce retaining wall
- …

Types of mortar

Mortar is classified by binder type and by function.

- Depending on binder material used in the mortar it is classified into 3 types:
  - Lime mortar comprising lime, sand and water (Unusual at present)
  - Cement mortar comprising cement, sand and water
  - Mixed mortar comprising lime, cement, sand and water
- Depending on the function it is classified into 2 types:
  - Building mortar: used to bind bricks, stones together into a block
  - Surfacing mortar: used to surface the structure.

Mortar type	Mortar grade	Cement grade	Material used for $1m^3$ of mortar	
			Cement (kg)	Sand (m^3)
Cement mortar	125	400	323	0.900
		300	380	0.862
		250	431	0.784
	100	400	300	0.910
		300	325	0.900
		200	380	0.860
	75	400	215	0.980
		300	255	0.953
		200	323	0.810
	50	400	145	1.052
		300	180	1.010
		200	240	0.980
	25	400	78	1.200
		300	100	1.100
		200	157	1.050



Practical exercise

Find out mixing rates of lime mortar -grade 50 using cement-grade 300 (PC30)?

Task:

Refer to table above Determine the component materials used for $1m^3$ of mixed mortar with strength of 50 after mixing fine sand and cement with strength of 300 as follows:

- Cement: ……....
- Fine sand:……..

☞ Learn about **cement concrete** for road structures maintenance.

1. Specifications for chippings used in cement concrete

Chippings for concrete can be pebble or crushed stones with nominal size of 1x2 cm, 2x4 cm etc. The following requirements must be followed:

- Stone strength must be higher than concrete strength from 30% and above.
- Shape and size of chippings must meet specifications.
- Percentage of flaky chippings should not exceed 25% of mass weight.
- Percentage of soft and weathered chippings should not exceed 10% of total weight.

- Chippings must be clean. Percentage of clay, mud, and dust should not exceed 2% for magma stone, 3% for deposit stone and 1% for crushed pebble.

2. Specifications for sand used in cement concrete

Following requirements must be followed:

- Sand must be clean, free from clay and other waste particles. Percentage of mud, dust and clay should not exceed 3% of total weight.
- Weight per volume of sand used for concrete of grade higher than 200 must be 1,400 Kg/m3 or higher and must be 1300kg/m3 or higher for concrete grade less than 200.
- Sand must be angular. Cracking sound is heard when sand is lightly squeezed in hand.
- Sand must have good grading i.e. coarse sand should be filled by fine sand to provide minimum voids.

3. Specifications for cement

Cement is an important material deciding strength and cost of concrete. Cement used for concrete can be Portland cement, or special cement, but whatever cement is used the following requirements must be followed:

- Strength (grade) of cement must be at least 1.5 times higher than strength of concrete. However, cement with strength 3 times higher than concrete strength should not be used. Most appropriate cement strength is from 2 to 2.5 times higher than concrete strength.
- When opening a cement bag, the cement particles must be soft, fine and do not stick together. A cool feeling is felt when thrusting the hands into the cement.
- Cement should not be stored for a long time. Portland cement will reduce its mixed bearing capacity by 20% after 3-month store, 30% after 6-month store and 40% after 12-month store. If the cement particles stick together in pieces but can still fall apart when squeezed, then its mixed bearing capacity has been reduced by 5 - 20% and should only be used for concrete grade lower than 170. These pieces of cement should be pressed into fine particles before use. If cement pieces are too hard and cannot be squeezed then its bearing capacity has been reduced by 20 - 50% and it should only be used for less important structures or for concrete grade lower than 110.

4. Specifications of water

Water used for mixing and maintaining concrete must be clean and free from harmful chemicals for concrete. In general, all drinkable water can be used for mixing and maintaining concrete. Waste water from industrial factories, sewage water, water from muddy ponds, and water polluted by oil are not used for mixing and maintaining concrete.

*F**ill in the following table** requirements for component materials of cement concrete*

Component Materials	Technical requirements
Crushed stone	*- Sufficient strength* *- Appropriate size.* *-The flakiness ratio should not exceed 25%* *- The friable and clay particle ratio should not exceed 10%* *- Clean*
Sand	....
Cement	....
Water	....

SELF ASESSMENT

1. Fill in the blank in following paragraph requirements of materials for rural road maintenance.
   a) Crushed stone using for double bitumen sealing treatment should be.....
   b) Cement using for mortar building head wall of culvert should be.....
   c) Hard bitumen using for pothole filling should be .....
   d) Colluvial gravel for reconstructed gravel pavement should be .....

Good	Not Good

2. Write in following blank table name of necessary materials to carry out rural road maintenance activities :

Double bitumen sealing on crocodile cracking pavement

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Replace broken concrete slabs

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Good	Not good

3.1 MAINTENANCE COST NORMS

◆SUMMARY

After completing Session 3.1 participants should be able to understand some of the key aspect of rural road maintenance norms and know how to apply them.

The participants are introduced norms that can be modified for use for rural road maintenance in Cambodia. The participants are given experience in using the norms by themselves. Participants should complete a Self-Assessment

ACTIVITIES:

a) Learn about norms that have been used for rural road maintenance
b) Learn about norm application in road maintenance and gain practice using the norms
c) Self - assessment

Existing norms for rural road maintenance

.

- .

Read and understand what ***the norms can enable you to know- Using the Vietnamese documents as an example:***

Norm
of routine maintenance
Rural Road

- 1996-

+ *Works* **and quantities of routine maintenance for** different types of rural road maintenance (for 1km in a year based on local condition). This is the basis to make plan, budget allocation and estimation of rural road maintenance.

+ **Average Labor Productivity** to carry out rural road routine maintenance activities.

Norm of Routine Maintenance - Rural Road Maintenance used to define the estimated annual maintenance demand for different types of rural road.

+ **Works and quantities of routine maintenance** estimated for 1km in a year based on local condition for different types of road, bridge and culvert. This is the basis to plan, budget allocation and estimation of rural road maintenance.

Norm
of Road routine maintenance

-2001-

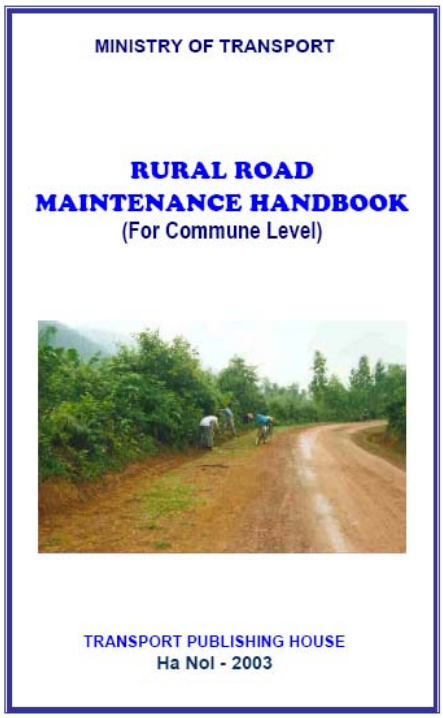
+ **The way to calculate labour force and machine demand** for routine maintenance items of road, bridge and culvert (depends on labour productivity and construction machine norm)

Norm of Road Routine Maintenance is used to define maintenance demand for each km of road rural road maintenance.

Norm
of repairing works estimate
- 2000 -

+ **Defines the requirement in terms of material, machine and labour type and quantity,** for each maintenance item.

+ Used to make unit price of repairing items including rural road, such as pothole filling, bitumen sealing...



☞ Using Vietnamese ***Rural Road Maintenance Handbook as an example-***

note

- Norm of Routine Maintenance gives maintenance demand of a kilometre in a year for different types of rural road.
- Norm of Repairing Works Estimate gives demand of material, labor and machine to carry out each item of repairing construction works

Look at the following figure to know the way to calculate unit price of a road maintenance item

1. Unit costs of some work items:

1.1. Pothole filling on gravel surface: Average depth of pothole is 10cm, calculated for 1m^2 of pothole.

Table 18

No	Consuming items	Unit	Quantity	Unit cost	Cost	Remark
1	Material					
	Gravel	m^3	0.1428	120000	17136.00	
	Clay	m^3	0.004	20000	80.00	
	Coarse sand	m^3	0.0102	54300	553.86	
2	Labour					
	grade 2,5/7	md	0.1429	11354.31	1622.5	
3	Equipment					
	Roller 8.5T	shift	0.012	266728.27	3200.74	
	Other equipment	%	5		160.04	
	Total				**22753.14**	

Material unit price is depended on locality and

Necessary material and machine for an unit of road maintenance item - This figure is taken from norm of capital construction estimate

Necessary daywork for an unit of road maintenance item - This figure conforms to labor productivity from norm of rural road maintenance

Labor and machine unit price conforms to Government Regulation

Look at the following figure ***to learn about usage of Norm of Repairing Works Estimate*** - Part II: Bridge and Road Repair

Note

Usage of the norms is not difficult. The most importance is define <u>which is the right issue</u> that needs to refer.

Kiem tra - Danh gia Assessment

1. Continue the following writing
    a. *Norm of routine maintenance for rural road is used to define*.....
    .....
    .....
    .....
    .....
    b. *Use norm of road routine maintenance for*
    .....
    .....
    .....
    .....
    c. *Norm of repairing works estimate for Capital Construction is used to*
    .....
    .....
    .....
    .....

Good | Not good

3.2 MAINTENANCE COST ESTIMATING

◆SUMMARY

After completing Session 3.2 participants should be able to understand the structure of cost estimating sheets and the steps required to establish a cost estimate for rural road maintenance.

The participants are introduced to the structure of cost estimating sheets and shown how to set up a cost estimate. The participants can practice setting up a cost estimate for rural road maintenance by themselves and then undertake a Self - Assessment

ACTIVITIES:

a) Familiarisation with a rural road maintenance estimate - learn about the structure of cost estimate sheets of rural road maintenance and their relations.
b) Find out about procedures and necessary data to generate a cost estimate of rural road maintenance
c) Make a cost estimate of road maintenance
d) Self - assessment

Rural road maintenance estimation - the structure of cost estimate sheets

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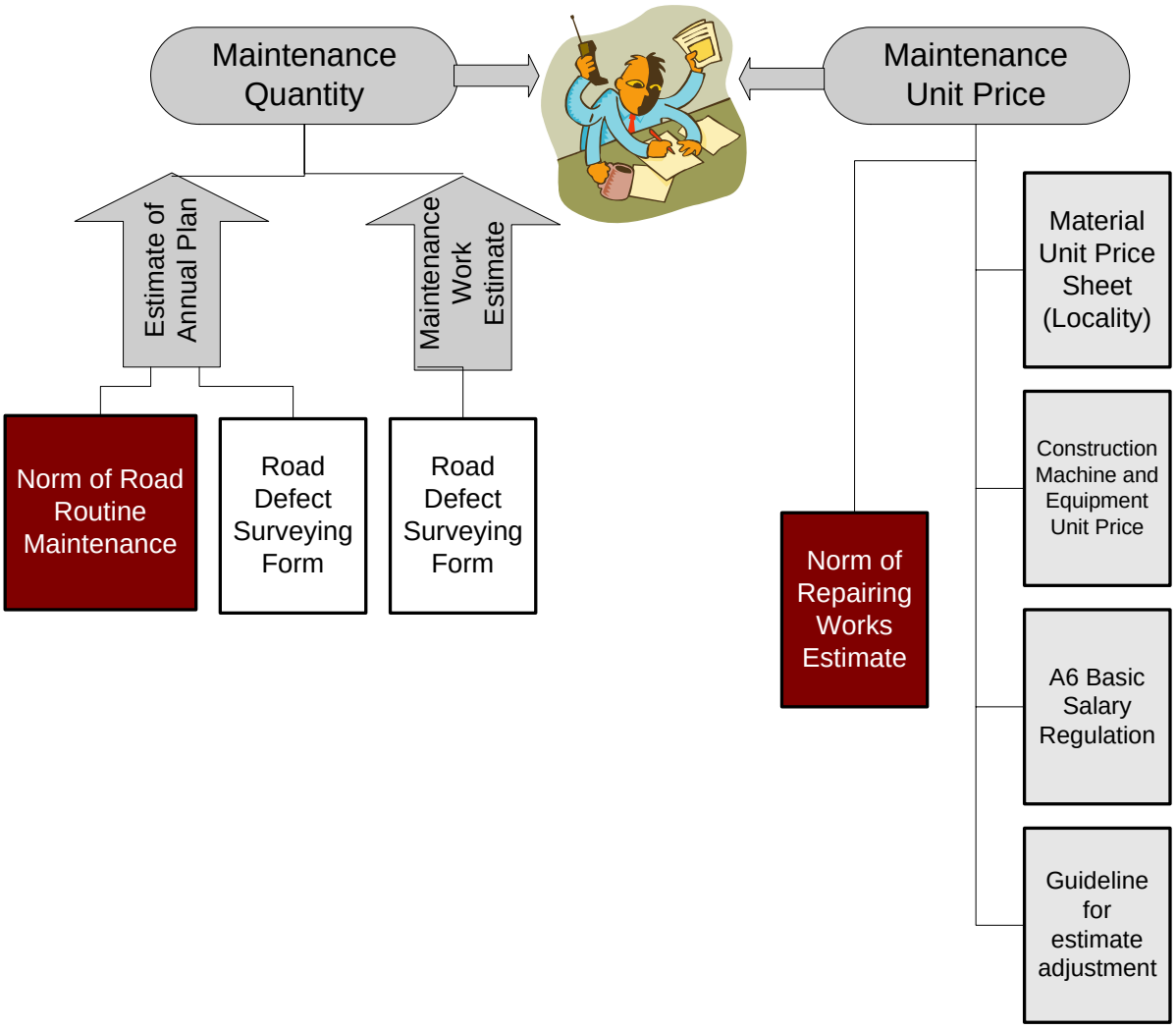
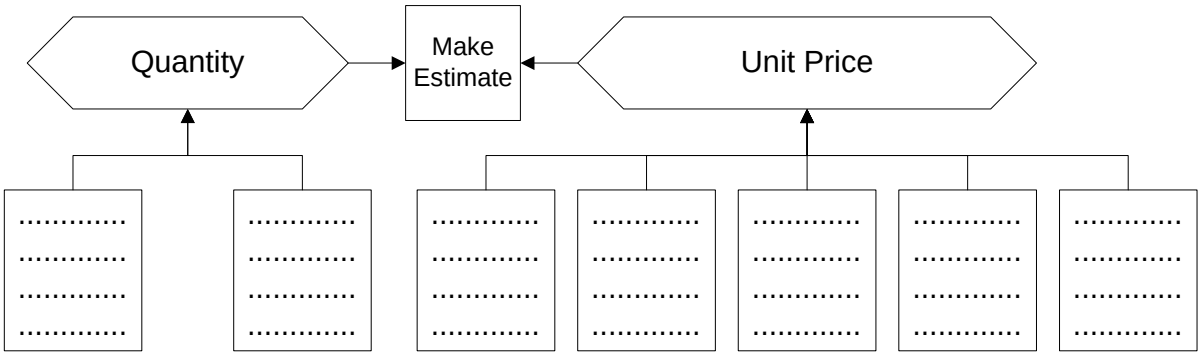
Look at the figure below to understand the documents that are necessary for road maintenance estimating



Fill in the blanks of the following figure with names of documents (or regulations) used to prepare a rural road maintenance estimate in your local condition.



☞ Look at example 1 of annual plan estimate for maintaining 1.6 km Commune bituminous road

Table 1:

maintenance demand of 1.6 km bituminous road

No.	Descriptions	Unit	Stipulated quantity	Road length	Maintenance demand
A	**Management works**				
1	Inspection, settlement of offences	Daywork			
B	**Traffic safety**				
2	Paint and repair guide posts and signs	Daywork	1	1.6	1.6
C	**Subgrade & drainage**				0
3	Grass cutting	Daywork	3	1.6	4.8
4	Ditch cleaning in wet season	Daywork	2	1.6	3.2
5	Side drain clearing	m/daywork	500/16.67	1.6	800/26.67
6	Shoulder reshaping	m2	400/26.67	1.6	640/26.67
7	Drain excavating	m3	5/5	1.6	8/8
8	Embankment/ Shoulder replenishing	m3	5/2.5	1.6	8/4
9	Small landslide removal	m3	4/2	1.6	6.4/3.2
10	Clean tow section (if necessary)	Daywork	2	1.6	3.2
D	**Pavement**				
11	Pothole filling	m2	20	1.6	32
12	Corrugation grading	m2	60	1.6	96
13	Materials refilling	m3	2	1.6	3.2
E	Soft spot repair	m3			
14	Pavement watering	Daywork	1	1.6	1.6
15	Culvert & bridge (less than 10m span)		1	1.6	1.6

Table 2: Unit Price Calculation Sheets of some road maintenance items

Code	Descriptions	Unit	Quantity	Unit Price	Cost	Note
XR.21.11 & XR.24.13	***Fill 15cm depth pothole by crushed stone and bitumen sealing***	sqm	1	US$	US$	
	Material				1.99	
	4x6 crushed stone	cu.m	0.138	4.88	0.67	
	2 x 4 crushed stone	cu.m	0.0035	5.09	0.02	
	1 x 2 crushed stone	cu.m	0.075	5.77	0.43	
	Bitumen	kg	4.821	0.14	0.67	
	Firewood	kg	3.86	0.03	0.13	
	Tripping or coarse sand	cu.m	0.0095	6.29	0.06	
	Labour			0.00	0.16	
	Class 4/7	daywork	0.208	0.77	0.16	
XR.33.41	***Crack sealing, bitumen ratio is 2.5kg/m2***	sqm	1			
	Materials				0.56	
	1 x 2 crushed stone	cu.m	0.015	5.77	0.09	
	0.015-1 chippings	cu.m	0.015	6.29	0.09	
	Bitumen	kg	2.675	0.14	0.37	
	Labour			0.00	0.03	
	Class 4/7	daywork	0.038	0.77	0.03	
	Construction Machine			0.00	0.08	
	8.5 tons roller	daywork	0.003	14.45	0.04	
	Bitumen heating tank	daywork	0.005	6.86	0.03	
XR.45.30 vµ XR.24.13	***Soft spot/ Settlement Treatment***	cu.m	1	US$	US$	
	Material				7.69	
	0 - 4 crushed stone	cu.m	1.319	4.85	6.40	
	1 x 2 crushed stone	cu.m	0.075	5.74	0.43	
	Bitumen	kg	4.821	0.14	0.67	
	Firewood	kg	3.86	0.03	0.13	
	Tripping or coarse sand	cu.m	0.0095	6.25	0.06	
	Labour			0.00	0.71	
	Class 3.7/7	daywork	0.95	0.75	0.71	

***Note:**

- The unit costs in calculation sheet above are made based on "Norm of Repairing Works Estimate "
- Materials unit price are depended on locality

-

- **Estimate of 1.6 km bituminous road repair**

Estimation for repairing 1.6 km of road

ID	Description	Unit	Qty	Unit price $			Amount $		
				Material	Labor	Machinery	Material	Labor	Machinery
A	**Management works**								
1	Inspection, settlement of offences	daywork	3.2		0.57			1.82	
B	**Traffic safety**				0.00			0.00	
2	Paint and repair guide posts and signs	daywork	1.6		0.57			0.91	
C	**Sub-grade & drainage**				0.00			0.00	
3	Grass cutting	daywork	4.8		0.57			2.73	
4	Ditch cleaning in wet season	daywork	3.2		0.57			1.82	
5	Side drain clearing	m	800		0.57			454.55	
6	Shoulder reshaping	sq.m	640		0.57			363.64	
7	Drain excavating	cu.m	8		0.57			4.55	
8	Embankment/ Shoulder replenishing	cu.m	8		0.57			4.55	
9	Small landslide removal	cu.m	6.4		0.57			3.64	
10	Clean tow section (if necessary)	daywork	3.2		0.57			1.82	
D	**Pavement**							0.00	
11	Pothole filling	sq.m	32	1.98	0.16		63.35	5.12	
12	Corrugation grading	sq.m	96	0.55	0.03	0.08	53.01	2.80	130,413
13	Materials refilling	cu.m	3.2	7.69	0.71		24.62	2.28	
E	Soft spot repair				0				
14	Pavement watering	daywork	1.6		0.57			0.91	
15	Culvert & bridge (less than 10m span)	daywork	1.6		0.57			0.91	
Total							140.98	852.02	7.41

☞ Sample 2: Crushed pavement estimating - the data is taken from Road Defect Surveying Form

Maintenance Demand Survey Form
Assumed surveying data

Table 8a - road defect quantity - site surveying results form								
Commune: An Son					*Road : An Son - An Lac*			
Road length: 2.2 km			*Road Code: AS01R3.5/5D2.2*			*Date: 12 - 3 - 2005*		
Pavement Type: Colluvial Gravel - Road/Pavement Width: 3.5m/5.0m						***Condition assessment***		***defects quantity***
Road Defects and Sphere of Influence								
Location	*K0 - K0+500*	*K0+ 500 - K1*	*K1 - K1+500*	*K1+500 2*	*K2 - K2+200*	*Valu e*	*Condi -tion Asses- sment*	
Drain cleaning (m)	*130*	*80*	*0*	*28*	*50*	*315*	*Bad*	*288 m*
Drain excavation (m/m3)	*20/6.4*	*0*	*0*	*0*	*15/4.8*			*11.2 m3*
Clearing brush/grass(m2)	*0*	*0*	*30*	*42*	*0*	*72*	*Bad*	*72 m2*
crushed stone pavement (cm)								
Reshape & refilling (m3)	*0*	*0*	*1.05*	*2.1*	*0*			*3.15 m3*
10 cm deep pothole (m2)	*40*	*32*	*0*	*0*	*0*	*2.53 %*	*Fairly Good*	*72 m2*
12 cm deep pothole (m2)	*0*	*0*	*55*	*65*	*0*			*120 m2*
Soft spot (m2)/(m3)	*3/1.9*	*0*	*0*	*0*	*0*			*1.9*
bridge, culvert and other structures								

Road Defects and Maintenance Quantity

No.	Items	Unit	Maintenance Quantity
I	**Road bed and Drainage**		
1	Brush/Grass Clearing	m2	72
2	Side Drain cleaning	m	288
3	Drain excavation	m3	11.2
II	**Pavement**		
4	10 cm deep pothole filling	m2	72
5	15 cm deep pothole filling	m2	120
6	Reshape and refilling surface	m3	3.15
7	Soft spot treatment	m3	1.9

Maintenance Works unit price

Code.	Description	Unit	Quantity	Unit $	Cost $	Note
XR.65	***Drain cleaning***	m	1			
	Labor				0.03	
	class 3.5/7	daywork	0.035	0.74	0.03	
BA.1733	***Side drain excavating***	m3	1			
	Labor				0.81	
	class 2.7/7	daywork	1.17	0.69	0.81	
XR.66	***Vegetation clearing***	m2	1			
	Labor				0.02	
	class 3.5/7	daywork	0.022	0.74	0.02	
XR.61.32	***Reshape, refill pavement using crushed stone***	m3	1			
	Material				6.44	
	Crushed stone 4x6	m3	1.32	4.88	6.44	
	Labor				0.23	
	class 4/7	daywork	0.3	0.77	0.23	
	Construction Machine				1.43	
	Hammer	daywork	0.5	2.87	1.43	
XR.22.11	***10 cm deep pothole filling***	m2	1			
	Material				0.82	
	Crushed stone 4 x 6	m3	0.138	4.88	0.67	
	Crushed stone 2x 4	m3	0.0035	5.09	0.02	
	Crushed stone 1 x 2	m3	0.0035	5.77	0.02	
	Tripping 0.015-1	m3	0.0159	6.29	0.10	
	Natural gravel	m3	0.0043	2.00	0.01	
	Labor				0.26	
	class 4/7	daywork	0.342	0.77	0.26	
XR.22.14	***15 cm deep pothole filling***	m2	1			
	Material				1.18	
	Crushed stone 4 x 6	m3	0.207	4.88	1.01	
	Crushed stone 2x 4	m3	0.0056	5.09	0.03	
	Crushed stone 1 x 2	m3	0.0058	5.77	0.03	
	Tripping 0.015-1	m3	0.0159	6.29	0.10	
	Natural gravel	m3	0.0043	2.00	0.01	
	Labor				0.31	
	class 4/7	daywork	0.396	0.77	0.31	
XR.45.30	***Soft spot treatment***	m3	1			
	Material				6.71	
	Crushed stone 0 - 4cm	m3	1.319	5.09	6.71	
	Labor				0.30	
	class 3.7/7	daywork	0.396	0.75	0.30	
	Construction Machine				1.47	
	Water tanker, sprayer	ca	0.002	19.60	0.04	
	Hand-held compactor	ca	0.5	2.87	1.43	

Table 3: Maintenance Estimate of 2.2 km crushed stone road - the quantity is assumed to take from surveying result.

No	Items	Unit	Quantity	Unit Price $			Cost $		
				Material	Labour	Machine	Material	Labor	Machine
I	**Road bed and Drainage**								
1	Brush/Grass Clearing	m2	72		0.03			1.87	
2	Side Drain cleaning	m	288		0.81			232.96	
3	Drain excavation	m3	11.2		0.02			0.18	
II	**Pavement**								
4	10 cm deep pothole filling	m2	72	6.44	0.23	1.43	463.80	16.70	103.21
5	15 cm deep pothole filling	m2	120	0.82	0.26	0.00	98.40	31.73	0.00
6	Reshape and refilling surface	m3	3.15	1.18	0.31	0.00	3.72	0.96	0.00
7	Soft spot treatment	m3	1.9	0.99	0.30	1.47	12.75	0.57	2.80
	Total						578.66	284.97	106.00

Direct Maintenance Cost	
VL = $578.66	$578.66
NC = $284.97 x 3.36 =	$957.51
M = $106.00 x 1.4 =	$148.41
T = VL +NC + M =	$1684.57
General Cost	
C = 5.3 % x T =	$89.28
Maintenance Cost	
Z = T + C = =	$1773.85
Management Cost	
K = 1% x Z =	$17.74
Total Cost: Z + K	$1791.59

*Note:

- The estimate above is calculated for maintenance works that is carried by Community Group or Length Person.
- If the maintenance works are carried by Contract with Professional Contractor, the total cost should be included payment of interest and VAT.
- Other maintenance works as big repair that survey & design works need be carried by professional contractors, surveying, designing and other cost should be included in the total cost conforming to State Regulations.

☞ ***Fill in following lines*** with relations between data in the table above

1.....

.....

2.....

.....

3.....

.....

note

Estimate of Annual Maintenance Plan is made with maintenance demand that conforms to Norms of Routine Maintenance. Maintenance Estimate of a road is made with maintenance demand that is defined by road defects surveying

Practice making estimate with maintenance demand defined by road defects surveying.

☞ ***Fill maintenance quantity*** in the table below using surveying data

No.	Items	Unit	Maintenance Quantity

Make unit price of the maintenance items

Code	Description	Unit	Quantity	Unit Price	Cost	Note

Complete estimating table below using the quantity and the unit price from two table above

No	Items	Unit	Quantity	Unit Price			Cost		
				Material	Labor	Machine	Material	Labor	Machine
	Total								

Direct Maintenance Cost

VL =

NC =

M =

T = VL +NC + M =

General Cost

C = 5.3 % x T =

Maintenance Cost

Z = T + C =

Management Cost

K = 1% x Z =

Total Cost: Z + K

SELF ASSESSMENT

1. Write names of documents that would be used to make road maintenance estimate in the following line
   a. *Estimate of Annual Maintenance Plan*

   .....

   .....

   .....

   .....

   .....

   .....

   b. *Estimate of maintenance works for particular roads*

   .....

   .....

   .....

   .....

   .....

   .....

   Good | Not Good

2. Fill steps to make road maintenance estimate in the lines below

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   Good | Not good

3.3 MAINTENANCE FUNDING

◆SUMMARY

After completing Session 3.3 participants should be able to understand the funding sources for Rural Road Maintenance, and know how to choose and mobilise these resources. They should be able to make plans for mobilising funding resources and understand various and models of maintenance implementation.

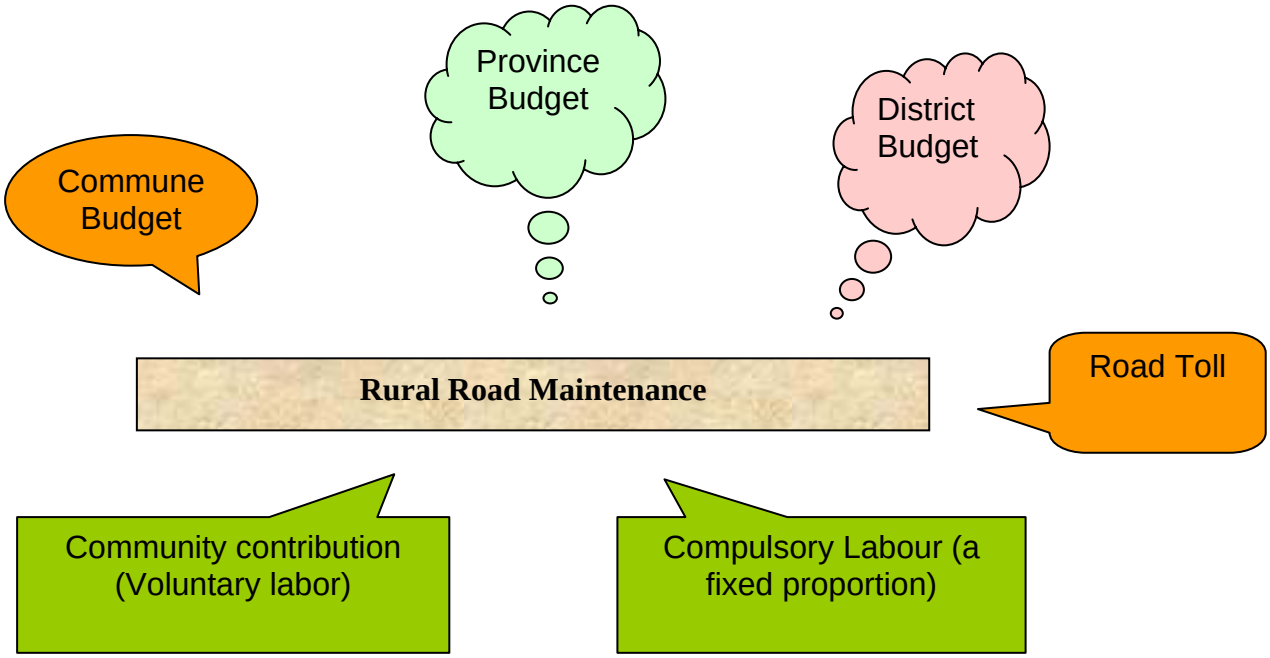
The participants are introduced funding sources that can be mobilised for Rural Road Maintenance and to models of maintenance implementation. The participants will prepare plans for Road Maintenance fund mobilisation & effective implementation with respect to local conditions.

ACTIVITIES:

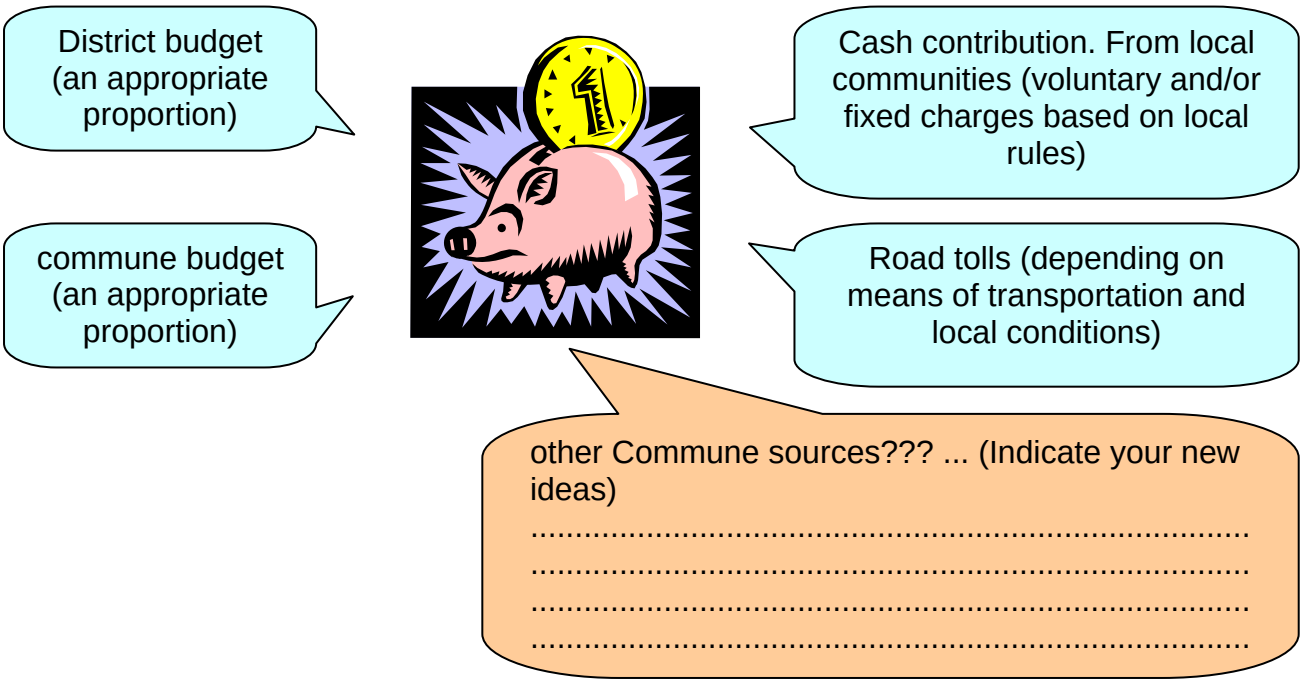
a) Learn about the funding sources that can be mobilised for Rural Road Maintenance
b) Learn about the models for implementation of Rural Road Maintenance
c) Prepare plans for funding mobilization & determining models for implementation of Road Maintenance
d) Self – assessment

Funding sources for Rural Road Maintenance

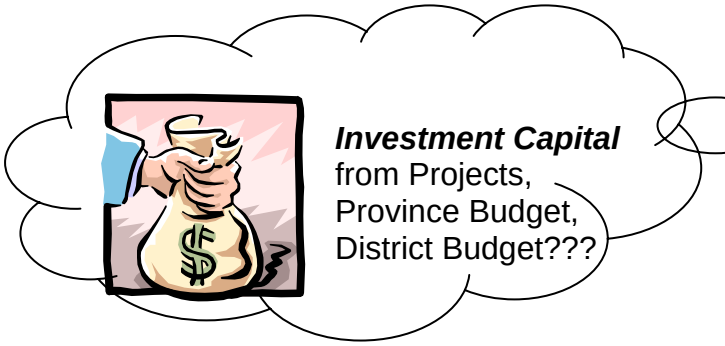
☞ Look at the below chart and memorize **possible funding sources** for Rural Road Maintenance



☞ ***Special fund exclusive for Rural Road Maintenance and Repair*** may be established using following sources

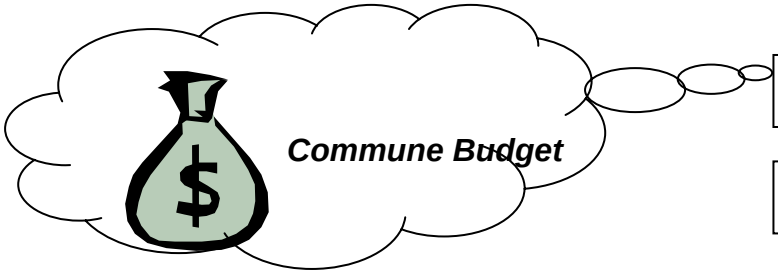


☞ ***Funds for Road Maintenance in your local area? –Tick (✔) in the boxes below to indicate funding sources that your region ever used.***



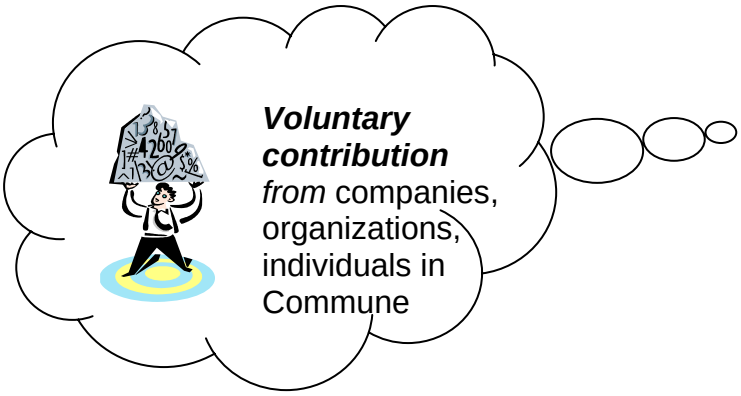
Investment Capital from Projects, Province Budget, District Budget???

Yes	
No	



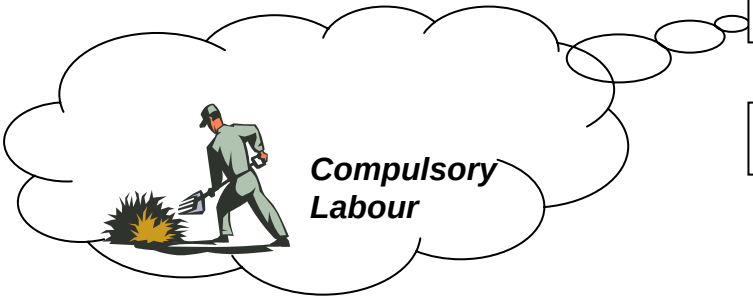
Commune Budget

Yes	
No	



Voluntary contribution *from* companies, organizations, individuals in Commune

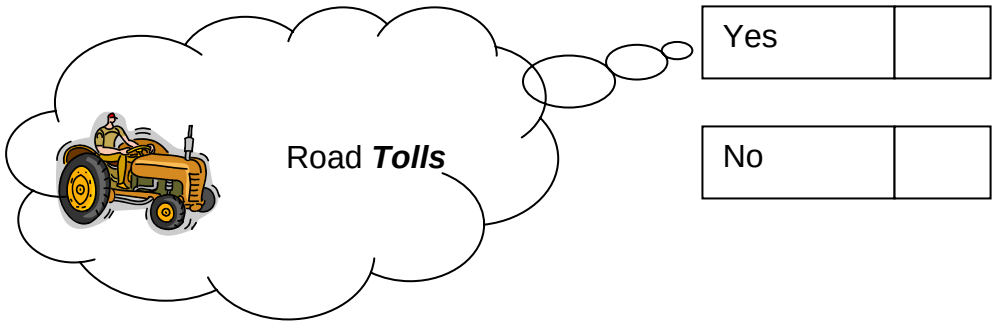
Yes	
No	



Compulsory Labour

Yes	
No	

Rural road maintenance



NOTES

If local leaders and each community, companies and organizations pay more attention to, there should be ENOUGH MONEY for Rural Road Maintenance.

Models of Rural Road Maintenance implementation

Comprehension of models for Rural Road Maintenance implementation

There are 6 maintenance implementation options for rural roads, these are:

1. Large contractors (SOE or Private)
2. Small contractors (Private)
3. Force account (District or commune road maintenance groups)
4. Community group.
5. Length person or Family contract
6. Compulsory/Voluntary labour

Each option has its own advantages and disadvantages depending on local conditions. For example when the funding is sufficient and stable, it is possible to use large and small contractors. But when the funds are limited, the options will be restricted to the labour based methods of, local community group, family contracts or compulsory/ voluntary labour. It may be suitable to use local community group or family contracts in provinces having high density of population, but these options may be more difficult to implement in mountainous or highland provinces with low density of population, where force account or small contractor arrangements may be more suitable.

☞ ***Please fill in following table*** the characteristic that you think most important and the model of Rural Road Maintenance implementation that should be applied

large Contractor	**Main characteristics** 1. Highly professional 2. Little connection with communities 3. Not enough money to pay	**Application Circumstance** 1. Periodic Maintenance (medium repair) 2. Urgent Maintenance
Fund administrator	**Main characteristics** 1. .... 2. .... 3.	**Application Circumstance** 1. .... 2. .... 3. ....
Fund administrator	**Main characteristics** 1. .... 2. .... 3.	**Application Circumstance** 1. .... 2. .... 3. ....
Local community	**Main characteristics** 1. .... 2. .... 3.	**Application Circumstance** 1. .... 2. .... 3. ....

Length person/family	**Main characteristics** 1. .... 2. .... 3.	**Application Circumstance** 1. .... 2. .... 3. ....
Compulsory/voluntary labor	**Main characteristics** 1. .... 2. .... 3.	**Application Circumstance** 1. .... 2. .... 3. ....

NOTES

With your local funding mobilization and necessary maintenance activities, you can CHOOSE the appropriate model to implement road maintenance

☞ ***Think of*** your commune, make a proposal of fund mobilization to apply to the circumstances of your local commune

Commune.....District.....Province.....		
Funding estimated for road maintenance	Calculating method	Total Amount
1. Funds from Province *2. District Budget* *3. Commune Budget* *4. Local community's contribution* *5. .....* .... ***Total:***	....	....

☞ ***Think of*** your Commune Road Network, choose the appropriate road maintenance implementation model by ***marking*** in the appropriate line

Models of road maintenance implementation	Your *Commune's* Fund	Possible use e.g. ***Commune A***
1. Large Contractor	.....	.....
2. Small Contractor	.....	.....
3. Fund Administrator	.....	.....
4. Local Community	.....	.....
5. Length person/family contract	.....	.....
6. *Compulsory/ Voluntary Labor*	.....	.....

SELF ASSESSMENT

1. Fill in following line with funds that you think possible to be mobilized for rural road maintenance
   a. .....
   b. .....
   c. .....
   d. .....
   e. .....
   f. .....
   g. .....
   h. .....
   i. .....
   .....

Good	Not good

2. Tick (✔) in the boxes to indicate the correlation to the available model of Rural Road Maintenance implementation.

- *Road Maintenance and Repair Company No. 471* ☐
- *Fertilizer Shop.* ☐
- *Son Thuy Commune Youth Association* ☐
- *Son Thuy Commune Women Association* ☐
- *Hanh Dung Rattan Weaving Enterprise* ☐
- *Huu Loi Enterprise* ☐
- *Road Administration Sub-Unit No.3 - Quan Son District - Thanh Hoa Province* ☐

Good	Not good

4.1 MAINTENANCE PLANNING

◆SUMMARY

After completing Session 4.1 participants should be able to understand the rural road maintenance planning process and know steps in planning rural road maintenance. Participants should then be able to make a rural road maintenance plan by themselves.

The participants are introduced steps to in establishing a Rural Road Maintenance plan and then are guided on how to produce commune road maintenance plans.

ACTIVITIES:

a) Find out about the structure of planning forms for road maintenance & data sources in a road maintenance plan.
b) Learn about planning procedures in road maintenance
c) Establish a plan of road maintenance
d) Self - assessment

Rural Road Maintenance Planning

Table 8. ANNUAL ROAD CONDITION ASSESSMENT – FIELD SURVEY FORM
(to be drawn A4 size with km columns wider to accommodate information >>>>)

COMMUNE:			**ROAD:**						
ROAD LENGTH: km			**Road Code:**				**Date:**		
Defect and extent of road affected						**TOTAL DEFECTS**	**A = TOTAL DEFECTS / LENGTH OF ROAD (km)**	**% AFFECTED = A/10**	**RATING**
Location (km)	1	2	3	4	5				
Side drains defective (metres of road affected)									
Vegetation to be cleared (metres of road affected)									
EARTH, GRAVEL AND CRUSHED STONE PAVEMENTS ONLY									
1-2% Surface Crossfall % (metres of road affected)									***Bad***
<1%									***VB***
Potholes (% of road surface area)									
>3cm or ≤ 5cm Corrugations (metres of road affected)									
> 5cm									
Soft spots (metres of road affected)									
Residual gravel thickness (cm)							Length of road needing re-gravelling……m		
BITUMEN/BRICK PAVEMENTS ONLY									
Surface Cracking (metres of road affected)									
Potholes (% of road surface area)									
CONCRETE PAVEMENTS ONLY									
Corner break (No of panels)									
Panels cracked (No of panels)									
No of panels with cracking > 1 m/m²							Number of panels need to be replaced		
OTHER DEFECTS (QUANTIFY)/ REMARKS									

Number of structures requiring inspection
Culverts:
Bridges:
Retaining walls: Inspector:

Table 9. ANNUAL ROAD CONDITION ASSESSMENT – FIELD SURVEY FORM
EXAMPLE
(to be drawn A4 size with km columns wider to accommodate information >>>>)

COMMUNE: XXXX						**ROAD: XXXXXc**			
ROAD LENGTH: 3.9 km			**Road Code: HA02R3.5/5D3.9**				**Date: 3 – 12 - 2002**		
Defect and extent of road affected						**TOTAL DEFECTS**	**% TOTAL DEFECTS / LENGTH OF ROAD %**	**AFFECTED – A/10**	**RATING**
Location (km)	1	2	3	4	5				
Side drains defective (metres of road affected)	**-**	**-**	**-**	**-**		**0**	**0**	**0**	✔
Vegetation to be cleared (metres of road affected)	**40**	**-**	**80**	**-**		**120**	**31**	**3.1**	***Bad***
EARTH, GRAVEL AND CRUSHED STONE PAVEMENTS ONLY									
1-2% Surface Crossfall % (metres of road affected)	**800**	**700**	**-**	**400**		**1900**	**487**	**49**	***Bad***
<1%	-	-	-	-		-	-	-	***VB***
Potholes (% of road surface area)	**10**	**0**	**0**	**2**		**12**	**3.1**	**0.3**	✔
>3cm or ≤ 5cm	**200**	**0**	**0**	**300**		**500**	**128**	**12.8**	
Corrugations (metres of road affected) > 5cm	**200**	**0**	**0**	**200**		**400**	**103**	**10.3**	
Soft spots (metres of road affected)	**-**	**5**	**-**	**-**		**5**	**1.5**	**0.2**	✔
Residual gravel thickness (cm)	**5**	**11**	**12**	**10**			Length of road needing re-gravelling **1,000** m		
BITUMEN/BRICK PAVEMENTS ONLY									
Surface Cracking (metres of road affected)									
CONCRETE PAVEMENTS ONLY									
Corner break (No of panels)									
Panels cracked (No of panels)									
No of panels with cracking > 1 m/m²							Number of panels need to be replaced		

OTHER DEFECTS (QUANTIFY)/ REMARKS ***There are 3 Indicators = Bad, 1 Indicator Very Bad.***
1,000 metres require regravelling = 525cubic metres compacted = about 660 cubic metres loose.

Number of structures requiring inspection
Culverts: ***Culvert at km 0.75 has crack on north west wingwall and damaged outlet apron***
Bridges: ***Bridge at km 2.70 requires inspection after flood***
Retaining walls: Inspector:

☞ ***Study thoroughly*** the example of annual rural road maintenance plan shown in the above table then write the answers to questions in following lines

Question 1: Which documents and information that you need to make a road maintenance plan?
Answers:

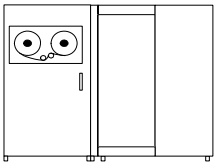
- .....
- .....
- .....
- .....
- .....
- .....
- .....
- .....

Question 2: Which knowledge that you need to make a road maintenance plan?
Answers:

- .....
- .....
- .....
- .....
- .....
- .....
- .....
- .....

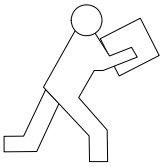
Study carefully procedure of road maintenance planning to checks the answers above

1



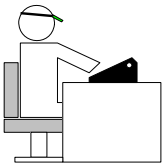
Make Road Inventory

2



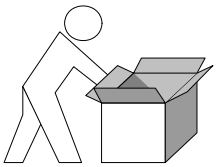
Road Defect Survey

3



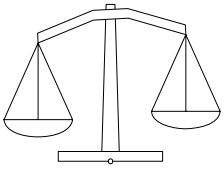
Define Road Maintenance demand and cost

4



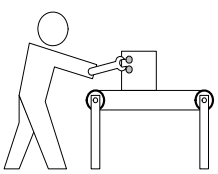
Fund mobilization planning

5



Define priority to balance fund

6



Finish road maintenance plan

☞ ***Study*** the following example of road maintenance planning for a Commune Road Network

1. ***Road Inventory of Son Thuy commune***

road inventory form

No	Road Code	Road Name	Road Length (km)	Pavement Type	Pavement Width (m)	*Number of <6m span culvers & bridges*	*Number of ≥6m span bridges*	*Distance of material transport (km)*
1	ST01R3.5/5D8.6	A	8.6	Earth Road	3.5	*24*	*2*	*Laterite quarry / 0.6*
2	ST02R3.5/5D6.0	B	6.0	Earth Road	3.5	*18*	*3*	*Laterite quarry / 1.6*
3	ST03R3.5/5D3.6	C	3.6	Earth Road	3.5	*8*	*0*	*Laterite quarry / 0.7*

2. ***Road defects survey***

(Data in the table below is assumed)

Table 8a - road defects quantity - site surveying results form								
Commune: y						*Road : **A***		
Road Length: 8.6 km			*Road Code:* ST01R3.5/5D8.6			*Date: 15 - 3 - 2005*		
Pavement Type: Earth Pavement - Road/Pavement width: 3.5m/5.0m						***condition assessment***		***road defect quantity***
Road defect and sphere of influence								
Chainage (km)	*K0 - K2*	*K2 - K4*	*K4 - K6*	*K6 - K8*	*K 8 - K8 + 600*	*Quant it-y*	*Condi tion Assess ment*	
Side Drain cleaning (m)	*125*	*50*	*80*	*300*	*150*	*785 m*	*Bad*	*705 m*
Drain excavation (m/m3)	*40/12.8*	*0*	*20/6.4*	*20/6.4*	*0*			*25.6m3*
Brush/Grass clearing (m2)	*60*	*50*	*20*	*120*	*40*	*290 m2*	*Bad*	*290 m2*
pavement								
> 5cm deep corrugation (m)/(m2)	*60/210*	*0*	*0*	*120/320*	*0*	*2%*	*Bad*	*530 m2*
10 cm deep pothole (m2)	*80*	*20*	*130*	*50*	*40*	*1.36 %*	*Fairly Good*	*320 m2*
15 cm deep pothole (m2)	*20*	*30*	*0*	*0*	*20*			*70 m2*
Soft spot (m2)/(m3)	*6/3.6*	*0*	*6/3.0*	*7/2.8*	*0*			*7.4*
bridge, culvert and other structures								

Table 8a - road defects quantity - site surveying results form								
Commune: y						*Road : B*		
Road Length: 6.0 km			*Road Code:* ST02R3.5/5D6.0			*Date: 16 - 3 - 2005*		
Pavement Type: Earth Pavement Pavement/Road width: 3.5m/5.0m						***condition assessment***		***road defect quantity***
Road defect and sphere of influence								
Location (km)	*K0 - K1+500*	*K1+500 - K3*	*K3 - K4*	*K4-K5*	*K5 - K6*	*Quant it-y*	*Condi tion Assess ment*	
Side Drain cleaning (m)	*0*	*0*	*0*	*0*	*80*	*130 m*	*Bad*	*80 m*
Drain excavation (m/m3)	*50/16*	*0*	*0*	*0*	*0*			*16m3*
Brush/Grass clearing (m2)	*0*	*0*	*0*	*70*	*80*	*150 m2*	*Bad*	*150 m2*
pavement								
> 5cm deep corrugation (m)/(m2)	*0*	*0*	*0*	*0*	*0*	*0*	*Good*	*0*
10 cm deep pothole (m2)	*40*	*0*	*0*	*100*	*50*	*1.34 %*	*Fairly Good*	*190 m2*
15 cm deep pothole (m2)	*30*	*15*	*0*	*10*	*0*			*45 m2*
Soft spot (m2)/(m3)	*4/3.2*	*7/3.5*	*0*	*0*	*6/3.0*			*9.7 m3*
bridge, culvert and other structures								

Table 8a - road defects quantity - site surveying results form								
Commune: Son Thuy						*Road :**C***		
Road Length: 3.6 km			*Road Code:* ST03R3.5/5D3.6			*Date: 17 - 3 - 2005*		
Pavement Type: Earth Pavement Pavement/Road width: 3.5m/5.0m						***condition assessment***		***road defect quantity***
Road defect and sphere of influence								
Location (km)	*K0 - K1*	*K1- K2*	*K2 - K3*	*K3- K3+600*		*Quant it-y*	*Condi tion Assess ment*	
Side Drain cleaning (m)	*0*	*80*	*98*	*0*		*238 m*	*Bad*	*178 m*
Drain excavation (m/m3)	*0*	*20/6.4*	*40/12.8*	*0*				*19.2m3*
Brush/Grass clearing (m2)	*18*	*32*	*40*	*40*		*130 m2*	*Bad*	*130 m2*
pavement								
> 5cm deep corrugation (m)/(m2)	*0*	*60/210*	*0*	*0*		*1.67 %*	*Bad*	*210*
10 cm deep pothole (m2)	*20*	*30*	*50*	*20*		*1.7 %*	*Fairly Good*	*120 m2*
15 cm deep pothole (m2)	*20*	*25*	*25*	*10*				*80 m2*
Soft spot (m2)/(m3)	*7/3.5*	*6/3.6*	*0*	*6/2.4*				*9.5 m3*
bridge, culvert and other structures								

2. <u>Define road maintenance quantity and cost</u>

Comprehensive table of road maintenance quantity

No.	Items	Unit	Road Maintenance Quantity
I	**Road bed and Drainage**		
1	Brush/ Grass clearing	m2	570
2	Side drain cleaning	m	963
3	Drain excavation	m3	60.8
II	**Pavement**		
4	*Corrugation removing*	m2	740
5	*10 cm deep pothole filling*	m2	630
6	*15 cm deep pothole filling*	m2	195
7	*Soft spot treatment*	m3	26.6

Unit price of road maintenance items

Code.	Description	Unit	Quantity	Unit Price	Cost	Note
XR.65	***Side drain cleaning***	m	1	$	**$**	
	Labor				0.03	
	class 3.5/7	daywork	0.035	0.74	0.03	
BA.1733	***Side drain clearing***	m3	1		0.00	
	Labor				0.80	
	class 2.7/7	daywork	1.17	0.69	0.80	
XR.66	***Brush/grass clearing***	m2	1		0.00	
	Labor				0.02	
	class 3.5/7	daywork	0.022	0.74	0.02	
XR.34.21	***Corrugation removing***	m2	1		0.00	
	Material				0.28	
	Natural gravel	m3	0.14	1.99	0.28	
	Labor				0.03	
	class 3.7/7	daywork	0.035	0.75	0.03	
	Machine				0.15	
	10T Roller	daywork	0.003	16.42	0.05	
	5 m3 watering truck	daywork	0.005	19.49	0.10	
XR.11.11	***10 cm deep pothole filling***	m2	1		0.00	
	Material				0.29	
	Natural gravel	m3	0.145	1.99	0.29	
	Labor				0.18	
	class 4/7	daywork	0.238	0.77	0.18	
	Machine				0.01	
	5 m3 watering truck	daywork	0.0007	19.49	0.01	
XR.11.12	***15 cm deep pothole filling***	m2	1		0.00	
	Material				0.43	
	Natural gravel	m3	0.217	1.99	0.43	
	Labor				0.28	
	class 4/7	daywork	0.238	0.77	0.28	
	Machine				0.02	
	5 m3 watering truck	daywork	0.238	19.49	0.02	
XR.45.30	***Soft spot treatment***	m3	1	0.74	0.00	

	Material				2.78	
	Natural gravel	m3	1.4	1.99	2.78	
	Labor				0.64	
	class 3.7/7	daywork	0.85	0.75	0.64	
	Machine				0.13	
	5 m3 watering truck	daywork	0.002	19.49	0.04	
	Vibrating compactor	daywork	0.033	2.85	0.09	

Maintenance Estimating Sheet

No.	Items	Unit	Quanti-ty	Unit Price $			Cost $		
				Material	Labor	Machine	Material	Labor	Machine
I	**Road bed and Drainage**								
1	Brush/ Grass clearing	m2	570		0.02			9.23	
2	Side drain cleaning	m	963		0.03			24.84	
3	Drain excavation	m3	60.8		0.80			48.90	
II	**Pavement**				0.00			0.00	
4	*Corrugation removing*	m2	630	0.29	0.18	0.01	181.66	115.26	8.59
5	*10 cm deep pothole filling*	m2	195	0.43	0.28	0.02	84.15	54.11	3.04
6	*15 cm deep pothole filling*	m2	740	0.28	0.03	0.15	206.02	19.43	108.56
7	*Soft spot treatment*	m3	26.6	2.78	0.64	0.13	74.06	16.95	3.54
	Total						545.89	288.72	123.73

Direct Cost

VL = $545.89 $545.89

NC =$288.72 x 3.36 = $970.10

M = $123.73 x 1.4 = $173.22

T = VL +NC + M = = $1,689.21

Overhead cost

C = 5.3 % x T = = $89.53

Maintenance Cost

Z = T + C = = $1,778.74

Management Cost

K = 1% x Z = $17.79

Total cost: Z + K $1,796.53

3. ***Fund mobilization and maintenance organization models***

The table below expresses results of fund mobilization and maintenance organization models (assumed data)

Funding resources	Calculation	Mobilized funds $
- Commune Budget	Deduct 5% from total budget of 100,000,000 VND	300
- District Budget	Support $200	200
- Monetary community contribution	$1 household/ 1year -150 household	150
- Compulsory Labor	1 daywork/1year/person - 300 people - 1 daywork value =$1	300
- Transport business fee	$5VND/1household/1year - 18 household	90
- Business/Production Agent contribution	$25 VND/1Agent/1year - 8 agents	200
Total		**$1,240**

4. ***Define priority and balance funds***

Maintenance activities in the following table are expressed in priority order

No.	Maintenance Activities	Maintenance Cost (Direct Cost) $	Total Cost $	Accumulative Cost $
1	Side drain cleaning	24.84	41.65	41.65
2	Drain excavating	48.90	81.99	123.64
3	Soft spot treatment	94.54	106.79	230.43
4	15 cm deep pothole filling	141.30	178.78	409.21
5	10 cm deep pothole filling	305.51	385.40	794.61
6	Brush/Grass clearing	9.23	15.48	810.09
7	Corrugation/rut removing	334.01	350.30	1,160.38

Roads in the table below are expressed in priority order of road importance.

No	Road Code	Road Name	Traffic Volume (Daily PCU)	Corrugation removing quantity	Cost	Accumulative Cost
1	ST01R3.5/5D8.6	A	150	530	$250.89	250.89
2	ST03R3.5/5D3.6	B	95	210	Left to carry out later	
3	ST02R3.5/5D6.0	C	80	0		

5. ***Road maintenance plan and estimated implementing models***

Look at the table below that presents Road Maintenance Plan and Corresponding Estimated Implementing Models

No.	**Maintenance Activities**	**Cost $**	**Estimated Implementing Model**
1	Side drain cleaning	41.65	Compulsory Labor
2	Drain excavating	81.99	
3	Soft spot treatment	106.79	Force Account
4	15 cm deep pothole filling	178.78	
5	10 cm deep pothole filling	385.40	
6	Brush/Grass clearing	15.48	Compulsory Labour
7	Corrugation/rut removing - road ST01R3.5/5D8.6	250.89	Force Account
Total		1,060.98	

***Remarks: The plan is established with total cost of $*1,060.98 *VND, and balanced with mobilized fund of* $1,240**

☞ ***Practice*** road maintenance planning based on your actual commune condition - ***Fill*** necessary data in the following tables

1. Commune Road Inventory

Road Inventory form

No	Road Code	Road Name	Road Length (km)	Pavement Type	Pavement Width (m)	*Number of <6m span culvers & bridges*	*Number of ≥6m span bridges*	*Distance of material transport (km)*
1								
2								
3								

3. Road defects survey

Table 8a - road defects quantity - site surveying results form								
Commune:						*Road :*		
Road Length: *km*			*Road Code:*			*Date:*		
Pavement Type: .....- *Pavement/Road width: .....*						***condition assessment***		***road defect quantity***
Road defect and sphere of influence								
Location (km)						*Quantity*	*Condition Assessment*	
pavement								
bridge, culvert and other structures								

Table 8a - road defects quantity - site surveying results form			
Commune:		*Road :*	
Road Length: *km*	*Road Code:*	*Date:*	

Pavement Type: .....- Pavement/Road width:						***condition assessment***		***road defect quantity***
Road defect and sphere of influence								
Location (km)						*Quant it-y*	*Condi tion Assess ment*	
pavement								
bridge, culvert and other structures								

Table 8a - road defects quantity - site surveying results form								
Commune:						*Road :*		
Road Length: km			*Road Code:*			*Date:*		
Pavement Type: .....- Pavement/Road width:						***condition assessment***		***road defect quantity***
Road defect and sphere of influence								
Location (km)						*Quant it-y*	*Condi tion Assess ment*	
Pavement								
Bridge, culvert and other structures								

6. <u>Define maintenance quantity and cost</u>

Combine maintenance quantity in the tables above and fill in the following table:

No.	**Items**	**Unit**	**Maintenance Quantity**
I	***Road bed and Location***		
II	***Pavement***		
.....	.....	.....	.....
II	***Bridge, Culvert, and other Structures***		
.....	.....	.....	.....

Finish the Unit Price of following calculations & supplement other necessary Unit Price calculations

Code	Descriptions	Unit	Quantity	Unit Price	Cost	Note
XR.65	***Side drain cleaning***	m	1			
	Labor				**454**	
	class 3.5/7	daywork	0.035	12971	454	
BA.1733	***Drain excavating***	m3	1			
	Labor				**14,156**	
	class 2.7/7	daywork	1.17	12099	14,156	
XR.66	***Brush/Grass clearing***	m2	1			
	Labor				**285**	
	class 3.5/7	daywork	0.022	12971	285	
XR.34.21	***Corrugation removing***	m2	1			
	Material				**.....**	
	Natural gravel	m3	0.14	.....	.....	
	Labor				**462**	
	class 3.7/7	daywork	0.035	13193	462	
	Machine				**2,582**	
	10 ton roller	daywork	0.003	288922	867	
	5 m3 watering truck	daywork	0.005	343052	1,715	
XR.11.11	***10 cm deep pothole filling***	m2	1			
	Material				**.....**	
	Natural gravel	m3	0.145	.....	.....	
	Labor				**3,220**	
	class 4/7	daywork	0.003	13529	3,220	
	Machinery				**240**	
	5 m3 watering truck	daywork	0.003	343052	240	
XR.11.12	***15 cm deep pothole filling***	m2	1			
	Material				**.....**	
	Natural gravel	m3	0.217	.....	.....	
	Labor				**4,884**	
	class 4/7	daywork	0.361	13529	4,884	
	Machinery				**274**	
	5 m3 watering truck	daywork	0.0008	343052	274	
XR.45.30	***Soft spot treatment***	m3	1			
	Material				**.....**	
	Natural gravel	m3	1.4	.....	.....	
	Labor				**11,214**	
	class 3.7/7	daywork	0.85	13193	11,214	
	Machinery				**2,342**	
	5 m3 watering truck	daywork	0.002	343052	686	
	Vibrating compactor	daywork	0.033	50170	1,656	

Maintenance estimating sheet

No.	Items	Unit	Quant i-ty	Unit Price			Cost		
				Material	Labor	Machine	Material	Labor	Machine
I	**Road bed and Drainage**								
1									
2									
3									
II	**Pavement**								
III	**Bridge, Culvert, and other Structures**								

Direct Cost

VL =

NC =

M =

T = VL +NC + M =

Overhead Cost

C = 5.3 % x T =

Maintenance Cost

Z = T + C =

Management Cost

K = 1% x Z

Total Cost: Z + K

7. ***Fund Mobilization and Maintenance Organization Models***

Fill the results of fund mobilization in the table below

Funding Sources	Calculation	Mobilized Fund
Total		

8. ***Define priority and balance funding sources***

Fill in the table below the maintenance activities in priority order

No.	Maintenance Activity	Maintenance Cost (Direct cost)	Total cost	Accumulative Cost
1				
2				
3				
4				
5				
6				
7				

Remarks:

.....

.....

.

Fill in the table below maintenance activities in priority order of road importance

No.	Road Code	Road Name	Traffic Volume (Daily PCU)	Maintenance Quantity	Cost	Accumulative Cost

9. ***Maintenance Plan and Estimated Implementing Models***

Fill in the table below the maintenance activities and corresponding estimated implementing models

No.	Maintenance Activities	Cost	Estimated Implementing Models

Total Cost		

Remarks:

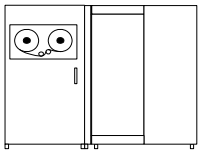
.....

note

It is necessary to have comprehensive, such as road inventory, defect survey, estimating... to establish a road maintenance plan.

SELF ASSESSMENT

1. Fill in the blanks below to finish planning procedures in road maintenance

1 

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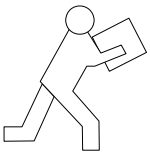
2 

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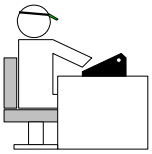
3 

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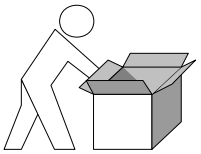
4 

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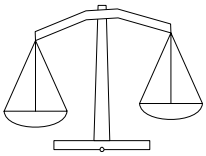
5 

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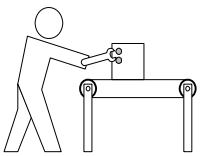
6 

.....

Good	Not good

4.2 MAINTENANCE WORKS QUALITY ASSESSMENT

◆SUMMARY

After completing Session 4.2 participants should be able to understand the parameters used to assess quality of Rural Road Maintenance works and know how to define the parameters to assess the maintenance works quality

The participants are introduced to the parameters for road maintenance quality assessment and given guidance on measuring, assessing the road maintenance quality.

ACTIVITIES:

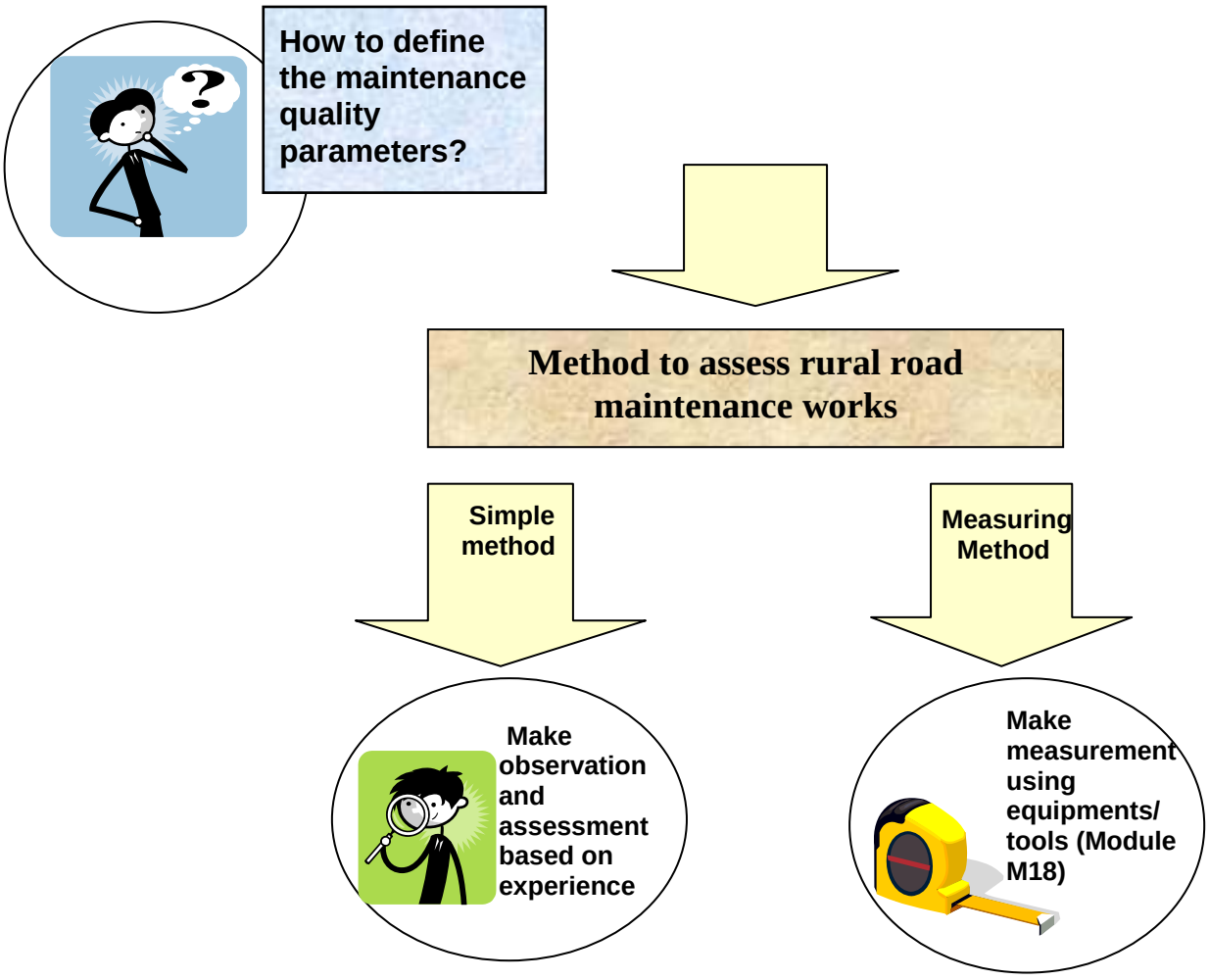
a) Learn about the parameters for road maintenance quality assessment
b) View & find out the measuring method to define the parameters for road maintenance assessment - equipments and/or tools, procedure & calculation.
c) Self - assessment

The parameters for road maintenance quality assessment

Quality assessment should be carried out not only when maintenance works is finished but also during implementation.

Each maintenance work can be assessed using particular parameters. Some popular parameters are given below.

- Material quality parameters (as presented in Module M11)
- Geometric dimension parameters
- Density of compacted soil and pavement materials.
- Evenness of bitumen spraying and crushed stone spreading.
- .....



Read the following presentation ***to know about*** parameters for geometric dimension assessment

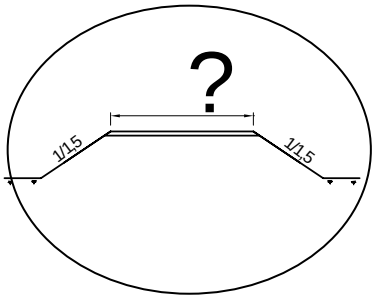
These parameter used to assess geometric dimensions of road maintenance works if it they conform to requirements.

Geometric dimension assessment parameters

Length/width:

1. Formation
2. Pavement
3. Drain
4. Retaining wall
5. Foundation

.....

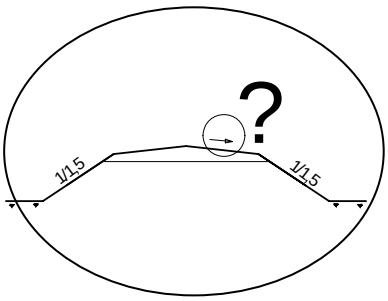


Length/width permitted tolerance:

1. It does not exceed tolerance of 10cm.
2. It does not exceed 5% respective dimensions of drains/ culverts...

Cross fall

1. Pavement camber
2. Formation



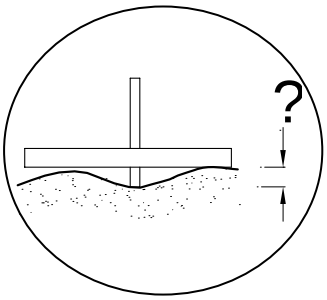
Cross fall permitted tolerance

It does not exceed:

1. ± 0.5% for pavement
2. ± 0.5% for shoulder

For example, the finished cross fall should be from (4 – 0.5) = 3,5% to (4+0.5) = 4.5% for required cross fall of 4%

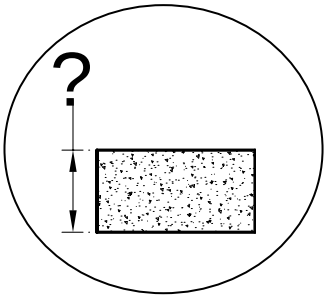
Roughness of pavement assessed by 3m straight edge



Roughness permitted tolerance:

Interstice between the straight edge and pavement does not exceed ..... mm depended on type of pavement

Pavement thickness



Pavement thickness permitted tolerance

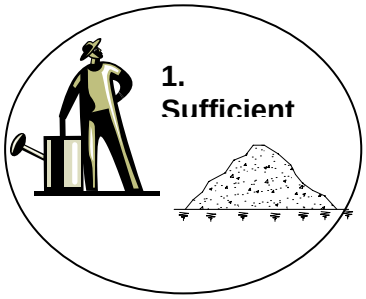
Maximum tolerance of pavement thickness is 10%

*For example, the finished pavement thickness should be from (20 - 20*10/100) = 18cm to*
*(20 + 20*10/100) = 22cm for required pavement thickness of 20cm*

☞ ***Read*** the following paragraph ***to understand*** parameter to assess evenness of bitumen spraying and chipping spreading

Manual bitumen spraying and chippings spreading usually are required during bituminous pavement construction and/or maintenance of rural road.

There are 2 main requirements of bitumen spraying and chippings spreading



Bitumen spraying:

The difference *of bitumen spraying rate per sq.m does not exceed* ***5%*** *in comparison with requirement*

Chippings spreading:

The difference *of chippings spreading rate per sq.m does not exceed* ***8%*** *in comparison with requirement*

Practice

Commune X Maintenance Group carried single bitumen sealing with bitumen rate of 1,2 kg/m^2; and chippings spreading rate (0,5x1cm sized) of 10 litre/m^2

Calculate the bitumen and chipping rate (per sq.m) that conform to requirement?

Solution

Calculate the chipping rate per sq.m:

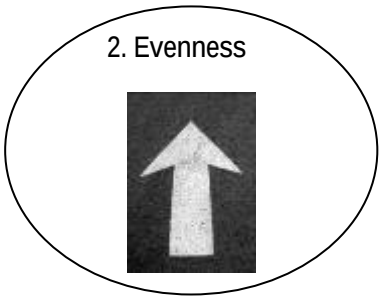
The minimum chipping rate is : 10litre - 10 litre *8/100 = 10 litre - 0,8 litre = 9,2 litre/m^2

The maximum chipping rate is: .....

Calculate the bitumen rate per sq.m:

The minimum bitumen rate is: .....

The maximum bitumen rate is: .....



Bitumen spraying:

The difference of bitumen in different locations on pavement does not exceed 10%

Chippings spreading:

The difference of chippings in different locations on pavement does not exceed 10%

Practice

Commune X Maintenance Group carried single bitumen sealing with bitumen rate of 1.2 kg/m^2; and chippings spreading rate (0.5x1cm sized) of 10 litre/m^2

Sprayed bitumen and spread chipping follow checking results at three locations on pavement are given below:

At checking location 1: bitumen : 1.15kg/m^2 ; chippings : 9.3 litre/m^2

At checking location 2: bitumen: 1.25kg/m^2 ; chippings: 10.7 litre /m^2

1.Check for sufficiency of bitumen & chippings at both of the checking locations

2. Check for evenness of bitumen spraying and chippings spreading?

Solutions

1. Check for sufficiency of bitumen and chippings

Items	Unit	Required Rate	Actual		Quantity differences in comparison with requirement		Permitted tolerance (%)	Conclusion	
			At location1	At location2	At location1	At location2		At location1	At location2
Bitumen	kg/m^2	1.2	9.3	10.7	(1.2-1.15) *100/1.2=4.16	.....	5	Good	.....
Chipping	litre/m^2	10	1.15	1.25	.....	=(10.7-10) *100/10=7	8	.....	Good

2. Check for evenness of bitumen spraying and chipping spreading

Items	Unit	Actual rate at	
		Location 1	Location 2
Chippings	litre/m^2	10.7	9.3
Bitumen	kg/m^2	1.15	1.25
Difference between rate at the locations	%	=(1.25-1.15)*100/1.15=8.7	.....
Permitted tolerance	%	10	10
Conclusion		Good	.....

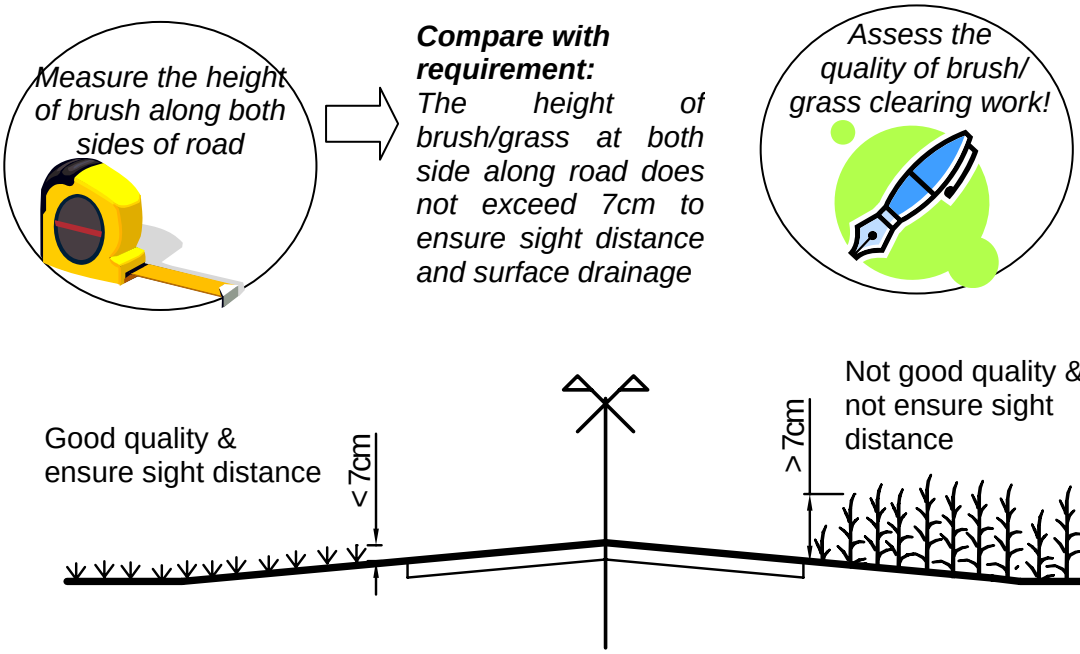
Final conclusion:

.....

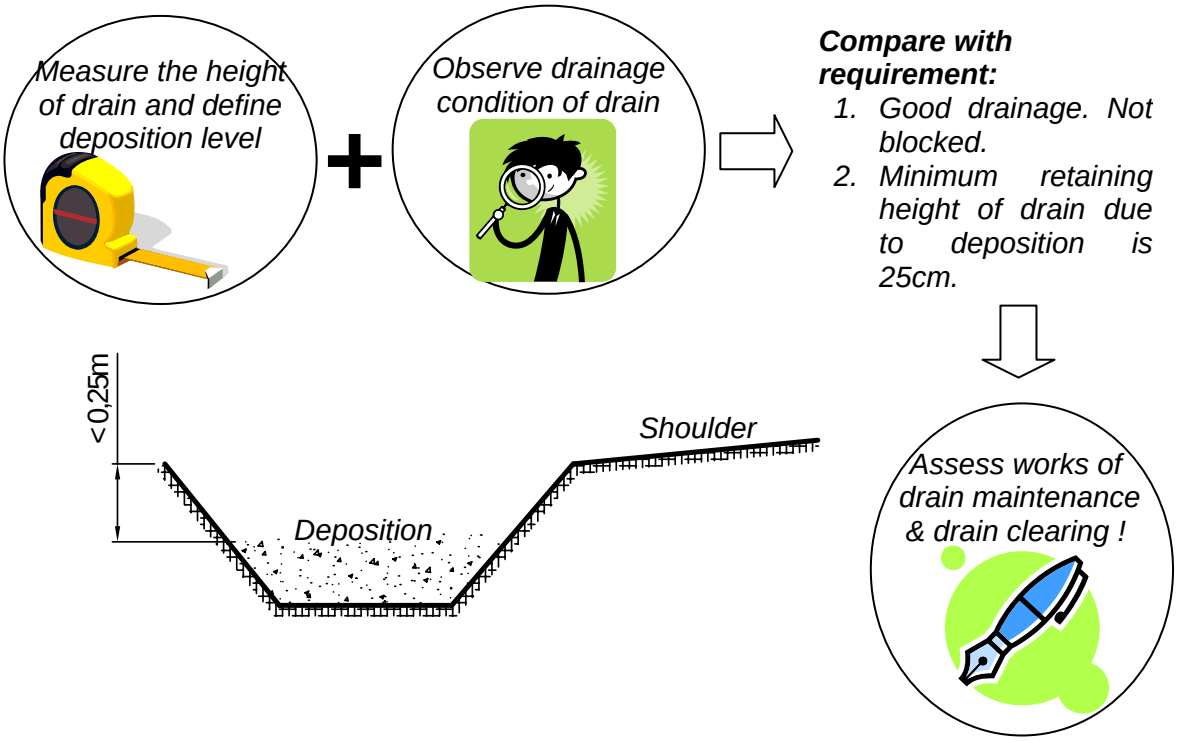
.....

1. Learn about measuring method to define quality control parameters of maintenance works - tools, procedure and calculation.

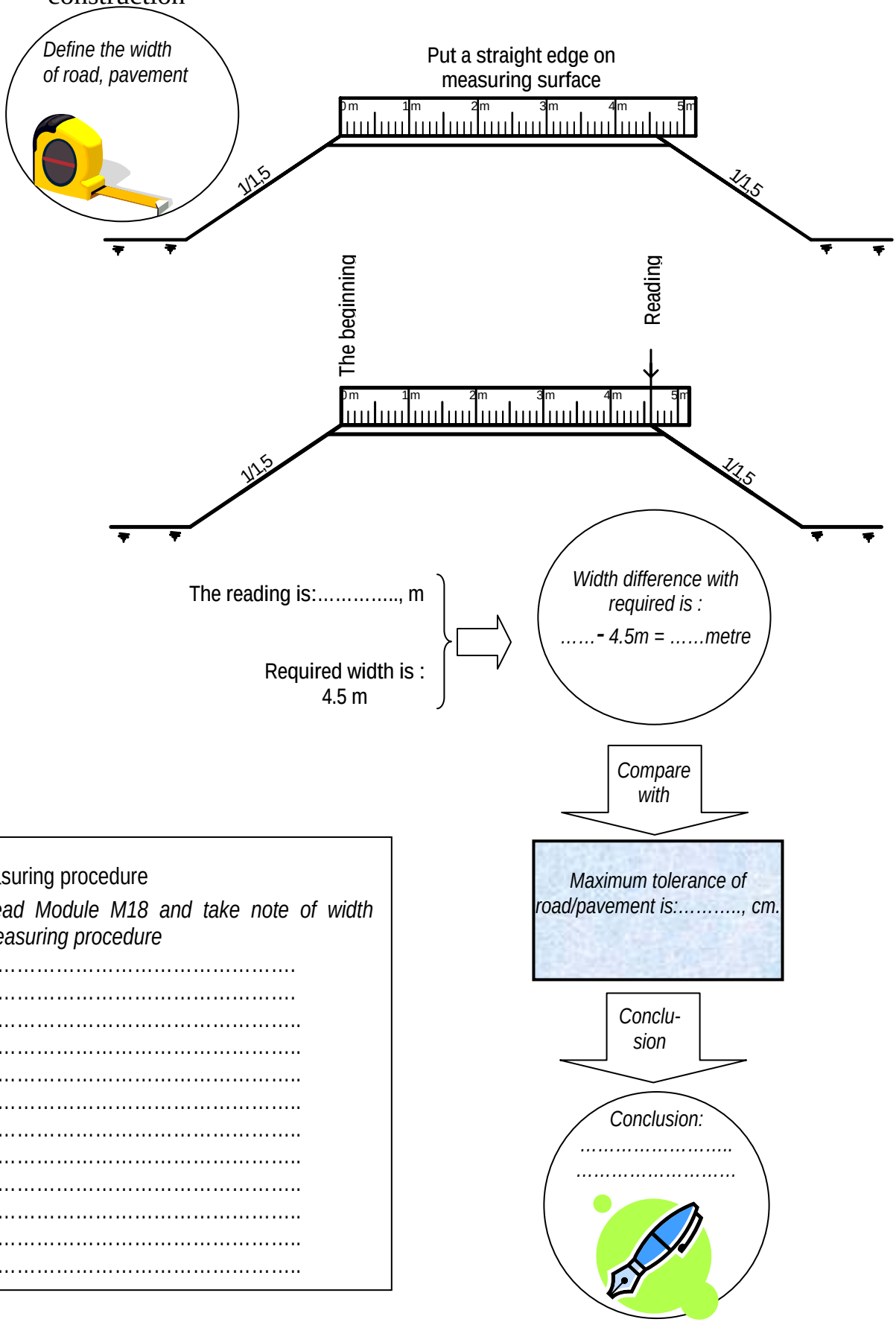
☞ ***Read*** the following paragraphs to know about quantity control of brush/grass clearing for sight distance.



☞ *Read & learn about method* to assess quality of drain clearing work



Read and learn about method to assess width of road after construction



Measuring procedure

Read Module M18 and take note of width measuring procedure

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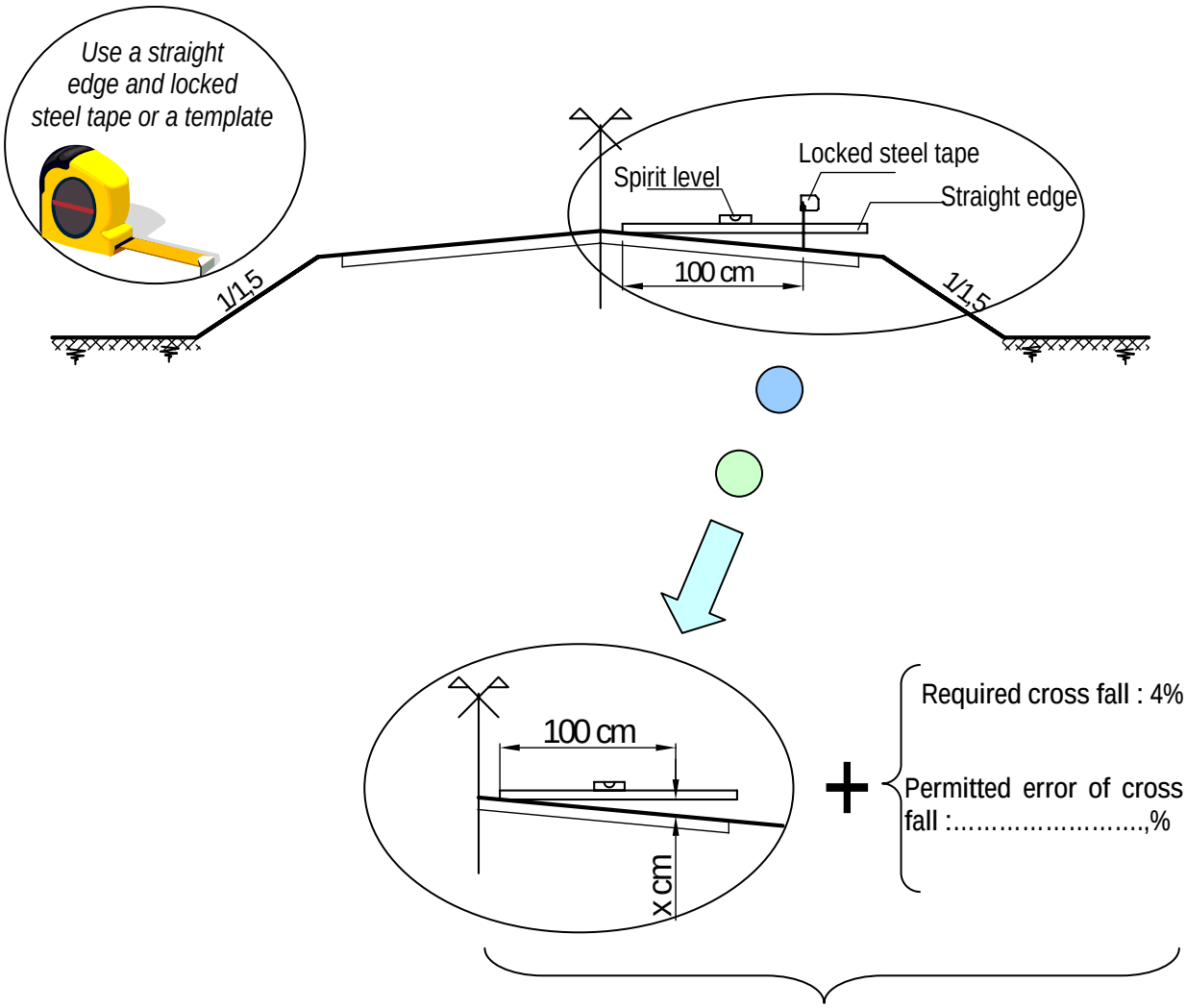
Read the paragraph below of cross fall (road camber) measuring



Measuring procedure

Read Module M18 again and take note of cross fall measuring:

……
……
……
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……
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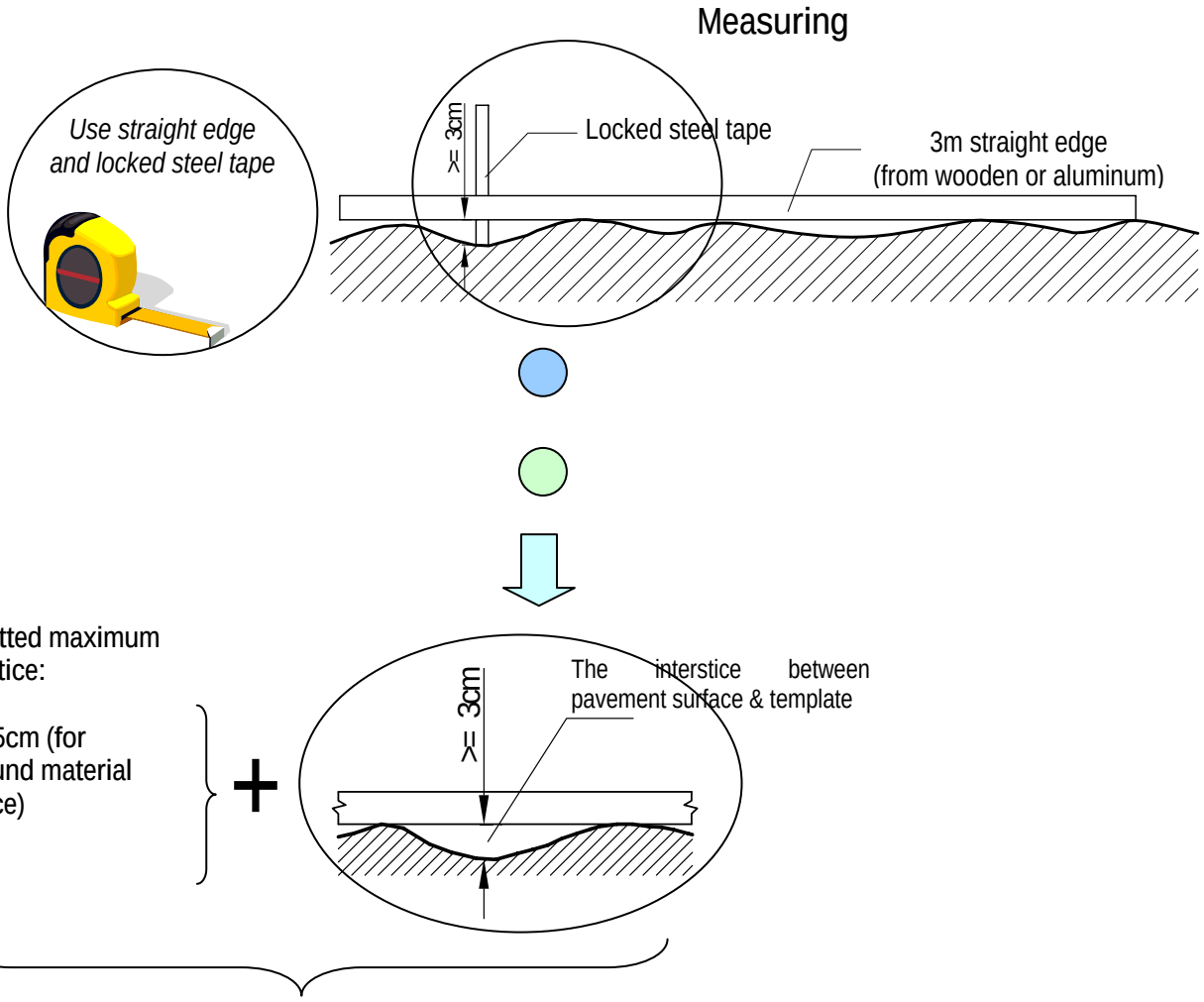
……
……
……
……
……

Calculation, Conclusion

It is satisfied at cross fall if the actual cross fall is
from:
4% - ……% = ……..%
to:
…… + ……% = …….%

☞ ***Learn about*** method to assess ***pavement roughness*** (corrugation level)



Measuring procedure:

Read Module 13 18 and summary measuring procedure of roughness using 3m straight edge

……
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……
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……
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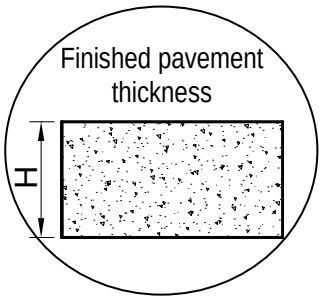
☞ *Read carefully* the method below of pavement thickness estimate and *make followed calculations*

Dig a pit and measure pavement thickness using straight edge or locked steel tape



Permitted tolerance of pavement material thickness does not exceed 10%.

The required finishing pavement thickness is 15 cm. What is the permitted range values of pavement thickness ? Present calculation in following line.

……
…

……
…

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…

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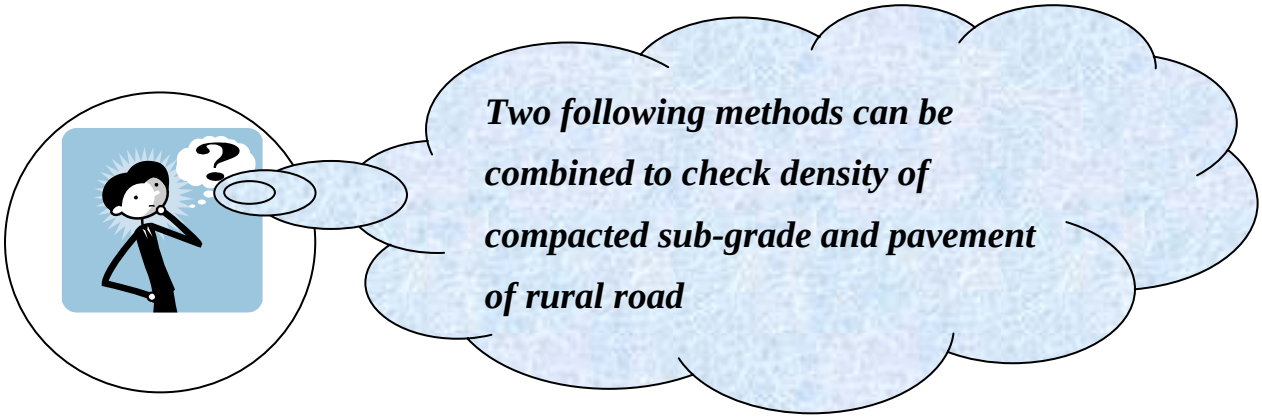
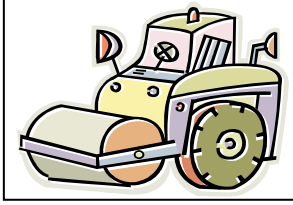
…

……
…

☞ ***Look at*** methods to assess density of compacted sub-grade and pavement material





Assess compaction level

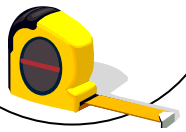
Observe marks on pavement surface during compaction

Measure to define compaction ratio ($K_{layering}$)
$K_{layering} = H_1/H_2$
H_1 & H_2 is material thickness before and after compaction

Observe pavement surface in front of roller:
corrugations during rolling means un-compacted

Observe behind roller:
Roller rutting means un-compacted

$K_{layering}$ < 1,3
means un-compacted



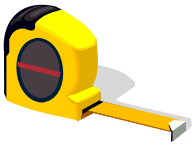
or

For crushed stone pavement
Put a crushed stone on pavement and let roller pass. The stone, that has pushed into pavement surface, means un-compacted. Otherwise, the stone that has been broken, means finishing compaction.

To define compaction ratio $K_{layering}$

1 **Measuring tools**

Locked steel tape



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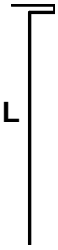
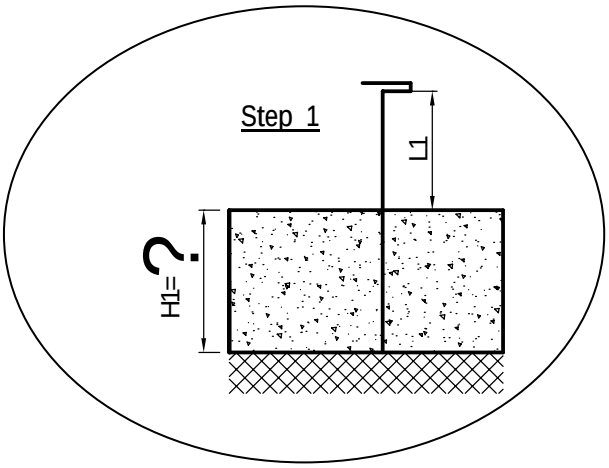


Steel bar (length **L**)

2 Measure material layer thickness

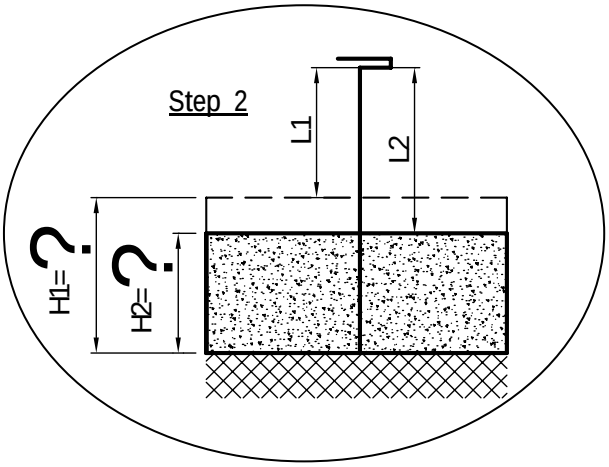


Step 1

After layering and grading:

1. *Put steel bar to full depth of layered material thickness.*
2. *Measure the distance, L_1, from top of steel bar to material layer surface using locked steel tape*

→ $H_1 = L - L_1$



Step 2

After compaction:

1. *Grade material around steel bar to compacted surface*
2. *Measure the distance, L_2, from top of steel bar to material layer surface using locked steel tape*

→ H_2 = ...

3 Calculate compaction ratio: $K_{layering} = \frac{H_1}{H_2}$

Note

Density is key factor of sub-grade and pavement quality. It should be controlled during construction and checked after completion

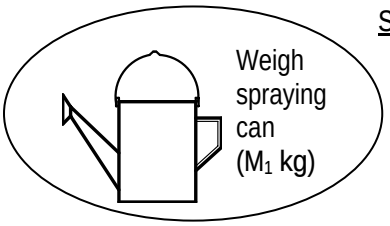
☞ ***Read* the** paragraph of bitumen spraying assessment below ***: bitumen rate & spraying evenness.***

Bitumen should be sprayed evenly and fully covered pavement surface. Hand-spraying should make by strips that overlaps 2-5 cm into each others. Walking speed of spraying worker need be controlled to ensure evenness.

1 Implementing Procedure

Step 1

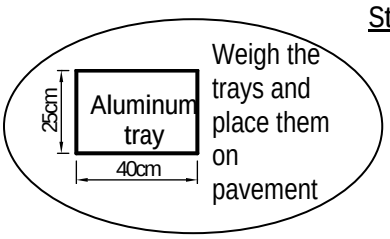
Weigh spraying can
The mass of spraying can is M_1 kg.



Step 2

Weigh two aluminum 25cmx40cm trays. Tray 1 weighs Q1 kg, ans tray 2 is Q_2 kg)

Place the trays on pavement that is going to be sprayed bitumen

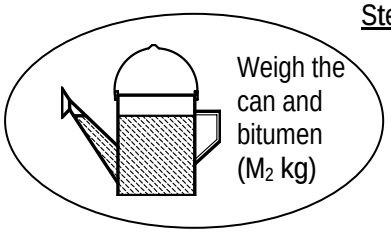


Step 3

Take hot bitumen into spraying can.

Weigh the spraying can that includes bitumen.

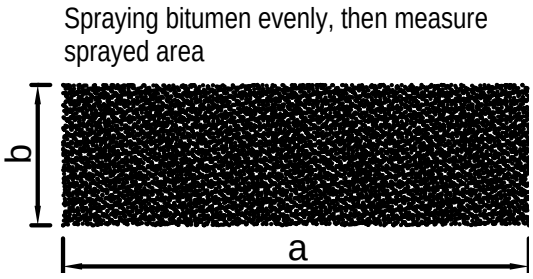
The mass of can included bitumen is M_2 kg



Step 4

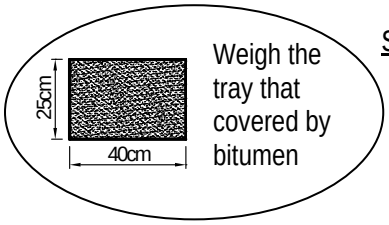
Spray all bitumen evenly on pavement surface (by rectangle strip).

Define the area of sprayed bitumen. S = a. b, (m^2)



Step 5

Take the aluminum trays that are covered by bitumen out of pavement and weigh::
Tray 1(covered by bitumen) weight is P1 kg
Tray 2 1(covered by bitumen) weight is P2 kg



2 Results and Assessments

Bitumen that has been sprayed on pavement

Bitumen content = $\frac{M_2 - M_1}{S}$, *kg/m²*

Compare the calculated bitumen rate with required rate to define if the difference exceed 5% ?

Bitumen that has been sprayed in tray 1 = $P_1 - Q_1$ (kg)

Bitumen that has been sprayed in tray 2 = $P_2 - Q_2$ (kg)

Make comparison to define if the deference between bitumen in the two trays exceed 10% ?

☞ *Assess chippings spreading*: chipping rate and evenness.

Chippings ar spread immediately after hot bitumen spraying. The two trays that has been covered by bitumen, is replace on pavement to define the evenness of chipping spread.

1 **Procedure**

Step 1

Measure out chippings by wooden box with dimension of ***a x b x h (dm)***

→ *Chipping volume in the box is :* ***V = a.b.h , litre***

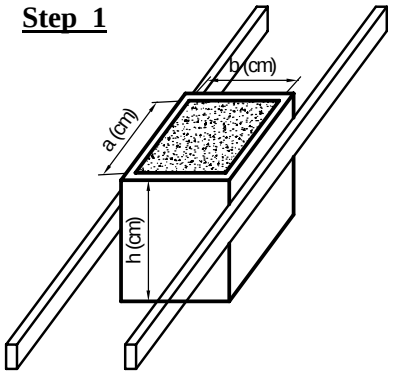
Step 2

Hand-spread all chippings in the wooden box on pavement in rectangular area

Step 3

Measure the chipping rectangular area, ***S = x . y*** *(m^2)*

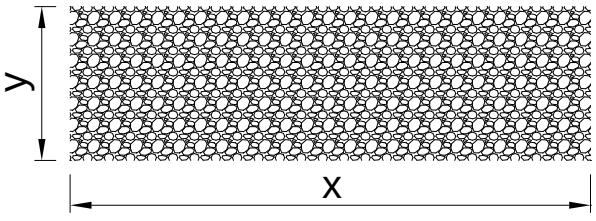
Step 1



Step 2

Hand-spread chippings

Step 3



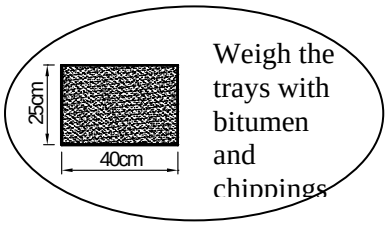
Step 4

Step 4

Take the two trays of sprayed bitumen and spread chippings, then weigh them:

Mass of tray 1 (with bitumen and chippings) is K_1 kg

Mass of tray 2 (with bitumen and chippings) is K_2 kg



2 Calculate and Assess

Spread chipping quantity

Chipping rate = $\frac{V}{S} = \frac{a.b.h}{x.y}$ (litre per sq.m)

Compare calculated chipping rate with requirement to find if the difference exceeds 8%.

Chipping spread on tray 1 = K_1 - P_1 (kg)

Chipping spread on tray 2 = K_2 - P_2 (kg)

Compare the chippings spread on the tray 1 and tray 2 to find if the difference exceeds 10%.

SELF ASSESSMENT

1 Hamlet A Road Maintenance Group carried out reconstruction of gravel pavement.

During construction, they used 50cm long steel bar to measure depth of layered material. The results were **L_1 = 22cm,** L2 **= 30cm. Define the layering ratio ($K_{layering}$) and give conclusion on density of compacted material.**

Solution

Due to L1 = 22cm, the layered materials thickness (before compacting) is:

$$H_1 = L - L1 = \text{…….., cm}$$

Due to L2 = 30cm, the material thickness after compaction is:

$$H_2 = L - L1 = \text{…….., cm}$$

Then, layering ratio is :

$$K_{;ayering} = \frac{H_1}{H_2} = \text{…….}$$

Conclusion:

…….....
.....

Good | Not good

2 A commune A transport staff took the results during inspection of bitumen spraying as followed.

Mass of bitumen spraying can: 0.8 kg

Mass of bitumen spraying can with hot bitumen: 7.1 kg. It was used to spray on pavement area of 5 m^2

Mass of tray 1 (without bitumen) is 0.5 kg

Mass of tray 2 (without bitumen) is: 0.55 kg

Mass of tray 1 with hot bitumen is 0.65 kg

Mass of tray 2 with hot bitumen is 0.72 kg

Required bitumen rate is 1.5 kg/ cu.m. Make calculation to find out if the sprayed bitumen rate is sufficient and even.

Solution:

Sprayed bitumen on pavement:

…….., *kg*

Sprayed bitumen rate:

…….., *%*

The difference between sprayed bitumen rate % requirements:

…….., *%*

Bitumen sprayed on tray 1:

…….,*kg*

Bitumen sprayed on tray 2:

…….,*kg*

The difference between sprayed bitumen on tray 1 and tray 2

…….., *%*

Conclusion:

…….....
.....

.....

Good | Not good

4.3 MAINTENANCE COMMUNITY SUPERVISON AND AUDIT

◆SUMMARY

After completing Session 4.3 participants should be aware of the community role in Rural Road Maintenance supervision and audit. Grasp the components of community Rural Road Maintenance supervision and audit

The participants are introduced the importance of community Rural Road Maintenance supervision and audit

ACTIVITIES:

a) Find out the importance of Road Maintenance Community Supervision & Audit
b) Learn about the activities of Community Supervision & Audit for rural road maintenance
c) Compare with & give comments on the activities of Community Supervision & Audit of one's own locality
d) Self - assessment

The importance of Community Supervision & Audit for Rural Road Maintenance.

.

☞ ***Read*** the following paragraph to learn about the importance of Community Supervision & Audit for Rural Road Maintenance

Rural Road Network plays key role that is the decisive factor to affect agricultural production, to all activities and to the Community's life

The Role of Rural Road Network: Promote agricultural production, Create jobs and increase incomes etc.

Rural Road Maintenance funds can be mobilized from many sources that include labor & monetary contributions of people .

Community Supervision & Audit presents not only people-owned rights. Contributions to Rural Road Maintenance make people to become a Client, so they have power to know how their contributed money has been used?

There is no professional staff for Rural Road Supervision & Audit, because of

Simple Maintenance Works

Limited funds

Absence of Supervision & Audit results in low quality of road maintenance, bad road conditions and waste of money

Rural Road Maintenance Supervision & Audit is the responsibility of Community!

☞ ***Community Supervision & Audit???***

Who are Community???

Which activities should be carried to supervise & audit rural road maintenance ???

"Community Supervision & Audit" do not mean all people in Commune involved in supervising & auditing. Board of Community Supervision & Audit includes Qualified & credible people that are representative of commune to carry out supervising & auditing works of rural road maintenance.
They can be:

Chairman of Commune or Hamlet

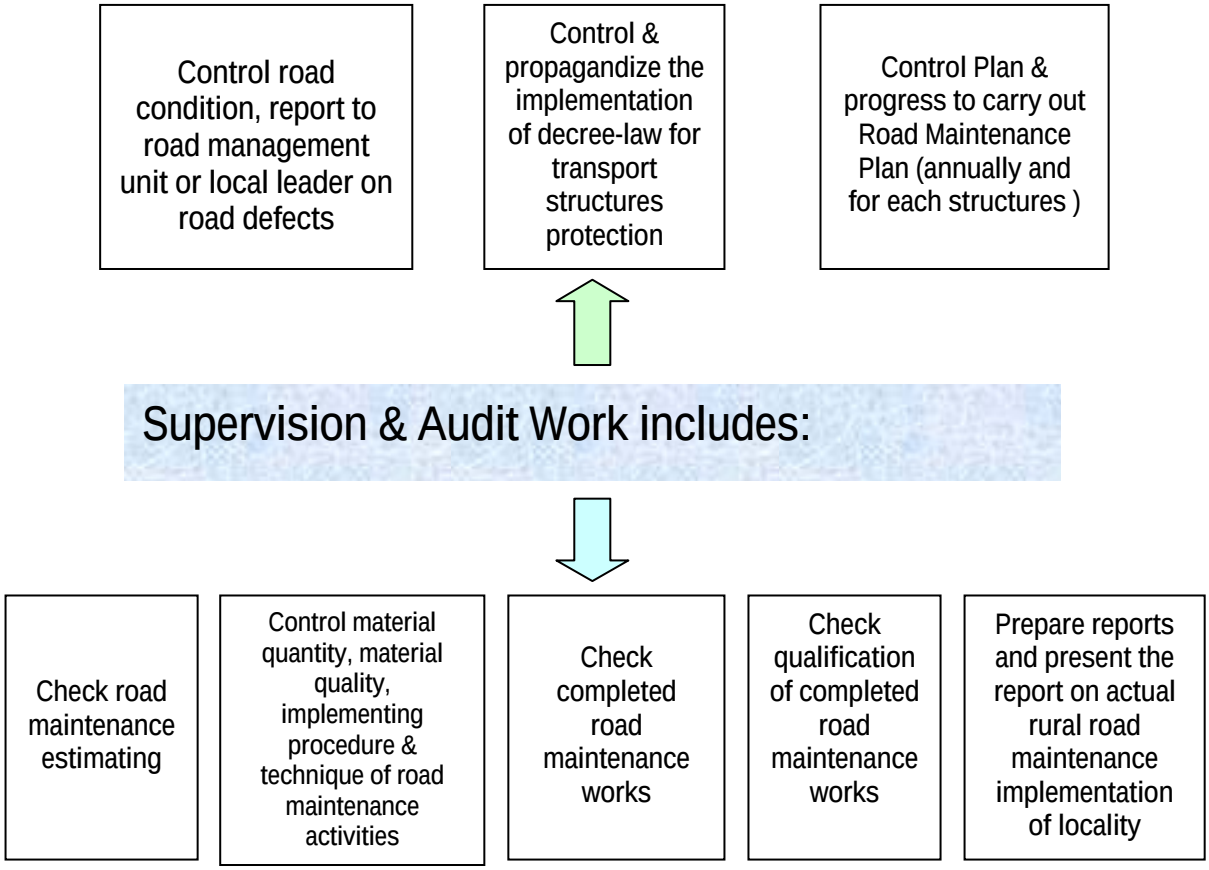
Chairman of War Veteran Association

Chairman of Commune Woman Association

Commune Transport Staff

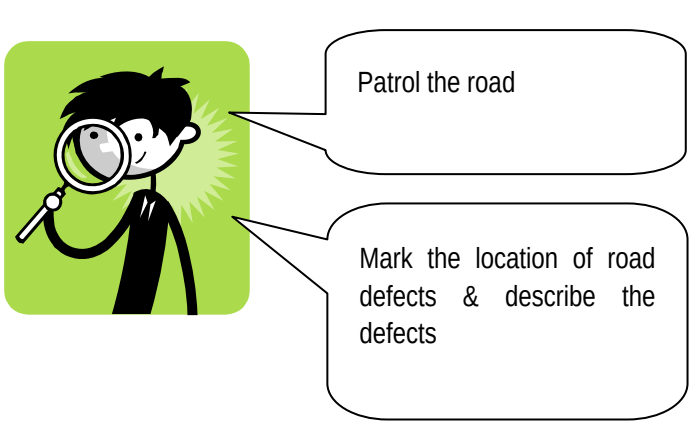
Secretary of Commune Youth Union

Leader of Retirement Cell



1. Contents of Rural Road Maintenance Supervision & Audit

☞ ***Control*** road conditions, ***realize*** road defects**,** then ***report*** to road management unit or local authorities



Study by yourself
M4 - Road defects & cause

You must carry out well these activities

☞ ***Control & propagandize the implementation*** **of decree-law** for transport structures protection

Look for and read Decree-Law on rural road protections

Check road maintenance and propaganda for road maintenance implementation at locality

☞ ***Control*** Plan & Progress to carry out Road Maintenance Plan

Read again yourself
M2 - Rural Road Maintenance
M17 - Rural Road Maintenance Planning
You must carry out well these activities !

It is necessary to understand road maintenance plan

Should know all types of rural road maintenances

☞ ***Check*** road maintenance estimating

Checking estimate means

Correct quantity?

Correct Unit Price?

Correct methodology?

Read again by yourself
M15- Norms for Rural Road Maintenance
M16- Rural Road Maintenance estimating
You must be able to check estimating!

☞ ***Control*** material quantity, material quality, implementing procedures & techniques of road maintenance

Sufficient material quantity?

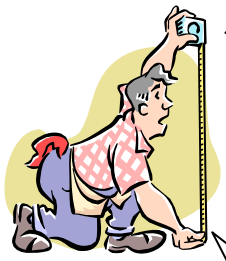
Good material quality?

Correct implementation?

Read again by yourself
M11- Materials for rural road maintenance
M12, - Road Maintenance techniques - routine maintenance 1
M13 - Road Maintenance techniques - routine maintenance 2

You must be able to carry out these activities!

☞ ***Check*** completed road maintenance works



How is quantity?

How is quality?

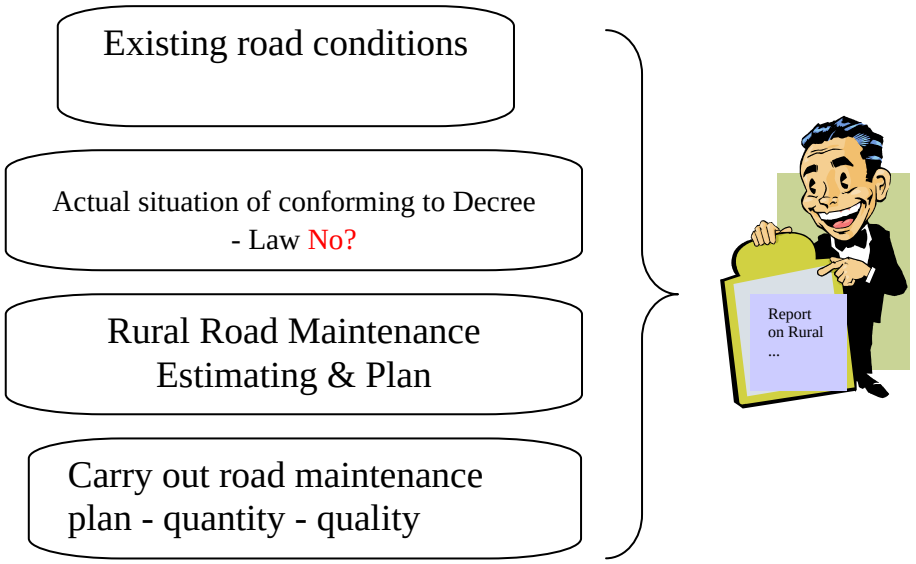
It can be handed over? - Community Supervision Minute?

Read again by yourself
M19- Rural Road Maintenance quality assessment
You will know how to measure finished works quantity & to assess quality

It is necessary to have format of Community Supervision Minute

☞ ***Look at*** some of following formats of Community Supervision for reference

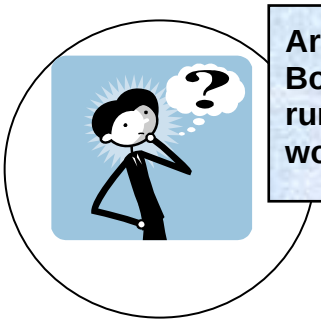
Read following paragraphs to know the contents of report on Rural Road Maintenance Supervision & Audit



Look at the form below of report on Road Maintenance Supervision & Audit for reference

Apply local conditions of Community Rural Road Maintenance Supervision and Audit.

Fill into the blanks with information of your locality on Community Rural Road Maintenance Supervision & Audit



Are there any Community Board to supervise & audit rural road maintenance works?

No	
Yes	

Communi ty Board includes

1. .....
2. .....
3. .....
4. .....
5. .....
   .....
   .....

What are activities of your local Community Board?

1. .....
2. .....
3. .....
4. .....
5. .....
   .....
   .....

5 Field Exercise

◆SUMMARY

The Maintenance Module field exercise will involve one day of **fieldwork** on a rural road close to Phnom Penh. The fieldwork will involve demonstration and use of equipment followed by data collection by participants.

This will be followed by a day on data **analysis** and drafting a 15-20min **presentation** by each of the three Groups.

6.1 Introduction

The course participants will be split into 3 Groups. Each Group will have responsibility for approximately 200m of rural road for which they will be required to assess for

- **Routine maintenance**
- **Limited Spot Improvement (in particular, drains, culverts)**

During this time on site the Dynamic Cone Penetrometer (DCP) and the MERLIN roughness measurement instrument will be demonstrated. Groups will be required to use this equipment themselves.

6.2 Key Site Activities

Following demonstration of equipment the following data collection activities are expected to be required to assess the maintenance and spot improvement requirements:

Brief road inventory: using Form1

2 DCP profiles: using DCP and Form 2

MERLIN survey 100m using Form 3

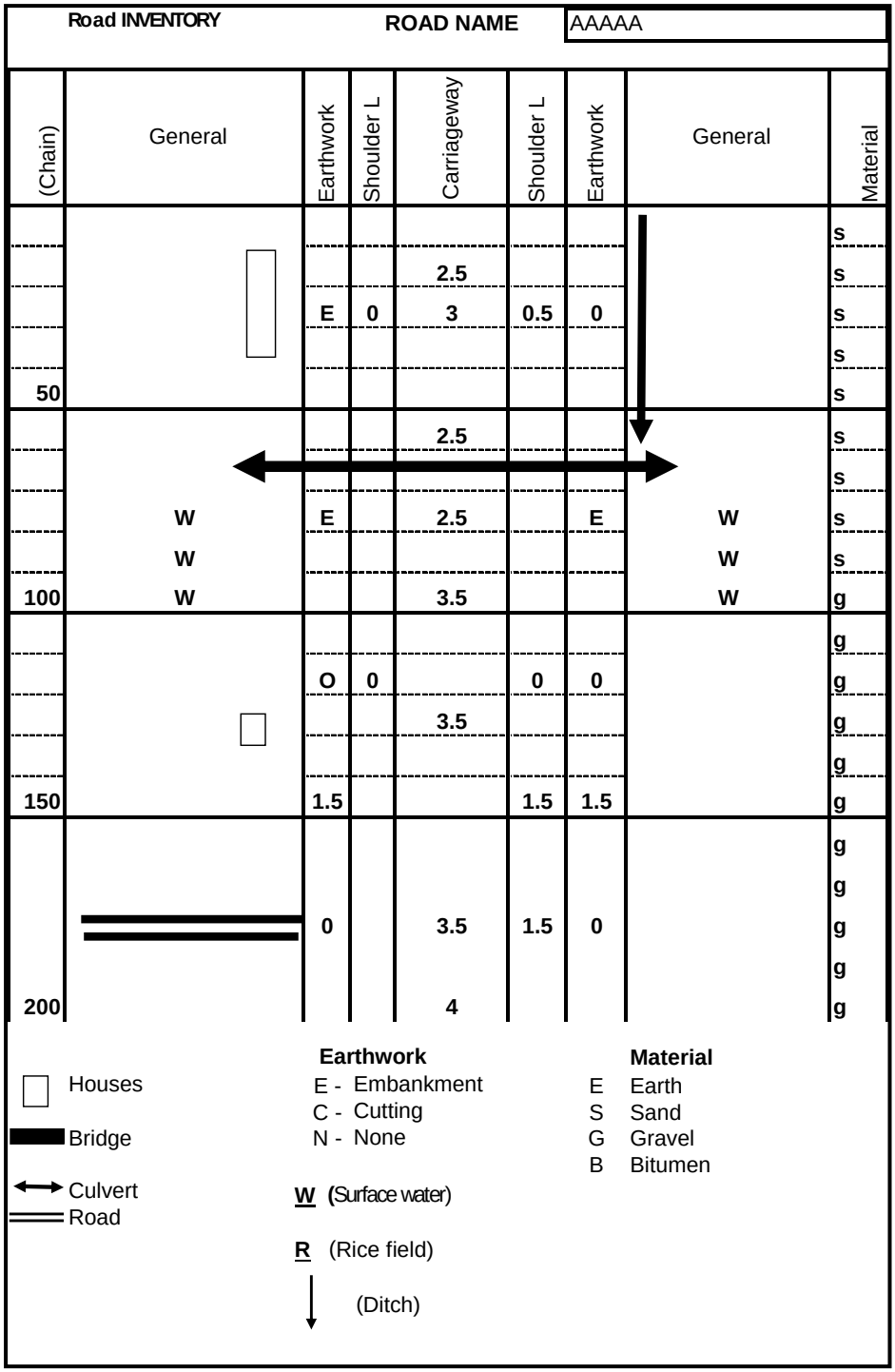
Maintenance requirement using Form 4

Traffic assessment: using Form 5

Road inventory

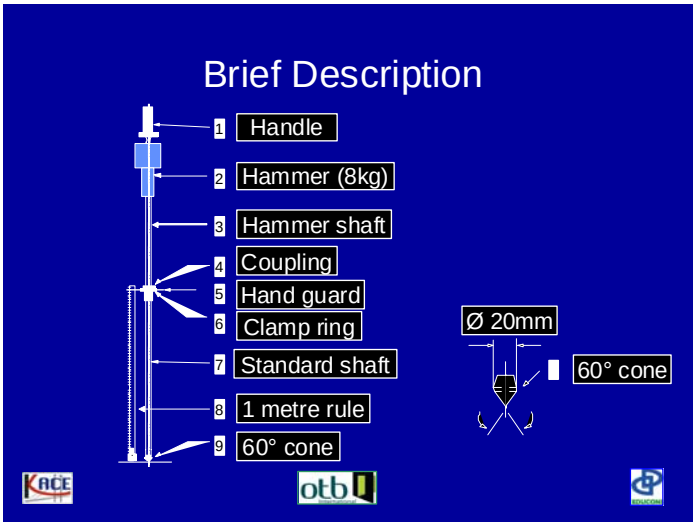
A simple road inventory of road the road section will be required – see Figure 1 for an example.

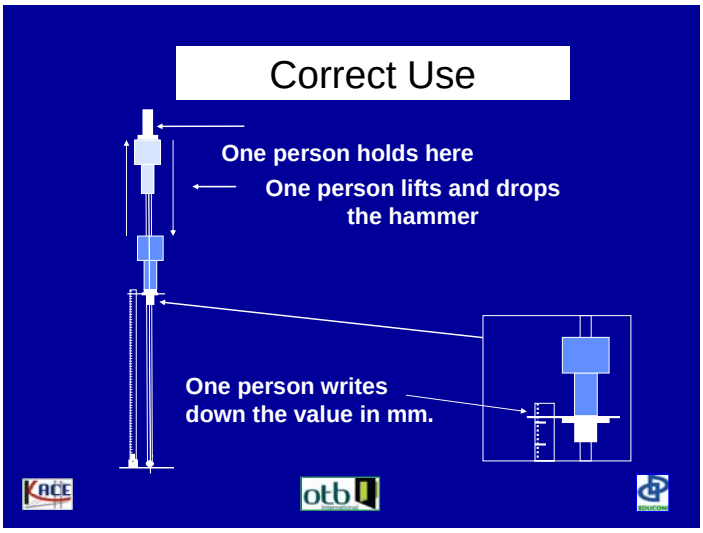
Figure 1 Inventory Example



DCP Profiles

Two cross section DCP profiles should be undertaken at representative locations. Each cross-section should comprise 1 DCP at the road centre and one at about 0.5m in from the carriageway edge. The standard DCP field sheet should be used.





MERLIN

The Merlin is a device for deriving the International Roughness Index for paved and unpaved roads (**MERLIN - M**achine for **E**valuating **R**oughness using **L**ow-cost **IN**strumentation). Each group should undertake a **100m survey** (average of two measurements).

Roughness is used as a criterion for assessing road deterioration – it may not have immediate application at LVRR level but is used by many road management programmes as guide to when maintenance is required.

The MERLIN device works by transferring an expression of surface roughness onto a standard recording chart by means of the calibrated movement of a central foot and lever.

Maintenance Requirement

Each Group should assess the maintenance requirements for their 200m section with the aid of Form 4 – as shown during the lectures.

DF090.02 **ROAD DEFECT SURVEYING FORM** **Form1: Pavement Defects**

Province:.....	District:.....	Commune:.....	Starting Time:.....	Finishing time:.....
Road Code:.....	Road name:.....	From:..... To.....	Surveyor Name:.....	Date:.....

Page: .....

Chainage: Km / m — 0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000

Summary
- Pavement/Shoulder width (m):.....
- Pavement type:.....

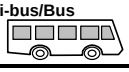
Pavement

1	Pavement clearing (length/area) -m/m2-
2	Corrugation (depth/area) -cm/m2-
3	Rutting (depth/area) - cm/m2-
4	Pothole (average depth/area) - cm/m2-
5	Soft spot (volume/area) - m3/m2-
6	Cracking, raveling, fretting (area) - m2
7	Numbers of concrete slab need to be replaced - slab -
8	Concrete pavement cracking (area) - m2 -
9	Crack, joint damage (length) - m -

**Items 7, 8, 9 are exclusive for concrete pavement*

Traffic

Each group should obtain an estimate of traffic on the road by undertakinga partial traffic survey for 3-4 hours using the standard traffic sheet.

Province			
District			
Daily 12 hour counts ***DATE***			
Traffic Class	**Hour 1**	**Hour2**	**Hour 3**
MOTORCYCLE 			
CAR, 4WD, PICKUP 			
Tractor 			
LIGHT TRUCK =< 5 TONS GVW 			
TRUCK > 5 T (2 axle) GVW 			
TRUCK > 5 T (3 axle +) GVW 			
Mini-bus/Bus 			
PEDESTRIAN, WALKER			
ANIMAL/HAND CART 			
BICYCLE 			
TOTALS			
Rain This Period?			

6.3 Data Analysis

On **Thursday** the Groups will return to the training building and will analyse all the recovered data; that is

DCP data- for road and sub-grade strength

Merlin data – for road roughness

Traffic data – to obtain a figure for ADT

Inventory and Maintenance Defect data – for to prepare a budget and plan for the next round of routine maintenance on their 200m of road and required spot improvements

At the start of the session there will be short presentations on the analysis procedures.

Each Group should prepare a 15-20 minute presentation which must contain at least the following:

1. A description of the road and the work done
2. Details of the road section sub-grade strength and surface roughness
3. Assessment of the road traffic
4. A budget and plan for required routine maintenance
5. Proposals for immediate and required spot improvements eg ditches, culverts and short sections of pavement
6. Proposals on how to secure budgets for this work

RURAL ROAD PAVEMENT AND SURFACE CONDITION MONITORING

IN SITU STRENGTH TESTING BY DCP

THE DCP EQUIPMENT

1 INTRODUCTION

The TRL DCP (Dynamic Cone Penetrometer SOI0026) is an instrument designed for the rapid in-situ measurement of the structural properties of existing road pavements constructed with unbound materials (Figure C1). Continuous measurements can be made down to a depth of approximately 850mm or, when extension shafts are used (Figure C2) to a recommended maximum depth of 2 metres. Where pavement layers have different strengths the boundaries can be identified and the thickness of the layers determined.

Correlations have been established between measurements with the DCP and CBR (California Bearing Ratio) so that results can be interpreted and compared with CBR specifications for pavement design. A typical test takes only a few minutes and therefore the instrument provides a very efficient method of obtaining information.

2 ASSEMBLY

The design of the DCP uses an 8kg weight dropping through a height of 575mm and a 60. cone having a diameter of 20mm.

The instrument is assembled as shown in Figure C1. and should be supplied with appropriate tools such as: two 13-17mm AF Spanners, Tommy Bar, 3mm AF Hex Wrench and a bottle of 'Loctite 242' used for securing handle/top rod and bottom rod/cone joints.

Some instruments are usually split at the top rod/anvil joint for carriage and storage. Later models are split at the lower rod/anvil joint to facilitate the use of extension shaft sets. It is important that joints are checked regularly during use as operating the DCP with any loose joints will reduce the life of the instrument considerably.

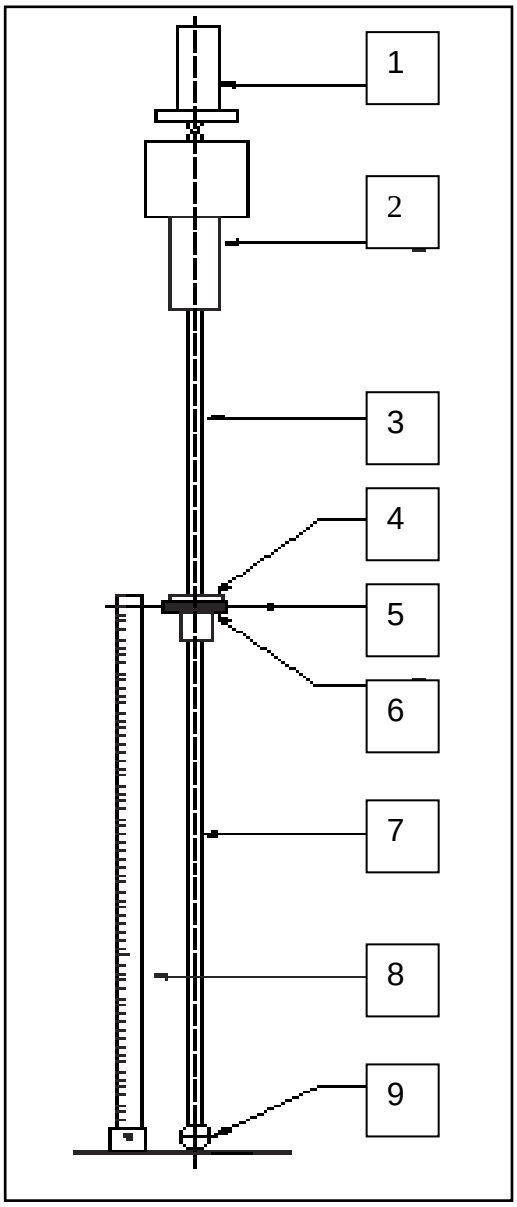


Figure C1 The Assembled DCP

1. Handle
2. 8kg Hammer
3. Hammer shaft
4. Coupling
5. Handguard
6. Clamp ring
7. Standard shaft
7.1m rule
8. 60 degree cone

3 OPERATION

After assembly, the first task is to record the zero reading of the instrument. This is done by standing the DCP on a hard surface, such as concrete, checking that it is vertical and then entering the zero reading in the appropriate place on the test sheet (Figure C3).

The DCP needs three operators, one to hold the instrument, one to raise and drop the weight and one to record the results. The instrument is held vertical and the weight is touching the handle, but not lifting the instrument. The operator then lets it fall freely (with out lowering it

by hand). If during the test the DCP leaves the vertical, no attempt should be made to correct this as contact between the bottom shaft and the sides of the hole will give rise to erroneous results.

It is recommended that a scale reading should be taken at increments of penetration of about 10mm. However it is usually easier to take a reading after a set number of blows. It is therefore necessary to change the number of blows between readings according to the strength of the layer being penetrated. For good quality granular bases readings every 5 or 10 blows are normally satisfactory but for the weaker sub-base layers and sub-grade readings every 1 or 2 blows may be appropriate. There is no disadvantage in taking too many readings, but if too few are taken, weak spots may be missed and it will be more difficult to identify layer boundaries accurately hence important information will be lost.

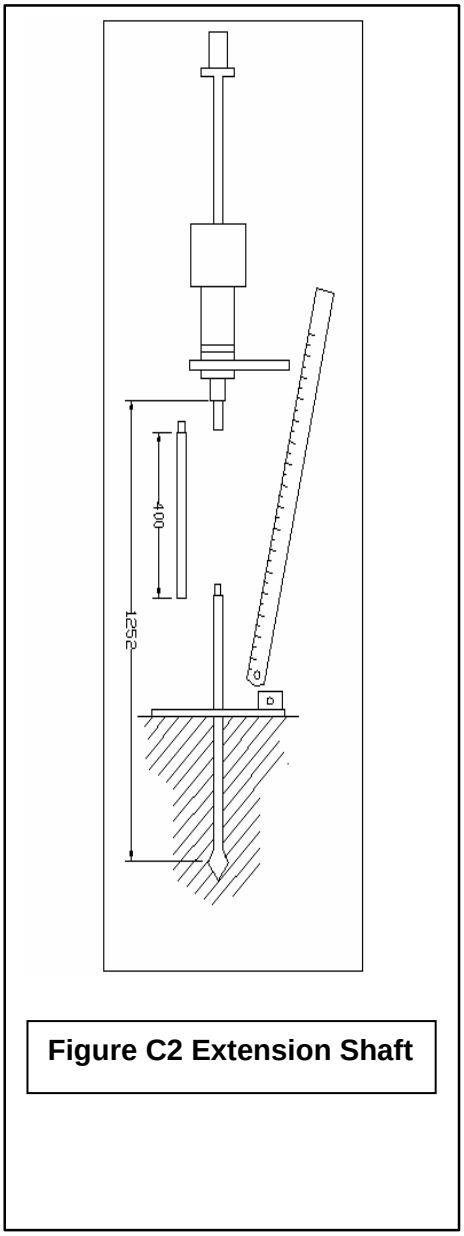


Figure C2 Extension Shaft

When the extended version of the DCP is used the instrument must be driven into the pavement to a depth of 500-600mm before the extension rod is added. To do this the meter rule has to be detached from its base plate and the bottom shaft split to accept the extension. After re-assembly a penetration reading should be taken before the test is continued.

After completing the test, the DCP is removed by gently tapping the weight upwards against the handle. Care should be taken as if this is done too vigorously damage may result.

Little difficulty is normally experienced with the penetration of most types of granular or lightly stabilized materials. It is more difficult to penetrate strongly stabilized layers, granular materials with large particles and very dense, high quality crushed stone. The instrument has been designed for strong materials and therefore the operator should persevere with the test. Penetration rates as low as 0.5mm/blow are acceptable but if there is no measurable penetration after 20 consecutive blows it can be assumed that the DCP will not penetrate the materials. Under these circumstances a hole can be drilled through the layer using an electric or pneumatic drill or by coring. The lowers of pavement can then be tested in the normal way. If only occasional difficulties are experienced in penetrating granular materials it is worthwhile repeating any failed tests a short distance away from the original test point.

The DCP can be driven through both single and double surface dressings but it is recommended that thick bituminous surfacing should be cored prior to testing.

SITE/ROAD			DATE					
			TEST NO					
SECTION NO/CHAINAGE			DCP ZERO READING mm					
DIRECTION			TEST STARTED AT					
WHEEL PATH								
No OF BLOWS	TOTAL BLOWS	READING mm	No OF BLOWS	TOTAL BLOWS	READING mm	No OF BLOWS	TOTAL BLOWS	READING mm

Figure C3 Standard DCP Field Sheet

If the DCP is used extensively for hard materials, wear on the cone itself will be accelerated. The cone is a replaceable item and it is recommended by many authorities that replacement be made when the diameter has reduced by 10 percent. However other causes of wear can also occur hence the cone should be inspected before every test.. Typically the cone will need replacing after about 10 holes in hard material and in the absence of damage other than shoulder wear this is the recommended practice

4 INTERPRETATION OF RESULTS

The results of the DCP test are usually recorded on a field test sheet similar to that shown in Figure C3 and the results can then either be interpreted by hand calculator or transferred to a standard EXCEL-type spread-sheet and processed by computer, Figure C4. Alternatively, there is now available a DFID funded TRL computer programme that can now be used to calculate not only layer depths and CBRs but other related relationships and plots. This programme may be downloaded via www.transport-links.org,

The boundaries between layers are easily identified by the change in the rate of penetration. The thickness of the layers can usually be obtained to within 10mm except where it is necessary to core (or drill holes) through materials to obtain access to the lower layers. In these circumstances the top few millimeters of the underlying layer is often disturbed slightly and appears weaker than normal.

Relationships between the DCP readings and CBR have been obtained by several authors.(Figure C8) The relationship derived by Kleyn and Van Heerden is based on the largest data set and is the one currently used by the TRL.

Kleyn and Van Heerden (60^{o} cone) $\quad Log_{10}(CBR) = 2.632 - 1.28\ Log_{10}(mm/blow)$

Formulas for Excel

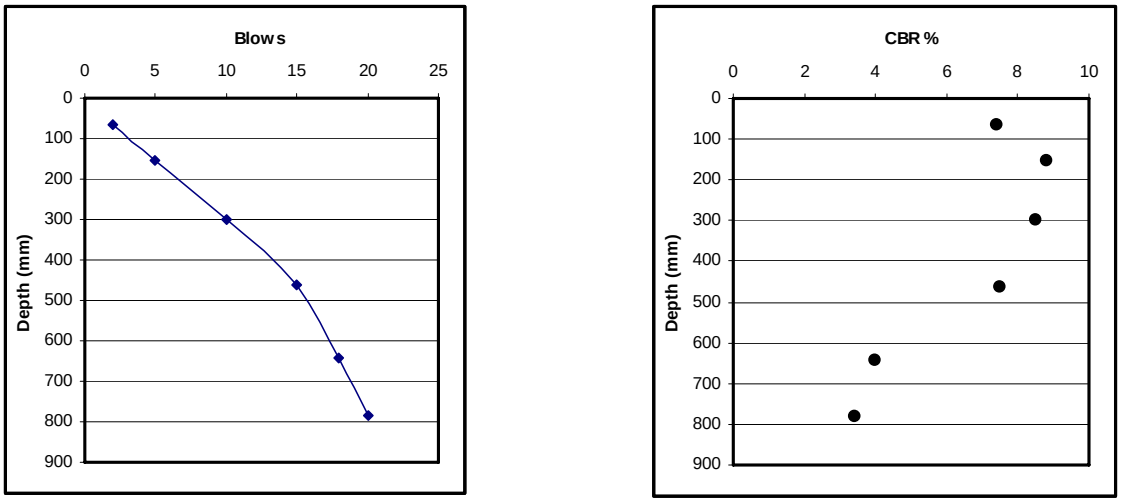


Figure C4: Typical EXCEL Calculation Sheet and Plots for DCP Data

RURAL ROAD PAVEMENT AND SURFACE CONDITION MONITORING

MERLIN ROUGHNESS SURVEYING

MACHINE FOR EVALUATING ROUGHNESS USING LOW-COST INSTRUMENTATION - MERLIN Guide -

1 Introduction

The Merlin (Plate1) is a device for deriving the International Roughness Index for paved and unpaved roads (**MERLIN** - **M**achine for **E**valuating **R**oughness using **L**ow-cost **IN**strumentation). A detailed explanation of its development can be found in Cundill 1991 (TRL Research Report 301). The device is suitable for both paved and unpaved roads

Plate 1 The MERLIN Equipment

MERLIN has now been successfully manufactured in Viet Nam based on TRL design and used for Rural Road surface evaluation of Rural Road Surfacing Trial Project. A Viet Nam made MERLIN costs USD200. While UK made is more than USD1000.

This document presents some basic specifications and instructions on how to use this MERLIN..

2 MERLIN Description

The MERLIN device works by transferring an expression of surface roughness onto a standard recording chart by means of the calibrated movement of a central foot and lever. The principal components of the MERLIN are as as shown in Figure D1.

The Merlin can be operated in one of two different modes, the mode of operation depends on the location of the measuring foot (see below). By changing the position of the foot the magnification factor can be set to either 5:1 or 10:1, this dictates how far the chart pointer moves compared to the measurement probe. That is when the Merlin is set to 5:1 magnification the pointer moves approximately 5mm on the chart for every 1mm the probe moves. Therefore for very rough surfaces the Merlin needs to be set to 5:1 magnification and for smooth surfaces the Merlin should be set to 10:1 magnification Figure D2

3 Merlin Calibration

Prior to use the Merlin must be calibrated to produce a scaling factor (Sf), this will correct any discrepancy in the magnification between the probe and the chart pointer. Determination of the Sf is given in detail in TRL Report 229 and is briefly described below.

Calibration is a simple procedure. Place the Merlin on a flat surface, make a mark on the edge of the Merlin chart next to the pointer. A calibration block (usually made from machined metal) of known thickness (T), usually about 6 mm, is then placed under the probe and a second mark is made on the Merlin chart next to the new position of the pointer. The distance between these two marks, measured in mm, is the displacement (S).

The Scaling factor, $Sf = \frac{10 \times T}{S}$ When MERLIN in 10:1 Magnification (equation 1)

$$Sf = \frac{5 \times T}{S}$$ When MERLIN in 5:1 Magnification

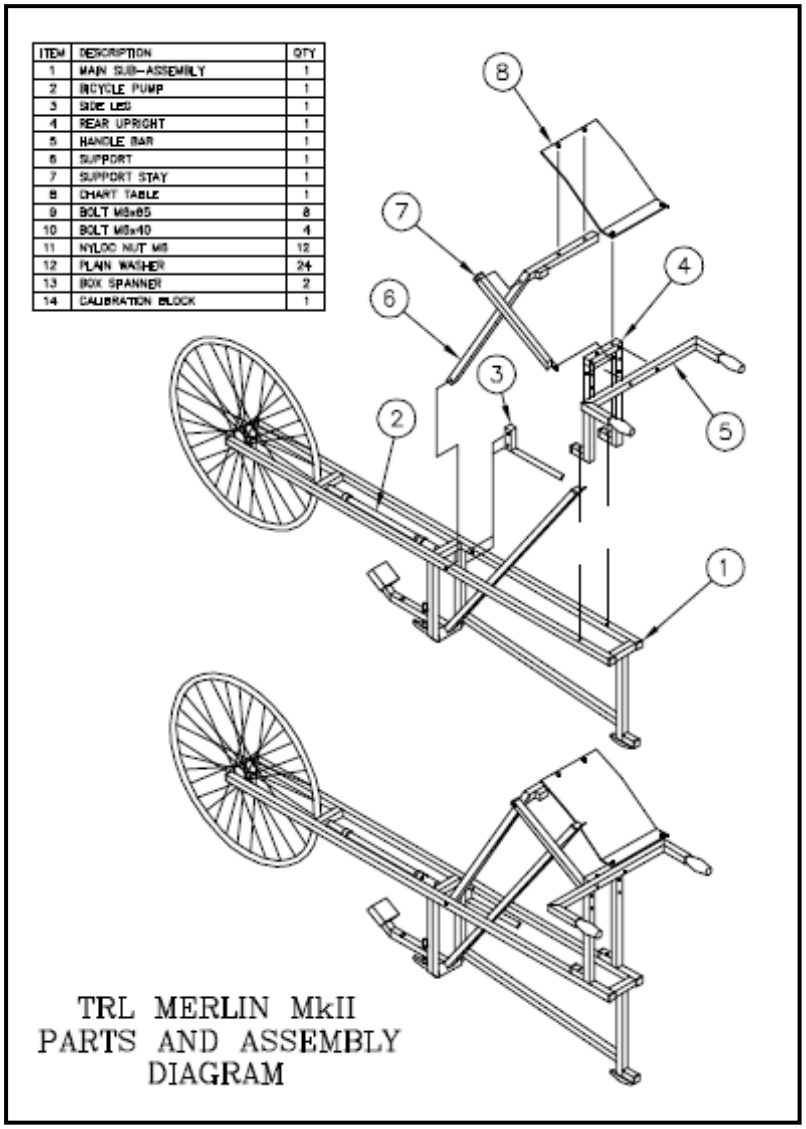


Figure D1 The MERLIN Equipment

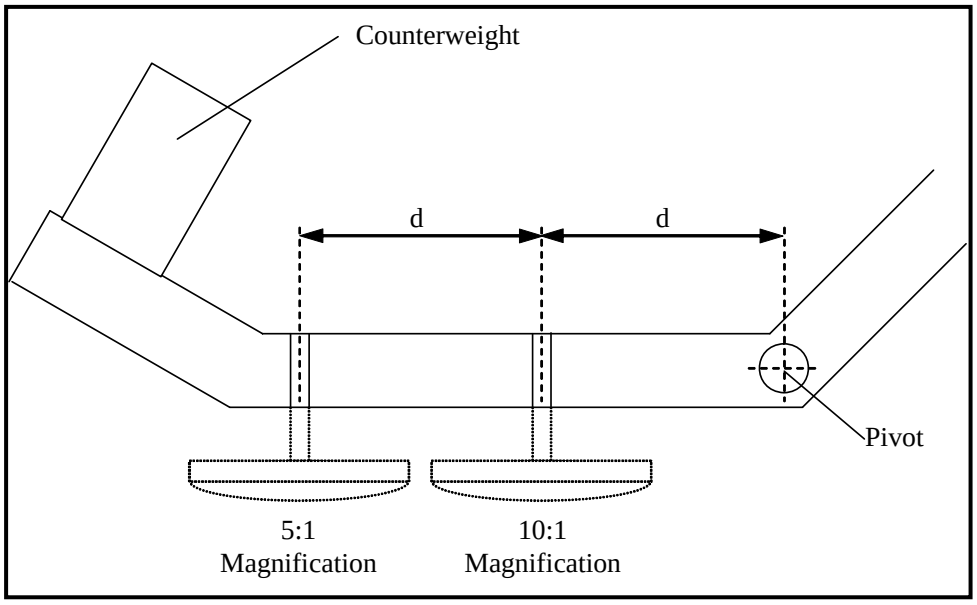


Figure D2 Alternative Probe Positions

For example, if a block of metal of thickness 6.5 mm, produces a Merlin pointer displacement of 32.5 mm when set in the 10:1 position, then T=6.5, S=32.5, hence Sf = (10x6.5)/32.5 = 2.

4 Survey Operation

:

1. Merlin Calibration; As per section 3 above.

2. Place the Merlin on one wheel track. Put a mark (x) in pointer position cell on the chart and also mark (x) in the small counting check box (Plates 2 and 3). Figure D3 presents the standard chart to be used

3. Lift and push the Merlin forward one half –wheel distance. Stop, lower the machine to rest on the surface and make further marks as above.

4. Continue this process for the length of the wheel track on the trial section and then survey the second wheel track. 1 Merlin sheet is used for each measurement of 1 wheel track section.

1. Having completed the survey (minimum of approximately 200 readings) then the IRI can be calculated. Figure D4 is a typical completed field-sheet

2. Note the number of readings (Number of marked cells in the small check box)e.g. 186 cells.

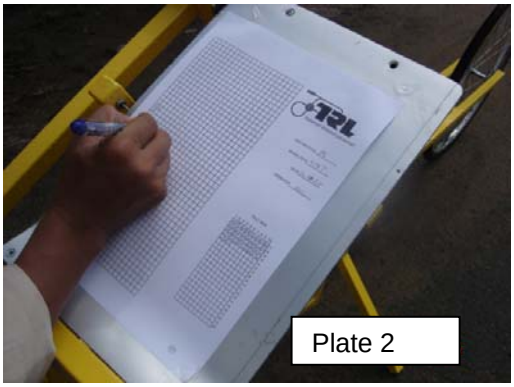


Plate 2

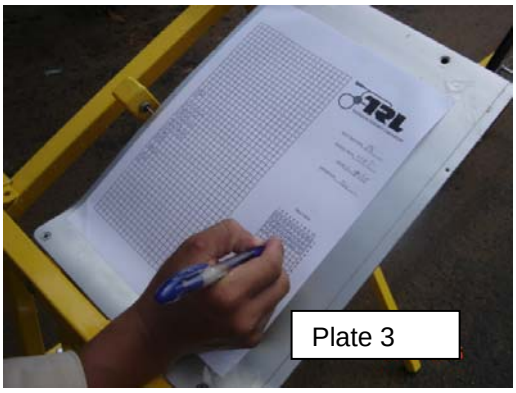


Plate 3

3. Calculate 5% of the total number of Merlin measurements; e.g. for 186 readings, 5% = (5/100)x186 = 9.3

4. Count in 9.3 of readings from each end of the distribution on the Merlin sheet and make one mark at each of these points.

5. Measure the distance between these two marks (in mm), e.g. L = 103mm.

6. Calculate the scaling factor Sf = 10 x T/ S = 10 x 8 / 93 = 0.86 (10:1 Magnification)

7. Calculate the Merlin D value. This is determined by multiplying the distance measured in c) by the scaling factor (Sf), which should already have been calculated in equation: D = L x Sf = 103 x 0.86 = 88.58

8. Calculate the IRI for each wheel path using:

   IRI = 0.593 + (0.0471xD) = 0.593 +(0.0471x88.58) = 4.8 mm/m

9. Calculate the average IRI for the section by taking the mean of the results for each wheel path. The final result should be a single IRI value (in mm/m) for the section.The above calculations cab be easily set up as standard Excel sheet. Table D1 presents an example from Tien Giang, RRST-I. Table D2 summarises standard interpretations of IRI figures.

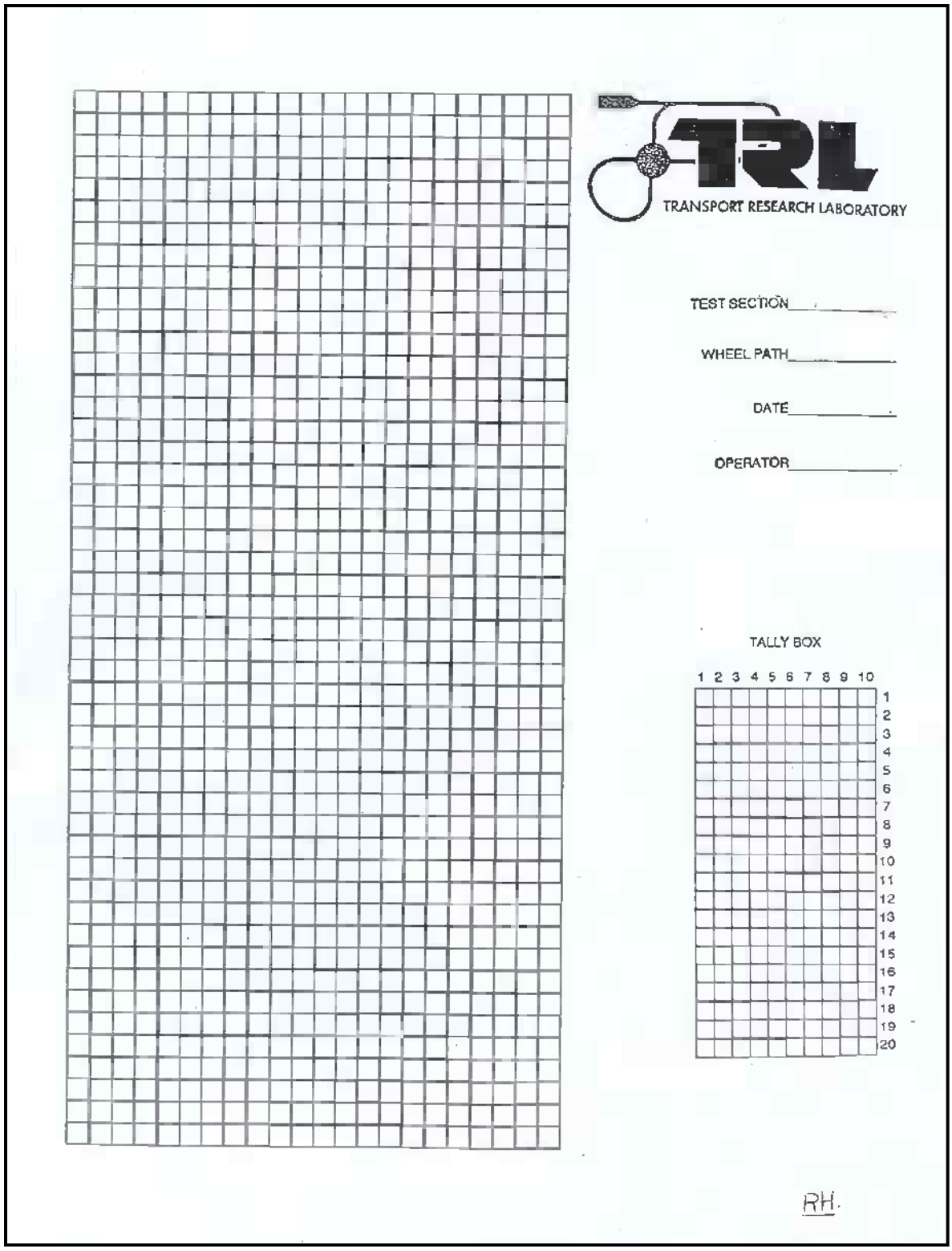


Figure D3 Typical MERLIN Field Chart

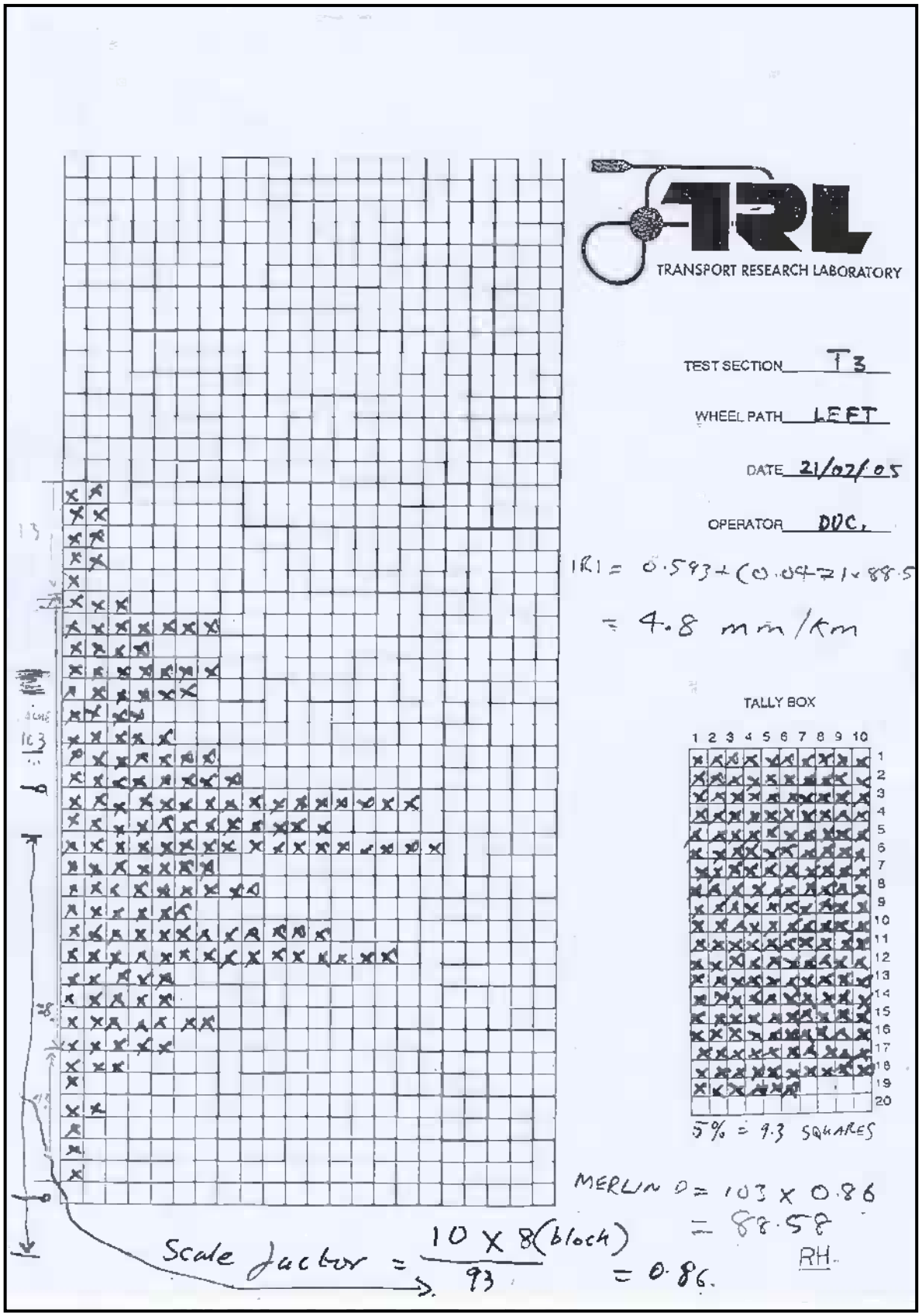


Figure D4 Typical Completed MERLIN Chart

No.	Road Name	Wheel Path	Date	S (mm)	Scaling Factor	D 1 (mm)	Dc 1 (mm)	IRI 1 (m/km)
	Tien Giang							
8	T2 Bamboo Reinforced concrete	RHL	28/07/2005	93	0.86	116.00	99.78	5.29
		CL						
		LHL	21/07/2005	93	0.86	121.00	104.09	5.50
9	T3 Steel Reinforced concrete	RHL	27/07/2005	93	0.86	98.00	84.30	4.56
		CL						
		LHL	21/07/2005	93	0.86	103.00	88.60	4.77
10	T4 Sand seal on DBM	RHL	28/07/2005	93	0.86	183.00	157.42	8.01
		CL						
		LHL	28/07/2005	93	0.86	190.00	163.44	8.29
11	T5 Sand seal on DBM	RHL	07/08/2005	93	0.86	190.50	163.87	8.31
		CL						
		LHL	21/07/2005	93	0.86	186.00	160.00	8.13
12	T6 Sand seal on Lime stab soil	RHL	07/08/2005	93	0.86	112.00	96.34	5.13
		CL						
		LHL	21/07/2005	93	0.86	125.00	107.53	5.66
13	T7 Pen Mac	RHL	21/07/2005	93	0.86	170.00	146.24	7.48
		CL						
		LHL	21/07/2005	93	0.86	166.00	142.80	7.32
14	T8 WBM	RHL	21/07/2005	93	0.86	204.00	175.48	8.86
		CL						
		LHL	21/07/2005	93	0.86	128.00	110.11	5.78
15	T9 Bamboo Reinforced concrete	RHL	28/07/2005	93	0.86	105.00	90.32	4.85
		CL						
		LHL	21/07/2005	93	0.86	118.00	101.51	5.37
16	T10 Natural Gravel	RHL	28/07/2005	93	0.86	103.00	88.60	4.77
		CL						
		LHL	21/07/2005	93	0.86	114.00	98.06	5.21

Table D1 MERLIN Spreadsheet for IRI Calculations

IRI (Roughness Range)	**Road description**
1.5 → 2.5	Recently bladed surface of fine gravel or soil surface with excellent longitudinal and transverse profile (usually found only in short lengths).
3.5 → 4.5	Ride comfortable up to 80-100km/h, aware of gentle undulations or swaying. Negligible depressions (e.g. < 5mm/3m) and no potholes.
7.5 → 9.0	Ride comfortable up to 70-80km/h but aware of sharp movements and some wheel bounce. Frequent shallow moderate depressions or shallow potholes (e.g. 6-30mm/3m with frequency 5-10 per 50m).
11.5 → 13.0	Ride comfortable at 50km/h (or 40-70km/h on specific sections). Frequent moderate transverse depressions (e.g. 20-40mm/3m-5m at frequency 10-20 per 50m) or occasional deep depressions or potholes (e.g. 40-80mm/3m with frequency less than 5 per 50m). Strong corrugations (e.g. > 20mm/0.7-1.5m).
16.0 → 17.5	Ride comfortable at 30-40 km/h. Frequent deep transverse depressions and/or potholes (e.g. 40-80mm/1.5m at frequency 5-10 per 50m); or occasional very deep depressions (e.g. 80mm/1-5m with frequency less than 5 per 50m) with other shallow depressions. Not possible to avoid all the depressions except the worst.
20.0 → 22.0	Ride comfortable at 20-30km/h. Speeds higher that 40-50km/h would cause extreme discomfort, and possible damage to the car. On a good general profile: frequent deep depressions and/or potholes (e.g. 40-80mm/1.5m at frequency 10-15 per 50m) and occasional very deep depressions (e.g. > 80mm/0.6-2m).

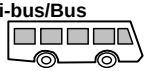
Table D2 – Standard IRI Evaluations

Traffic Form

FORM : Manual Classified Traffic Count

Province		**SURVEYOR**	
District		**LOCATION**	

Daily 12 hour counts ***DATE*** HOURS

Traffic Class						**Daily Average**
MOTORCYCLE 						
CAR, 4WD, PICKUP 						
Tractor 						
LIGHT TRUCK =< 5 TONS GVW 						
TRUCK > 5 T (2 axle) GVW 						
TRUCK > 5 T (3 axle +) GVW 						
Mini-bus/Bus 						
PEDESTRIAN, WALKER						
ANIMAL/HAND CART 						
BICYCLE 						
TOTALS						
Rain This Period?						

Daily Survey Period:	6.00 hours to 18.00 hours

GVW = Gross Vehicle Weight