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.
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 - m² (sq.m) - of pavement need to be cleared
- The area - m² (sq.m) - of rutting & corrugation
- The area - m² (sq.m) and average depth (m) of pothole
- The volume - m³ (cu.m) — of soft spot

**For gravel & crushed stone road**
- The area - m² (sq.m) - of pavement need to be cleared and/or filled
- The area - m² (sq.m) - of rutting & corrugation
- The area - m² (sq.m) and average depth (m) of pothole
- The volume - m³ (cu.m) — of soft spot

**For bituminous & brick paving road**
- The area - m² (sq.m) - of pavement need to be cleared
- The area - m² (sq.m) and average depth (m) of pothole
- The volume - m³ (cu.m) and the area m² (sq.m) - of soft spot
- The area - m² (sq.m) - of cracking/raveling/fretting of bituminous pavement or raveling of brick paving
- The area - m² (sq.m) - of rutting

**Concrete Road**
- Number of concrete slab need to be replaced and length of the slab
- The area - m² (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
Look carefully at pavement defect surveying form below to understand its structure.

<table>
<thead>
<tr>
<th>Chainage</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
<th>350</th>
<th>400</th>
<th>450</th>
<th>500</th>
<th>550</th>
<th>600</th>
<th>650</th>
<th>700</th>
<th>750</th>
<th>800</th>
<th>850</th>
<th>900</th>
<th>950</th>
<th>1000</th>
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<tbody>
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</tr>
</tbody>
</table>

**Pavement/Shoulder width (m):**

**Summary:**
- Pavement type:

**Pavement clearing (length/area):** m/m²

**Corrugation (depth/area):** cm/m²

**Rutting (depth/area):** cm/m²

**Pothole (average depth/area):** cm/m²

**Soft spot (volume/area):** m³/m²

**Cracking, raveling, fretting (area):** m²

**Numbers of concrete slab need to be replaced:** slab

**Concrete pavement cracking (area):** m²

**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 \textit{Rural Road Maintenance Handbook} to realize assessment parameters of side drain & road shoulder.

- 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

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

- 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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Km</th>
<th>m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

**Summary**

<table>
<thead>
<tr>
<th>Pavement/Shoulder width (m):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement type:</td>
<td></td>
</tr>
</tbody>
</table>

**Shoulder - road bed - side drain**

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shoulder reshaping (m/m³)</td>
<td></td>
</tr>
<tr>
<td>2 Grass cutting on shoulder (m/m³)</td>
<td></td>
</tr>
<tr>
<td>3 Brush clearing on road side (m³)</td>
<td></td>
</tr>
<tr>
<td>4 Side drain clearing (m)</td>
<td></td>
</tr>
<tr>
<td>5 Additional excavation of side drain (m)</td>
<td></td>
</tr>
<tr>
<td>6 Minor landslide removing (m)</td>
<td></td>
</tr>
<tr>
<td>7 Embankment/slope refilling (m³)</td>
<td></td>
</tr>
<tr>
<td>8 Side post/traffic sign clearing (unit)</td>
<td></td>
</tr>
</tbody>
</table>
Read carefully this surveying form for defects of bridge, culvert, retaining wall... to understand the form structure.

| Location | Km | 0 | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 |
|----------|----|---|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Province: | District: | Commune: | Starting Time: | Finishing time: | Page: |
| Road Code: | Road name: | From: | To: | Surveyor Name: | Date: |
| Pavement/Shoulder width (m): | | | | | |
| Pavement type: | | | | | |
| 1. Clean debris on bridge surface (m²) | | | | | |
| 2. Replace bridge wooden plank (m³) | | | | | |
| Replace bridge wooden nails (unit) | | | | | |
| 4. Repair abutment (c, i) | | | | | |
| 5. Remove concrete, masonry (m³) | | | | | |
| 6. Soil excavation (m³) | | | | | |
| 7. Replace concrete (m³) | | | | | |
| 8. Replace masonry (m³) | | | | | |
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, - \textit{mm}
  - centimetre, - \textit{cm} (1cm = 10mm)
  - decimetre, - \textit{dm} (1dm = 10cm = 100mm)
  - metre, - \textit{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

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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, \( ^\circ \)
  - minute, \( ' \) \((1^\circ = 60')\)
  - 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 \(30^\circ, 45^\circ, 60^\circ, 90^\circ\) angle).

![Quadrant](image1)
![Template for 45° angle](image2)
![Template for 30° vs 60° angle](image3)

**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](image4)
![Template for checking slope of 1/1,5](image5)
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 …)

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

![Diagram of depth measurement using straight edge and tape measure]

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

![Diagram of pavement area measurement]

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 range, then continue to the end of defect.
- Note the reading at the end, then accumulate to measured length.

![Measurement Diagram]

**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)

\[ V = \frac{(S_1 + S_2)}{2} \times h \]

where:
- \( S_1 \) & \( S_2 \) is area base
- \( h \) is height of the prism

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

**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**

**Implementing steps:**
- Define bound of defect
- Convert to 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 \( V_{exc} = S \cdot H_x \) = soil refilling
- Renewed masonry \( V_x = S \cdot H_x \)

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

<table>
<thead>
<tr>
<th>Location (km) or landmark</th>
<th>K0 K0+500</th>
<th>K0+500 K1</th>
<th>Assessment parameter</th>
<th>Rating</th>
<th>defect quantity**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road bed - shoulder - side drain</td>
<td>130 80</td>
<td>210 (m) Bad</td>
<td></td>
<td>210 m</td>
<td></td>
</tr>
<tr>
<td>Side drain clearing (m)</td>
<td>20/6.4</td>
<td>0</td>
<td>20 (m2) Bad</td>
<td>6.4 m³</td>
<td></td>
</tr>
<tr>
<td>Vegetation clearing (m²)</td>
<td>30 42</td>
<td>72 (m²) Bad</td>
<td>72 m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavement</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Module 10: Road defects survey and maintenance demand determination

<table>
<thead>
<tr>
<th>Defect Description</th>
<th>Quantity/m²</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross fall (%)/(m)</td>
<td>2/120</td>
<td>1.5-2</td>
</tr>
<tr>
<td>Corrugation (5cm&gt;h&gt;3cm) (m)/m²)</td>
<td>0</td>
<td>Bad</td>
</tr>
<tr>
<td>Corrugation (h&gt;5cm) (m)/m²)</td>
<td>200/700</td>
<td>34%***</td>
</tr>
<tr>
<td>Pothole (Htb=12 cm) (m²)</td>
<td>80</td>
<td>140 m²</td>
</tr>
<tr>
<td>Soft spots (m²)/m³</td>
<td>20/14</td>
<td>5.4%****</td>
</tr>
<tr>
<td>Dirt/debris on bridge surface (m²)</td>
<td>0</td>
<td>5 m²</td>
</tr>
<tr>
<td>Replace bridge nails (unit)</td>
<td>30</td>
<td>30 c, i</td>
</tr>
<tr>
<td>Soil excavation for culvert outlet (m³)</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>Soil refilling for culvert outlet (m³)</td>
<td>3</td>
<td>3 m³</td>
</tr>
<tr>
<td>Culvert outlet masonry (m³)</td>
<td>4</td>
<td>4 m³</td>
</tr>
</tbody>
</table>

*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%)

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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>
<thead>
<tr>
<th>Location (km) or landmark</th>
<th>Assessment parameter</th>
<th>Rating</th>
</tr>
</thead>
</table>

**Road bed - shoulder - side drain**

**Pavement**

**Bridge, culvert and other structures**
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:

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

Formula to calculate pothole area:

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

Good  Not good