# MODULE 18 FINISHED WORKS QUANTITY MEASUREMENT IN RURAL ROAD MAINTENANCE

## Objectives

After fulfilling Module 18, you will be able to:

- Know measuring methods to define the quantity of finished road maintenance work.
- Be skilful at measuring, calculating the quantity.
- Self- Assessment.

## Requirement

The participants are required to have comprehended following modules:

- Module 2: "*The Concepts of Rural Road Maintenance"*
- Module 4: "*Rural Road Defects and the Causes"*
- Module 12,13,14 "*Maintenance Techniques"*

## Methodology

- The participants are introduced to the measuring method, defining the quantity of some main finished maintenance works.
- The participants practise measuring, do the calculation to define the finished works quantities.
- Self - Evaluation

## Training Kit

- Rural Road Maintenance Handbook
- Module 18: *"Finished Works Quantity Measurement of Rural Road Maintenance "*


1. Learn about measuring methods to define the finished work quantity of some main activities of rural road maintenance - equipments and/or tools, measuring & calculating methods
2. Learn about calculating methods to define the finished maintenance works
3. Practice of measuring finished work quantity on field
4. Self - assessment

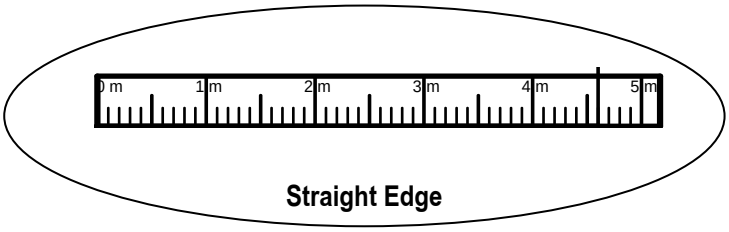
## 1. Learn about measuring methods to define finished works of some main maintenance activities - measuring equipments/ tools & calculation.

*Measuring tools: include followings:*

1. *Length measuring tool*
2. *Angle measuring tool*
3. *Cross fall template*

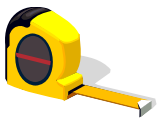
### Length measuring tool

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




**Straight Edge**

**Tape measure**



**Locked steel tape measure**

**Steel tape measure**

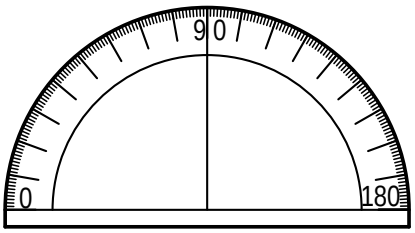
**Cloth tape measure**

Note

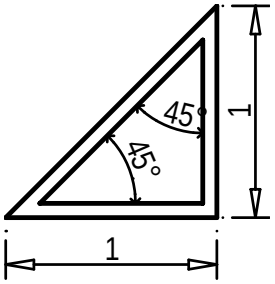
*Using straight edge or locked steel tape for measuring short distance & tape measure for long distance to ensure accuracy*

## Angle measuring tool

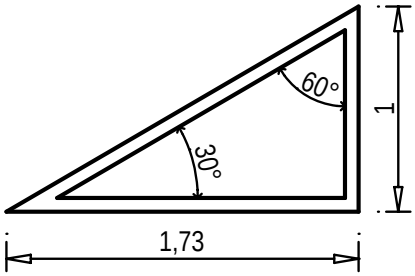
- used to measure angle value:
  - degree, - $^{o}$
  - minute, - ' ($1^{o}$ = 60')
  - second, - " (1' = 60")
- angle measuring tools:
  - Quadrant: made from plastic to measure different angle value.
  - Angle measuring template made from wood, is used to check particular common ($30^{o}$, $45^{o}$,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




**Quadrant**



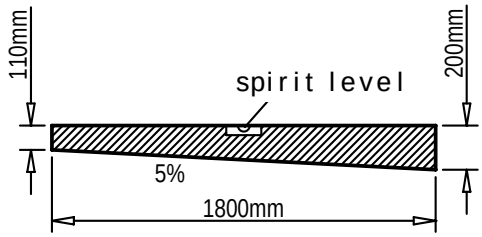

**Template for 45° angle**



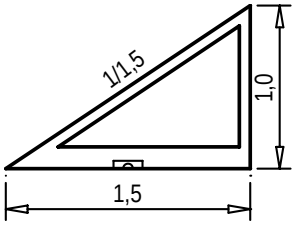

**Template for 30° và 60° angle**

## *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 as cross fall, that usually expressed by %.
  - 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 meters)

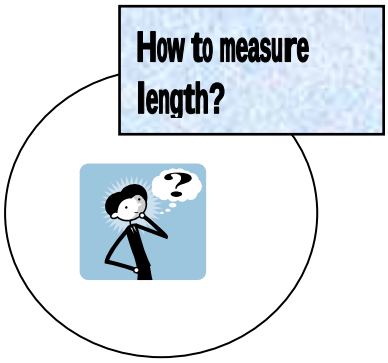



**Template for low slope**

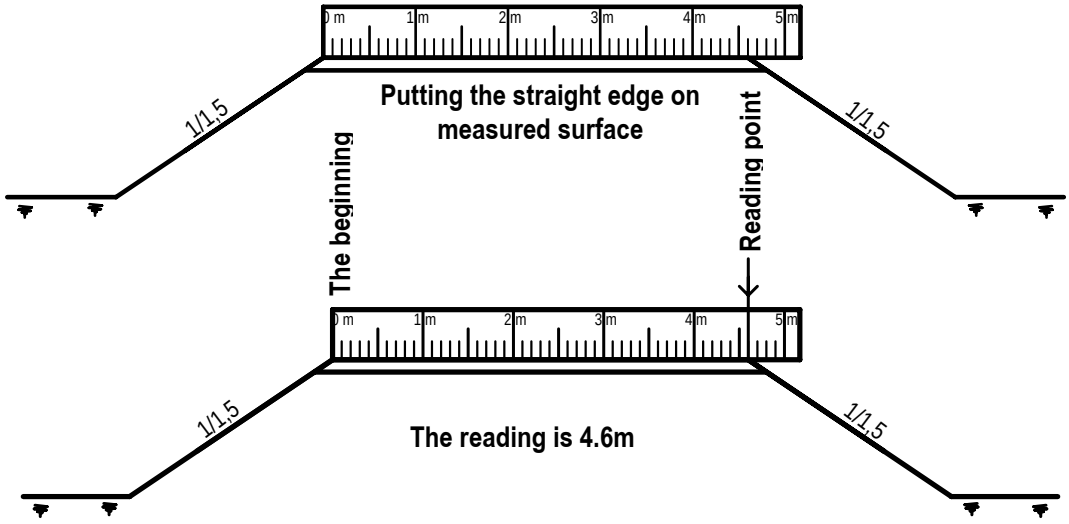



**Template for checking slope of 1/1,5**

## *Length measuring method*



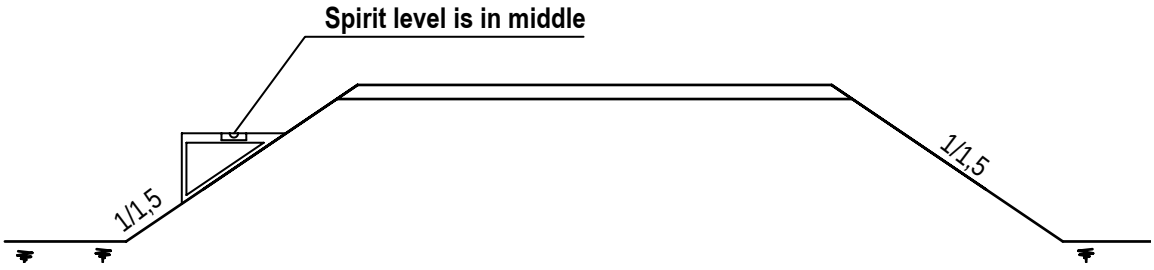

**Step 1:**
Put a straight edge on the measuring object (for example: put a straight edge on the sub-grade surface to measure sub-grade width) with the straight edge begin (marked by 0) at the begin of measuring distance (left edge of sub-grade). The measure is at right angle with road axis.
**Step 2:**
Define reading at the end of measuring object (right edge of sub-grade)
The reading is length of the object.




## *Slope measuring method*

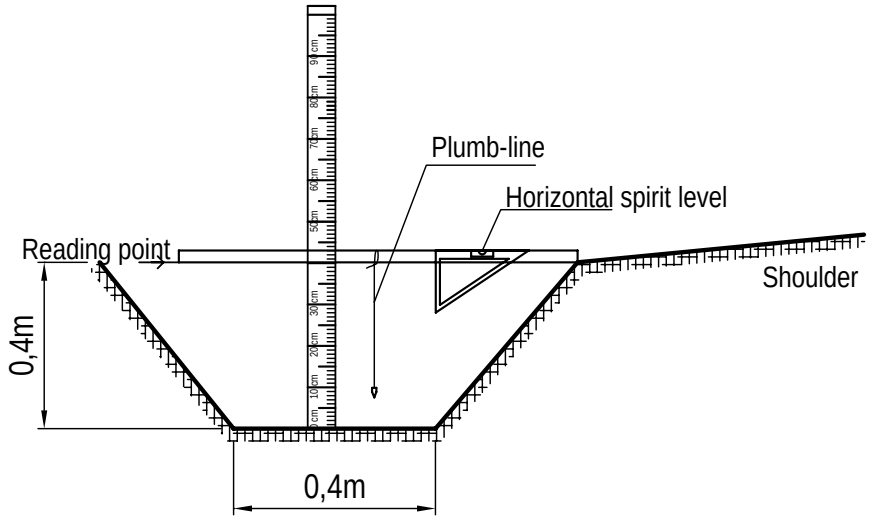
**Step 1:**
Select a suitable template with slope is equal to the slope of measuring object (for example, use 1/1.5 slope measuring template for checking 1/1.5 slope)
Put the template on the surface of measuring object.

**Step 2:**
Check spirit level on the template. If the spirit level is in the middle, the slope of measuring object is equal the slope of template.



*Height measuring method (measure different level between two points or two planes)*

**Measure the depth of side drain:**
**Step 1:**
Put a straight edge horizontally (monitored by spirit level) on drain top.
**Step 2:**
Put another straight edge vertically that is parallel with plumb-line. One end of the straight edge is in the bottom of drain.
**Step 3:**
Define reading in the vertical measure at the lower edge of the horizontal The reading is depth of side drain.



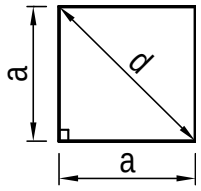
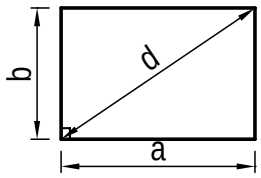
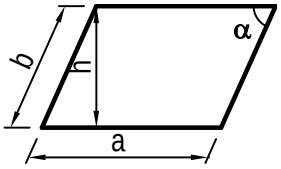
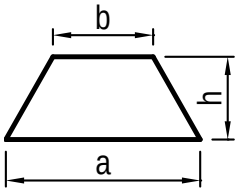
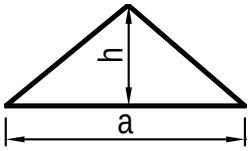
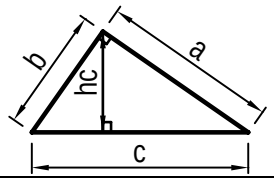
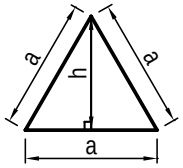
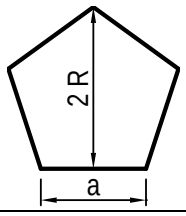

## 2. Method for calculating finished maintenance works

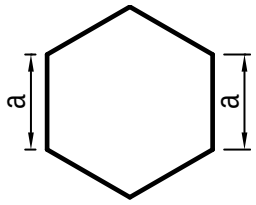
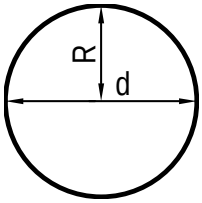
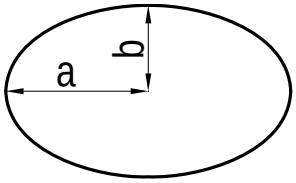
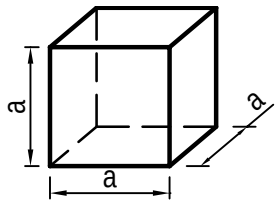
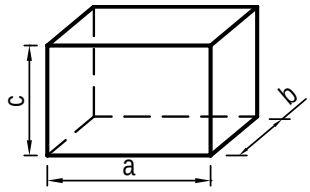
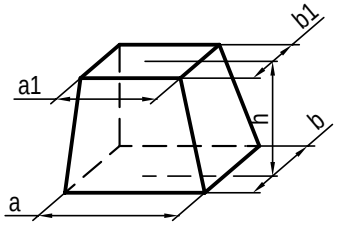
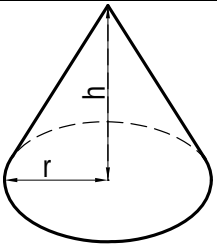
*Calculation of finished maintenance works can be calculated after measuring. The calculations of maintenance works, such as:*

- Earth work quantity (volume) : excavation for filling, filling, top soil excavation, mud excavation, drain excavation, …
- Pavement quantity (volume): crushed stone, natural gravel, …
- Quantities (areas) of grass growing, bitumen spraying, …

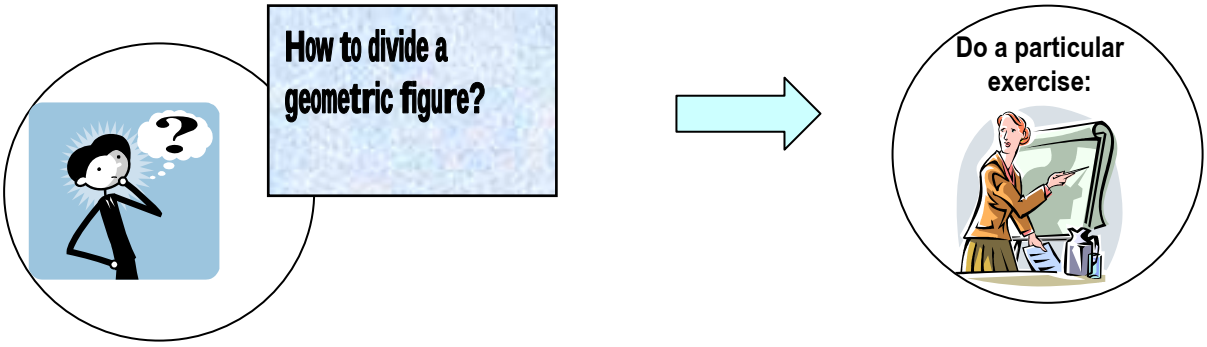
*can be carried out using common formulas*

☞ *Read "Rural Road Maintenance Handbook"* - page115 to know formulas to calculate area/ volume of common geometric figures, then *fill necessary information* in the blanks of the table below

| | | |
|---|---|---|
| Square | $S = a^2$<br>d = ……. |  |
| Rectangle | S = a.b<br>d = ……. |  |
| Parallelogram | S = a.h or<br>S = ……. |  |
| Trapezium | S = ……. |  |
| Triangle | S = ……. |  |
| Square triangle | S = ……. |  |
| Equilateral triangle | S = ……..<br>h = ……. |  |
| Pentagon | S = ……. |  |

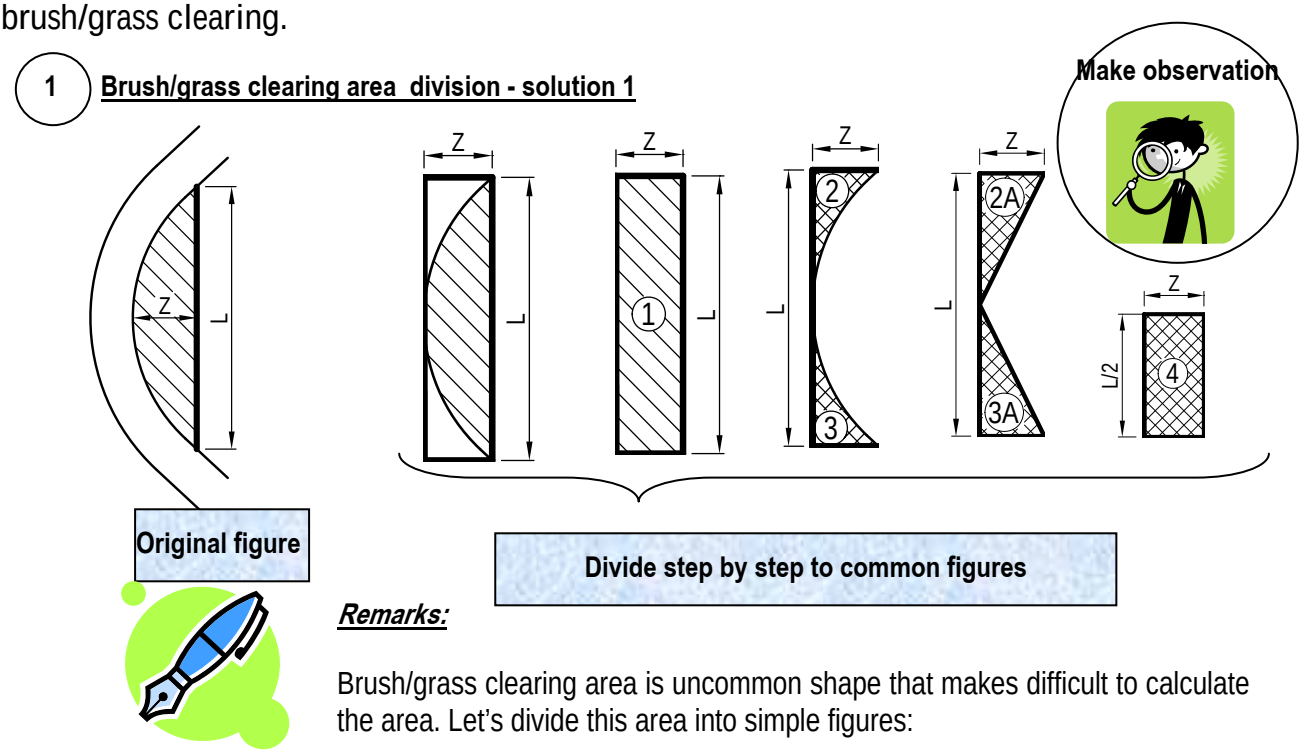
| | | |
|---|---|---|
| Hexagon | S = …… |  |
| Circle | S = ……<br>U = …….. (perimeter)<br>$\pi = 3,14$ |  |
| Ellipse | S = π.a.b<br>$\pi = 3,14$ |  |
| Cube | V = …….. |  |
| Rectangular parallelepiped | V = …….. |  |
| Frustum of pyramid | V =…… |  |
| Cone | $V = \frac{1}{3}\ \pi.r^2.h$ |  |

☞ *Look at* the following presentation to know dividing methods of complicated geometric figures to calculate area/volume




Read *"Rural Road Maintenance Handbook"* page 126 (the figure 66) of the area of brush/grass clearing.

1 **Brush/grass clearing area division - solution 1**




***Remarks:***

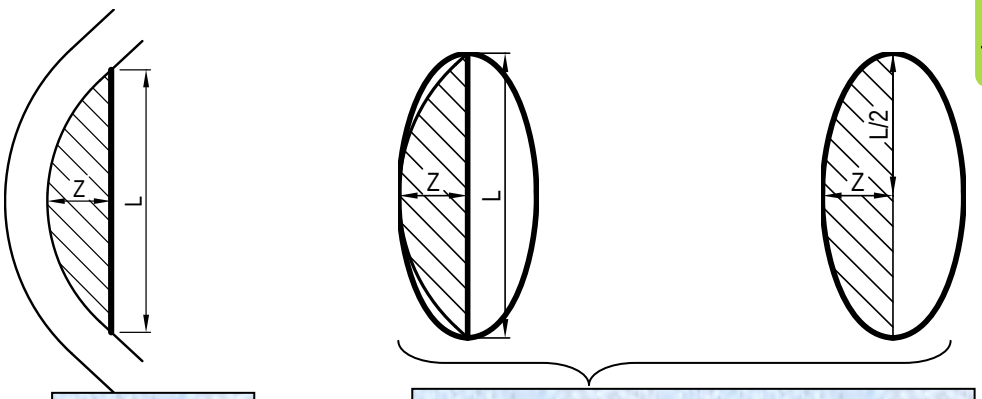
Brush/grass clearing area is uncommon shape that makes difficult to calculate the area. Let's divide this area into simple figures:

Clearing area = Area 1 - ( Area 2 **+** Area **3**)
However:
Area **2** ≈ Area **2A** *(≈: approximation)*
Area **3** ≈ Area **3A** *(≈: approximation)*
Then:
Clearing area = Area **1** - (Area **2A** **+** Area **3A**)
= Area **1** - Area **4**

= **Z . L - Z . L/2 = Z . L/2**

**Observation**

## 2 Brush/grass clearing area division - solution 2




**Original figure**

**Divide step by step to common figures**

***Remarks***

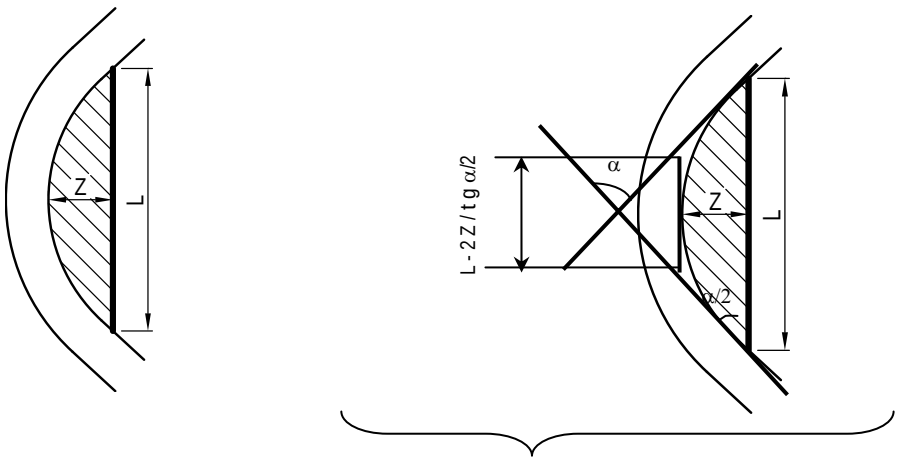
Brush/grass clearing area looks can be supposed half of ellipse that its bigger radius is **L/2** and the smaller is **Z**

$$\text{Clearing area} = \frac{1}{2}\ \text{Ellipse Area}$$

$$= \frac{1}{2}\ \pi.Z.\ \frac{L}{2}$$

$$= \frac{1}{4}\ \pi.Z.\ \mathbf{L}$$

## 3 Approximately convert to common figure - solution 3




**Original figure**

**Approximately convert to common figure**

Clearing area can be convert approximately to trapezium that its bigger base is **L** and the smaller is **(L - 2Z/tg (α/2))**

Clearing Area = (L - Z/tg (α/2)) x Z

**Practice**

Hamlet B maintenance group carried brush/grass clearing to ensure sight distance in horizontal curve:

- Required sight distance L = 40m
- Maximum clearing distance Z = 5m.
- Reading measured angle of α/2 = 23 degree

*Calculate the clearing areas **(S)** that Hamlet B maintenance group has been carried using all three solutions expressed above.*

Solutions

Solution 1: **S =** ……

Solution 2: **S =** ……

Solution 3: **S =** ……

Comments on differences between three results of methods ……

Other solution for clearing area calculation : (if any)…….....

……

n o t e

*Complicated area can be divided or converted to simple figure to calculate area and/or volume.*

☞ *Look at* the following presentation *to know calculation* of road maintenance quantity

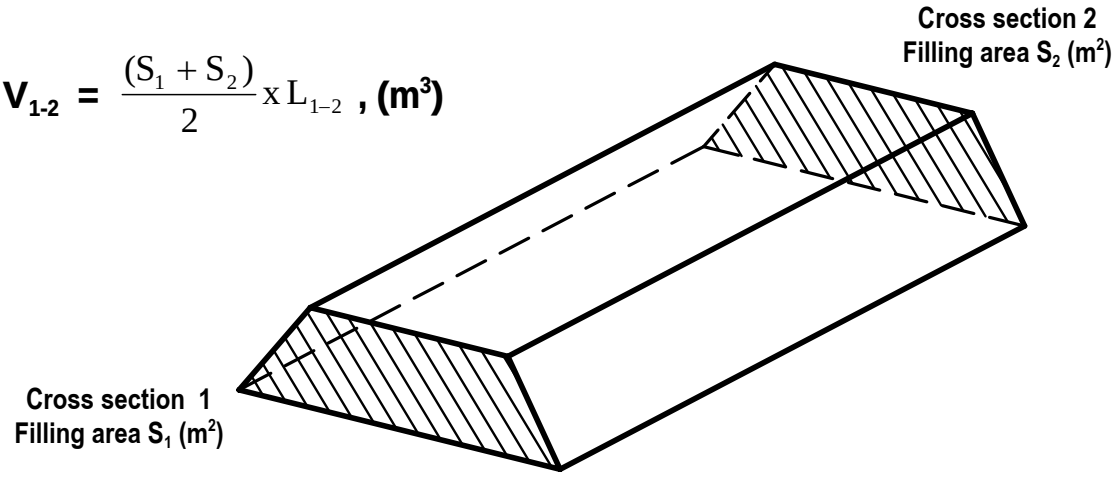
*Average cross section area is normally used to calculate road bed filling quantity*

To calculate the road bed filling of section from location 1 to location 2. The distance between them is $\mathbf{L_{1\text{-}2}}$ (m)

- Filling area at cross section 1 is $\mathbf{S_1}$ ($m^2$)
- Filling area at cross section 2 is $\mathbf{S_2}$ ($m^2$)

Then, the road bed filling from 1 to 2 is:

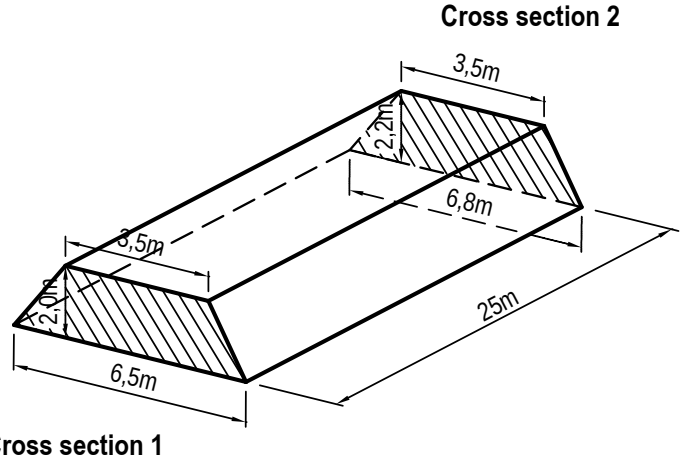
$$\mathbf{V_{1\text{-}2}} = \frac{(S_1 + S_2)}{2} \text{x } L_{1-2} \text{ , } (\mathbf{m^3})$$




**Practice**

Carried out periodic maintenance works include road bed filling in distance of 25m (See the figure beside) .

Calculate carried out the filling quantity



Solution

**Step 1:** Calculate filling area at the ends of section. (section 1 and section 2))
Assumed: $S_1$ is area of beginning section.
$S_2$ is area of ending section.

Then

$S_1$ = ……., $m^2$

$S_2$ = ……., $m^2$

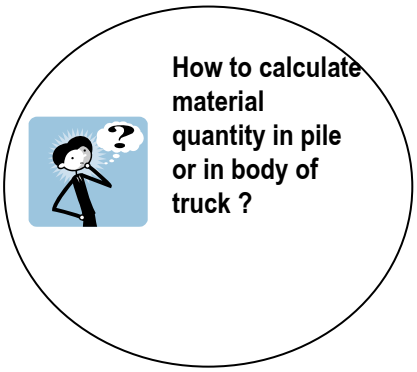
**Step 2:** Calculate road bed filling quantity from section 1 to section 2:

$$V_{fill} = \frac{(S_1 + S_2)}{2} \times L_{1-2} = \text{……., } m^3$$

n o t e

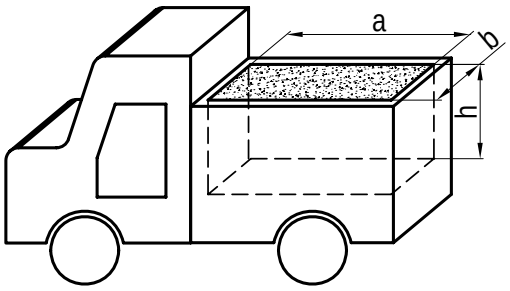
*The smaller distance ($L_{1-2}$) between calculated sections, the more exact road bed calculated quantity.*
*The maximum distance between calculated sections is 30 m for road works*

*Look at* the following paragraph of *calculation* for delivery material quantity




***To define material quantity in body of the truck***

**Procedure:**




***Step 1:*** Prepare measuring tools
Check the surface of material to ensure evenness
To reshape the surface even if necessary.

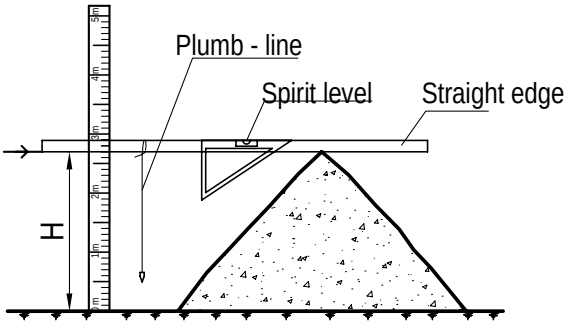
***Step 2:*** Measure the dimensions of truck body and the depth of material
- a : Truck body length, meter
- b : Truck body width, meter
- h : The depth of material in truck body, meter
-

***Step 3:*** To calculate material quantity in truck body:
**V = a . b . h**, $m^3$

***Example:*** Calculate natural gravel quantity in the body of a tractor while measured dimensions are : a = 2,5m ; b = 1,6m ; c = 1m

**V = a . b . h** = ……., $m^3$

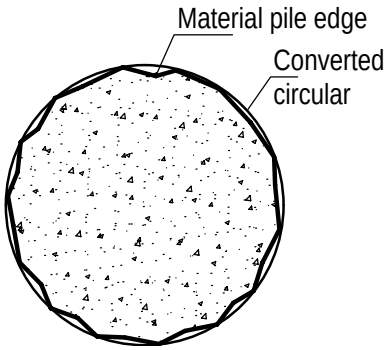
**To define material pile quantity**




***Remarks:***
Material pile usually is in cone shape, so material pile quantity can be defined as followed:

**Procedure:**

***Step 1:*** Prepare measuring tools
Pile up material to cone shape .




***Step 2:*** Measure the height of material pile using:
- Straight edge with spirit level
- Plumb-line to define vertical
- Locked steel tape to measure .

***Step 3:*** Measure circumference of circular edge using cloth tape (**U**). Then calculate the approximate radius of the measured circular base of the cone:

$$R = \frac{U}{2\pi}$$

***Step 4:*** The volume of material pile:

$$V = \frac{1}{3}\pi.R^2.H = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots, m^3$$

**Practice**

Calculate quantity of a crushed stone pile on pavement while the height of pile is H = 1,5m and the perimeter of the circular base is U = 7m.
With U = 7m ,the approximate radius of the measured circular base of the material pile is':

$$R = \frac{U}{2\pi} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots, m$$

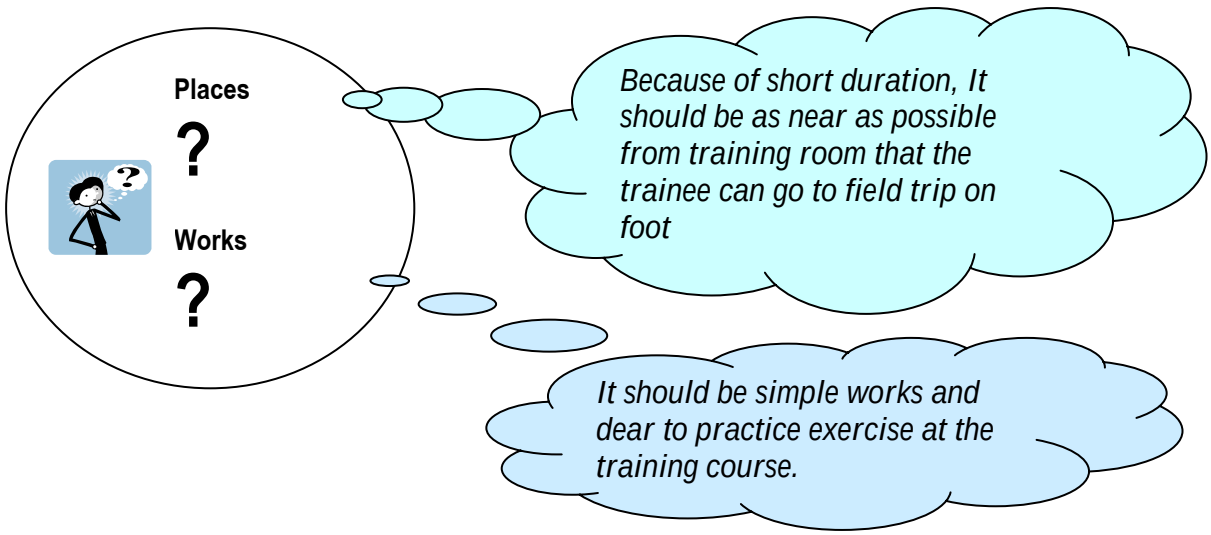
Then, the quantity of the crushed stone pile:

$$V = \frac{1}{3}\pi.R^2.H = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots, m^3$$

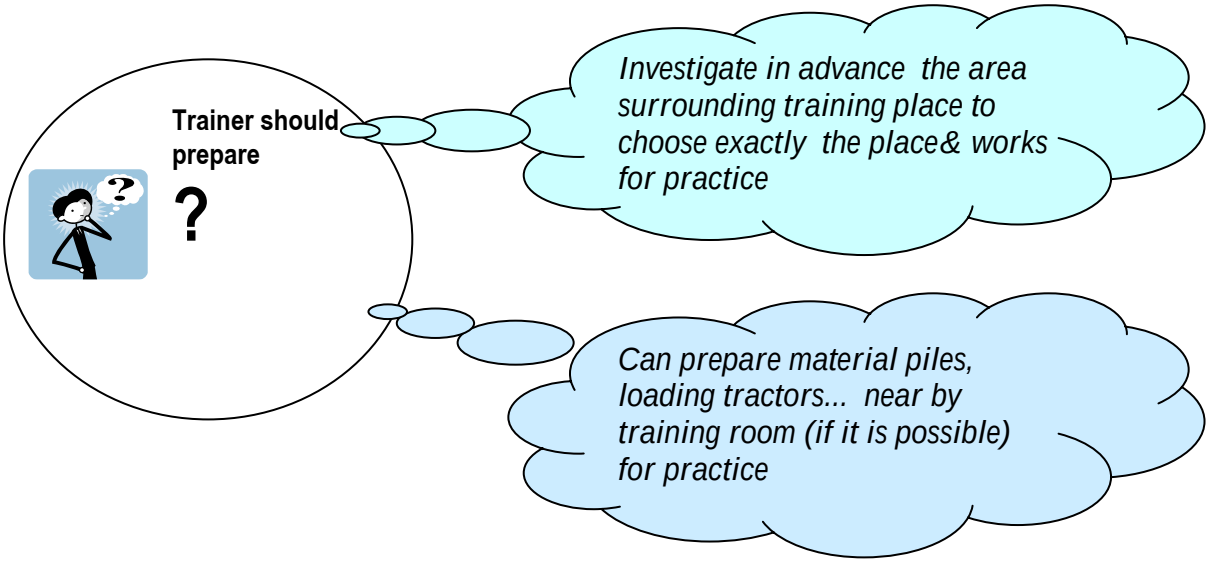
## 3. Practice measuring finished maintenance works at site

*The practice will be carry out conforming to local condition (district road network condition) and following instruction of district trainer. Some suggestions are given below:*

☞ *Read* suggestions of places & works for field trip practice



☞ *Read* the suggestions of trainer's preparation




☞ *Carry out* the practice and *fill* the results into the table below

**Practising works:**

.....

.....

.....

**Practising method and results:**

.....

.....

.....

.....

.....

.....

.....

**Calculation:**

.....

.....

.....

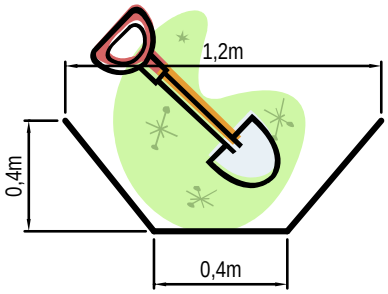
.....

.....

## Kiem tra - Danh gia  Assessment

**1**

The routine maintenance works that has been carried out by Commune Road Maintenance group include side drain excavation in 100 m long section. The dimensions of supplemented side drain are given in the figure beside.




Calculate side drain excavation quantity that has been carried by Commune Road Maintenance group.

**Solution:**

Step 1: Calculate excavated side drain cross - section:

$S_{drain\ excavation}$ = ……..

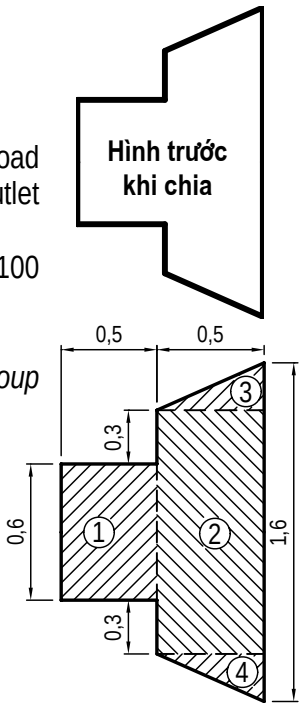
Step 2: Calculation excavated side drain

$V_{drain\ excavation}$ = ……..

| Good | Not good |
|---|---|

**2**

The routine maintenance works that has been carried out by Commune Road Maintenance group include culvert outlet stabilization. The dimensions of outlet stabilization is given in the figure beside.
The outlet stabilization is made from masonry with thickness of 25 cm and #100 cement mortar.




1. *Calculate masonry quantity that the Commune Road Maintenance group carried out.*
2. *Calculate necessary material quantity of the masonry works.*

**Solution**

part 1

**Step 1:** Calculate outlet stabilization area:
Being easy to calculate, the outlet area is divided into 4 simple parts (see the figure above)
Then,

$S_{outlet} = S_1 + S_2 + S_3 + S_4$

Where:

$S_1$ = ……., $m^2$
$S_2$ = ……., $m^2$
$S_3$ = ……., $m^2$
$S_4$ = ……., $m^2$

So:

**$S_{outlet}$ =** ……., $m^2$

**Step 2:** Calculate masonry volume for outlet stabilization

**$V_{outlet}$ =** ……., $m^3$

**Based on the Norm of Construction**
Necessary materials for ***1m³ masonry include:***

- 1.2 $m^3$ stone
- 0.057 $m^3$ crushed stone
- 0.42 $m^3$ mortar

part 2

Based on the Norm of Construction for masonry and cement mor necessary materials for 1$m^3$ masonry are defined as follow:

- 1.2 $m^3$ stone
- 0.057 $m^3$ crushed stone
- 0.42 * 325 kg of cement = 136.5 kg of PC30 cement
- 0.42 * 0.9 $m^3$ sand = 0.378 $m^3$ sand

**How to calculate the necessary materials for mortar?**

So, the necessary materials for the masonry quantity that is calculated above **$V_{outlet}$ = ……., $m^3$** are included:

- Stone = 1.2 *……., $m^3$
- Crushed stone = 0.057 *…… ……., $m^3$
- Cement = 136.5 *……., kg
  (It equals to …… …… 50kg cement bag)
- Sand = 0.378 *……., $m^3$

See table 16 page 140 of "Rural Road Maintenance Handbook"
Necessary materials for ***1m³ # 100 cement mortar*** include:
- 325kg PC30 cement
- 0.9 $m^3$ coarse sand

Good | Not good