MODULE 10 ROAD DEFECTS SURVEY AND MAINTENANCE DEMAND DETERMINATION

Objectives

After fulfilling Module 10, you will be able to:

- Comprehend the methods to survey the road defects and other structure's defects.
- Understand and be able to follow the procedure of surveying road defects.
- Understand and be able to use the field surveying forms
- Understand and be able to use the road condition evaluation form, establish the bill of quantity for maintenance.
- Be able to independently conduct work ranging from road defect survey, fill in the investigation form to preparing the Bill of Quantity.
- Self - Assessment.

Requirement

The participants are required to have comprehended following modules:

- Module 1: "*Local Road Network"*
- Module 4: "*Rural Road Defects and Causes"*

Methodology

- The participants are introduced assessment standards of conditions of road, structures & safety facilities.
- The participants are given thorough explanation on the structure and the usage of investigation forms.
- The participants are introduced methods to measure road defects (trainers demonstrate as a sample)
- The participants practice road defects surveying, fill in the form and make Bill of Quantity for maintenance
- Self - Assessment

Training Kit

- Rural Road Maintenance Handbook
- Module 10 "*Road Defects Survey and Maintenance Demands Determination*"

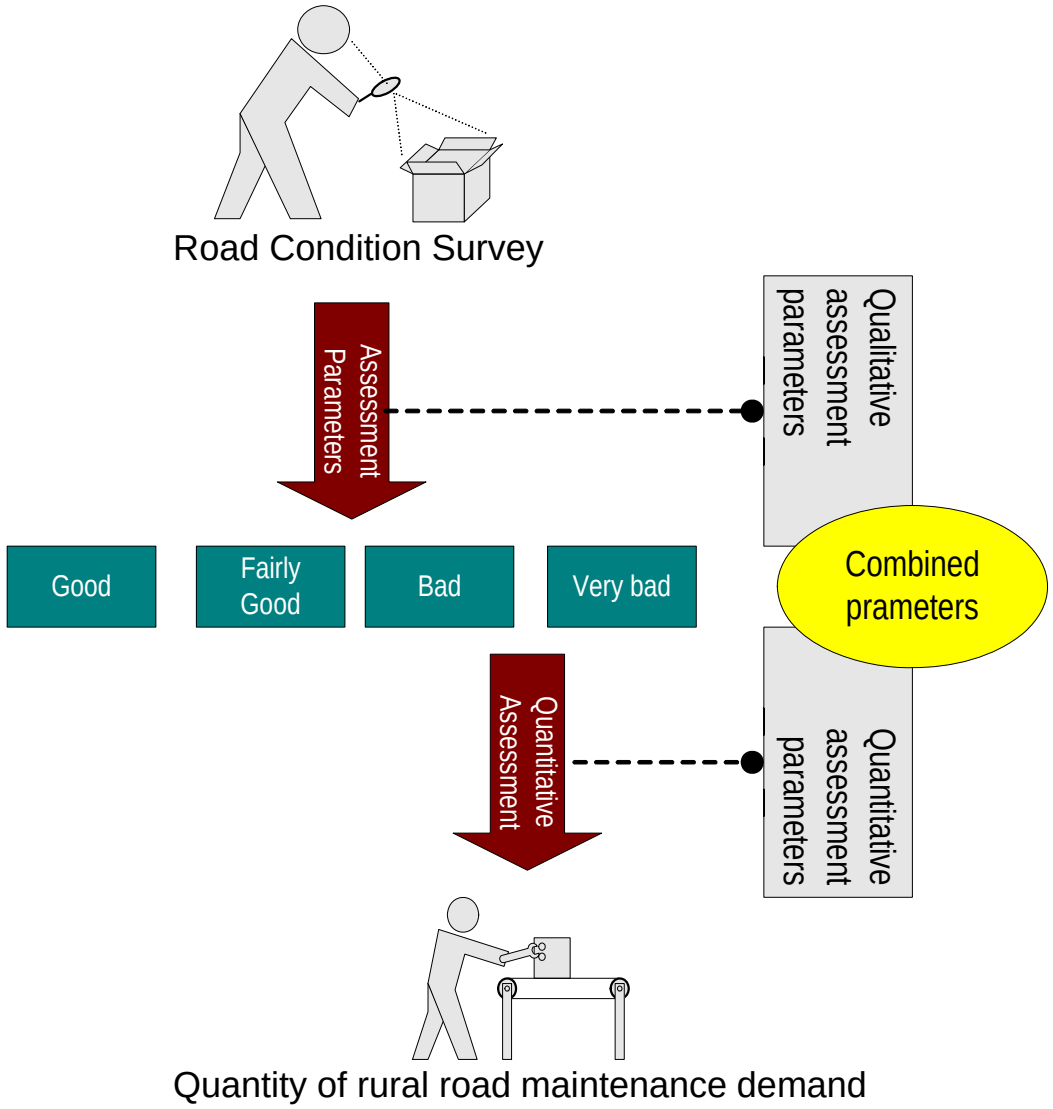
Studying Activities

1. Learn about assessing standards of road conditions
2. Realize simple surveying tools & learn about usage of surveying tools to establish a road defect survey
3. Learn about pavement defects survey, surveying form & preparation of bill of quantity
4. Learn about the other road & structure defects, surveying form & preparation of bill of quantity
5. Practice road defects surveying on site

Self - assessment

1. Learn about indicators for assessment of rural road conditions and indicators for quantifying road defects

Look at the figure below to distinguish qualitative and quantitative assessment parameters for rural road maintenance works.



Realize road condition assessment parameters

Read Table 2, Table 3, Table 4, Table 5 (pages 24, 25, 26,27) – of ***Rural Road Maintenance Handbook*** *to realize road condition assessment parameters.*
Fill in the blank below with road condition assessment parameters for each type of road

For Earth Road

- Cross slope
- % of pothole in total pavement area
- Height of corrugation & % of corrugation in total road length

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

For gravel & crushed stone road

For bituminous & brick paving road

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

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

For concrete road

☞ *Realize* parameters to quantify road defects for estimating maintenance cost of road pavement

Look at the presentation of parameters for quantifying pavement defects below:

For Earth Road

- The area - m^2 (sq.m) - of pavement need to be cleared
- The area - m^2 (sq.m) - of rutting & corrugation
- The area - m^2 (sq.m) and average depth (m) of pothole
- The volume - m^3 (cu.m) – of soft spot

For gravel & crushed stone road

- The area - m^2 (sq.m) - of pavement need to be cleared and/or filled
- The area - m^2 (sq.m) - of rutting & corrugation
- The area - m^2 (sq.m) and average depth (m) of pothole
- The volume - m^3 (cu.m) – of soft spot

For bituminous & brick paving road

- The area - m^2 (sq.m) - of pavement need to be cleared
- The area - m^2 (sq.m) and average depth (m) of pothole
- The volume - m^3 (cu.m) and the area m^2 (sq.m) - of soft spot
- The area - m^2 (sq.m)- of cracking/ raveling/ fretting of bituminous pavement or raveling of brick paving
- The area - m^2 (sq.m) - of rutting

- Number of concrete slab need to be replaced and length of the slab
- The area - m^2 (sq.m) – of concrete slab need to be cut out & replaced and the thickness of slab
- The length of crack/ joint need to be filled by bitumen mastic

Concrete Road

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

RT2 Project

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 -																					

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

☞ *Realize* assessment parameters of side drain, road shoulder, bridge, culvert, retaining wall... condition.

Read Table 1 (page 22) - of Rural Road Maintenance Handbook to realize assessment parameters of side drain & road shoulder

For road shoulder and side drain

- Are there any damaged sections of side drain or shoulder (erosion/ deposition for example) ?
- Is vegetation (brushwood/grass on shoulder/ side drain excessive 7cm high

- What damage at which component of structure?
- Damage magnitude

Bridge, culverts & other structures

☞ *Realize* quantitative parameters of defects of side drain, shoulder & other structures.

For shoulder and side drain

- The area - m^2- of shoulder need be reshaped
- The area - m^2- of vegetation on shoulder need to be controlled
- The area - m^2- of vegetation along road need to be controlled
- The length - m -of deposited side drain need to be cleared
- The volume - m^3- of side drain to be additionally excavated
- The volume - m^3- of minor landslide need to be cleared
- The volume - m^3- of slope gully need to be refilled

- The area - m^2 - of bridge surface need be cleaned
- The area - m^2 - of rotten bridge wooden need to be replaced
- Number - unit - of nail in bridge wooden plank need to be replaced
- Number - unit - of abutments need to be maintained
- Volume - m^3- of concrete/masonry... need to be removed
- Volume - m^3 - of soil excavation

Bridges, Culverts and other structures

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

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:.....	.....

			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:.....																					
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)																					

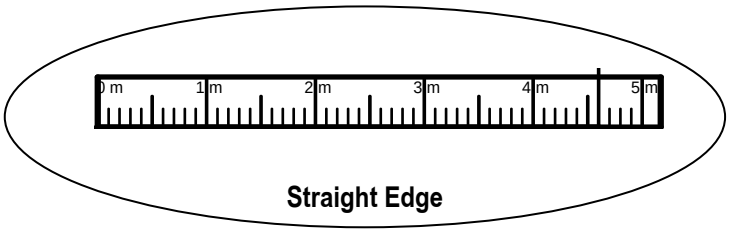
2. Learn about common tools for rural road defect surveying

Measurement tools: consist of following main tools:

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

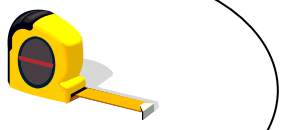
Length measurement tool

- 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



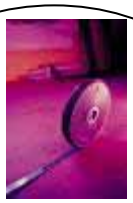
Straight Edge

Measurement Tape



Locked steel measurement tape

Steel measurement tape



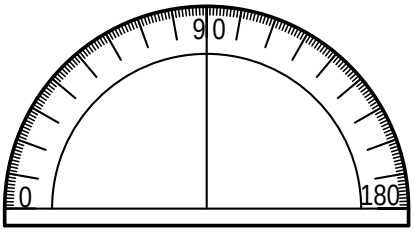
Cloth measurement tape

Note

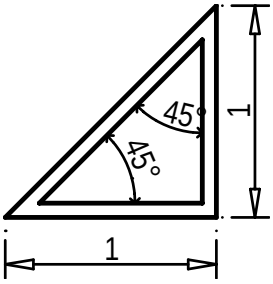
Using straight edge or locked steel tape for measuring short distance &measurement tape for long distance to ensure accuracy

Angle measuring tool

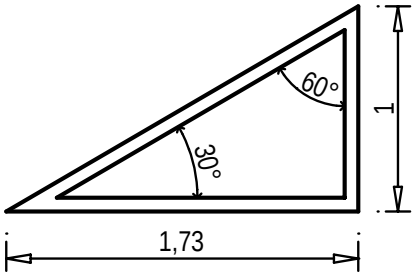
- used to measure angle value:
  - degree, - ^{o}
  - minute, - ' (1^{o} = 60')
  - second, - " (1' = 60")
- angle measuring tools:
  - Quadrant: made from plastic to measure different angle value.
  - Angle measuring template made from wood, is used to check fixed angles (30^{o}, 45^{o}, 60^{o}, 90^{o}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



Quadrant



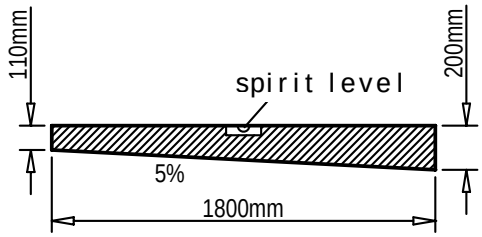
Template for 45° angle



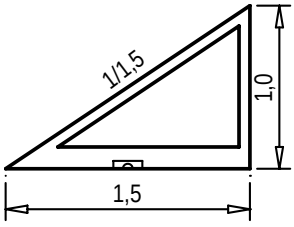
Template for 30° và 60° angle

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)



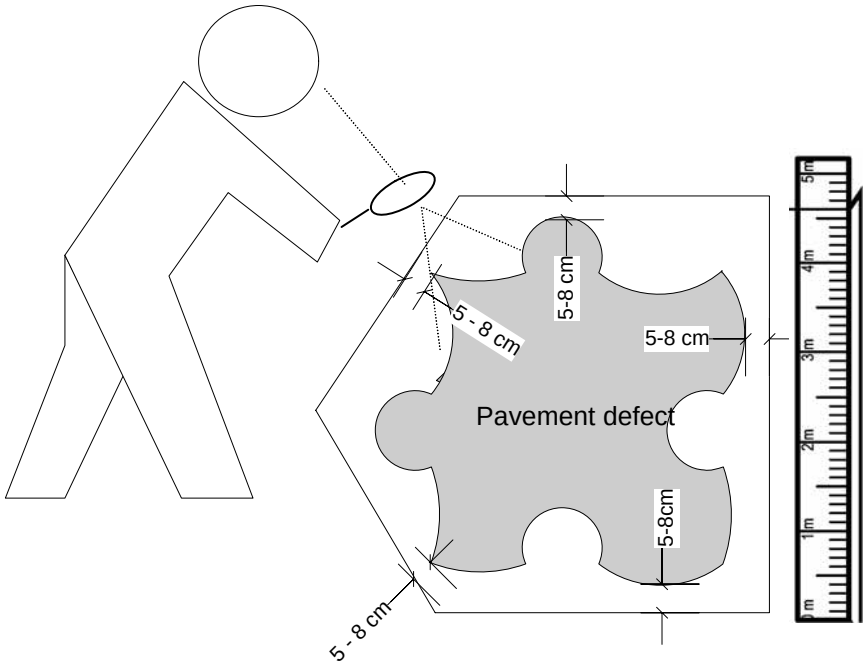
Template for low slope



Template for checking slope of 1/1,5

3. Learn about method of pavement defects surveying to make qualitative & quantitative assessment

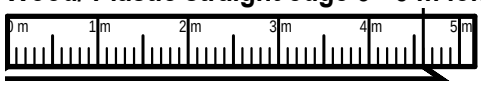
Measure area of pavement damage



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

Measuring tools:

Wood/ Plastic straight edge 3 - 5 m long



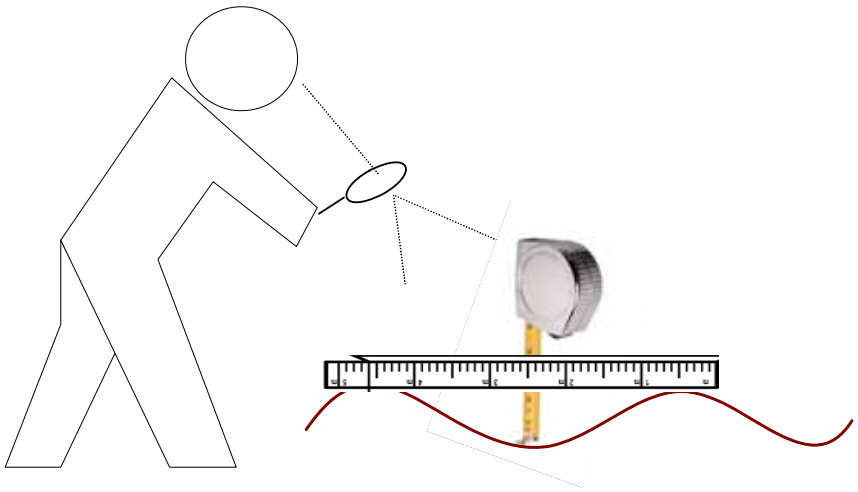
Steel measurement tape

Cloth measurement tape

Measuring steps:

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

Measure the depth of corrugation, rutting and pothole



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

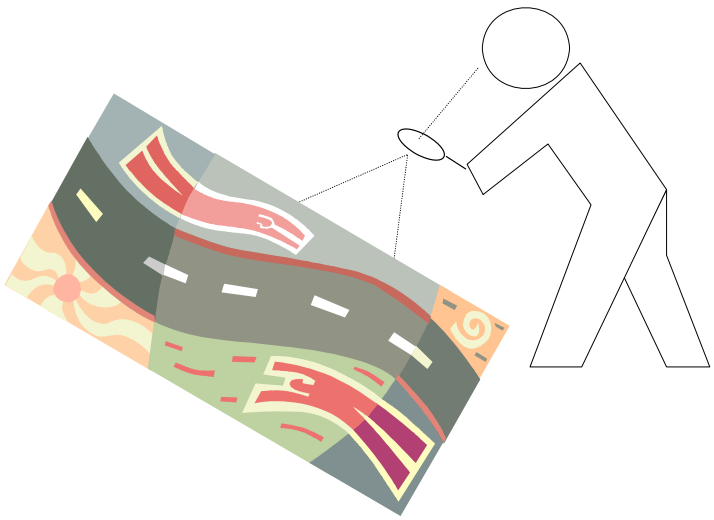
Implementing steps:

- *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*



4. Learn about methods of qualitative & quantitative assessment for shoulder, side drain, embankment & other structures defects.

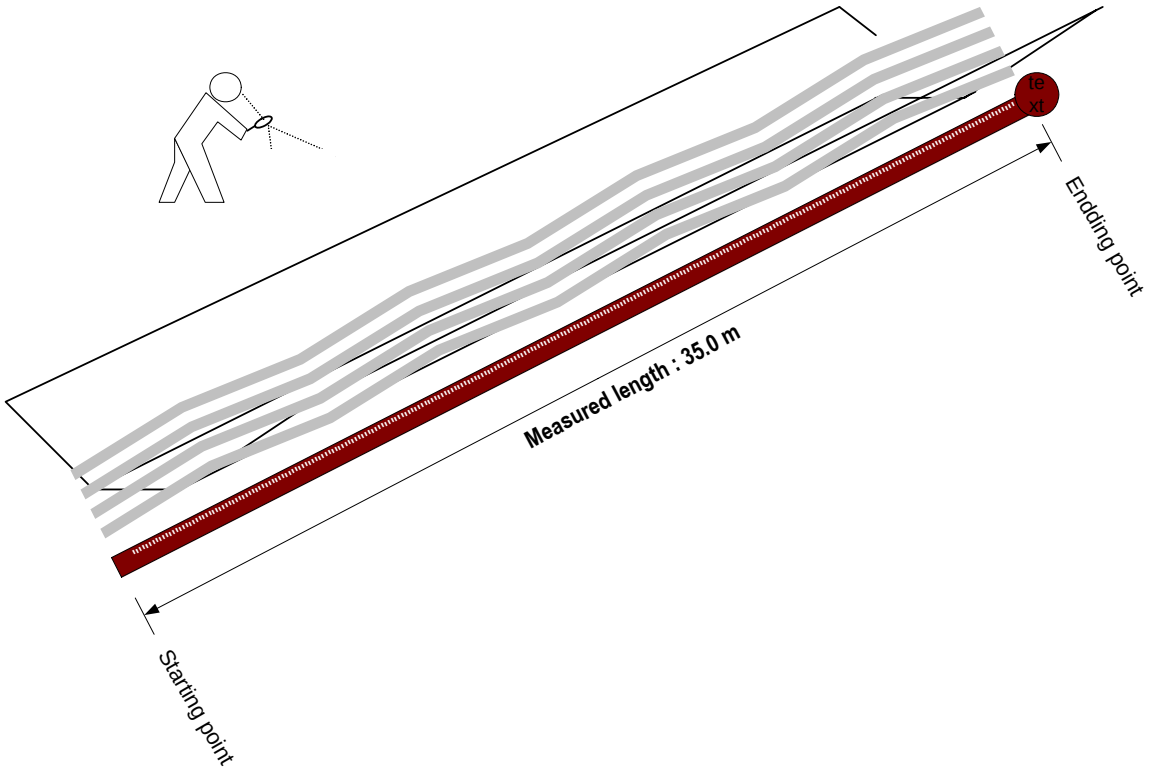
Length measuring (length of side drain needs to be cleared, length of shoulder needs to be reshaped...)

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*



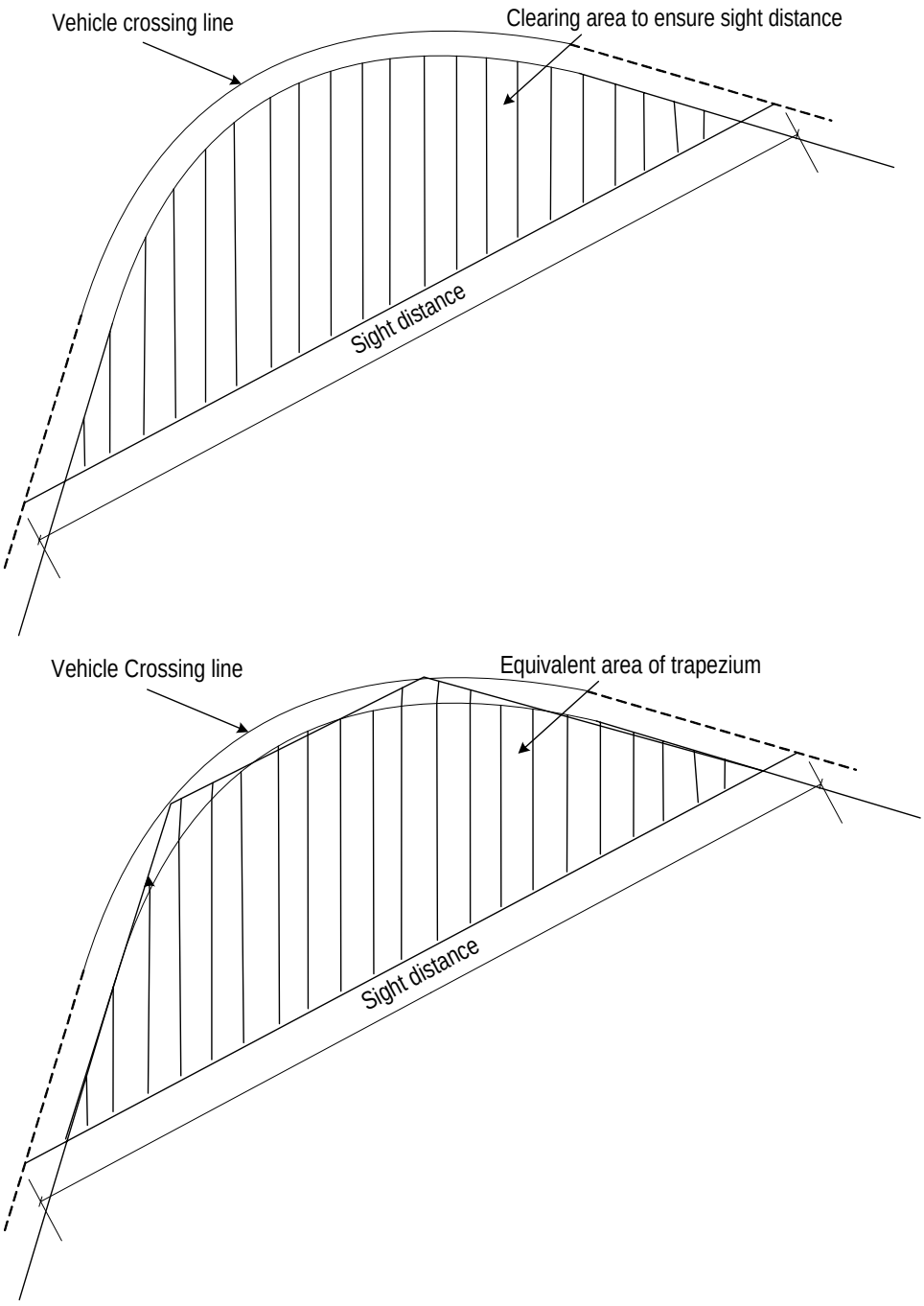
Measure area (Vegetation area need be cleared....)

Used tools:

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

Implementing steps:

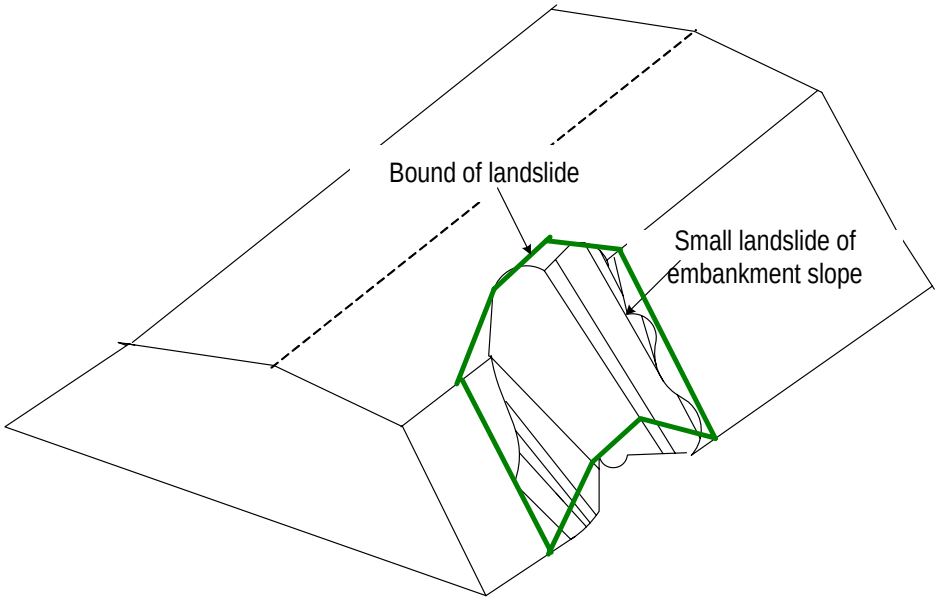
- *Define bounds of clearing area (for example, sight distance in horizontal curve.*
- *Convert to equivalent that is simple to define area (for example to trapezium).*
- *Measure major dimension of the area (for example, both bases & height of the trapezium)*
- *Calculate the area using appropriate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



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

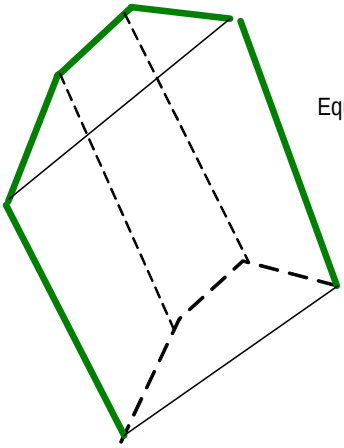
Used tools:

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

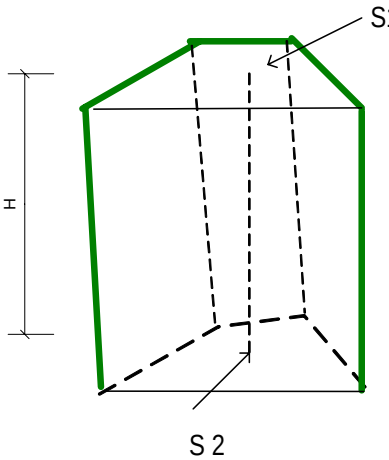


Implementing steps:

- *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

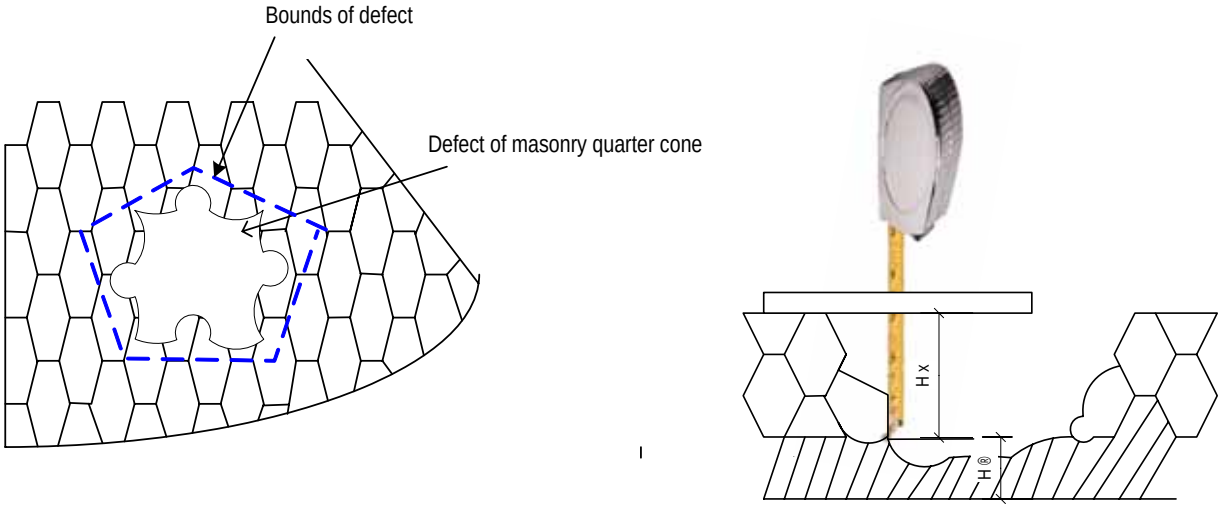


Equivalent shape to calculate volume

V= (S1+S2)/2 x h
where:

- S1 & S2 is area base
- H is height of the prism

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 ($V_x = S .H_x$)

Ghi nh í

Defect zone should be converted to equivalent simple shape (there is available formula to calculate area/volume in Rural Road Maintenance Handbook) to define maintenance demand

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

Table 8a - 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%)*

memo rization

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*

5. Practice field survey for qualitative and quantitative assessment to define maintenance demand.

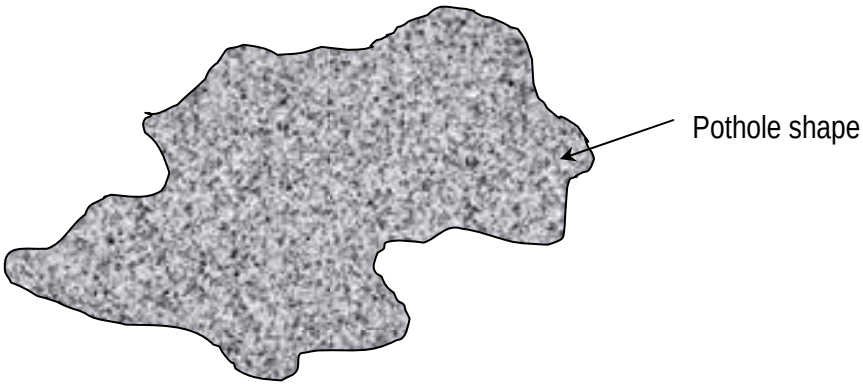
☞ *Take forms* 1, 2 and 3 to site, *make survey & record data* to the forms

☞ *Make calculation & put data to* the complex table

Table 8a - defect quantity - field survey result form								
Commune:.....					Road :			
Road length: ..... km			Road code:		Date:			
Pavement type:			Pavement width/ Road width:.....		**condition assessment ***		**defect quantity****	
Type and location of defects								
Location (km) or landmark						*Assessment parameter*	*Rating*	
road bed - shoulder - side drain								
pavement								
bridge, culvert and other structures								

Kiem tra - Danh gia — 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